The use and development of geographical information systems (GIS) and spatial modelling for educational planning

Robert James Langley

Submitted in accordance with the requirements of the degree of
Doctor of Philosophy

The University of Leeds
School of Geography

September 1997

The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others

Abstract

Since the passing of the 1988 Education Reform Act British education, particularly at a secondary level, has been transformed. The changes enacted in this and subsequent legislation have opened up state-provided education to a market-oriented system which is led more by the preferences of parents than the dictation of local or national planners. This means that local authorities and other providers of education have been left in a situation where they are relatively powerless to provide adequate schooling in a proactive manner. It is also the case that there is a danger of a 'two-tier' education system developing whereby the better-informed middle classes are served by high-achieving schools and less advantaged pupils are left to fill inner city 'sink' schools which cannot provide them with the same educational chances due to lower resource levels. This thesis presents a feasibility study of a variety of techniques drawn from academic and applied geography which can be utilised by such planners in order to better target the resources available to them and improve their reactions to the vagaries of the market.

These tools concentrate on geographical information systems (GIS) and spatial modelling techniques. Although both of these sets of techniques have for many years been applied in other areas, including within local Government, they have yet to permeate to a decision-making level in education planning. Thus the time is ripe for their wider dissemination and application in this area. Several examples of the possible uses of GIS are given, using real data for Leeds schools and pupils. Various types of spatial model are described and the most appropriate are calibrated and applied using the same Leeds data.

The thesis concludes that the benefits of modelling techniques for planners at all scales, from individual schools to national Government, could be enormous. Through the application of these tools planners will be better placed to provide an education service which caters for all pupils within it. However, there are caveats regarding the requirement for further research into improving model performance and ensuring that output is sufficiently user-friendly.

Acknowledgements

There are many people who have contributed to this thesis in many ways. Primarily I would like to thank Graham Clarke for years of advice, support, assistance and lunch during my time as a postgrad at Leeds. For help with modelling (and without whose programs the thesis would be very much shorter) I am grateful to Gary Diplock. Ileta Sherriff, erstwhile Demographic Planning Officer at Leeds City Council, provided as much data as I could use, as well as being a vital sounding-board for ideas on dissemination and policy. Becky Michell's involvement in the dynamic modelling was central to the development of that section of the work and John Stillwell's assistance with GIS programs was also invaluable. Many other people have helped me at different stages with different parts of my work, and it is impossible to thank them all individually. I would however like to name Adam Tickell and Niall Majury for serving time on my research support group, Heather Eyre and Oliver Duke-Williams for helping with last-minute modelling problems, my parents for four (more) years of saving newspapers, encouragement and help whenever it was needed and finally Anouk Kendall not only for helping to produce the final product but for providing a very welcome distraction.

Software and data used

GIS work was carried out in ATLAS*GIS using GeoPlan digital boundaries with school locations digitised by the author.

Data concerning Leeds schoolchildren was provided by Leeds City Council's Education Department (both pupil location data and school-level factors).

The spatial modelling software used in chapters six and seven was written by Gary Diplock with minor adjustments at the author's suggestion, tested and calibrated by the author.

Software used in the first part of chapter eight was written by Gary Diplock, based in part on programs originally written by Graham Clarke. Again, testing was performed by the author. The second part of chapter eight uses models developed and written by Rebecca Michell, with rules for the education planning version developed by the author and implemented by Rebecca Michell; again testing was carried out by the author and the models use parameter values specified by the author.

Contents

List of figures

List of tables

Chapter one

British schools in the 1990s: towards a planning solution

1.1 Introduction

Britain has witnessed radical educational changes in the past decade. In particular, since 1988 a market system has been introduced and subsequently developed within which schools now 'compete' for pupils. An education system which had traditionally been overseen solely by local Government has changed to one where the local education authorities (LEAs) have much reduced powers, having become often only monitors of a school network over which they have little or no direct control. Schools without fixed catchment areas managing large budgets based on their pupil rolls are now at odds with each other in the fight for the 'best' pupils, whose examination results are published annually for all to see and compare. This climate of inter-school competition is undoubtedly producing winners and losers in terms of school 'success', as some schools are inevitably seen to be outperforming their rivals. The 'winners' are those schools perceived to be performing well and which are hence increasing their attractiveness to parents, while the losers are those schools with poor performance indicators relating to exam success, truancy rates and so forth.

There are a number of issues arising from these changes which are of importance to geographers and educationalists alike but which have not been addressed by either. Firstly, although the changes in education are very much geographical in scope, geographers have yet to approach them and produce the valuable studies of which the subject is capable. Secondly, education is not using geography to solve the many new and difficult problems it is facing. The vast majority of techniques used in educational planning are outdated, and even those drawn from geography (such as goal programming) are rendered virtually obsolete by the recent reforms. A further issue which is of importance is the possibility of geographical modelling and education informing one another. Models can be, as will be discussed in depth, of enormous importance in providing planning solutions for education planners, but the process is not simply one-way. The very fact that education is such a data-rich field gives an ideal opportunity for the testing and updating of models which have often not been rigourously tested on empirical data. This is particularly the case with dynamic models, where almost no empirical work exists, and in the application of interaction models to the public sector, since most recent work has been in their use in the private sector. There is thus a gap in the current literature which geographers have yet to exploit which can bring together a number of important research fields and provide practical real-world assistance to those affected by the reforms in British education.

There is certain to be a spatial dimension to the success and failure engendered by the changes in education. In the first instance there is a divide between rural and urban areas in terms of access to resources and the ability to exercise choice, and in the second there is the question of intra-urban school competition. Rural areas will be less affected by the various reforms in that it is harder for any pupil to choose between a very reduced set of potential schools, all of which may be very distant and of similar attractiveness. However, in urban areas the problems will be particularly acute; any pupil would normally have relatively easy access to a wide range of schools at the appropriate level. The discussion in this thesis concentrates on urban education at the secondary level (ages eleven plus) in the state education system, as this is the sector which appears to be the most immediately and widely affected by the reforms.

Within cities the spatial variations will occur because there is a well-known correlation between educational attainment and the residential and social background of pupils (Bradford 1991, Mortimore and Blackstone 1983, Rogers 1986). In this case it is likely that the best-performing schools in terms of raw exam results will be those located in more affluent peripheral areas – the 'leafy suburbs' – because they are the ones with access to pupils from more privileged social groups. The schools in these areas will therefore enjoy increased pressure for places, possibly leading to the introduction of strict selection procedures. This will leave inner city and suburban estate schools to 'mop up' those pupils whose parents are unable to exercise choice (for reasons of cost, transport availability, knowledge constraints, *etc.*) and leaves these schools in a position of spiralling decline, as low positioning in the league tables reduces a school's attractiveness and it therefore pulls in less pupils (and thus less funding), reducing the likelihood of improved performance and so reinforcing its position in the city's 'hierarchy' of schools. A popular school, in contrast, is likely to become oversubscribed and therefore more able to take those pupils who will achieve high grades and keep the school at the top of published league tables. The potential now increasingly exists for schools to introduce controversial selection procedures (see chapters two and three). There is already some evidence of these trends occurring in Scotland, where the market reforms were introduced earlier (Adler *et al.* 1989, Willms and Echols 1992).

It is, given these concerns for the future equity of provision, important to monitor and predict as far as is possible the changes wrought by market reforms, as well as helping schools faced with falling rolls to become more attractive in the marketplace. This may be possible through new marketing techniques such as school specialisation or advertising, or by the introduction of new performance indicators which might soften the 'hard' published figures which are based on exam success alone.

Given the geographical variation in the location of high- and low-attaining schools there has been an increased interest in the potential rôle of geographical information systems (GIS) in the altered planning environment. GIS has to date had varying degrees of success in local authority applications. There is certainly some evidence of increased time efficiency (Bromley and Coulson 1989, Swainston 1993), but it also seems to be the case that there is 'underachievement' in terms of effecting policy change (Campbell 1994, Worrall 1990). Part of the problem is due to the level of analysis available in current GIS, an argument explored in depth elsewhere (Birkin *et al.* 1996, Longley and Clarke 1995). It centres on the contention that while GIS *per se* is obviously advantageous in terms of data storage, visualisation and overlay it would be more useful in a policy context if married with the analytical power of traditional spatial modelling. The product of this union, which is intended to produce more powerful, flexible information systems, has been labelled 'intelligent GIS' by some commentators (Birkin *et al.* 1996), but more generally goes by the title of 'spatial decision support systems' or SDSS (Densham 1991, Densham and Rushton 1988).

The aim of this thesis is to provide a feasibility study of the various techniques available in geography for application to the problems of educational planners in Britain in the 1990s. This can be seen as a first step on the road to providing a fully integrated SDSS which can be employed by LEAs in the day-to-day planning of the education service. The remainder of this chapter introduces the concepts and principles upon which the main body of the thesis elaborates in order to define the techniques which appear to be of the most practical use to those who plan for the provision of schooling in Britain.

1.2 Market reforms and the planning framework

1.2.1 Introduction

The framework under which British schools are planned has, as has already been stated, undergone considerable change in the last ten years. This has introduced a whole new set of problems to be tackled by those who plan for school provision. To begin with, there are more bodies than ever before involved in the planning process, including central Government (operating through a quango), going all the way down to the individual schools themselves, who have gained the ability to affect planning decisions through their right to opt out of LEA control. Since this is the case, it is important to examine both the legislative process which has led to the system as it currently stands, and then to consider in depth the set of tasks facing planners in education. This section firstly introduces the major recent reforms and then outlines the most significant of the problems being faced by those in control of education. As such, it sets the tone for the later sections, which begin to introduce the geographical concepts which are discussed and applied in detail in the remainder of the thesis.

1.2.2 Educational reforms

Legislation introduced by the British Conservative Government since 1979 has been designed to redefine the structure of the education system. The intention has been to shift the agency of change from the producers (local Government and schools) towards the consumers (parents and pupils). In this way education has been pushed into a 'market' setting in line with general Conservative thinking. The legislative reforms culminated, to all intents and purposes, with the 1988 Education Reform Act (ERA). As well as centralising the definition of school curricula and forcing the delegation of funding from local authorities directly to schools, a number of other reforms were introduced which directly affected planners. For example, schools are now allowed to 'opt out' of local authority control altogether, receiving all funding direct from central Government. The introduction of fully open enrolment means that parents are now free to choose which school their children attend, no longer constrained to a single authority, let alone their nearest school.

Since 1979, therefore, the rôle of educational legislation has been to decrease the power of local Government and increase the "quasi-market" (Bowe *et al.* 1992, p24). This overall "marketization" (Goodwin 1992, p78) of education has met with considerable opposition, especially from those who operate at a local level. Schools are now forced to compete for pupils by appearing to be 'different' from each other. As every state school is forced by law to provide essentially the same curriculum, set centrally by the Department for Education and Employment, then this is likely to lead to schools trying to show that they outperform their 'rivals' on some other criterion, such as exam success.

To help ensure that market forces prevail, schools are required to publish performance indicators relating to such data as exam scores and truancy rates. These indicators are published as league tables of 'best' and 'worst' schools in an area (a subject covered in depth across chapters three, four and seven) and are intended to inform the process of parental choice. Although parents have traditionally viewed schools with good reputations as an important factor in the decision to move to a new area (see for example Lawson 1993 and Shaw 1996 on the effect of schools on house prices), the publication of these performance indicators is likely to mean schools which may already be popular with middle class parents will draw more advantaged pupils (and thus funding) from a wider area, to the detriment of already underprivileged parts of towns and cities. Local planners will be unable to prevent the increasingly inequitable distribution of educational resources and perhaps also increased social divisions across Britain's urban areas. The full legislative background to the current educational situation is considered in chapter two.

1.2.3 Planning issues in the 1990s

The aim of this section is to examine the consequences of the legislative changes from the perspective of the local education authority (LEA) and its traditional planning functions, rather than to present a full appraisal of the possible implications of the reforms. The latter can be gleaned from texts such as Maclure (1992) and Bowe *et al.*

(1992). LEAs have a large number of functions. Their major task, according to the 1944 Education Act, is

> "to secure that there shall be available for their area sufficient schools for providing primary ... and ... secondary education",

but alongside this they must fulfil a series of other commitments. LEAs are expected to plan not only how many schools will be required at various levels, but also, crucially, where they will be required and what demand for transportation there is likely to be. This is clearly a very significant set of tasks, and the sums of money involved every year are huge – local authorities in England spent some £22.7 billion on education in 1991-2 (Craig 1994).

A number of these planning rôles have an explicit spatial dimension. The first of these concerns the provision of school places. This is always a thorny issue because of the intense loyalty of the public at a local level to particular schools (Bondi 1989). It is consequently one of the most demanding tasks an LEA has to carry out. LEAs need to know the impacts of reductions in school capacity and perhaps also of amalgamations, closures and openings. Similarly, LEAs need to examine the dynamics of the marketplace in greater detail. For example, what might the consequences of parental choice be and is it possible to predict the likely pressure on places if current trends persist? For these sorts of 'what if?' questions we need a sophisticated level of spatial analysis, since in addition to parental choice, school growth or decline will also be a function of declining or growing local populations and changes in local competition (Ball *et al.* 1994).

The lack of control an LEA has over 'opted out' schools adds an extra difficulty to the planning task. The LEA has no power to close such schools, or reduce their provision, which complicates the task of rationalisation immensely. The Government's newly-appointed quango, the Funding Agency for Schools (FAS), is intended to take over many of the functions of local authorities and central Government. Responsible primarily for opted out schools, this body will distribute resources directly to such schools rather than operating through the LEAs. It will also, significantly, have powers over the wider planning of school provision. Once 10% of an LEA's schools have opted out, the two bodies will become equal partners in the planning process, and the FAS takes over full responsibility for planning once this figure reaches 75%. It is important to recognise the fact that the FAS has no local accountability, in the tradition of quangos, being appointed by and accountable only to central Government.

Another key area of schools planning is the control of funding. General funding of schools is by formula. These are derived by the LEAs themselves based on central Government rules which essentially mean that most of a school's budget depends on the pupil roll. The specific detail of the formula is left to individual LEAs to define. Resources for what is known as additional educational need is clearly a part of this wider process of formalisation. The majority of authorities have a certain amount of money set aside to allocate on the basis of perceived social and/or educational need, usually allocated on a *per capita* basis. There is therefore a requirement to define an index of deprivation and accurate and meaningful performance indicators to measure educational 'need'. Work to develop indicators of this kind is ongoing in many LEAs (and can be given a clear geographical perspective through the use of GIS, as discussed in chapters four and seven). For more information on the wide variety of these measures of educational need, see Lee (1991) and the discussion in chapter three.

There is also a burgeoning interest in the need for performance indicators to measure the true relative performance of schools at local and national level. The interest has been fuelled by the Government's decision to publish annual league tables of exam results as part of the 1988 ERA and, more controversially, truancy rates, leading to many calls for a method of improving such tables for the comparison of schools. This is clearly relevant both for the allocation of resources based on need, but also for the publication of data likely to influence parental choice – the wisdom being that a school apparently performing well in the league tables will attract the interest of a greater number of parents and thus ultimately more children and more funding. The actual merit of the tables if they are published without weightings is however limited. In order not to penalise schools which appear low in the unweighted tables it is generally considered to be reasonable to define some form of weighting system and thus new tables of performance indicators rather than tables of raw exam results. Indeed, as Schagen (1994) reports, pressure from educationalists is forcing the British Government to investigate the possibility of developing 'value added' indicators. That is, can LEAs or schools find ways of 'softening' the raw indicators of examination success, by adjusting for prior attainment or social context, in order to demonstrate that their school(s) might actually be performing well given the intake of students from less well-off environments? For this we need to identify new suites of performance indicators which relate pupils' residential locations to individual schools (see also Bradford 1991).

Another geographical or equity concern arises from the possibility of parental choice leading to social, ethnic or religious segregation in British schools. There is increased evidence that a market based on choice serves the middle and upper classes better than the lower or working classes (see for example Judd 1995xvii). The study of Ball *et al.* (1994, pp19-21) in London suggests the following explanations;

- that middle class parents are better informed and are more able to exploit the market situation
- that middle class parents are better able and willing to move their children around the system. This argument is based around the greater material resources available to these members of society.

There is similar evidence emerging from elsewhere in the world, where market systems have been introduced in education (see Waslander and Thrupp 1995 for a review of reforms in New Zealand). The implication of this sort of evidence is that schools in middle class suburbia will be generally more attractive to parents from elsewhere in the city. Conversely it is argued that schools closer to more deprived areas may lose their most able students as parents exercise greater choice. Thus there are a number of serious planning issues that LEAs face in response to the shift towards a market-driven system. Many of these issues have an explicit geographical focus. The problems of the LEA are set out in relation specifically to Leeds in chapter three, and the geographical concepts are introduced in the following sections and then expanded in chapters four to eight.

1.3 A geographical approach to the problems

1.3.1 Introduction; the work of geographers

As has been noted in the previous section, many of the problems facing educational planners are of a very geographical nature. This is particularly true of the planning of sufficient provision for pupils and the monitoring of the impacts of parental preference. Relatively little has been written within geography explicitly concerning education and educational planning difficulties. However, there is a great deal of work which could easily be applied to the sorts of issues raised here, and there is also a small but expanding body of work which relates specifically to market reforms in education (see for example Bondi 1989, Bradford 1991, Clarke and Langley 1994, 1995, 1996, Higgs *et al.* forthcoming, Higgs, Webster and White forthcoming and Langley 1995). The work relevant to this thesis can be classified into three broad categories, which are expanded in the chapters which follow. The first of these relates to the broadly non-quantitative geographical approach which is explicitly related to education. This includes much of the work of Bondi (*e.g.* 1989) and to a lesser extent some of the work of Bradford (*e.g.* 1991). The second field of geographical study concerns GIS and spatial modelling, on which an enormous amount has been written, but very little concerned with educational planning uses of the technology. The third area relates to the huge body of work discussing educational reform, which contains little or no explicit geography but which sets out the problems faced by the educational system.

In this case it seems appropriate to outline the main features of various techniques available in geography and relate them to education, since we have already seen that the multifarious problems faced in education are frequently geographical in aspect. The main geographical tools of interest to planners would seem to be firstly geographical information systems (GIS), described below and in chapter four, and secondly spatial modelling, introduced in section 1.3.3 and expanded and applied in chapters five, six and eight. Essentially, GIS allows data users to better visualise and combine their datasets, thus producing improved management information and helping to support better the decision-making process. Spatial modelling takes one further step along this line of reasoning, allowing planners to take current pupil flows and perform a variety of 'what if?'-style queries, generating likely school rolls under any number of network change scenarios. Clearly this can aid the definition of best sites for new schools, the impacts of school closure or help to build new performance indicators which incorporate more than simple raw exam results. The sections below provide a basic exposition of these techniques, setting a context for later chapters.

1.3.2 Geographical information systems

Geographical information systems (or GIS) are computer packages which allow the user to perform a number of tasks based around spatially referenced data. This is particularly relevant in education, where almost all the data available can be related to a spatial unit of one kind or another. Certainly the most immediate benefit of GIS is its ability to display data visually, as maps. This can provide immediate improvement in information for officers and other data users, simply because of the more instant impact of trends or patterns, which can often be missed in tabular data. In education, where problems often develop in areas of a city with several schools this technique can provide clear advantages over simple text-based analysis because it enables the definition of more precise problem areas in a shorter time.

Chapter four takes this theme and outlines with regard to Leeds how GIS tools can be of benefit to planners. Going beyond simply mapping the various data available to an LEA, the discussion includes the more analytical aspects of GIS. In particular there is a consideration of the potential for data linkage, where two or more datasets are taken and mapped at the same time, whether through simple arithmetic operations (say to produce 'market share' information for individual schools) or by means of polygon overlay, which allows two or more sets of data to be displayed simultaneously. Perhaps the most obvious use of this technique would be to display pupil or school locations in relation to socio-economic data from the census. When used with data regarding say truancy or exam results these maps could begin to produce some new indicators of residential disadvantage which could be employed to explain patterns of success or failure at a school level.

It is also common in GIS work to use buffering analysis to define new 'catchment areas' and their population in terms of other data held in the GIS. This could mean describing the population within five miles of a road network, or outlining the number of supermarkets within ten minutes' drive of a particular housing estate. In education terms the process would most likely involve defining distance or travel time buffers around schools and using these to describe the potential roll in terms of socio-economic data held in other layers of the GIS database. However, the main problems with this technique are that it fails to take into account *a.* the fact that pupils may travel from all over a city to a particular school and catchments are therefore overlapping and *b.* the potential interaction between schools (a particular problem in 'what if?' GIS queries – the impacts on other schools of one change in the network are not considered). It may thus produce false impressions of any one school roll, and will certainly distort the overall picture for the city. In particular, it is unlikely that all pupils will travel an equal distance to all schools, since variations in population density, school location and social composition within cities make for wide variations in travel distance and time of the journey to school. In this sense, as will be shown in chapter four, buffering could be best employed as a determinant of those pupils who qualify for free home to school transport under the criteria laid out by LEAs.

1.3.3 Spatial modelling

As we have seen, GIS has the potential to greatly enrich the educational planning arena. However, in terms of permitting complex 'what if?' querying of school rolls it can only go so far. This is where the potential of spatial modelling becomes clear. Spatial models have been developed in geography since the 1960s and have found a number of applications in the private sector, most notably in retail planning. Essentially, the most common form of *spatial interaction model* (although there is a range of other models – see chapter five) takes data concerning the current *trip matrix*[1] and *distances travelled*, together with information regarding the relative 'attractiveness' to trippers of the range of destinations and attempts to reproduce this data mathematically. Once this *calibration* process has been satisfactorily performed and the model is reproducing the current flow pattern accurately it is possible to use it to introduce changes into the network. The advantage of using a model of this kind for impact assessment of network changes (usually facility closure or opening) is that the impacts across the system are considered. In educational terms this means that if the closure of one school is contemplated then the pupils from that school will be redistributed according to 'market forces' – the attractiveness of other schools – rather than arbitrary LEA relocation. Similarly, a new school defined in a model can divert pupils away from any other school in the network, and these impacts will be clear in the model output. These processes are explained in more detail and exemplified in chapters five and six.

Dynamic modelling is discussed in chapter eight. This is a relatively simple development from the spatial interaction modelling discussed above. Essentially, it allows time-series projection of a network's development from the current situation to an 'equilibrium' status. This means that, working from a basic model, certain rules for facility growth or decline are applied and the development of the network is modelled

---

[1] Defined as the journeys from 'origin zones' (usually residential areas) to 'destination zones' (normally facilities such as schools, shopping centres *etc.*).

iteratively. This is clearly only fully applicable in a market situation (where facility size is affected by previous performance), but since it is now more than ever possible for schools to become too small in roll terms to be economically viable and thus face closure, it seems an ideal time to utilise such techniques in education. Two variations of this model type are discussed. The first is based on Harris and Wilson's (1978) model, which encourages the linear growth or decline of schools and which eventually leads to an equilibrium solution containing a few very large facilities and the majority at zero. Because of problems with data these models have been very rarely applied, especially outside retailing. Education provides an ideal opportunity for testing them and allows for badly-needed empirical applications. The second dynamic model has been developed by Michell (forthcoming) which contains more complex rule-based growth/decline mechanisms and which 'steps' change in facility size, in this case by whole classrooms. The results of these models are compared in chapter eight, but both allow planners to see the likely long-term development of the system with which they work and thus plan to arrest or enhance the likely effects of market forces on the network. This clearly gives planners a distinct advantage in terms of monitoring change and preventing costly development mistakes. It could also enable LEA officers to target areas of a city which are most vulnerable to declining rolls or the worst-case segregation scenarios posited above and which are therefore perhaps in greatest need of the specialist financial and technical support which the LEA is in a position to offer.

1.4 Aims of the thesis

The situation in British education is clearly serious. The planning difficulties faced by LEAs in particular, and increasingly the FAS as well, are hard and cannot be addressed by means of traditional methods alone. These have been developed in an educational framework which owed little or nothing to a commercially-biased, market-based approach. The last decade has seen this circumstance overturned and an education system which is increasingly a 'free market' has developed. Within this radically altered setting planners are far less able to plan and much more left to react to changes which result from, for example, parental preference. In this case it seems that the time is ripe for the introduction and development of new methods which can enable a more proactive approach and improve network monitoring.

Geography can offer a suite of tools which seem ideal for employment in education. Both GIS and spatial modelling are, as we have seen, extremely well-suited for application to the kinds of problem faced by school planners. To this end this thesis is concerned with testing a variety of the techniques outlined in relation to data from the Leeds LEA. It sets out to be a feasibility study for the marriage of education and geography rather than the development of a full-blown SDSS for educational planners, although this would be the eventual ideal for the end users of these techniques, since what is needed at an operational level in local authorities is an easy-to-use set of simply calibrated models which are set in context by GIS-centred mapping software.

In order to push forward this development and pave the way for further, more detailed research into the various techniques outlined, this thesis discusses the whole range of factors and tools introduced in this initial chapter. The first few chapters introduce education at legislative and local authority levels and discuss some of the work already carried out by geographers in this field, developing the concept of education as very much a geographical issue. Building from this, the later chapters consider GIS and its application to educational problems in more depth, using both the simple data mapping tools and more complex analysis available in GIS to describe the data obtained for Leeds LEA. Then static and dynamic spatial interaction models are applied to the pupil and school data gathered for Leeds to create a calibrated suite of models appropriate for the educational planning tasks identified. The final chapter summarises the findings of the research, discusses the potential for these models in the actual day-to-day decision-making process and poses future research questions arising from the work presented.

There are thus three main aims of this thesis. Firstly, to approach and define the educational changes outlined from a geographical perspective in order to shed new light on problems which are widely acknowledged to exist by educationalists but which have not been fully addressed by geographers. Secondly, to provide possible solutions to some of these problems using techniques developed in geography over many years and successfully applied in many similar situations. This will enable planners to replace often outmoded techniques and will further enable geographers to witness real-world applications of often academic tools. The third and final aim is to open up a new and valuable data-rich field for the testing of, in particular, geographical modelling techniques. It is often the case that little or no empirical testing has been carried out by the developers of such tools, and the education application can potentially give geographers a great opportunity to test and update their academic work. This thesis will go some way to achieving this final goal, but perhaps more importantly will draw attention to the enormous potential of working within an area not often considered by geographers.

Chapter two

A brief history of British education since the nineteenth century

2.1 Introduction and overview

Education has formed a major element of Government policy since the turn of the century, and it has become a subject area of very great importance and debate. From the first attempts to expand education from its traditional place as a domain of the wealthy in the latter 19th century has grown the current and widely accepted system of a universal and free state-maintained system up to and even beyond the age of eighteen. It is certain that a number of fundamental changes have been undertaken by Governments over the century, because the system which exists today would be utterly unrecognisable to the nineteenth century reformers. The churches' power and control has been very greatly diminished from the days when many MPs considered that education was the province solely of religious foundations and that the state should not interfere in this authority.

The rise in the late nineteenth century of newly wealthy working class entrepreneurs clearly had an impact as the composition of the Commons changed and thus attitudes to the education of the 'masses' also altered. Up to 1944 most legislation was based around providing a basic education through to the early teens, and there were exemptions for those with jobs. In part it was also a period in which the state was to wrest power away from the churches, and provide a more centralised mode of control for the nation's schools. After 1944 the rôle of the welfare state and free provision of services to all those who wanted them has been the key characteristic of British education and other public services (such as health care). From this has grown the situation whereby all children are guaranteed an education to age sixteen, and through to eighteen if that is the path chosen by the pupil. A continued part has been played by the local education authorities (LEAs), who have had the major control of education at a local level since the earliest introduction of a national 'system'.

However, as will be seen, the situation is again beginning to change, with the Conservative Government of the 1980s and 90s's desire for stronger central control and a more 'entrepreneurial' market-led school system. The shake-up of the education system which has taken place in the last decade has undoubtedly been the most important change since 1944, and in many ways can be seen as a reversal of what was done for equality of provision in the 'welfare' years immediately after the war and through to the late 'seventies (see sections 5 and 6 for more detail on these recent changes).

This chapter attempts to set out the various items of legislation relating to education which have been passed by Government since the early years of this century, in order to contextualise the more recent changes which have been made. There are, as with most subjects, a number of key developments which deserve to be discussed more fully than the majority of the subject area. To this end both the 1944 Education Act and the 1988 Education Reform Act (ERA) are dealt with in separate sections, with preceding sections for each to set them in a proper historical and political context. The final section deals with the considerable body of legislation which has been passed since the 1988 ERA, and also with the problems of implementing that Act. As might be expected the chapter attempts to be broadly descriptive in character, acting as it does to set the context for the education system which exists in the mid-1990s. Because of this, the period up to 1944 is dealt with relatively cursorily, while the period from 1988 to the present is covered in much greater depth. In addition, the chapter deals solely with the body of debate which affects education up to age eighteen, as higher education is generally considered as a separate subject, and is not the province of this thesis. In addition, the main body of the chapter is concerned with England and Wales, since the education systems in Northern Ireland, and especially Scotland are somewhat different.

2.2 The evolution of a system : the nineteenth century to 1936

2.2.1 First steps; to 1902

Education in the nineteenth century and before was the domain of those who had the means to pay for it. The state provided almost no facilities or finance for the education of the masses, and it was left mainly to the churches and private individuals or institutions to educate children. This led to heavily biased and locally varied curricula, often with a very strong religious or 'moral' slant. In 1839 the Whig Government set up a Committee of Privy Council on Education in order to monitor the situation and advise the Government on educational matters. There was a great deal of opposition to this move, particularly from the Conservatives, who considered state involvement in schooling "an assault on freedom" (Gordon *et al.* 1991, p4). The Committee of Privy Council, although the clear precursor of today's Department for Education, was very low-key, meeting infrequently and passing little legislation.

This general lack of activity led to calls for a body with some 'real' authority and a place in Cabinet. This was advocated in 1856 by a Select Committee on the subject – a Ministry of Public Instruction was outlined in a Conservative bill prepared by the Government of 1866-8, but it never received assent (Gordon *et al.* 1991). The closest to this which <u>was</u> achieved was a bill in 1857 allowing boroughs and cities to establish education committees and raise money for public elementary education from the poor rate. 1862 saw the introduction of legislation revising the code of practice for distribution of central state aid to schools. Under the new Revised Code it was to be distributed on the basis of the <u>results</u> of local schools rather than <u>need</u> (Gordon *et al.* 1991). Very close parallels can be drawn between this change and Conservative Governmental policy in the 1990s, as we shall see.

In 1870 the national system of school boards was set up. These were locally-elected bodies responsible for the promotion of elementary education in their areas. School boards were permitted to charge fees for attendance at their schools, and also to pass bylaws making such attendance compulsory for children between the ages of five and thirteen. Although the boards had the power to make attendance compulsory, it was rare for the laws to be passed, and there were widespread exemptions for those children in work because of the importance of child labour to Britain's burgeoning industries (Statham *et al.* 1991).

Further developments in the latter half of the nineteenth century continued to refine the system introduced in 1870. The 1880 Education Act required school boards to pass bylaws for the attendance of five- to ten-year-olds, the minimum period of education now compulsory. The fact that it was left to the school boards themselves to pass individual laws rather than implementing a national law illustrates in the clearest manner how education was perceived to be a local issue. There were of course dissenting voices throughout this period, and by the 1890s the viewpoint of the 'radicals' (those on the far left, mainly in the labour movement) had crystallised to the following main points;

- equality of opportunity in education should exist for all children,
- this equality should be guaranteed by the provision of maintenance grants and free school meals,
- the school leaving age should be raised to sixteen, and education to this age should be both compulsory and full-time,
- education should be financed directly from taxation,
- all but secular subjects should be excluded from the curriculum

(taken from an 1897 Trades Union Congress resolution, in Griggs 1983). It is interesting to note that it is the demands of the 'radicals' of the 1890s which have eventually formed much of what we take for granted in the 1990s. There was certainly a concern at the time that a free or assisted education system might enable the children of working-class families to receive a better education than that available to the higher classes (Gordon *et al.* 1991).

1899 saw the Board of Education Act, which replaced the Committee of Privy Council with a Board of Education under a President, a very junior Cabinet rôle. It was given a mainly supervisory capacity over the education system, and although it did pass a certain amount of legislation, it was very restricted in its actions until the time came for a major national shake-up in 1944.

2.2.2 Local rule, world war; 1902 to 1918

By 1902 "English education was characterised by local diversity" (Gordon *et al.* 1991, p9), with the exact nature of schools depending entirely on the religious and political groups in control, as we have seen. Cities such as Manchester and Birmingham were in the forefront of provision because of the number of wealthy and influential businessmen amongst the citizenry. The reformers saw "compulsory age-specific education ... as the best means of preventing the evils of child labour" (Gordon *et al.* 1991, p12). However, education was still largely seen as a local issue, and the thrust of reform was to increase local and not central powers.

Legislation and date	***Provisions***
1902 Education Act	School boards replaced with local education authorities (LEAs); LEAs allowed to provide non-denominational state secondary schools
1906 Education (Provision of Meals) Act	LEAs permitted to provide meals for undernourished pupils
1907 Education (Administrative Provisions) Act	LEAs required to provide basic medical inspections of pupils

source: Statham et al. *1991*

Beyond these relatively minor measures, however, very little was done to change the general pattern of British education during this period.

2.2.3 Rethinking the basics; 1918 to 1936

The First World War forced a rethink of the issues surrounding education. Apart from the terrible human and financial cost of four years at war, it brought a growing realisation that the British system of education was seriously deficient. Failure in the Boer War (1899 to 1902) had highlighted some problems, but now the situation really came to a head (Gordon *et al.* 1991). In 1918 a bill was passed which went some way to addressing many of the problems identified during the crisis of the war.

The main provisions of this Act were;

- the abolition of attendance exemptions between the ages of five and fourteen,
- the abolition of the 'half-time' system of schooling, whereby pupils had been allowed to work for half the day and attend school for the other half,
- the abolition of expenditure limits on LEAs which had been set in 1902,
- the banning of the employment of under-twelves, and the setting of a maximum of two hours per day work for twelve- to fourteen-year-olds,
- the abolition of all fees for elementary schools,
- the empowering of LEAs to;
  – provide nursery schools for the under-fives
  – raise the leaving age in their area to fifteen
  – allot maintenance grants to scholarship pupils at secondary schools
  – provide a wider range of ancillary services,
- the establishment of central Government funding to cover at least 50% of LEA costs,

- the recommendation that 'continuation schools' be provided for fourteen- to sixteen-year-olds who left school, which they should attend for 320 hours *per annum*, and this scheme should later be extended to sixteen- to eighteen-year-olds and the general leaving age increased to fifteen

(Gordon *et al.* 1991 and Statham *et al.* 1991). The 1918 Act has been described as introducing "a fully national system of public education" (Statham *et al.* 1991, p42), and while this is without doubt partly true, many of its provisions were still entirely optional, especially in the post-elementary sector, and it was still a locally-determined system.

There were other problems with the implementation of the 1918 Act. Not least of these was the financial aspect. The enormous expense even of the abolition of exemptions to fourteen and the banning of child labour and elementary school fees, coupled with the massive reconstruction costs after the war meant that no one was willing (or indeed able) to finance the other changes. This reluctance continued despite pressure from industries increasingly desperate for better-educated employees, especially in scientific and technical subjects.

Also at this time the rapidly growing labour movement was providing a strong and influential dissenting voice. In his pamphlet for the Labour Party in 1922, Richard Tawney wrote that,

> "[the Labour Party's] objective ... is both the improvement of primary education and the development of public secondary education to such a point that all normal children, irrespective of the income, class, or occupation of their parents, may be transferred at the age of eleven+ from the primary or preparatory school to one type or another of secondary school, and remain in the latter till sixteen." (1922, p7)

He recommended increasing grants for pupils in secondary education, expanded building programmes and so forth, until a free and universal system was properly established. At about the same time it was

> "suggested that the provision of more schools, larger maintenance allowances and the abolition of fees at municipal secondary schools was overdue" (Armytage 1970, p207).

Labour was also highly critical of the capitalist, imperialist and competitive notions which were implicit in school curricula at this time (Gordon *et al.* 1991) – perhaps significantly a criticism levelled at the Tory Government during the planning stages of some aspects of the national curriculum in the late 1980s. There was a more conservative voice, however, at the time; one which believed that the

> "extension of compulsory schooling beyond the age of fourteen could be opposed as being an unwarranted infringement of the individual rights of young people and their parents" (Gordon *et al.* 1991, p47).

It is these voices, perhaps, which meant that despite the widely-acknowledged problems and pressures on education, the 1920s and '30s were, for the most part, a period of educational reportage rather than of actual legislation. A number of important reports were published by the Consultative Committee of the Board of Education, which have come to be known by the name of their chairman, a convention which has remained to this day. The most important of these reports were those of Hadow (Board of Education 1926, 1931) and of Spens (Board of Education 1938). Spens is discussed in section 3 below, while we concentrate on Hadow in this section.

Armytage describes the 1926 Hadow report as "a major breakthrough" (1970, p208) although it was a broad reworking of Tawney's 1922 recommendations (*q.v.*). However, it finally set the natural break between *primary* and *secondary schooling at* eleven plus. It was not until Hadow that 'primary' as we understand it today was officially defined. Hadow recommended the institution of comprehensive or multilateral schools for post eleven education, in which all children would be educated equally, and recognised the problems inherent in huge classes. The reports recommended a change in teaching practices in the first of a series of suggestions which culminated in Plowden's 1967 report (*q.v.*) on primary schools and the child-centred learning which was to define primary teaching practices throughout the 1970s (Middleton and Weitzman 1976).

The culmination of the heated debate and strong criticism of the educational system was the 1936 Education Act. This was intended to address many of the problems already acknowledged by introducing three major changes aimed at forcing secondary reorganisation along Hadow lines and solving the problems of the voluntary schools. In essence, it;

- raised the leaving age to fifteen, with certain exemptions for those aged fourteen and in 'beneficial employment',
- allowed LEAs to assist voluntary schools financially with improvements to accommodation, in return for which it
- gave LEAs the power of appointment and dismissal over teachers in voluntary schools

(Middleton and Weitzman 1976). However, a combination of factors meant that the 1936 Act was never implemented. Financial bickering over the readiness or otherwise of LEAs to implement reorganisation combined with the approaching war in Europe to push education onto a political back-burner.

2.3 The build-up to reform : 1937 to the 1944 Education Act

2.3.1 War sets the tone; 1937 to early 1941

> "The abandonment of the 1936 Act must be reckoned one of the troughs in British education; but it also marks the end of an era. The period between the wars had been a particularly frustrating and negative period" (Middleton and Weitzman 1976, p191)

Despite the problems encountered during the inter-war years, many of the theoretical issues had been resolved, and there was a strong case for a more centrally organised and widespread primary and secondary system. Reports such as Hadow had shown the way forward, and the voice of the Labour Party and others on the left ensured that the possibility of a free and universal system from five to at least fifteen or sixteen was always on the agenda. There were still many practical problems with the system, however, which still needed to be addressed.

1938 saw the publication of the Spens Report. This stated that

> "the existing arrangements for ... education ... above the age of eleven plus in England and Wales have ceased to correspond with the actual structure of modern society or with the economic facts of the situation" (Board of Education 1938, p353).

In this sense it broadly supported the findings of Hadow a decade earlier. However, on the exact nature of the new secondary system it differed considerably. While Hadow had favoured a comprehensive system, Spens preferred a system offering choice and variety in teaching styles. This manifested itself in the report's recommendation of a tripartite system of grammar, modern and technical schools. It also stated that the raising of the leaving age to sixteen "must ... be envisaged as inevitable" (Board of Education 1938, p380). However important the Spens report was seen to be, educational development was brought to a virtual standstill at the end of 1938 by a widespread "review of expenditure" (Middleton and Weitzman 1976, p181) occasioned by the war effort.

The outbreak of war in autumn 1939,

> "put an end to any immediate prospect of continuing the efforts at mild reform which had been apparent in the last four years of the inter-war period" (Gosden 1976, p141).

The educational chaos which followed the evacuation of children from the cities was caused partly by inadequate planning and partly by a lack of adequate facilities and finance. The disruption caused by school building requisition and the constant threat of bombing in some areas added to these pressures.

With the confirmation of Winston Churchill's largely Conservative Coalition Government in May 1940 changes really started to get underway at the Board of Education. Herwald Ramsbotham, President of the Board since April, was joined by James Chuter Ede as the Parliamentary Secretary, a post he held until he was made Home Secretary in 1945. Chuter Ede was a Labour MP, and his dedicated presence and together with the alliance of party and personal ambitions at the Board of Education were to have fruitful consequences. Much of what was achieved in the next four years was no doubt due to wartime exigency, but much came from the dedication of the personalities involved.

The unity of parties caused by the war led to a realisation that almost all groups felt a great deal of dissatisfaction with the educational *status quo*. In October 1940 Ernest Bevin asked,

> "if the boys at secondary schools had been able to save us in the Spitfire, their brains could be used to produce the new world [after the war]" (quoted in Middleton and Weitzman 1976, p207)

– a clear endorsement of improved state provision for all. However, there was strong resistance to change from Churchill, still PM at the time (Middleton and Weitzman 1976).

2.3.2 From Green Book to Bill; 1941 to 1944

> "I certainly cannot contemplate a new education Bill"
> Winston Churchill. September 1941

The production in spring 1941 of the 'Green Book' was in effect the final stage in the battle for reform. The recommendations contained in this book remained almost entirely unchanged and were co-opted by Butler into his 1944 Act. It thus "effectively charted the main features of the policies which the Ministry of Education was to follow in the twenty years following the Education Act of 1944" (Gosden 1976, p239)[2]. To further ensure the process of reform Ramsbotham had the book properly bound (the only wartime Government document to receive this treatment) and disseminated it to a wide range of groups, all of whom were charged with providing a written response (Middleton and Weitzman 1976). Having noted that the balance of power had shifted to the LEAs since 1902, and that "the disparity of provision between ... local authorities was no longer acceptable" (Gosden 1976, p240), it was clear that something radical had to be done to alter the situation.

In July 1941 Richard Butler succeeded to the post of President at the Board of Education. He had been a Conservative MP since 1929, and his first appointment as a junior minister had been in 1932. He was thus a highly experienced man, and brought to the post a,

> "willingness to listen to all reasonable expressions of public opinion and [a] capacity ... for accommodating widely divergent points of view" (Gosden 1976, p321),

skills which were to stand him in good stead for this current job.

Churchill told Butler on his appointment that the rôle of the central Government in education was to guide "not by instruction or order but by suggestion" (Butler 1971, p90), an endorsement of the *status quo*, with the Board of Education presiding over a system of local variance. This was the start of the struggle between Butler and Churchill, for Butler was "anxious to press ahead with the reform of the system as rapidly as possible" (Gosden 1976, p268). It must have been something of a blow, then, when in September of 1941 Churchill told Butler that, "I certainly cannot contemplate a new education Bill" (Butler 1971, p94). Despite this blatant opposition Butler and Chuter Ede were determined to continue the work of the last five years. Interestingly, the political parties were in general agreement about both the need for and the nature of reform – a situation best illustrated in the Butler/Ede partnership.

---

[2] A summary of the Green Book's main points can be found in Appendix I

1943 saw two major developments. A White Paper included most of the Green Book's proposals, together with the revised proposals for LEA reform and the future of voluntary schools. The White Paper was applauded on both left and right of the Commons because it actually addressed many of the shortcomings of the system as it was – the new document was "a complete recasting of the educational machinery" (Gosden 1976, p314).

The counties had been designated as the new areas for LEAs. The decision to create a real Ministry of Education to replace the 'Board which never met' was taken by Butler and Ede. Apart from clearing up its actual rôle in Government and in relation to the LEAs, this change would avoid "pressure for a 'real' Board comprising representatives of authorities and teachers" (Gosden 1976, p317).

Also in 1943 the Norwood Report was published. Although originally constituted to consider the curriculum and examinations in secondary schools, the committee had extended their study to the whole question of secondary education provision. They felt that,

> "up to the age of eighteen + all pupils should either receive full-time education or be brought under the influence of part-time education" (Board of Education 1943, p140).

The report basically brought together recommendations of both Hadow's and Spens' reports, suggesting a tripartite system of secondary education based around grammar, modern and technical schools, each of which should be accorded parity. The report also stated that there would be three different types of pupil under this system from age eleven, catered for by the different but equal schools. Pupils should be allotted to these schools not on the basis of the old examination, but on the strength of primary school teachers' reports and if necessary some objective series of tests at eleven plus. The period from age eleven to thirteen was to be a 'probationary' one in secondary education, and at thirteen there should be an opportunity to change school type if it was considered appropriate. To this end the report suggested a common curriculum from eleven to thirteen (Armytage 1970). The influence of this report on the 1944 Act is clear[3].

---

[3] The main provisions of the Act can be found in Appendix II

The 1944 Act is interesting in that it was overseen by a Conservative MP (Butler), taking advice from Labour MPs (Chuter Ede, Bevin and Attlee amongst others), and with a civil service department in agreement that the time for reform was at hand. It was passed by a Coalition Government in direct opposition to the Prime Minister, and finally put to rest many of the educational troubles of the previous forty years. Butler had "argued that one of the fundamental principles on which the bill had been built was that there should be a variety of types of school" (Gosden 1976, p327), a view which although not necessarily very strongly evident in the 1944 Act, has resurfaced as the declared basis for much recent legislation.

2.4 Implementation of reform and the road to change; 1944 to 1988

2.4.1 Redevelopment under consensus; 1945 to the late 1950s

The Labour Government returned in 1945 under Clement Attlee was faced with myriad difficulties, not least of which were the financial problems occasioned by restructuring after six years of war. These problems were particularly pertinent to education because "the old system which had grown out of the Education Act of 1902 was run down to the point of collapse" (Middleton and Weitzman 1976, p314) both in terms of its physical capacity and the state of its buildings and in broader educational terms. As Dale notes,

> "the apparent unfairness of the distribution and access to differential life chances and social goals [*i.e.* to grammar schools] represented a major challenge to the legitimacy of the education system" (1989, p96).

Thus the Government were faced with an education system which was unsuited to the postwar world, and with a huge increase in the birth rate which had to be accommodated within the framework of the new legislation to which they were committed.

Before February of 1947 legislation had been passed to increase the compulsory attendance age to fifteen, one of the main provisions of the 1944 Act. Large sums had also been allocated for educational building programmes and increases in teacher training, to cope with the fact that the raising of the leaving age to fifteen meant that there would instantly be an additional 390,000 English and Welsh pupils, and 70,000 more in Scotland (Middleton and Weitzman 1976). The numbers would also continue to rise with the demographic changes as the postwar babies passed through the system.

Despite the apparent success of the central Government in funding building programmes and teacher training, the education system of the time was still essentially based around the local authorities. Individual schools would influence their local authorities who would in turn influence each other and eventually the Ministry of Education (Dale 1989). Such a 'bottom up' approach to education could be seen as problematic at a time when the greatest need was for a general restructuring of a struggling system, and such local level planning could have been allowed to flourish once the entire system was running according to the provisions of the 1944 Act.

The situation remained the same *vis à vis* the relative rôles of Ministry and LEA – there was never any question of the Ministry doing anything more proactive than overseeing the development of the tripartite system, either physically or through curricula. These were seen quite firmly as the province of the LEA and individual schools respectively (Lawrence 1992). In particular there was no attempt made to change the grammar schools, because in the words of Sir John Maud, the Permanent Secretary at the Ministry, they were "the only successful working models of state secondary education" (Lawrence 1992, p13). In fact even the success of the Ministry in nurturing a tripartite system was limited. The idea of the technical school comprised a third of this system, but very few such schools were ever actually created by local authorities, and the system rapidly became, in effect, a bipartisan one of grammars and secondary moderns. According to Lawrence (1992) it was the influential views of Maud and Sir Martin Roseveare (senior HMI 1944-57)

> "that persuaded [the Ministry of Education] to resist Labour backbench attempts to introduce wholesale comprehensive secondary schooling forthwith" (pp16-17).

Added to this pressure was the feeling amongst Labour members that the élitist grammar schools had always been championed as a means of self-improvement for the working classes. The postwar Labour Government as a whole can be seen as a period of legislative torpidity which was seriously hampered by financial constraints and the efforts of coping with lack of trained teachers and rises in pupil numbers.

The general election in 1951 returned a slim Conservative majority and Florence Horsburgh was made the Education Minister, although so low was Churchill's opinion of the Ministry that she was kept out of Cabinet until September 1953. This change of Government signalled a shift in central attitude to education, away from the broadly consensual views of the previous decade. Reductions in spending on the newly-created Welfare State in general and on state education in particular meant that Horsburgh was left to operate mainly as "a Treasury representative to watch expenditure" (Middleton and Weitzman 1976, p334). The main pressure was, as it would continue to be until the 1970s, the rapid rise in the number of pupils and the consequent strain on physical resources. Lawrence writes that it was such all-pervasive question that

> "vital long-term strategies to deal with other concerns as scientific and technical education and ... 15-19-year-olds never took root" (1992, p24).

The early 1950s was a period which, although seeing a change in the general thinking of Government, did not produce any new legislative changes. The serious concerns over classrooms and finance were sufficient to hold back any more radical changes at a Governmental level for some time to come.

One development during this period was the 1954 Gurney-Dixon report (Ministry of Education 1954) into early leaving. This drew attention to the fact that in the decade since 1944 very little had been achieved in persuading children to stay on at school post-fifteen. Yet again, as in the build-up to the 1944 Education Act, it was proposed that maintenance payments be made in order to produce significant increases in these numbers, but yet again the report was noted and then "sank beneath the waves of political indifference" (Lawrence 1992, p33). There was also the question of the continuing problem with rapidly rising rolls. However, as Middleton and Weitzman (1976) report there was a trend in Government thinking to 'plan' for this negatively, by waiting for a natural decline rather than by recruiting additional teachers. The period became one of increased pressure on the teachers who were already in schools, and consequently of increased agitation over pay and conditions, a theme which was to become commonplace over the next forty years. In 1956 a White Paper was published noting that there was a need to boost the provision of technical education, and this became another theme of these years – technical education was recognised as being vitally important for the development of a strong post-war economy in Britain, but there was very little actually done beyond the vague commitment of many Conservatives to the tripartite system which had been suggested by the Butler Act a decade before. The problems noted in technical education continued into the 'sixties, and can even be seen in today's system, with the emphasis on City Technology Colleges and technology in the national curriculum. For further discussion of these points see section 2.5 below.

There was still a great deal of room for improvement in the provided system, and indeed the 1957 National Union of Teachers (NUT) conference called for at least 100,000 more teachers to join those already working. The Labour Party partly based its stance against the Conservatives on a claim that it would try and reduce the class sizes to forty in primary schools and thirty at secondary level. The argument used against this was the purely practical one that it would require at least 116,000 additional teachers, and that there were only 260,000 currently working (an increase of 45%).

The 1950s were not a boom time for British education. Classes were too large for effective teaching, the quality of the teacher training schemes was in question (although the length of training was raised to three years) and some 80% of school-leavers had no GCE O-Levels. (Middleton and Weitzman 1976). The Conservative Prime Ministers of the time felt, perhaps, that education was "no more than a routine obligation" (Lawrence 1992, p33), and that as long as all children were receiving an education they could concentrate on other issues. Added to this, as Wilson (1961, p18), the Senior HMI during the period, notes, the individually very reasonable demands on the education system made for an agenda which was simply too huge for the underfunded and overstretched service. As the decade drew to a close, the 1959 general election returned the Conservatives for a further term of office. This coincided with the 1959 Crowther Report (Ministry of Education 1959), which again criticised the staying-on rate and recommended strongly that the provisions of the 1944 Act for maintenance payments and compulsory part-time schooling for 16- and 17-year-olds be brought into law. Needless to say the recommendations were not acted upon. Lawrence sums up the 1950s by the phrase "Government by administrative convenience" (1992, p28), a reasonable comment on a decade when little was done to alter the status quo in education or affect the system to better fit Butler's model as set out in the 1944 Act.

2.4.2 Schism builds – comprehensivists and tripartisans; the 1960s

The 1960s were a period when the policy gap between the Conservative and Labour parties really began to widen significantly. While the Conservatives concentrated on the same policies, essentially, as they had been pursuing since the war, the Labour party changed tack and explicitly brought on board the idea of the comprehensive school. The Conservative Government was heavily criticised for ignoring the ever-growing number of reports which condemned the state system as it existed, from the examinations system (Ministry of Education 1960) through technical education and children of below average ability (Ministry of Education 1963).

From 1962 the Government began to give education a much higher profile than previously, and partly to curry popular favour money was pumped into the system. For the first time total expenditure exceeded £1 billion, partly due to a teachers' salary increase and the development of middle schools by LEAs. The Conservatives' movement towards the idea of comprehensive schools could easily be seen as a damage limitation exercise. This form of schooling was already developing apace under the eye of the LEAs, and such schools had become popular with a more liberal middle class (Middleton and Weitzman 1976). The one-off form of the increased expenditure also meant that it was of limited use – there still seemed to be little room for a long-term plan for British education. However, positive changes were made to the framework which supported the education system, although at this stage there was still no attempt by the central Government to interfere in the actual running of the system, which was left to the LEAs. The curriculum was still seen very much as something which should be determined by the schools themselves with some guidance from the examination boards, influenced perhaps by the LEAs but essentially unique to each school.

Criticisms were still rife and the 1963 Newsom Report was the culmination of a recognition "that British education had fallen behind most countries of similar development" (Middleton and Weitzman 1976, p348). This is arguably a situation from which the country has never recovered, and one for which the education system is still strongly criticised[4]. The Newsom Report itself concentrated particularly on the secondary modern schools, where the majority of children were educated, and was perhaps the first official report to acknowledge the specific problems of 'slum schools' (now referred to more euphemistically as 'inner city schools'). Essentially it was

[4] See for example the recent report "Learning to Succeed" by the National Commission on Education (1993), which contains many of the very same criticisms as the reports published throughout the postwar period

concerned that the children in these schools, while being "half our future" (the subtitle of the report), were receiving an education which was far below that of children in other schools, such as grammars and to a lesser extent comprehensives. Its recommendations, including that the leaving age be raised again, to sixteen, were once again largely ignored; indeed, Lawrence reports that the document "disappeared from view" (1992, p34) in the changes which overtook the Ministry in 1964.

1964 saw a number of significant developments within education. The first of these was the fact that the birth rate reached its highest point since World War I. This underlined the overpowering need to base policy on "demographic imperatives" (Lawrence 1992, p49) rather than on significant shifts in policy – there had to be enough places for all these children in the system as it stood. The second development was the creation of the Department of Education and Science (DES) out of the old Ministry of Education. This had four main sections; higher education, science, schools and planning, and was intended to be a sign of the newly progressive outlook the Government had on education.

The two main parties did not significantly alter their education policies for the election in October 1964 – the main difference "was on the matter of secondary school selection" (Lawrence 1992, p37), as they were both still agreed on the need for a continued building programme, more further and higher provision, an increase in teacher supply and an increase in the leaving age to sixteen. It is interesting to note that the Conservatives of this period, in common with current thinking (see sections five and later), were "maintaining [a] principle of choice" (quoted in Lawrence 1992) in education. Devaluation and increased tax rates enabled increased recruitment of teachers and expanded building programmes. There were still problems, not least in higher education, because better secondary provision meant that there was much greater demand for places in further and higher education, an issue which had become increasingly politicised with the impending enfranchisement of eighteen-year-olds (and thus higher education students).

One significant document to be passed by the DES during this period was Circular 10/65. This document required LEAs to submit plans to the DES for the introduction of a full comprehensive secondary schooling system. It came at a time when some 10% of secondary pupils were already in comprehensive schools (Dale 1989), a figure very telling of the revolutionary nature of the LEAs, since this development had gone ahead under a Conservative Government broadly opposed to comprehensives.

The 1967 Plowden Report (DES 1967) on primary schools, commissioned by Edward Boyle five years previously, was a very significant document. While it was critical of the system as it stood and many of its recommendations were, as usual, ignored or long delayed, it did have long-reaching effects at a national and local level. At a local level, that of the individual school, it endorsed practices which had already begun to be used (such as a more student-centred approach) and at a national level it encouraged the development of educational priority areas, the expansion of nursery education and the contribution of parents to education. The report continued to be influential until it began to fall out of favour in the 1980s. A second report, the Dainton Report in 1968 (Council for Scientific Policy 1968) on science and technology was highly critical of the state of education in these fields. It actually suggested that there had been a decline in the teaching of science subjects at secondary schools, despite the strongly pro-technology line taken since Wilson's rise to Government.

Despite the financial problems of the day, a £2.5 billion education budget was allocated during this period, taking it higher than defence for the first time. This was used to repair the cuts of 1968 and to decrease class sizes but was still insufficient to push through the full reforms desired. The Labour Government tried for an Education Act in 1970 to force the development of a comprehensive system from five to sixteen, but although a Green Paper was prepared, it was never published because the Government was forced to go to the country, and lost in June 1970 to the Conservative Party.

It was during this period that the 'Black Papers' were published. These were collections of right-wing essays on education which attacked the "liberalised" (Middleton and Weitzman 1976, p363) system which had developed under Labour. They comprised of complaints about teaching methods, the rise of the comprehensive school (by 1970 some 30% of secondary education was in comprehensives – Lawrence 1992) and about the expansion of higher education.

2.4.3 The collapse of consensus, the rise of the centre; the 1970s

In early 1970 Sir Herbert Andrew, the Permanent Secretary at the DES, stated to the Report on Teacher Training that,

> "the curriculum is *not under central control* ... the concept of curriculum is a matter on which HMI gives advice but over which *we do not exercise control* ... generally the academic side is *not under the control of the Department* any more than other parts of the education system" [emphasis added] (House of Commons 1970, p419),

a telling statement which summed up the situation as it stood at the end of Labour's five-and-a-half years in power – as before, the LEAs still exercised the real power over schools in that they were free to plan in whatever way they saw fit, so long as an education was provided within the basic demands of the 1944 Act, and the schools were free to set the curriculum according to personal preference and the requirements of examination boards. The DES' rôle was very limited; essentially education was planned in a bottom-up manner, and the DES did not seem to be able to co-ordinate an attempt to centralise the system as it would have liked to. The first tentative steps towards the system we have at present began to be taken in the single term of office the Conservatives had in the 1970s with a DES under Margaret Thatcher.

Thatcher had been made Opposition spokesperson on Education in 1969. She claimed an intention in the election statements to shift funding towards the primary and nursery sectors and accepted the invalidity of selection at eleven plus (a mainstay of Labour's policy for some years, and an attitude which should be contrasted with Conservative policy once Thatcher became PM – see section 5). Labour counter-attacked by linking education and social equality and a promise to continue with the reorganisation of the secondary sector. They had at this point let the issue of private education recede from the limelight. The Conservatives took office, and Thatcher, as their Secretary of State for Education, was faced with the unenviable task of fighting for extra resources in a climate of extreme economy.

The most infamous policy of this period was the increase in the cost of school meals and the removal of free milk for the over-sevens in primary schools, a policy which produced huge popular anger. At the same time there was a dilution of the comprehensive scheme (Circular 10/70 in 1970 had reversed Circular 10/65's demand for plans for reorganisation) as cash-strapped councils accepted simple renaming of schools and multi-site comprehensives into the fold. There was enormous pressure for extra funding for nursery schooling, for better primary education along Plowden lines and still for the increase of the leaving age to 16. It is an interesting comment on the effect of the DES on local planning that in 1970 about a third of secondary pupils were in comprehensives but by 1974, the end of the anti-comprehensive Conservative period, that figure had doubled (Lawrence 1992).

The raising of the leaving age was finally achieved in 1972, a year of several educational events. This can be seen at least in part as a fairly cynical attempt to gain popularity by implementing what was in effect a Labour policy just three years after the Labour Government had been forced to delay the decision for financial reasons. The increase immediately precipitated something of a crisis in further and higher education as more and more children stayed on. This created yet another enormous pressure on resources already stretched to their limit. 1972 also saw the publication of Labour's 'Green Paper' from 1970. This pledged fully comprehensive secondary education, standards of educational service for LEAs laid down centrally, the abolition of selection to age eighteen, increased democratisation of education through a shake-up of governing bodies, eventual compulsory education through to eighteen and the abolition of fee-paying schools. This was notable partly for its long-term strategy, since none of the items could be introduced at once, and for its rather hopeful tone, given the almost impossible financial constraints on education in the years since the war.

Two reports produced in 1972 were significant; the James Report on teacher education and training recommended making the training of teachers into an undergraduate degree rather than being taught at colleges, but as it coincided with a need for fewer teachers its effect was more to point the way to the future than provoke real change. The Halsey Report was more important. The first of these reports (volumes two through five were published in 1974-5) recommended an increase in pre-school provision, more assistance for deprived children (defined as those in educational priority areas) and a greater co-ordination between the DHSS and the DES, a coalition which had certainly been overlooked in the past, as schools were already providing social services in the form of free meals, milk, health and dental checks and the like. Dale states that it would

> "be easy but facile to suggest that it was the arrival of Margaret Thatcher at the DES which confirmed the breakdown of the post-war settlement" (1989, p106),

but it is undoubted that this period is one in which the tenuous consensus which had developed during the attempt to rebuild a shattered education service after the war reached a crisis point.

The strikes of the winter of 1973-4 finally forced a troubled Government into a general election in February 1974. All the major party's manifestos put the expansion of nursery provision as a priority, although the introduction of special educational needs (SEN) was a newer development for most. The Labour and Liberal parties were pushing non-selective secondary education as before, while the Conservatives, despite their earlier claims to be anti-selection at eleven plus wanted to retain a combination of comprehensives and grammars. Faced with economic chaos, Labour had committed themselves to the introduction of fully comprehensive secondary schooling backed by an expanded nursery sector and improved primary provision and open access to higher education.

They began by issuing Circular 10/74, which effectively repeated Circular 10/65, rescinding Circular 10/70 and reiterating the demand for LEAs to submit plans for comprehensive secondary schooling. A number of other circulars were also issued, but the DES "knew at the time that since a circular was only advisory, they would have to resort to other pressures" (Lawrence 1992, p68) – in other words they would have to legislate. The problems faced by this Government were essentially the same as those faced by all Governments in the period since 1944, only in many cases in reverse; economic problems were nothing new in education, but the ideas of falling rolls and increasing teacher surpluses were ones which would have been alien to any other Secretary of State for Education in the period from 1944 to that point.

Apart from Circular 10/74 there was the 1976 Education Act. This Bill required LEAs to accept children at secondary level without selection, and was therefore finally a success in getting some of the intentions of the Circulars mentioned passed in law. There were two other developments of rather greater significance in 1976. These were the publication of the 'Yellow Book' and of James Callaghan's infamous speech at Ruskin College, Oxford. These events "signalled the tightening grip of central over local Government in terms of the curriculum" (Lawrence 1992, p78) as well as the beginning of the decline of local control more generally.

The 'Yellow Book' ("School education in England: problems and initiatives") was in particular extremely critical of the Schools' Commission, set up to guide the development of the curriculum in schools. The Ruskin College speech was important because it signalled a shift from the concern that education produce socially well-balanced students to an emphasis that they should also have skills which would be of use in the outside world. This was seen partly as constructive because it addressed criticisms levelled by industry but also as it questioned the teacher-centred curriculum. The setting-up of the Assessment and Performance Unit (APU) at the DES in 1976 was

> "a clear sign that central Government wished to play its own central role in the development of the curriculum and in the control of teaching" (Lawrence 1992, p86),

a move which clearly fitted with the tenor of the Labour party at the time. There were also increasing fears on the right that teachers had too much autonomy and that there was little accountability in the system (Dale 1989). It is ironic that in the current climate it is the left which is mainly concerned about the lack of accountability built into the altered education system by the Conservatives (see section 5).

In 1976 the Fookes Report was published (House of Commons 1976). This document made four main recommendations;

- that the Secretary of State should help to shape the curriculum but not actively control it,
- that the DES should make more documents available and encourage more open debates on education,
- that a 'standing education commission' be established with representatives from all interested groups and
- that the DES should show a greater concern for developing long term strategies rather than spending all its energies on the allocation of resources.

The DES supported all these recommendations, and "everything was set for a period of triumphant leadership in British education" (Lawrence 1992, p69).

Other reports published over this period included the 1977 Taylor Report, which reviewed the management structure of maintained schools and their links with LEAs. The main recommendations centred around an increased rôle for governors in the creation of curricula and more general school management, suggestions which can be seen as very clear precursors of the legislation passed a decade later under the Conservative Government (see below). The 1978 Warnock Report was extremely influential, although it dealt mainly with education at a primary school level. Its recommendations concerned provision for special educational needs, and was taken up mainly at a school level.

This period as a whole was marked mainly by difficulties on the practical side and by the change in direction on the theoretical and policy side. A Government with a shaky tenure dealing with an oil crisis, unemployment and a falling birth rate produced policies aimed at increasing its control of education while providing a non-selective education for all children in the type of school which was seen as being the most egalitarian. Overall, it should be remembered that in a time with many more pressing problems, the reform of the education system was of relatively little importance, and the DES continued to be a department which essentially allocated the resources it had to the best of its ability.

2.4.4 The death of local control; the road to the ERA

1979 was a very significant year for Britain in that it was the year in which the Conservative Government which was to remain in power until the end of the 1990s was first elected. This was to be a period of considerable upheaval in the education system

The following table summarises the main provisions of the Education Acts and related legislation which were passed in the decade from 1979 to 1988.

Date and legislation	*Main provisions*
1979 Education Act	Repealed the 1976 Education Act's requirement for LEAs to draw up plans for wholesale comprehensivisation
1980 Education Act	Reduction of the provision of milk and meals; introduction of the Assisted Places Scheme; parental preference (with right of LEA refusal); introduction of parents on school governing bodies; nursery schooling made discretionary not compulsory; *reduction of* LEAs' *ability to refuse to* cater for pupils from outside their jurisdiction; schools required to publish brochures and examination results, HMI reports *etc.*
1981 Education Act	introduction of Special Educational Needs *cf.* system of 'handicaps' which had been employed following Warnock Report
1984 Education (Grants and Awards) Act	Shift in financial control of education from LEAs to Secretary of State
1986 Education Act	Firmer guidelines for governing bodies (covering statutory membership, exact duties *etc.*); banning of corporal punishment in state schools (and in private schools whose fees are paid by the state)
1986 Social Security Act	Abolition of LEAs' obligations to provide free meals, milk, health checks etc. to any pupil; reduction of their discretionary powers to do same

It is clear that there was beginning to be a shift away from the idea of a locally-determined system of education and certainly away from the idea of schools as important providers of the Welfare State.

2.5 Rewriting Butler; the 1988 Education Reform Act

2.5.1 Introduction and general provisions

The 1988 Education Reform Act (ERA) has been described as "the most important and far-reaching piece of educational law-making for England and Wales since the Education Act of 1944" (Maclure 1992, pV). It has undoubtedly affected more areas of education than any other single item of legislation since 1944. In some ways it is even more significant than the Butler Act because, as we have seen, that Act was in large part a legitimisation of processes already well underway, inspired by restructuring after a devastating war. Since then, Maclure's statement that "demography always has a bearing on educational planning and administration – usually a bigger part than ideology" (1992, p33) has certainly held true. Throughout the 1960s and '70s, and even into the 1980s, the huge rise and then the rapid fall in school rolls dominated the educational scene, as we have already seen. However, the ERA has little or nothing to do with changing pupil numbers. At the heart of this legislation is the fundamental question of control. The power of LEAs had been eroded slightly through the 1980s, as we have seen above, but in many ways the ERA can be seen as sounding the death-knell for local control of education, despite the fact that many of its policies had started life as local initiatives (Dale 1989). It has been described as “the result of feverish short-term planning based solely on hard-line Thatcherite doctrines” (Lawrence 1992, p114), and its emphasis on market economics and central rather than local control would certainly appear to support this analysis. This section provides a largely descriptive consideration of the ERA, although later sections attempt to provide a more analytical approach to the implications of the various policies introduced in 1988.

2.5.2 The national curriculum

The national curriculum was introduced to

> “promote the spiritual, moral, cultural, mental and physical development of pupils at the school and of society; and prepare such pupils for the opportunities, responsibilities and experiences of adult life.” (ERA, 1988, section 1 (2), a and b)

It prescribes which subjects should be taught, what proportion of the school week should be given over to these subjects and how these subjects should be assessed. As the name implies, the power of the national curriculum rests squarely with the Secretary of State;

> “It shall be the duty of the Secretary of State so to exercise the powers conferred ... as; a) to establish a complete National Curriculum as soon as it is reasonably practicable ... ; and b) to revise that Curriculum whenever he considers it necessary or expedient to do so.” and “The Secretary of State may by order specify in relation to each of the foundation subjects – a) such attainment targets; b) such programmes of study; and c) such assessment arrangements; as he considers appropriate for that subject.” (ERA, section 4 (1) and 4 (2))

Schools are legally required to provide the curriculum thus prescribed.

The compulsory school life of a pupil is divided into four ‘key stages’ under the national curriculum. Key Stage 1 runs from arrival at school until the age of 7 (6-8), Key Stage 2 runs from age 8 to 11 (10-12), Key Stage 3 runs from age 12 to 14 (13-15) and Key Stage 4 from 15 to 16 (or until GCSEs in the final summer of compulsory schooling). A series of tests at the end of each key stage is intended to provide an ongoing measure of a child’s progress, but again this has created considerable controversy, particularly the idea of testing seven-year-olds.

A considerable furore developed around the national curriculum from its inception. Not only did teachers consider it and its associated tests an excessive burden on their teaching time, there were also accusations levelled at the content of some subjects – notably history and geography – as being racist, unrepresentative and biased towards the British imperialist past. There was also a feeling that the national curriculum was being rushed through without proper planning or consideration of the implications of increased workload and so on.

The principle of a national curriculum, centrally-determined and legally enforced in all maintained schools, is one which has overturned the situation which has held sway certainly since 1944 – that of locally-determined (usually by an individual school) curricula leading to nationally recognised examinations differing by Board, sat at ages sixteen and eighteen. It also, as Bowe *et al.* note, "preempts the goals and beliefs of the individual consumer" (1992, p27). It thus undermines the whole concept of 'choice' in education which the Government sees as so central to their overall policy. Choice is limited to how the curriculum is delivered; there is no longer any control over what is delivered. This point is taken up again in section 5.7 below.

2.5.3 Open enrolment and the local management of schools

Further means of 'nationalising' the education system are provided by fully open enrolment and the introduction of local management of schools (LMS). The first of these takes the concept that parents can have a say in the school which their children attend, introduced by the 1944 Act and reinforced in the early 1980s, to its logical conclusion. Basically stated a school cannot refuse to take any child at all until the number on its roll has reached the 'standard number' – that is, the number of children that were on its roll in the 1979-80 academic year, when rolls nationally were at their maximum. In cases where the school has changed since that academic year, the standard number is set at the school's physical capacity. This applies to children from outside the previous catchment area, and even to those from other LEA areas. This clearly has implications for selectivity in popular schools and the continued viability of unpopular ones. It also opens up for question the criteria on which parents can select schools and thus the validity of the Government-published league tables of results and truancy statistics. There are also implications for those with limited access to transport (just how far do such people have a real choice?) and for those in rural areas where there are few schools even for those with transport. The idea of non-fixed catchment areas and pupils coming from any area to any school has strong policy implications for planners, who must now take into account the concept of there being 'fashions' in schools, and far less easily predictable rolls. Given this, how can accurate or adequate provision be made while at the same time cutting down the number of places available to allow for the Audit Commission's declared aims of reducing the number of surplus places drastically?

Bowe *et al.* (1992) have noted the tensions between size (of classes or schools) and "effectiveness" (p46), and the possibility that this could create an 'ebb and flow' situation in schools which hinders planning for the long term, as a popular school becomes overcrowded and this in turn creates a fall-off in enrolment until the school again reaches its most 'efficient' level. Bradford (1994) also notes that the number on roll in 1979-80 may be misleading as a measure of the potential capacity of a school in the 1990s because of the increase in the use of, for example. information technology resources shared between faculties. This may mean that rooms which were once simply classrooms are now computer rooms or suchlike, common facilities which mean that if the school takes in its standard number it will be overcrowded. Maclure notes that open enrolment is a very simple attempt to reverse the producer-led system as it previously existed and turn it into a market, or as Bowe *et al.* phrase it, a "quasi-market" (1992, p24) because the 'parental choice' of Government rhetoric is in fact only an expression of a preference limited by a large number of factors. Perhaps the greatest flaw with the open enrolment system as a whole is that it could be seen to make the fulfilment of section 8 of the 1944 Education Act, to provide sufficient places for children in their areas of jurisdiction, somewhat problematic for LEAs.

Open enrolment also relies on the ability of parents to compare schools' performances objectively. This is supposedly made possible by the fact that schools are now forced by law to produce brochures detailing examination results and other information about the school. This process is essentially made into a marketing exercise by the fact that there are no guidelines as to how the information should be presented. Clearly this is unsatisfactory from the point of view of parents making a truly informed choice of school.

LMS has other implications for planners, but perhaps the most significant are those which impact on the whole ethos of local control of schools. Under LMS LEAs must delegate a certain proportion of their budgets to the schools themselves, and it is left to the schools to decide how this money is spent. By 1995 some 90% of LEA budgets will have to be thus delegated and the LEAs will be more or less in the position of providing central services to schools which do not take their business to private sector suppliers. Thus the LEAs are being forced to enter into competition with the private sector, although in the educational field they have the benefit of considerable experience in the provision of just these services. In 1991-2 some £9.5bn of a total budget of £13.7bn was delegated to schools through LMS (DfE 1992ii). In the same year John Major described LMS as better than the "bureaucratic rule of local Government" (DfE 1992i, p4).

LMS also forces schools to become accountable for their own budgets. This creates tensions in the management of schools, where headteachers are now expected to run both the financial and the pastoral/educational sides of what are in effect multi-million pound, large employee firms expected to deliver a fixed product to as many consumers (pupils) as possible. The introduction of funding formulæ based on the number of pupils at a school (or on 'age-weighted pupil units' as the jargon has it) has also increased the pressure on schools to innovate as far as possible within the constraints of national curriculum delivery (in order to attract the maximum number of pupils). This essentially means either producing an improved image to parents through marketing, or the offering of specialisations within the framework of the national curriculum, whether that be languages, sport, music or some other area of school life.

2.5.4 Opting-out; the Grant Maintained school

A further major section of the ERA concerns the development of grant-maintained (GM) schools. These are schools which for one reason or another decide to 'go it alone' and remove themselves from the LEA's authority altogether. They are helped in this by one-off and longer term grants from central Government, as well as receiving all the money the LEA would have spent on them and the services for the school direct from the LEA. The school then has complete freedom to spend the money as it chooses. There are clearly some similarities between this approach and LMS, although the major difference here is that not only is financial control removed from the LEA, the planning provision involving the school is also removed. Thus strategic planning is upset in an LEA area because it has no power to open or close GM schools, reduce them in size, increase their size, amalgamate them *etc.* This returns to the point made above about an LEA's ability "to plan provision in accordance with its statutory duties" (Whitty and Menter 1991, p77) as set out in the 1944 Education Act. There is also a contradiction evident in the clash between the ability of schools to opt out of LEA control and the demands of the Audit Commission that surplus places be removed from the system in the interests of economic efficiency (see for example 1989).

The strategic control of GM schools is increasingly in the hands of central Government, increased recently through the creation of the Funding Agency for Schools (FAS), a central quango which is beginning to take over the planning capacity of LEAs. This appointed body is empowered from April 1994 to take joint responsibility for LEA planning decisions once 10% of schools in an area are GM, and assume full responsibility for planning once 75% are GM. Thus the power of the LEAs over their own schools is further eroded. this time in a very serious manner, for the whole concept of local democratic accountability is at risk.

Opted-out schools have very serious implications for the future provision of education in England and Wales, especially since the Government is beginning to step up its efforts to increase the number of GM schools in the country. Roy Pryke, chief education officer for Kent, has suggested that there is "a serious problem with the policy of schools opting out ... [which] is threatening to undermine the quality of the education service" (1993, p12). Schools become GM for a number of reasons, but the two main ones are to avoid reorganisation under LEA schemes and to benefit from large one-off cash handouts given by central Government (Bowe *et al.* 1992). The implications for full financial control of a school once it has gone GM are very much lessened by the fact that LMS has already made schools accountable for their own finances.

The problems that the creation of GM schools outside local control has caused can be extended further. Rogers (1992) suggests that this may lead to a situation where there are essentially two tiers of 'state' education with the GM schools joining independent schools in an élite layer; essentially a return to the 'them and us' situation which existed when grammar schools were the norm (see earlier sections). There has been considerable concern expressed that open enrolment and GM schools are paving the way towards a new range of selective state education which provides only for the academically most able. The discussion of City Technology Colleges in the next section adds to this criticism.

There has been a great deal of debate and speculation as to the future of the GM policy. The number of schools which have voted to opt out has been very much lower than the Government originally intended. At the beginning of the 1996/7 school year there were 260 GM primaries and 554 GM secondaries (FAS, personal communication). Out of a total of some 24,000 schools in Britain therefore, only about 6% are GM. This has led to a consideration of a 'forced' opt-out for all schools (Judd 1994), the removal of the need for a parental ballot at all schools (Dean 1994, 1995i) and most recently special conditions for voluntary schools to opt out without a ballot (Hackett 1995, Judd 1995). These potential developments have to be set against a background of an increasing number of 'no' ballots in recent months, independent schools requesting an 'opt in' to the state sector (Abrams 1995) and reports critical of the cost of putting pupils through GM schools (Ward 1996), the latter of which goes against the original claim that GM schools would be more cost-effective. At the same time, the FAS is planning the first purpose-built GM schools (Dean 1995ii) in Essex and Surrey, and the Government is still promoting the GM policy through the granting of 'Excellence Awards' to GM schools for community and sports work (DfEE 1996ii), awards schemes for which LEA schools are not eligible.

The GM schools policy has been one devised and implemented by a Conservative Government, but Opposition parties have a varied response to their introduction. The Labour Party in particular, while until recently opposed to GM schools on principle, at their last party conference rejected calls to introduce a policy returning all GM schools to local authority control (Goodwin 1995). However, Labour opinion remains that the GM policy as it currently stands is academically and socially divisive and requires considerable change.

2.5.5 City Technology Colleges

City Technology Colleges (CTCs) are perhaps the closest the British education system comes, at present, to having privately-funded public education. These centres of learning have selective entry policies, technologically-biased curricula and were intended to solve many of the problems faced by inner city areas by providing private finance for technologically advanced schools. The scheme has not been a great success. Private companies have not been keen to sponsor such hugely expensive schemes (Whitty *et al.* 1993), particularly not by 'putting all their eggs in one basket' as the funding of a CTC, preferring to spread their resources in geographically larger-scale schemes, such as through the provision of teaching aids to all schools (*e.g.* ICI). Only 7 CTCs were set up by September 1990, a shortfall of 13 on the Government's declared aim of 20 CTCs by that time. To date, only 15 CTCs are in existence (DfEE, personal communication). The scheme has been subsidised to a very great extent by central Government rather than the private finance which was intended to support it. It cannot really be judged a success in terms of value for money or inspiring private-public links, and indeed OFSTED has recently argues that at least one CTC is failing academically (Joseph 1994).

2.5.6 Conclusions; implications for local governance and accountability

It seems clear that the 1988 ERA signalled a sea-change in British education. The power of the LEAs was diminished as the rôle of central Government increased and individual schools gained more autonomy. The power of local Government to provide an integrated education system as laid out in the 1944 Education Act was weakened, particularly by the division of planning responsibility between LEAs and the FAS. This introduction of a "quasi-market" (Goodwin 1992, p78) has been met with considerable opposition at a grass-roots level and indeed many of the new developments have been relatively unsuccessful, – GM schools and CTCs in particular – serving to alienate schools, parents and local authorities alike. As the balance of power has shifted away from elected local authorities to central Government and the FAS (Morris 1990), accountability with regard to education has been severely reduced. The imposition of such "undemocratic centralism" (Goodwin 1992, p85) has certainly increased fears for the future equity of provision. Indeed, this conclusion is supported by an American report on the state of the British education system. Describing the system as a 'warning bell' to others, the report claims that in particular opting out and the national curriculum have led to "confusion, frustration and an erosion of democratic accountability" (Pyke 1996, p4). It would seem that although the 1988 ERA was introduced in order to improve choice in education and encourage the development of a diverse schools system accessible to all, in this it has failed, although some elements of the Act, such as LMS, have allowed schools and authorities more flexibility in funding to target resources more to where they are required than was possible before.

2.6 Consolidation and conclusion; 1988 to 1997

Relatively little in terms of actual policy was passed in the period 1988 to 1993, and the educational arena was mainly occupied with battles over the impacts of the ERA. This was a period when the various policies of the ERA were being implemented and altered – a consideration of forcing all schools to opt out (see above), drafting and redrafting of the national curriculum and changing local authority structures to accommodate open enrolment and a loss of planning privileges.

However, despite the huge changes wrought in education by the 1988 Act, a change of Prime Minister, the reform of the NHS and the poll tax débâcle served to overshadow the area in public life. Kenneth Clarke made some attempt to revive the department in 1991 by publishing white papers on post-compulsory training and the rationalisation of higher education, partly in response to criticisms levelled by Sir Claus Moser[5] in late 1990. The development of National Vocational Qualifications (or NVQs)

> "drew many to the conclusion that someone at the DES had dusted down a copy of the 1944 Act or even reread some of the numerous reports from Royal Commissions dating back to mid- and late-Victorian times" (Lawrence 1992, p122).

There is certainly an historical tendency for criticism of the quality of vocational education to be at the forefront of educational debate in Britain.

In 1993 the Government commissioned a major report on the national curriculum and the way in which it was assessed, after four years of complaints that the national

---

[5] Subsequently published after a thorough study by the National Commission on Education as 'Learning to Succeed' (1993)

curriculum as originally constituted contained too much work for teaching within the time available and also that it was too structured to enable variation in teaching content or style. The report from the Schools Curriculum and Assessment Authority (SCAA) under its chairman, Sir Ron Dearing, recommended a reduction in core subjects and a redrafting of history and geography curricula, a reduction in the actual fixed content of all subject curricula to enable more variation in examinations and the development of more vocational qualifications in line with current examination schemes (SCAA 1994).

Another significant development in 1993 was the passing of another Education Act. This confirmed the responsibilities of various organisations with respect to education and instituted the FAS from April 1994. It confirmed the arrangements for governance and running of GM schools and clarified regulations relating to voluntary schools and open enrolment. It also considered provision of education to children with special educational needs and their assessment, as well as introducing legislation dealing with attendance problems (for further details see Morris *et al.* 1993). Essentially, by the end of 1993 the legislation initially introduced in 1988 was firmly in place and schools were providing a national curriculum within a market-oriented school system incorporating full state schools, GM schools and the traditional independent sector. In the years since the 1993 Act relatively little has changed in education in terms of legislation, although as we have already seen the GM schools policy has slowed almost to a halt and the CTC programme had been acknowledged by most sources as a relative failure. There has been much speculation over the future of the education system as a whole, a tense debate which has resulted in enormous press coverage, a selection of which is contained in Appendix III. The most recent speculation and suggestion has surrounded increased quotas for selection in schools (see for instance MacLeod 1996) and also the full reintroduction of grammar schools. Selection in particular has been the source of some contention since the open enrolment policy has led to some schools becoming very highly oversubscribed. In many ways this has been a reintroduction of a two-tier state education system by the back door, in that many schools become very much a second choice for parents unable to get their children into the 'right' school in the area. Indeed, the effect of a 'good' school on house prices, while always important, has become far more important in recent years (Lawson 1993, Bolster 1994). The introduction of open selection procedures at popular schools[6] can only add to the increased social standing of the schools which already benefit from a good reputation, which adds to the concerns over the future equity of provision in Britain's education service. There is also the added problem that the drive for good examination results at a school level (as published in the annual 'league tables') has marginalised poorer-performing pupils to the extent that many children are no longer even entered for exams because schools are concerned about their general standing in the tables (see Abrams 1996v and 1996vi).

As the 1988 ERA and later market-oriented legislation becomes fully operational there is a urgent need to monitor the impacts on the education system and in particular on outcomes within specific areas. The following chapter discusses the potential of a geographical approach to education and the rôle of the LEA in contemporary Britain, leading in later chapters to a more specific discussion of a range of geographical techniques which could be employed by LEAs to maintain their position as providers of quality education to the vast majority of children.

---

[6] Set out in the 1996 White Paper 'Self-Government for Schools', the proposed levels are; 20% of roll in LEA schools, 30% of roll in LEA Technology and Language colleges and 50% in GM schools. The selection can be "by general ability or by ability or aptitude in particular subjects, without needing central approval" (DfEE 1996xi)

Chapter three

Geography and education, LEAs and league tables

3.1 Introduction

As we have seen, the local education authority (LEA) is the key provider of state education in Britain. We have also seen how the rôle of the LEA is being constantly reappraised in the light of sweeping new legislation which is redefining the provision of education. This chapter is intended to make more specific the general explication of British education given in the previous chapter. It is also useful at this point to begin to introduce some of the ideas from geography which have begun to take root in the educational arena. To this end, the chapter begins by considering some of the work which academic geographers have carried out with regard to education. This includes consideration of the qualitative methodology behind school closure (Bondi 1989), the definition of pupils' performance in examinations in terms of their home environment (Bradford 1991) and the application of geographical information system (GIS)-based methods to school performance (Higgs *et al.* forthcoming).

This is followed by a detailed exposition of Leeds LEA itself in order to contextualise the data which are utilised in the GIS and modelling examples in later chapters. The final section of this chapter considers a range of performance indicators which can be utilised either in place of or in parallel with the league tables which have caused so much controversy in terms of marginalising schools with lower examination results (see chapter two). In this way the chapter serves to set the scene for the more detailed applied work in chapters four and six through eight in that the problems faced by LEAs have been fully introduced and expounded in order to show how useful many of the techniques which exist could be if applied by planning officers.

3.2 Geographers on education

A number of geographers have written on educational subject matter, ranging from qualitative surveys of selection processes for school closure (Bondi 1989) to the potential of GIS for measuring variability in school performance (Higgs *et al.* forthcoming). Some of this work is discussed in section 3.4 below, since it relates directly to performance indicators as considered by that section. However, in terms of showing that many of the problems facing educationalists are by their nature geographical, this section describes some of the work already mentioned.

Bondi (1989) takes as a starting point the fact that school rolls had been declining for a decade and that there was (and still is, to an extent) enormous pressure on schools to reduce the number of surplus places in their areas. Her argument centres on the fact that although LEAs may produce 'rational' plans for reducing places based on sound economic and demographic criteria, the intense local loyalty to particular schools means that these plans cannot always proceed as authorities would wish. This leads to reorganisation scenarios comprised largely of compromise. The paper also highlights the fact that it is desirable but extremely problematic to utilise reorganisations (which inevitably involve a high level of closure and amalgamation) in order to maximise the quality of the remaining building stock. In other words, planners should aim not only to consider the population of areas when removing schools from a network, but should also aim to leave the buildings which are more suited to a modern educational environment. The conclusion of the paper is that although the situation was already complex for planners, it is likely to become more so (as we have seen) with the introduction of reforms such as GM schools, open enrolment and the like.

Further to the possibilities outlined in Clarke and Langley (1995, 1996), other researchers in geography have taken up the theme of using GIS to examine aspects of the education system. In particular, Higgs, Webster and White (forthcoming) have suggested that GIS may have a great deal to offer in terms of better understanding the social and spatial impacts of parental preference legislation. Their argument takes many similar lines to those presented in chapter four (and Clarke and Langley 1996) but usefully reiterates the fact that GIS can be extremely useful in several areas; showing the variation in catchment characteristics across an area (in terms of socio-economic indicators), the variation in school 'performance' in terms of published indicators, the relative accessibility of residential areas to facilities such as schools, the differences between traditional fixed catchments and those actually existing under parental preference legislation and in the definition of improved transportation networks or settling of disputes regarding allocation of free transport.

Both Bradford (1991) and Higgs *et al.* (forthcoming) deal with the issue of school performance and are therefore outlined more thoroughly in section 3.4 below. For this section it suffices to state that Bradford notes the link between residential environment and school attainment while Higgs *et al.* use the link between social disadvantage (defined through census data) and educational attainment to better contextualise the school league tables as presently published. Bradford (1994) takes a more demographic approach to the problems facing planners because of changing population structures, and discusses ways in which this might combine with the changing legislation to affect planning in the future. In particular he highlights current trends in the numbers of school-age children and defines how the planning response to such trends must be different in the present climate to the framework which existed prior to 1988.

Petch (1988) discusses how an attempt to redefine catchment areas for secondary schools in one local authority came up against the barrier of parental opposition and the 'loyalty' of parents to their particular local schools. However, although written in the context of the limited parental preference legislation which existed prior to 1988, it predates the fully open enrolment and GM school initiatives of that year. Thus it provides a useful pointer to the sociological implications of school reorganisations, but misses many of the more recent issues which have dogged LEAs trying to reorganise schooling. Indeed, much of the Bondi and Matthews (1988) research comes not from a quantitative or GIS-based planning background, but takes a more qualitative, sociological perspective on the problems faced by educationalists in general, from the issues surrounding consultancy before school reorganisation through to a consideration of the varying geography of race and educational and employment experience. The work of Garner (1988) builds on Moulden and Bradford (1984 – see section 3.4) and in some ways predates that of Bradford (1991) and other geographers in that it provides an attempt to link neighbourhood deprivation to educational attainment. This study tries to separate the various influences of home background, school-specific influences and the neighbourhood within which either are located to see if, as Bradford (1991) maintains, the general area has an influence beyond the more immediate factors of home and school. In this case, for a region of Scotland, it was concluded that certainly deprivation has a significant negative impact on a child's educational attainment, an impact operating over and above the influences of home and school. The conclusion drawn is that

> "because there is an unhappy coincidence of home and neighbourhood characteristics which negatively influences educational attainment in deprived neighbourhoods, the young people living there are doubly deprived. First by their home circumstances and second by where they live" (p252).

Matthews *et al.* (1988) also examine the varying influences on children's performance, only in this case they concentrate on the in-school factors which may have an impact on pupil attainment. Building from a number of US studies which have found that schools in inner city or deprived areas had less-qualified teachers than in more affluent suburban schools and some evidence from the UK which emphasised higher teacher turnover in inner cities, the authors conclude that in fact the same differences do not appear to exist in the UK that exist in the States, at least partly because of the administrative system under which schools operate. In their view, the fact that state schools in any one area (or city) all operate under the *aegis* of a single body, the LEA, there is little room for the same kind of funding or prestige variation which exists in the US. This means that teachers are treated with the same level of employment conditions and pay scales whether they teach in inner city or suburban schools. This has been an important difference between the American and British educational models. However, it is an interesting footnote to the work of Matthews *et al.* that the legislative background to their study has now changed, perhaps beyond all recognition, and schools are now much more independent from the LEA and each other and may therefore be in more of a position to offer the kinds of differential environment which have traditionally affected teachers in the US. This may mean that the concerns they raise for variations in teacher experience and turnover become more significant as market reforms take root.

3.3 The changing place of the LEA

3.3.1 Introduction

Chapter two has given an overview of the legislative changes wrought by the British Government in recent years. The aim of this section is to discuss the implications of these changes from the point of view of the educational planner and then to introduce an area which provides the case study for the geographical techniques used in later chapters. The following section reiterates a number of the difficulties for educational planners which have been thrown up by the new market approach to schooling. This is succeeded by a description of the city of Leeds, in northern England, and the LEA which oversees the state education sector in the Leeds area.

3.3.2 Planning problems facing LEAs

Since many of the most important issues facing local authorities have been discussed in chapters one and two (and see the review in Clarke and Langley 1996), this section serves mainly as a reminder of the most pertinent of these and thus as a general introduction to the description of the Leeds LEA and its specific problems in later sections.

The main problems centre around the issue of planning sufficient places for pupils at state schools in Britain. This is a particular concern given the potential for parents to select schools for their children under open enrolment. Such choice effectively opens up a 'free' market within state schooling, permitting any child to be educated at virtually any school. In reality, the range of choice is more limited and it is particularly difficult to obtain places at popular schools without living in close proximity. However, the fact remains that the LEA is now in a position of reacting to changes in parental perceptions of schools, rather than being in the position they have traditionally occupied – that of the prime mover in terms of educational provision. LEAs now have to sit back and watch the changing patterns of school usage and react as best they can to rising or falling rolls in cities. In many ways this may mean that they are in a position where rather than increasing the size of popular schools (an extremely expensive business) they may have to increase the attractiveness to parents of the unpopular schools which are left with large proportions of surplus places. Often these schools will be in inner city or suburban estate locations far from the 'leafy suburbs' where the majority of the traditionally high-performing (in terms of examination results) schools are located. LEAs are therefore in a position much more of monitoring and attempting to deflect the worst excesses of a market situation, which it has been suggested could lead to increased social, racial and religious segregation in British cities.

They also have to work with the very real possibility that decisions to rationalise an entire network of schools could lead to mass opting out, and the complete loss of status for the LEA. In this case planning control would pass to the FAS and the rôle of the LEA would be very significantly reduced, to that of a service provider on a par with private companies. This also has implications for the funding of schools. Once control of the schools has been lost to the FAS the financial burden is borne by central Government through its quango. The LEA no longer holds any of the funding power over the schools, and indeed cannot support GM schools in terms of additional social or educational funding. The vast majority of moneys are already delegated directly to schools, through the LMS initiative. However, a crucial proportion is withheld by LEAs to distribute at least in part according to certain criteria of additional need, whether that be defined in terms of a school's social composition (on the grounds that for instance middle class children generally perform better than others) or in terms of numbers of pupils with extra educational requirements (usually determined by those with statements of educational need).

LEAs are also required to provide home to school transport for many children, which provides significant logistical and definitional problems. Specifically, what <u>is</u> the shortest walking route from one point to another, and what are the most efficient routes for buses to take in order to collect the pupils who do qualify for free transport? Qualification for free transport is based on a simple rule set out in the 1944 Education Act; at secondary level, if a child lives more than three miles from their school and it is their closest appropriate secondary school then the LEA has an obligation to transport that child to school. All other pupils are expected to find their own way to school, although there are similar rules for primary pupils. This transport issue is made slightly less complicated in that the LEA does not provide its own buses or routes for buses, it provides children with free or cheap passes for the local bus service. In this way the need to define 'best' routes and times is removed, although it becomes even more important to define accurately which pupils qualify for such passes. These problems are summarised in more depth in chapter one and in Clarke and Langley (1995, 1996), to which the interested reader is directed.

3.3.3 A case study: Leeds[7]

The city of Leeds is in West Yorkshire, England, some 250 miles north of London and roughly equidistant from the east and west coasts. It had a population of some 675,000 people at the time of the 1991 census, making it the third largest city in the UK and it has been growing steadily since. The population is very mixed, with over 75 nationalities represented. Socially, the city is comprised of 38% ABs, 39% Cs and 18% DEs[8]. The city's education system comprises just one GM secondary school compared to 45 authority-maintained secondaries. In the 1994/5 academic year there were approximately 43,000 pupils in these 45 schools. The LEA's budget runs to over £500 million *per annum* the majority of which, according to Department for Education and Employment (DfEE) regulations, is delegated to the schools themselves. In the late 1980s and early 1990s the LEA pushed through a major reorganisation of the city's schools, removing the middle schools and making the high schools into comprehensive secondaries (*i.e.* for all pupils aged eleven plus). This task was aided by the fact that the market reforms were very new, and that the LEA therefore did not have the pressure of schools opting out to 'escape' merger, closure or redefinition. This reorganisation was prompted by two factors; the fact that the city had a three-tier system of schooling which was not consistent throughout the city and that there were some 22,000 surplus places in the city's schools at all levels. The reorganisation was strongly recommended by the Leeds Schools Commission (set up to advise on surplus places and the future of education in Leeds) and aimed to reduce the number of surplus places to around 3,000 by 1993 (Leeds Schools Commission 1993). This was considered sufficient as a 'safety margin' of places. It was then considered appropriate to set up a demographic planning unit to monitor and plan for changes in the city's population structure and to produce forecasts of pupils numbers and recommendations for closures and openings across the city. Within this context of reorganised schools and a new unit for planning of places

---

[7] The information in this section is drawn from a number of sources. Census data is drawn from the 1991 census of population, while the remaining information regarding the local authority is based partly on conversations with various LEA officers (in particular Ileta Sherriff, the Demographic Planning Officer) and on inter-office LEA working documents and information letters never formally published

[8] These categories are based on the Registrar General's classification of social groups, based on the occupation of the household head where the head is economically active. The definitions are: A, professional *etc.* occupations; B, managerial and technical; C1, skilled non-manual; C2, skilled manual; D, partly skilled; E, unskilled. There are also categories for the armed forces, the retired and other groups.

this section continues by describing briefly the techniques employed by the LEA officers.

The forecasting of pupil numbers is the main task of educational planners in the city and is carried out at three scales; whole city, areal and individual school. The methods used vary according to the scale, and the accuracy of predictions also varies with both spatial and temporal scale. Stated simply, shorter-term forecasts for larger areas are much more accurate than long-term small-scale projections. Information used includes;

OPCS projections of live births and actual birth figures
Area Health Authority figures for under fives
Form 7 numbers[9] (school-level information, January)
September returns (again, completed by schools annually)

Although there are some problems with the consistency of data (especially that which is provided by the schools themselves) the LEA considers that the base information is sufficiently accurate to base predictions on. There are two main methodologies which exist in Leeds for performing this task at a city-wide scale. The first involves taking OPCS projections of live births together with Form 7 returns, calculating migration rates and the use of a three-year mean to project likely future numbers of pupils in the city. The second is essentially the same methodology but incorporates a weighted mean (using three years, the most recent is given the heaviest weighting, with the weight reduced with distance from the present). This method is considered to be the most accurate for all school years except the post-compulsory, ages 16-19, group. It is acknowledged that prediction of these figures is more complex because the staying-on rate varies widely between schools, areas and years.

It has also been noted that the prediction of pupil numbers on an area basis (by postal district or electoral ward) could also provide officers with useful information for the planning process. The main benefit of using wards was acknowledged to be that LEA officers are working for council members who think in terms of wards (as political

[9] Form 7 is completed in January each year by every school in an LEA. These forms include information on pupil numbers in each year group, numbers with special educational needs, numbers in receipt of free school meals and other information regarding teachers and support staff.

boundaries) and are therefore most concerned about data at this level. However, the benefits of working at a postcode level were wider. Schools and the Area Health Authority hold their data at a postcode level which means that it can be simply aggregated to larger postal units and combined with other data such as that from the census. This can allow officers a good information set on which to base projections of pupil numbers at this scale, using a broadly similar methodology to that outlined for the whole city.

Predictions at the level of the individual school are more complex. It used to be sufficient for officers to utilise catchment-level OPCS data and previous pupil numbers. However, this is no longer possible or appropriate under a system of parental preference. Thus the LEA has moved to a postcode-based (postal sector) system involving historical information regarding the numbers of pupils from different areas. This system will, when fully operational, base the numbers of pupils at any given school on the numbers who have attended the school in the past from the various postal sectors. It is also possible to use some information regarding the 'feeder primaries'[10] to predict likely rolls at a secondary school. However, this is perhaps slightly less appropriate than it may have been under a fixed catchment area system, when it was possible to assign pupils from certain primary schools to set secondaries.

The demographic planning unit of the LEA produces pupil projections for up to ten years in the future. However, they are confident of the accuracy (especially at a smaller spatial scale) only up to four or five years. The prediction of pupil numbers at smaller scales is less accurate, particularly beyond a simple description of whether the school-age population will rise or fall. The idea of the unit is to endeavour to enable the LEA to keep surplus places at (particularly) secondary schools at 10% or less of capacity. This relatively arbitrary working proportion is considered to be sufficient to allow schools to cope with the vagaries of parental preference or migration or at a city scale to absorb large temporary influxes of pupils through unforeseen events such as fire.

The demographic planning unit, in concert with the admissions section of the LEA, plays the central part in the educational planning process in Leeds. Although their pupil

---

[10] The primary schools which traditionally send their pupils to a particular secondary school

projections are at certain scales sufficiently accurate to provide for general trends in the city, the smaller scale projections are far less accurate and have not changed a great deal in order to take into account the impacts of parental preference and the fact that school rolls are now more than ever based on the relative 'attractiveness' of schools to parents. There is no implementation of more advanced population modelling techniques (outlined in chapter five) and as the development of the city council's corporate GIS is incomplete there is at present no use of the techniques suggested by Higgs, Webster and White (forthcoming), Clarke and Langley (1996) or chapter four. Certainly no use is made of the spatial modelling techniques which seem to lend themselves particularly well to a market environment. These are introduced in chapter five and applied in chapters six and eight. The following section gives an introduction to some of the various methods of defining 'performance' in education, a topic as we have seen of considerable importance given the rise of league tables for schools and a crucial part of the modelling process which is introduced in later chapters.

3.4 The rise in importance of performance indicators

3.4.1 Introduction

A great deal has been written about the measurement of 'performance' in education – specifically about methods for the accurate and meaningful comparison of the relative efficiency of schools at various levels, whether that efficiency be financial or educational. Although such comparison has always been an issue,

> "what has been different about the last decade is not only that the measurement of performance has been pursued more consistently and vigorously, but that it has gone along with a significant shift in power in public sector organisations, and that it has been linked with the development of markets and control" (Walsh 1994, p51).

This shift to a market approach has been accompanied more recently by the annual publication of so-called 'league tables' of crude examination results and truancy rates, the latter published despite being based on a variety of definitions (Abrams 1993iv, Bennett 1994, Sharratt 1993 and Appendix III). The basic idea behind league tables is that schools will be inspired to improve their standing in the eyes of the consumer (their position in the tables). In the words of one commentator this is

> "a simple (simple-minded?) behaviourist carrot-and-stick approach where the rewards go to the good guys and the baddies immediately reform their ways" (Brown 1994, p56).

There is clearly much room for improvement in the situation as it currently stands.

The league tables have to date been the source of controversy in a number of ways beyond the simple definition of data and the fact that they do not accurately represent the 'performance' of various schools. They have been reported as having a far wider set of implications for the education of British children. In particular one of the most widely voiced concerns, and one which is increasingly vocalised, is that pupils are being excluded from A-Level courses because they are unlikely to enhance a school's average grade as reported in the league tables (Judd 1996vi). There is also increasing alarm amongst commentators that a similar process is taking place at GCSE level (Abrams 1996v, 1996vi), where the number of pupils who were not entered for exams increased by 11,500 between 1995 and 1996, an increase of almost a third. There is an additional problem with pupil exclusions. There is a fear that with increasing competition between schools that they are more willing than previously to exclude disruptive or difficult pupils permanently for fear of gaining adverse publicity or a damaged reputation, or at the extreme reduced examination figures in the tables (Abrams 1995viii). At the same time, however, there have been reports that in order to reduce the truancy figures for the league tables, repeat truants are being encouraged to take 'study leave' rather than being excluded (Abrams 1995vi). In this complex system of balancing reputation and league table position it seems hardly surprising that the common theme across reports is that the pupils lose out as the schools fight against each other for high rolls and status.

In order to prevent this already unsatisfactory situation from worsening it is generally considered appropriate to weight the tables in some way in order to measure how much 'value' is 'added' to individual pupils by schools (Burstall 1995iii, O'Leary 1993i, Passmore 1994iii, Sofer 1994). There are still many problems facing those who would develop a system of performance indicators to complement or replace crude exam scores. As Bradford (1991) suggests, there is no reason to assume that even "suitably adjusted ... [tables] ... can be meaningfully interpreted" (p319). It is also true, as in all studies of this type, that "the relationship between cause and effect may be extremely difficult to determine" (Walsh 1994, p53). While Walsh goes on to question whether we should measure the performance of public services at all, he points out that

> "if consumers cannot assess the quality of a service then they will either assume that all providers are the same, or decide on the basis of criteria that do not actually reflect quality" (p60),

of which he suggests price as the most common, although exam results may be the most appropriate example in an educational context.

From the point of view of interaction modelling, with its requirement for a measurement of the attractiveness of a facility to consumers (see chapters five and six for more details on this process), there is clearly a need to define measures which reflect the way a school is perceived to be performing by its consumers. If we take the league tables to be representative of this perception, it is immediately apparent that there are a wide range of factors apart from exam results which need to be accounted for in any system of indicators. The two most common criticisms of average exam results at sixteen (GCSEs) and increasingly of SAT scores at other ages as a direct comparison of schools is that

> "they ignore the social composition of the school; and they do not consider the level of attainment on entry into the school" (Bradford 1991, p322).

The indicators therefore tend to exaggerate the performance of secondaries with intakes from catchments of higher socio-economic status (see chapter six) and those with high levels of previous attainment amongst incoming pupils. Clearly, these two factors are very closely related. It has been reported that

> "national concerns about performance in education have stemmed from the apparent failure of the rapid expansion of education in the 1960s and 1970s, to generate wealth, or to realize social equity" (Riley and Nuttall 1994, p122).

At the same time a great deal has been made of the potential for parental choice based on league tables to exacerbate this socially divided (and divisive) education system (see for example Bradford 1991).

Therefore there is a clear need, since performance indicators of one sort or another seem here to stay (Barker 1995ii, Budge 1996ii, Wintour and MacLeod 1994), to analyse potential methods for improving their worth as valid comparators for schools and it could inform the planning process immensely if there were a number of performance indicators available to parents. To this end, the remaining sections of this chapter discuss a variety of methods for defining performance indicators other than the raw exam scores. These cover much of the possible range, from more qualitatively-based indicators through statistical regression measures to those based on the principles of spatial interaction.

3.4.2 Data availability

In terms of the mathematical modelling approach the definition of PIs needs to be readily quantifiable and it is to this end that I shall concentrate in this section on numerically-based measures of performance. As Jowett and Rothwell state, "the only concrete 'outcome' or yardstick by which performance can be assessed is examination success" (1988, p39) and such success is formed by a complex interplay of factors. This is not to say that there should not be development of more complex value-added type indicators – it simply means that the data which are readily available at present are concentrated in the kinds of measures of which Jowett and Rothwell write. Data availability is all-important in such a situation, and thus we come up against the first barrier to analysis. Table 3.1 shows the result of some fairly recent research into the availability of quantitative data in LEAs. Most of this data will, clearly, be aspatial in nature and will also be aggregated in some way, usually to a whole-school level. It would also be possible to add numbers on roll at various ages and, in many cases, child postcodes to the list. Added to that, the table shows only what LEAs perceive to be available, and personal contact in Leeds has shown the potential data resource to be immense, given a certain level of liaison between officers. The table also neglects to note that 100% of authorities should have access to school-level examination data, if only through looking at the lists of league table published annually. This does suggest that other parts of the table may now be somewhat dated as access to better data becomes more widespread. However, as Gray and Wilcox go on to state,

> "many LEAs ... do not appear to have a *systematically-organized database* containing pertinent information of a quantitative kind available to them for ready use [emphasis added]" (1994, p73),

and it is against this background that we must assess the various methodologies for defining performance.

Table 3.1: Quantitative measures reported by LEAs as available in 1990/91 for the measurement of schools' performance

Quantitative measures available	*% LEAs stating availability*
Public examination results	78
Post-16 destinations	55
Attendance	52
Exclusions	4
Incidence of free school meals	42
Incidence of special needs	44
Reading tests	12
English tests	9
Arithmetic/mathematics	8
Verbal reasoning tests	8
Non-verbal reasoning tests	5
Ethnic background of pupils	7
Other measures of pupil attainment	5
Other pupil characteristics	8
Staff characteristics	10
School characteristics	6
Financial/resource information	3
Parent/community information	3

Source: Gray and Wilcox 1994 (p73)

Perhaps the most basic measure of a school's attractiveness is its exam results as published. At present these are the only readily-available form of comparative data for secondary schools in Britain, and as such should perhaps form a starting point for a modelling analysis (see chapter six). However, there is a great deal of dissatisfaction with the publication of such unmodified statistics (see above) – the arguments against relying largely on the fact that schools with middle class pupil intakes regularly produce higher average percentage pass rates than schools in more deprived areas (see chapters four and six). Perhaps mainly because of this concern a great deal of work on 'added value' and other forms of performance indicator has emerged in the last decade. Added value works on the principle of considering the achievement a school has made in improving a child's performance on entry rather than simply considering the final results on exit, whether those be for GCSEs (age 16) or A-Levels (age 18). It is certainly true that in education, unlike retailing,

> "school size only is far from being a satisfactory measurement of attraction" (Appalraju 1979, p19);

this contrasts with the situation in retailing (Clarke 1986) and encourages the adoption of more complex indicators. The following sections discuss actual performance indicator research which has been carried out on a variety of scales and data.

3.4.3 LEA-based research

Work that is being carried out by LEAs themselves on 'value added' is not explicitly geographical, and is generally based on pupil-level data which may be difficult to collate on a wide scale. However, it provides a useful further approach to the definition of performance in schools. The following sections discuss slightly differing work from various areas in Britain.

3.4.3.1 Leicestershire

Work being carried out in Leicestershire LEA bases the 'quality' of a pupil's A-Level passes on the grades that same pupil achieved at GCSE. At the most basic level, and for individual pupils, the results at each examination level can be converted into point scores[11] and these can be plotted against each other on a very simple graph. Clearly this approach allows for comparison at a single-subject level, or across all subjects, and could even be used to compare schools, by use of averaged or normalised results across the whole pupil base. MacLeod (1991) introduces this simple concept and the following examples from an actual school can easily demonstrate its efficacy for comparing subjects, if not schools (see figure 3.1). In the graphs, individual pupil data[12] is plotted in a simple scatter graph. Those who fall below the straight line have performed worse than expected, given the GCSE results they gained, while those who fall above the line have achieved better A-Level results than might be expected. It should be noted that the GCSE results do not take into account the subjects taken, and that this whole approach ignores the influence of the pupils' residential or social environment (an influence noted in particular by Bradford, 1991, amongst others: see below). It should also be noted that this is an approach which it is very difficult to apply to GCSE outcomes because of the lack of data available for children's performances prior to the major examinations at age 16. The national 'attainment tests' (or SATs) which have been introduced recently are intended to begin to provide this kind of information for children aged 7, 11 and 14. However, there are a number of problems associated with these tests; the ambivalence of teachers to the testing of younger children; the bureaucratic difficulties of implementing national tests; and gaps in the tests' geographical coverage mean that they

---

[11] Where at A-Level an 'A' grade is worth 10 points, a 'B' 8, a 'C' 6 and so on; at GCSE a similar system exists, with 7 points for an 'A' grade, 6 for a 'B' down to 1 point for a 'G' grade.

[12] Real data supplied for two subject areas from a school in Leicestershire, provided by the author's father, deputy headmaster at the school in the example

are difficult to utilise as reliable indicators of value added. In addition there is a particular problem which is likely to be faced by researchers in that the range of problems associated with the SATs mean that there is little or no chance of their being released into the public domain for the foreseeable future.

Figure 3.1a: Subject A ('successful'), pupil distribution by GCSE and A-Level points scores

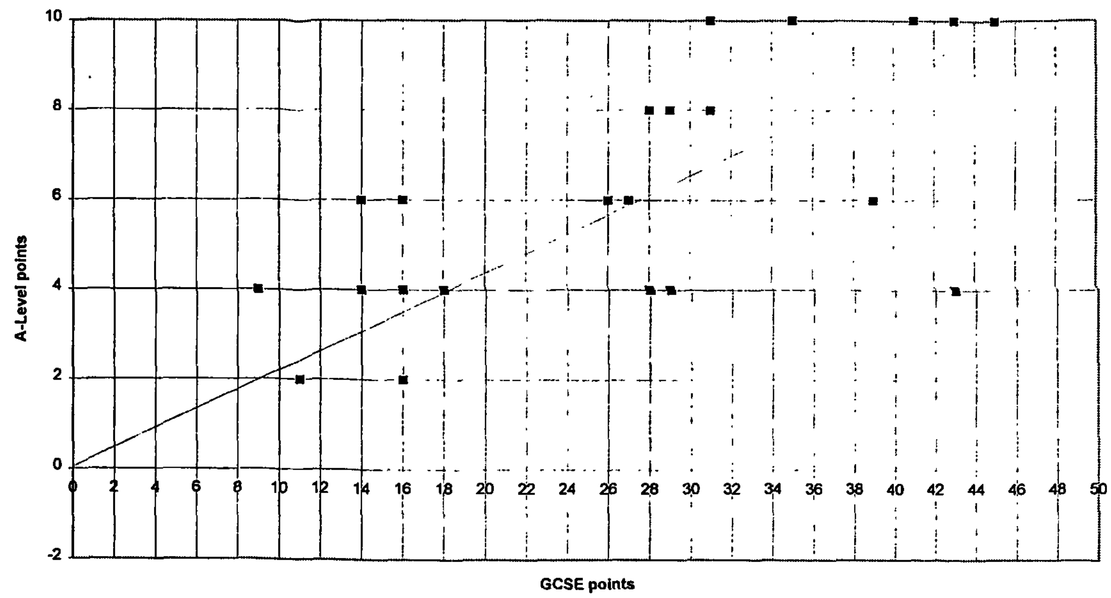
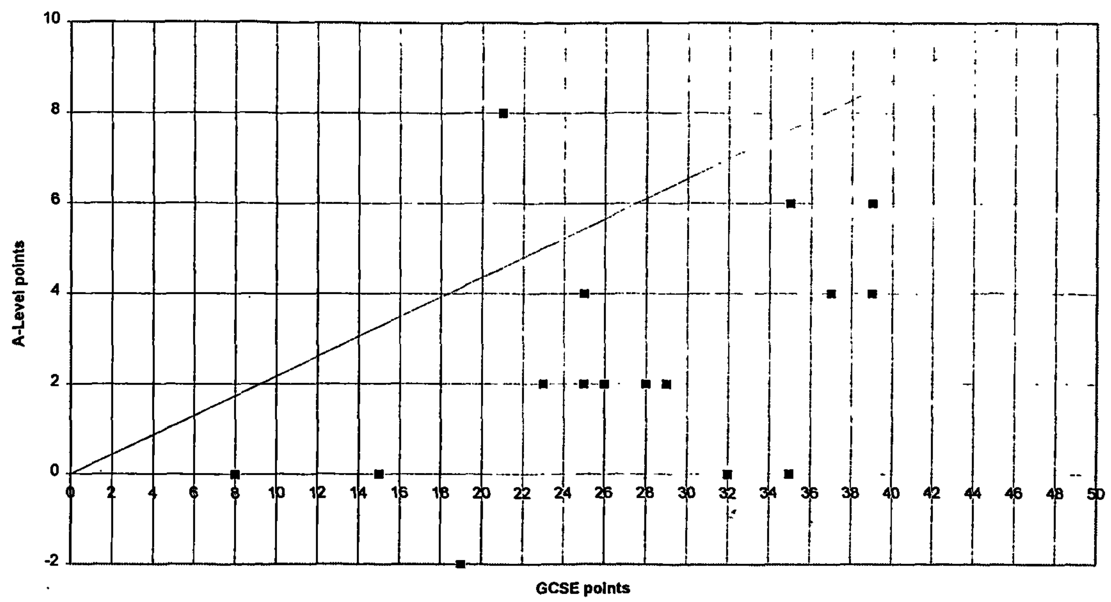


Figure 3.1b: Subject B ('unsuccessful'), pupil distribution by GCSE and A-Level points scores



It seems to be apparent from these graphs that pupils in subject *A* are achieving much 'better' results than those in subject *B* although their grades on entry are as evenly spread.

If this concept could be reproduced in a format that gave each school or each subject a single 'quality' mark which could then be utilised in a general measure of school performance (since we are concerned about flows to schools, and the league tables as published at a national scale will almost certainly always be a single measure for each school) then it is clear that it could provide a useful step along the value added road. The simplest measure would be a percentage measure for each pupil, measuring the proportion of the 'average expected result' at A-Level which had been obtained. This could then be aggregated up to a subject level, a school level, and no doubt also to an authority level, although as is always the case, definition would be lost along the way.

Crookes (1994) discusses work carried out in Leicestershire Education Department on a scale which sets a school's results against a particular year fixed as an index. The basis of this work is to calculate the change in results for a school as a percentage of the base year, thus gaining an idea of the school's improvement or decline over time. In order to reduce the problems associated with selecting a single year (with the potential problem that any year can be exceptionally 'good' or 'bad') as a base or index year, a rolling three-year average is utilised. In this instance, the first three-year period for which results are available, 1990-2, is used as the base year. Each school's improvement is then measured for the following three-year blocks (1991-3, 1992-4 *etc.*). However, although this is recognised as a useful approach, it is noted that

> "this sort of index favours schools that have a low starting point – to move from 1 to 2 is an increase of 100% but from 50 to 51 only 2%" (Crookes 1994, p2).

Clearly this will be a problem with any kind of measure which considers a school's relative improvement from its own starting score. The approach is recognised by the LEA as one which could begin to replace raw examination results as measures of school performance, using an 'improvement' score rather than an isolated score from one year which takes no account of previous performance.

3.4.3.2 Nottinghamshire

A report published in 1994 by Nottinghamshire County Council (Farnsworth *et al.* 1994) considers the GCSE and A-Level results for that county (in 1993) from a number of perspectives. The first section of the report considers the link between pupil characteristics and examination results while the later sections describe the results of a value added approach to the results which is based on socio-economic characteristics. Briefly, the report is an attempt to answer the following question;

> "What is the association between background and performance?" (Farnsworth *et al.* 1994, p1)

and three subsets of that main question;

> "[1] how can pupils' or schools' performances be compared making valid reference to the influences of poverty, gender, ethnicity or class? ... [2] to what extent should schools be held accountable for influences upon pupil performance that lie either beyond, or on the margins of, their direct control? ... [3] if schools are to be compared on the basis of examination data, are there cost-effective ways of adding to this data so that it can be turned to the developmental purposes of school improvement?" (Farnsworth *et al.* 1994, p1)

The research is based on a series of samples of Nottinghamshire pupils and their socio-economic characteristics. Over a period of four years, an initial 20% sample was used to discover those characteristics which showed statistical significance, and then the methodology shifted and a 100% sample was used in order to improve the accuracy of the results obtained. There is considerable emphasis placed on the acknowledgement that

> "socio-economic factors do not of themselves *cause* low or high performance" (Farnsworth *et al.* 1994, p3)

and that it can only be deduced that certain characteristics seem to be associated with either good or bad examination results.

Bearing this caveat in mind, the report continues by noting several associations in the data gathered;

- High attendance and professional parental occupation
- High staying-on rates and professional parental occupation
- High examination entry rates and professional parental occupation
- High mean examination scores and professional parental occupation
- Higher proportions of girls in higher achieving groups
- Higher proportions of white pupils in higher achieving groups
- Lower examination scores amongst those receiving FSM

These, it will be noted, are broadly similar to the connections noted in the Leeds data discussed in chapter six.

The value added work is based around a multi-level model (discussed in more depth in section 3.5 below) which employs pupil-level data on examination outcomes at age 16, parental occupational group, gender and receipt of FSM. The predicted examination values for each school and pupil are then compared with the actual results for that cohort and the residual (the difference between the two values) gives the 'value added' by the school or subject department to that pupil. In this way schools can be compared with each other given the 'expected' results for their particular catchments and within schools it is possible to compare pupils and departments and thus begin to target areas of the LEA and of individual schools which might be considered to be falling below the expected level.

Although Nottinghamshire has found this approach extremely useful and the project has been accepted by headteachers to provide information on their schools, there are a number of fairly immediate problems which could be identified. The first is that of data collection and preparation. A 100% sample of all of an LEA's pupils in terms of relatively 'sensitive' personal information (such as ethnicity or parental occupation) is a logistically complex and time-consuming task. Added to this, the data requirements of the multi-level model are such that the survey must be completed every year for every pupil and the various datasets combined into one central database. The second problem is one of explanation and dissemination. Model results must be explained to headteachers if they are to benefit from them, and they must be trained to employ the data sensibly. Equally, it must be possible to aggregate and anonymise the data sufficiently so that parents can be informed, at least in general terms, of the actual relative performance of the schools their children attend. Overall, however, the approach seems to work in that it can give schools a great deal of extra information at a variety of scales and does not require there to be any information about pupils' prior attainment. However, at the same time, the sheer scale of data required and the relative complexity of the models used makes it a very difficult methodology to employ at such a large scale and it seems likely that only a very dedicated LEA would take on the task of utilising it in the long term.

3.4.3.3 Manchester

Work on the schools in Manchester LEA has been the subject of a number of papers (Moulden and Bradford 1984, Bradford 1991). In these it is the importance of the 'residential environment' which takes centre stage. The 1984 Moulden and Bradford paper suggests that although the influence of the environment in which students live on their educational attainment is great, it is only part of a wider set of factors such as 'intelligence', social class and number of children *per* family. The essence of the Manchester findings were that

> "two children with exactly the same intelligence level, parental social class, and number of siblings would to some degree attain differently according to the local area in which they live." (Bradford 1991, p323)

This means that the general influence of the area in which a child lives can have an effect over and above the actual characteristics of the individual household. In other words, regardless of a child's *actual* social class he or she is likely to attain a higher level at school if the area is one with a high proportion of people of higher social class. Similar research on Scottish schoolchildren (Garner 1988, Garner and Raudenbush 1989) suggests that the effect of the local residential environment on two pupils with the same prior attainment and *home* environment may be as much as two attainment grades at age 16.

In an interesting departure from other research Bradford also considers the effect of parental choice on attainment. This, it transpires, has a significant effect on children's attainment. Coming fifth, statistically, behind the measures already mentioned, those children who did not attend their nearest appropriate school (the criteria for 'parental choice' under pre-1988 legislation)

> "tended to attain somewhat higher than expected given their intelligence, social backgrounds, and local residential area" (Bradford 1991, p328).

This could of course be indicative of a greater parental interest in the educational attainment of the children and therefore a more encouraging home environment generally rather than a direct indicator of improved attainment. In fact, it seems probable that this is the case, and Bradford emphasises this point (p329).

The final point made in the Manchester research is that under full parental preference the prior attitude of parents to particular schools may in effect be as large an influence on a school's attainment as the actual 'quality' of the students;

> "good marketing or an existing good reputation may ... in itself, by attracting large numbers of motivated pupils from outside its old catchment area improve the attainment level of its pupils." (Bradford 1991, p329)

This is in keeping with arguments made in earlier chapters which suggest that the increasing evidence of parental choice policies will be to increase the segregation of the British education system.

3.4.3.4 Leeds

Leeds LEA, although it employs officers whose task is to assist schools in the definition of their 'performance', has produced no formal publications relating to these issues. Because of this, this brief section is based on personal conversations with Malcolm Learoyd and Mark Pattison, advisors on the Raising Achievement Project (RAP). RAP takes in mainly examination results as a basis of its work and the officers then provide analyses which are requested by schools. The service is provided commercially on request to individual schools. Analysis of performance is accomplished at a range of scales depending on the requirements of the end user. The most common include relative studies with other schools, temporal studies of single schools and the relative performance across zones of the city. The analyses are generally performed with pupil-level data, perhaps relating individual scores with whole-school or whole-subject averages. Some social information is included in order to produce value-added studies based around exam scores and information from the Community Benefits and Rights section of the Council. The conclusions, given the nature of the work, tend to be specific to a particular school or area, although the project has identified a definite geography of truancy, based in part upon the availability of alternatives to school (such as the city centre or other large shopping areas). There is also a definite trend within the city for the inner schools to continue at a fairly constant level of achievement while the outer schools follow the more widespread, national average, pattern for a steady increase in performance as measured by exam success.

The Financial Services section of the LEA[13] has certainly noted problems with the allocation of additonal educational need (AEN)[14] resources based on the ethnicity of

---

[13] Based on conversations with Derek Howell, Principle Finance Officer, and Simon Darby, Senior Finance Officer, Leeds LEA

[14] Additional educational need (AEN) and special educational needs (SEN) are the two main measures of 'need' for extra assistance for pupils in schools. SEN is usually an educational measure (for example

pupils, because although a correlation does exist between deprivation and ethnicity, it does not always follow that pupils will require extra support solely because of their ethnic group. Specific problems include the fact that many GPs' children are included in this measure, as are children in traditionally educationally high-achieving groups, such as Hindus and more particularly Sikhs. In this case it is considered more useful to use the number of pupils for whom English is a second language ('E2L'). The introduction of E2L rather than a simple ethnicity measure actually widened the area covered by the social part of the funding formula, because some schools contain up to a third E2L pupils, even in traditionally high-attainment areas such as Horsforth in the north of the city[15]. However, the data on which these payments are based come largely from the schools themselves and are therefore often a headteacher's best guess at the proportions of pupils of various 'types' in a school. There is also the additional problem that it is exactly the same groups at whom additional funding is targeted who do not return LEA questionnaires regarding ethnicity and so forth. Research into the best methods for allocating such funding is ongoing in the LEA.

3.4.3.5 The School Curriculum and Assessment Authority (SCAA) for the DfEE

At the end of 1994 the SCAA under its chairman, Sir Ron Dearing, undertook a study of the various possibilities for value-added work in British schools (SCAA 1994). This work was responsible for the publication of two DfE pamphlets (1995i, ii) on value added and the initiation of a DfE-sponsored value added project at Newcastle University. The SCAA report considered a wide selection of current research for a number of age ranges. A total of 49 studies were covered, mainly from LEAs themselves, but including some more academic studies such as those of Goldstein on MLM (see below). The group made a number of recommendations, including that analysis should be carried out, "unless there were important reasons against this" (p23) on school-level data in order to reduce unnecessary bureaucracy and administration. This is an important point which has been mentioned above – temporally repetitive large-scale studies on pupil-level data are extremely difficult to carry out effectively or efficiently. They also acknowledged the importance in value-added studies of

---

allowing schools extra support for specific individual pupils with learning difficulties) whereas AEN is based on the theory that children from more deprived backgrounds *generally* benefit from additional resource support (see section 3.4.5)

[15] Where there are a large number of Bosnian children at primary schools

> "the need not to allow expectations of pupils from socially-disadvantaged backgrounds to be unduly low" (p47),

which is another recurring theme in the literature. The danger is that if it is found that pupils with such backgrounds tend *on average* to perform less well than socially advantaged pupils then no one will expect them to achieve at school and the imbalance in attainment will be perpetuated. A similar, although less strongly stressed, consideration should apply to gender imbalances in attainment, in that girls traditionally out-perform boys to a small degree in most subject areas.

The SCAA's recommendations, although criticised on publication (Gray 1994), include the development of "simple models" (p49) of value added by schools using school-level data, initially along three slightly different lines;

- linear model of academic outcome *versus* input academic measure (*e.g.* GCSE results *versus* A-Level results) (rec. 1/3a)
- model estimating proportion of pupils in a school achieving better than expected results (rec. 1/3b)
- tri-partite [*sic*] model which separates schools into three groups; those achieving roughly as expected according to national data, those achieving better than expected (upper quartile) and those achieving less well than expected (lower quartile) (rec. 1/3c)

With regard to the publication of school data (as annual 'league tables'), the report urges that raw data continue to be published alongside any value-added data, but that

> "further information on school performance, in addition to the data which is already available, should be published so as to put that data more appropriately into context" (rec. 2/1, p51)

and that some indication of the national spread about the mean for published data be given in order to further contextualise such data. They also recommended that the potential of using three-year rolling averages be investigated (rec. 2/3) as an alternative to single-year values in order to reduce the impact of 'good' or (perhaps more importantly) 'bad' years for individual schools (see Nottinghamshire, above). A further recommendation (2/4) was the publication of figures similar to those suggested in the Leicestershire study – a 'School Improvement Index' comparing a school's performance with its own performance in previous years – in order to supplement indications of how a school has performed in any one year. The report also recommends the continued development of improved data collection and analysis generally for schools and local authorities.

3.4.4 Multilevel modelling (MLM)

A further approach which has gained a number of advocates over recent years is multilevel modelling (often referred to as MLM). This is an approach based on the statistical technique of regression, and aims to take into account a range of factors which might influence a child's exam results;

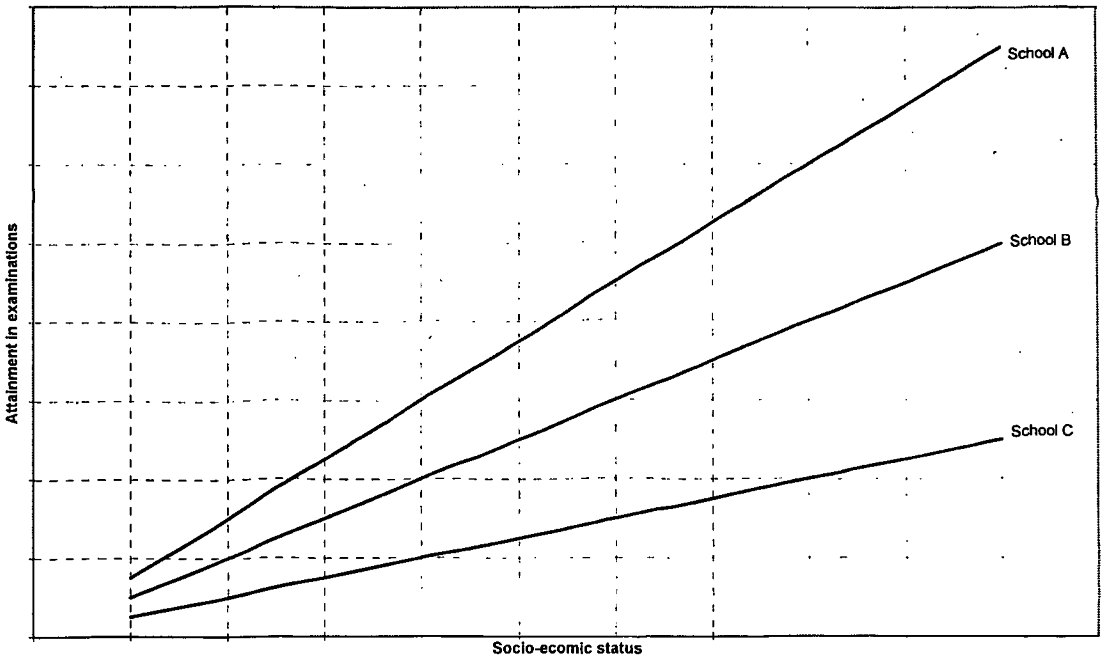
> "instead of isolating a single level of school organisation for study, [MLMs] watch for interactions across levels" (Raudenbush and Willms 1991, p6).

In other words, they are designed to take account of not only child-level data (for instance) but also the effects that schools, homes or some other level or set of levels might have on those children. In their simplest form MLMs take just two levels of data, which usually 'nest' with each other hierarchically[16], but it is possible to expand the approach to take into account more levels or more complex interplay between them. I shall concentrate on a simple explanation of the approach here – for an expansion see Goldstein (1987), Jones and Duncan (1994), Schagen (1994).

There is a wide literature on the subject of multilevel analysis of data, including much on education (see references above). This brief introduction to the area is based mainly on Paterson's (1991) account, which provides an excellent induction to the methodology of MLM. The multilevel approach recognises the fact that there are differences between schools in terms of the 'effective' delivery of education. To this end, it is clear, that if we follow the example of socio-economic status' effect on examination attainment, children of equal socio-economic status (SES) will not necessarily achieve the same results if they are at different schools. For example, a child of high socio-economic status might always, on average, 'outperform' a child of low socio-economic status, but the level of this variation might differ. This is perhaps most clearly explained in this simple figure;

[16] For instance, children can be nested into their schools, schools into LEA areas, children into residential areas *etc*.

Figure 3.2: Schematic representation of socio-economic status of pupils *versus* examination performance for three example schools



In all three schools the general trend is for examination performance to improve with socio-economic status. However, while school B demonstrates a very 'average' pattern, the relationship is far less marked in school C while in school A the SES of pupils makes a very marked difference to their exam scores.

Simple regression analysis is affected by 'chance' elements which may well have nothing to do with the elements being used in the equation;

> "regardless of whether they come from different schools, the observed difference in attainment between [two pupils of different SES] will arise from two sources: general association between attainment and SES, but also the chance factors that would cause any two pupils to differ even if they had the same SES" (Paterson 1991, p17).

These will be factors perhaps associated with the school, perhaps with some other psychological or physiological influence on the child. Hence, ordinary regression

> "could attribute to SES some attainment differences that were actually the result of school practice" (Paterson 1991, p21).

In an attempt to iron out this problem, MLM rewrites the standard regression equation[17] so that each school has its individual regression line;

$$\text{attainment}_{ij} = a_i + b_j\,(\text{SES})_{ij} + e_{ij} \qquad [3.5]$$

where the subscript *i* refers to pupils and *j* refers to schools. The standard MLM software then provides additional statistical tests to establish whether estimated differences in the effects of schools have occurred by chance because of the sample or whether they are likely to be a feature of the population as a whole. It can also test factors used to try and explain the variation between schools. In Paterson's example he uses school size and arrives at the hypothesis that "a pupil of average SES would have higher attainment in a larger ... school" (p24), although he qualifies this by acknowledging that school size is likely to be a proxy measure for other factors, such as a wider range of teacher skills or more facilities in classes.

Clearly MLM has much to offer those concerned with educational performance. It can take account of a range of data (although there is a need to define 'socio-economic status' in quantitative terms) and judge the likely effect of that data on outcomes such as examination results. However, much of the school-based work on MLMs comes from an educational rather than a geographical perspective (although there are notable examples of geographers employing MLM – see Duncan *et al.* 1996, Jones and Bullen 1993) and in this there is little explicit consideration of the effects of space on school outcomes. The use of socio-economic data implies that children will be from differing areas, but there is no real concern in the majority of the literature for where these areas are. From a number of points of view this could be seen as a failing. It is apparent that a child's address makes a difference to his or her socio-economic status, but it also affects that child's choice of schools and thus the possible range of in-school influences on attainment. However, there is no reason why an MLM approach should not provide the basis for a series of performance indicators based on quantitative data which could then be used as inputs into a spatial interaction model. They do not, however, appear to provide a complete solution to the problems facing educational planners.

---

[17] In this example; attainment = a + b (SES) + e
where a = intercept on y axis where x = 0
b = steepness of slope (ratio)
e = 'residual' (difference between actual and predicted attainment)

3.4.5 Finance departments: the definition of Additional Educational Need

Another requirement for the examination of neighbourhood and school populations is for the purpose of the allocation of financial support to help relatively disadvantaged students. This is usually referred to as 'additional educational need' or AEN and is a feature of the budgets of most LEAs, following a general policy of positive discrimination based on socio-economic disadvantage. Lee (1991) produced a survey of the varying methodologies used by schools to allocate such funding and a school's score on these indicators may be useful as a guide to likely performance (a school which is regarded as benefiting from AEN may perhaps be one which is failing to support its pupils sufficiently in-school). It is important to note that AEN is generally intended to support *socially* disadvantaged students by allocating more money to schools with a high proportion of these, in order to redress the balance with schools where many students are relatively socially advantaged and thus more *likely* to perform well in school. It is therefore a different measure to special educational needs (SEN) provision, which is targeted at *individual students* who have learning difficulties and is independent of any explicit social bias.

The measures employed and reported by Lee include both simple and complex indicators. The majority are based in some way on the proportion of pupils at schools in receipt of FSM, used as a proxy for a wider set of social disadvantages. However, the exact methods employed vary widely. Essex, for example, allocates extra funding to secondary schools if they have at least twice the sector average number of pupils entitled to FSM or a higher than average number of pupils scoring below a certain level on reading tests set at entry. In contrast, Gateshead automatically allocates all schools the equivalent of 0.5 full time teachers as additional support, but also has a formula for a 'social disadvantage quotient'. This formula takes the following form;

Amount allocated = £(SDQ x number on roll x unit cost *per* pupil)

The SDQ is calculated using the addresses of pupils to gather social data which are then weighted and summed;

Large families	(weight 1.0)
One parent households	(weight 1.0)
No car households	(weight 0.5)
Overcrowded family households	(weight 2.0)

Unemployment (weight 3.0)

This is clearly more complex in terms of data collection and collation that Essex's method, but it could be argued that it will be more accurate in terms of directing resources where they are most required. Most authorities appear to use some variation on these two basic approaches (see Lee 1991 for more examples).

These kinds of measure are potentially useful directly as 'performance indicators' only to an extent. Since they exclusively measure the relative social 'deprivation' of the schools in an LEA they do not give any indication of likely outcomes for pupils at those schools, except to the extent that they rely on the assumptions that; *a.* pupils from more deprived backgrounds achieve less good examination results and; *b.* extra financial support for schools can help alleviate these problems. What is required in terms of true 'PIs' is a method of combining these indicators of catchment deprivation with measures of school outcome. It is certainly difficult to see how a school could be shown to be 'improving' on an indicator which simply reflects the social composition of the area in which it is located – a brave school indeed would actually claim to have such wide-ranging social impact! However, it is, as has been noted before in this section, extremely useful to have an indication of the 'types' of pupil who attend each school in order to begin to build the sorts of PIs which are not exclusively based on exam outcomes. To this extent, there is clearly a great deal of potential in the work of LEA finance departments to help define the sorts of students (and by default, therefore, schools) who may require additional support from their authorities in order to achieve the same sorts of outcome as other, more advantaged students.

3.4.6 Further research, other possibilities, conclusions

There have been a number of other studies into the performance of schools and local authorities from a range of standpoints. Examples of most of these have already been given in this section, but there are a number of others which seem worthy of individual mention, and these are covered briefly here.

Brown (1994) reports work which categorises schools into four groups according to the socio-economic status (SES) of the population served by that school and their 'effectiveness' assessed on the basis of pupils' prior attainment (using MLM-based approaches);

- low SES, high effectiveness
- low SES, low effectiveness
- high SES, high effectiveness
- high SES, low effectiveness

The study focuses on the differential attainment of (and crucially, support for), "below-average achieving students" (p63) in these four school environments. However, he makes the important point that research thus far is "short on evidence that school effectiveness findings can be used to effect school improvement" (p65), or in other words, just because we know a school is performing well, we do not necessarily know why. Certainly part of the problem in actually effecting school improvement, Brown states, is that different pupils will react differently to various stimuli introduced to improve a school's performance and it is therefore difficult to achieve this across whole classes.

Riley and Nuttall (1994) discuss a number of measures, amongst them the links noted in a Canadian study between "effective classroom practices" (p127) and a series of other factors;

- low rate of student drop out
- low teacher turnover and absenteeism
- lack of conflict on school board
- high student attendance
- school board support and community acceptance
- teacher satisfaction.

In this respect, clearly, if it were possible to quantify 'effective classroom practices' then these could provide a useful measure of a school's performance as it related to a number of other factors. The reverse will clearly, to an extent, be true. Schools with low rates of drop out, truancy and teacher turnover could be said to be demonstrating effective classroom practices – a more academic way of phrasing the parental view that if a school has good exam results then it must be doing something right.

Another set of results is provided by Gordon (1996), who asserts the connection between 'family structure' and educational attainment. The main conclusions he draws in this regard are that children of single parents, and in particular non-employed[18] single parents, will achieve far less well in school than their peers with two resident parents. These children are also more likely to truant and less likely to stay on after compulsory schooling has ended. The outcome of this is that there is clear spatial variation in

---

[18] Which covers both the unemployed and those who are not economically active

unweighted average GCSE results. There is slight bias towards the south in terms of good results, and a slight non-metropolitan bias (towards the shire counties in particular), but the main difference is between inner city areas[19] and all others. He introduces the concept that attendance at school

> "is liable to be a significant intervening variable between environmental factors and exam performance" (Gordon 1996, p414)

and can therefore perhaps begin to provide the causal relationship which is missing from other analyses.

Haylock (1994) proposes what is not value-*added* but a value-*multiplied* approach based on national curriculum levels. In this schema a high attaining pupil moving from, say level 5 to level 6 (at Key Stage 2) would be 'worth' less in terms of value multiplied than moving a pupil at the same Key Stage from curriculum level 2 to level 3. The idea behind this is that it is 'easier' for teachers to continually push the high achievers to move from one level to another than it is to give the added support which is necessary to move lower achieving pupils up the curriculum ladder. The school could be given a score based on each pupil's progress, whereby the first pupil in the example would be worth 1.5 points (on the basis that 2 x 1.5 = 3) while the second would be worth only 1.2 (5 x 1.2 = 6). Thus a school which encourages its students across the ability range is given as much credit as those which "recruit brighter pupils" (p2) and thus show a steady increase in attainment level over the years.

Some simple research on the relative 'improvement' or 'decline' of GCSE results amongst LEAs in general and schools in Leeds in particular produces some interesting patterns. Carried out by the author and reported in Hackett (1995xx, xxi) this work shows that although there seems to be no particular pattern at a national level (see figure 3.3), in an individual city it is the inner city schools which have shown the greatest improvement in results and the 'high attainment' suburban schools have in many cases actually declined in performance. The patterns displayed in the maps show a clear contrast with the maps later in the thesis (particularly *cf.* chapter 4) which are concerned with raw examination data. A school or area is said to be 'improving' when the proportion of pupils gaining five or more GCSEs at grades A*-C is increasing while the

---

[19] the inner London boroughs, Birmingham, Leeds, Liverpool/Knowsley, Manchester, Newcastle and Sheffield

proportion of pupils gaining no GCSEs is decreasing. Similarly, a school or area is 'declining' in performance terms when the proportion of pupils with five or more good GCSEs is decreasing and the proportion with no GCSEs is increasing. Areas which are blank in the maps can be said to be 'polarising' either to show increased proportions of pupils at the two extremes of the pass scale (*i.e.* gaining either no GCSEs or at least 5 good passes) or with an increasing proportion of pupils falling into the area between these extremes (gaining some GCSEs but not 5 good passes). For ease of viewing in this example only the areas or schools showing a definite increase or decrease in performance are shown. The GCSE data used are from the DfEE's 1996/7 results list as published.

Figure 3.3a: England and Wales LEAs; 1992-5, areas of 'improvement' and 'decline' in GCSE results

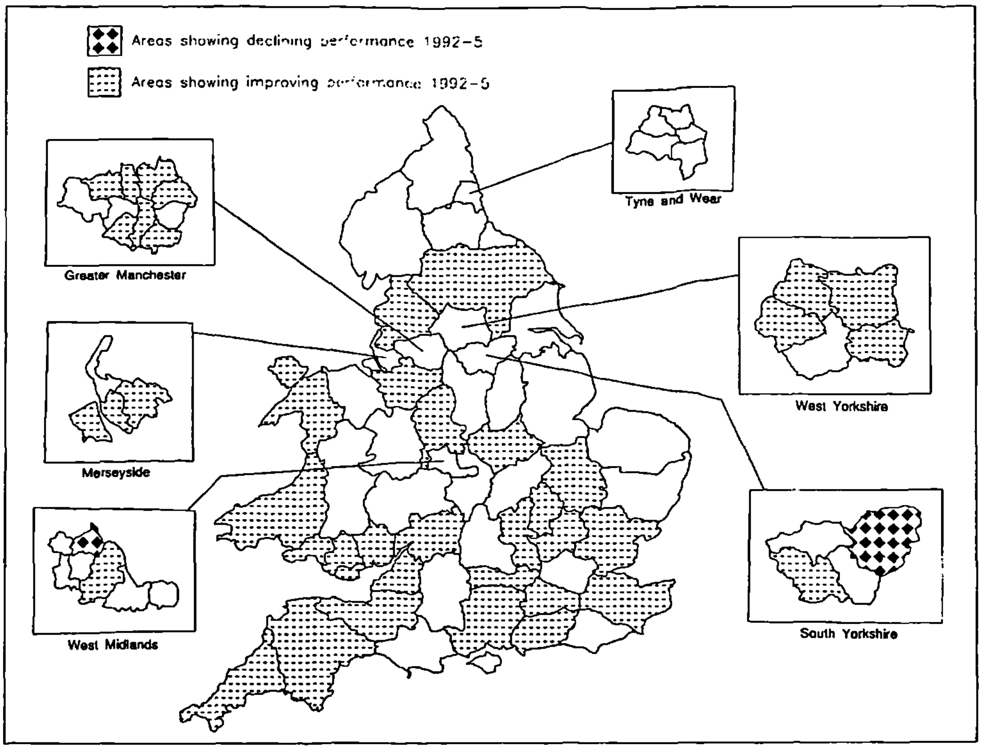


Figure 3.3b: London boroughs; 1992-5, areas of 'improvement' and 'decline' in GCSE results

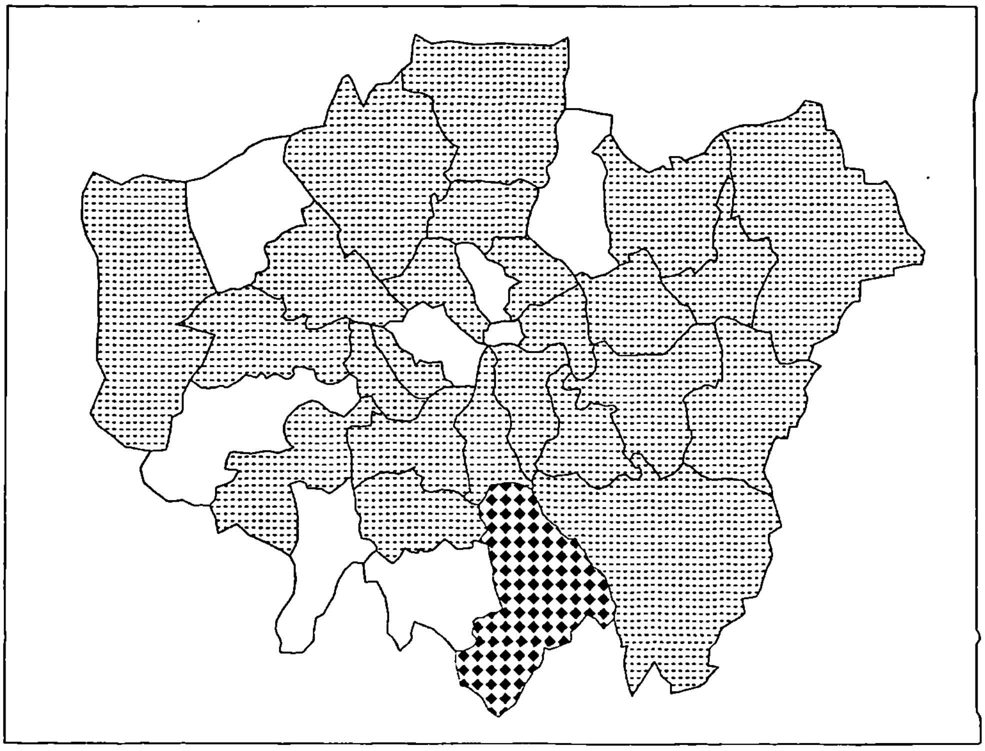
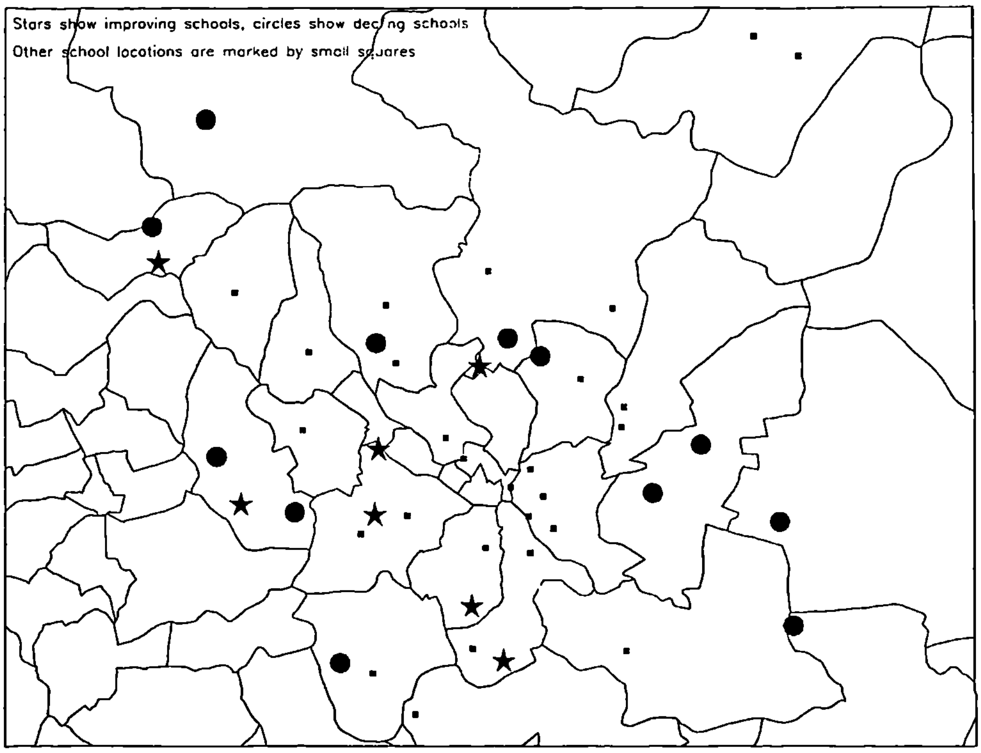


Figure 3.3c: Leeds secondary schools; 1992-5, areas of 'improvement' and 'decline' in GCSE results



Both Bellin *et al.* (1996) and Higgs *et al.* (forthcoming) take the use of census data as their basis for contextualising examination results as presented in the league tables. In this way, and through the use of GIS as a means of displaying the results so that they show a clear geographical bent in determining which areas of a city or LEA are in most need of added support, they aim to address the problem that areas of socio-economic deprivation are adversely affected by the publication of 'raw' results. Bellin *et al.* develop an index of attainment linking exam success or failure to a range of census variables through statistical methods. The variables used included such factors as employment data, ethnic structure and migration information. The study reveals that although in their sample of schools in south Wales there is some change in league table position when the socio-economic data are taken into consideration, there are also schools (including those at the very top of the table) which do not change a great deal at all. Indeed, the position in the tables before and after the adjustments carried out show a positive correlation significant to 99% confidence, although the fit line is not steep (the coefficient is 0.4771). A further useful observation is made in this report. If a school remains high in the tables after adjustment or it increases its position significantly, then there is unlikely to be a significant problem with its teaching style or academic output, whether that be *high or low in raw terms. However, if a school remains low in the* tables or shows significantly lower values than other schools on the adjusted scale (since by the very nature of a list someone must be at the bottom) then it begins to be possible to identify those schools which are failing their pupils in some way. Bellin *et al.* note that "the more damaging scenario is where there is little disadvantage and still lack of success in terms of examination performance" (1996, p24). However, although this is certainly true in general terms, in that schools in well-off areas do tend to produce higher results than less advantaged schools, there is a danger in taking this attitude in that it encourages an environment in which there is no expectation for less advantaged pupils to achieve good results, thus damaging the possibility of improving results in deprived areas at the expense of those who are already given more opportunity to achieve.

Higgs *et al.* (forthcoming) provides a useful review of work carried out in contextualising examination results, by both geographers and educationalists. They allocate census enumeration districts to schools in order to perform a catchment-based analysis which involves a range of census-derived data and the use of standard deprivation indices such as the Townsend Index (Townsend *et al.* 1988) and the Index of Local Conditions (Bradford *et al.* 1995, DoE 1994). GIS is used in order to display the results as maps and the results show distinct patterns of 'success' in raw results terms in more socially advantaged areas. The adjusted tables produced in the paper do begin to show (albeit with some caveats) that schools which appear to be performing poorly are not necessarily doing so given the socio-economic status of their intake. However, one immediate criticism of this work would be that the use of mutually exclusive and non-overlapping catchment areas to analyse school-level data would seem to be outmoded under the present climate, and it seems more appropriate to define schools based on their actual catchment, which may not be centred on the school and are certainly not non-overlapping.

Michael Barber (1994, Passmore 1994iv) has proposed the use of an index three-year average score with which future results can be compared, in a similar measure to the Leicestershire idea (see section 3.4.3.1). He highlights the potential problem that such a measure shows nothing about absolute performance (whether a school has high or low results), instead only showing how a school has performed relative to itself in previous years. Further work, along often similar lines to other research already noted, is discussed in Thomas *et al.* (1993), Garner (1994), Fitz-Gibbon (1994), Corbett (1994), Education (1994), Doe (1995), Murphy (1995), Boseley (1995) and O'Connor (1996i) amongst others.

In conclusion then, it is possible to see that there exists a vast range of possibilities in the area of performance indicators. These cover a multitude of possible fields, ranging from the simplistic (such as raw exam results) to the far more complicated indicators based on MLM or interaction modelling, the latter which are described in chapter five later on. One of the recurring themes is the difficulty of data collection and publication (no disaggregate data on pupils could ever be made widely available). This has a tendency to, at least until collection is more uniform and widespread, restrict certain kinds of study to single-time test exercises rather than a suitable basis for national application. This is particularly true of any methodologies which require the researchers to have access to pupil-level data. However, at the same time, a great deal of facility-level information is available, and this thesis has already shown the relative ease with which catchment profiles can be built up using pupil address data. There are a number of methodologies covered in this section which work well at a whole-school level and which can begin to improve raw examination data in terms of its comparability across schools and authorities.

It is always important to bear in mind a number of caveats when dealing with performance indicators, of whatever kind, and however 'statistically significant'. The first is the question, raised by Walsh (1994) amongst others that

> "it is not axiomatic that we should measure the performance of public service agencies at all" (p53)

and not a few commentators (*e.g.* Bradford 1991) query the potential impact of *any* published performance indicators (inevitably turned into lists of 'best' and 'worst' schools) – they will stigmatise whichever schools come last. This is perhaps best summarised by Hargreaves (1990);

> "If you strip a man naked in public, his first reaction is not usually to pull up his socks" (p110-11).

It is quite possible that rather than engendering a spirit of 'healthy competition' amongst schools in the fight for more pupils an ethos of PIs could encourage a greater division between schools at the top and bottom ends of published tables and thus continue the trends noted earlier in this thesis for increased social polarisation of schools. Bradford (1991) warns further that "education may be reduced solely to attainment [in exams]" (p321). However, it is clear that 'league tables' are here to stay, and it is equally clear that having some form of contextualising measure published alongside raw exam results is a useful and informative exercise. This means that there will continue to be a place in education for the sorts of measures outlined here, and perhaps more so within local authorities themselves, where more complex, detailed PIs could be employed for the purpose that is already partly defined for them – targeting resources more effectively towards the schools which may need extra support to reduce the declining rolls which are the consequence of parental choice.

3.5 Conclusions

This chapter has covered a range of issues of relevance to education planning in Britain in the 1990s. The general problems facing planners have been placed in the context of an urban LEA which provides the case study material for the applied chapters of this thesis. Performance indicators, an increasingly important part of LEAs' work, have been outlined in depth and a wide range of them described, from the simplistic exam scores published in the league tables through to complex statistical and mathematical models of attainment incorporating social and school information. These set the scene for the applied geography of chapters four and six to eight, where the set of tools outlined in chapter one are detailed and utilised with the Leeds dataset. There is also some further work on the development of performance indicators outlined in chapter five, where the theories of spatial modelling are applied to the measurement of performance.

It is a certain conclusion from this chapter that there is a distinct need for accurate and timely information regarding schools within an LEA. This is important from a variety of standpoints. The planning officers need to know where pupils will be living, and which school they are likely to attend. Finance officers need to be able to fairly distribute resources available based on 'need'. Parents need information to enable them to choose the school they think will best suit their children. Finally, auditors and central government need information which will allow them to monitor the overall 'quality' of the service being provided. An enormous range of indicators now exist to assist with these problems, as has been shown. From a geographical perspective the indicators can give a fascinating insight into the spatial variation in school or authority performance, and as we shall see in chapter four, this can be married with social data to attempt to begin to explain the patterns which emerge. It is also the case that there is a need within spatial modelling to provide for measures of the 'attractiveness' of schools in order to accurately predict which children will attend. To this end the indicators as outlined can be directly applied within the models, and we shall see some examples of this in chapters six and seven. There is thus a direct link between the work which has been carried out in LEAs, addressing different problems, and the explicitly geographical work detailed in the remainder of this thesis. This is a two-way process. Not only can a geographical approach begin to provide a methodology for explaining the educational data, but the educational indicator data can provide vital elements in the development of accurate geographical modelling tools.

Geographers are clearly and rightly increasingly interested in the general field of education, and more recently this interest has tended to incorporate some of the techniques initially outlined in Clarke and Langley (1994). What the remainder of this thesis attempts is to develop the arguments made there and to exemplify exactly how

GIS and spatial modelling techniques can be applied in the specific context of education in LEAs. Clearly, since the problems outlined are not unique to LEAs (although they are still the largest single provider of education in the UK and therefore the most widely affected) the techniques outlined can be utilised by any other body concerned with the planning of school places. This means that not only LEAs, but also the FAS, perhaps to a certain extent those who run independent schools and ultimately the DfEE would be wise to consider their implementation of modern geographical tools. It will become clear through the next six chapters how large an impact on the decision-making process such tools could potentially have.

Chapter four

Geographical information systems and schools planning: possibilities and problems

4.1 Introduction

Education is, as chapter three showed, a very data-rich field. It is a particularly valuable area from a geographical point of view since all of the data held on pupils or schools can be spatially referenced. This means that the data resource is one which lends itself very well to the sorts of display and analysis for which geographical information systems (GIS) were designed. At the most basic level, the value of simply displaying data in map form cannot be stressed too highly. This is especially the case in education, where the reasons for and implications of planning decisions must be presented to a wide range of groups, from parents to councillors, most of whom will have no specialist knowledge of the work carried out by planning officers.

At another level, the usefulness to planners of the ability to describe pupils in terms of say census data, or to assess the number of pupils within ten minutes of a school, or to identify the shortest route from a house to a school is also a crucial part of their work. It is becoming increasingly important under the more recent legislation discussed in chapter two for planners to know not only who goes to which school, but also to try and define why these interactions take place. GIS can begin to offer some assistance to planners through improved data handling and display.

This chapter attempts to define GIS in terms of its usefulness to education planners and then to explore the possibilities and limitations of GIS for such planners using the example of Leeds LEA. Section 4.2 defines GIS and its various functions, while sections 4.3 to 4.5 consider the three main applications in terms of education. The final section summarises the conclusions and suggests ways in which LEAs can begin to look beyond the simple analysis available in GIS as an introduction to the later chapters of the thesis.

4.2 Geographical information systems: definitions and functions

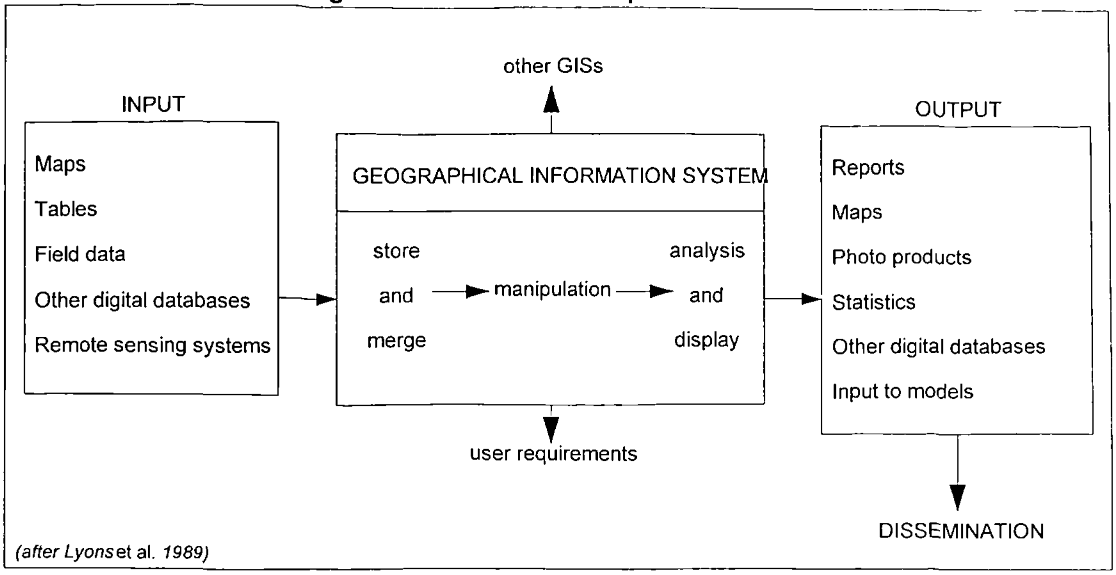
4.2.1 General definitions

The idea of collecting geographical information into one place for ease of reference and application is not new. As Wright (1988) reports, the Domesday book of 1086 was a form of geographical information system (GIS) insofar as it was a collection of data which was largely spatial in nature. In his article, Wright argues that it is not the concept of 'GIS' which has changed, but the technology employed in their creation and manipulation. However, he is one of the few commentators who take this explicitly historical line in defining GIS as we know it today. Ball and Babbage (1989) are more typical when they describe GIS as "a system which facilitates the storage and intelligent use of geographical data" (p4), while Stefanovic (quoted in Taylor 1991) defines GIS as,

> "'a system for capturing, storing, checking, integrating, manipulating, analysing and displaying data which are spatially referenced to the Earth,'" (p12)

which is a slightly more precise definition. Rhind (1981) takes a similar line, although he introduces more explicitly the concept of a computer-specific methodology. However, all commentators agree that it is the fact that GIS handles spatial information which is the key to its definition. Figure 4.1 summarises the main components of GIS as they relate to each other and suggests the kinds of input and output which may be associated with a GIS.

Figure 4.1: The main components of GIS



Perhaps the most immediately obvious use of GIS is the ability to quickly and easily take in data and output it in the form of maps. This means that GIS is ideal for the displaying of complex data resources in an easily-understandable and useful format. This is the case for all potential users, but is perhaps particularly helpful when information or decisions must be communicated to a non-expert audience, or the range of system users is extremely wide. A longer discussion of the origin and definition of GIS can be found in Maguire (1991) and more generally in contributions to Maguire *et al.* (1991i, ii)

4.2.2 GIS and local education authorities

The development of GIS within local authorities as a whole has a chequered history. The principal use has been for the production and maintenance of land use maps, and substantial savings of time and money have been suggested (Bromley and Coulson 1989, Buxton 1989, Antenucci *et al.* 1991, Swainston 1993). However the general consensus in most review articles (Worrall 1990, Birkin *et al.* 1996) is that GIS has not penetrated into more proactive areas of local planning and remains therefore at a low level of policy analysis. Certainly the production of maps is useful, but in the words of Hirschfield *et al.* (1991), "this is rarely adequate as the sole outcome" (p154). Indeed, some are beginning to conclude that GIS is the latest in a series of IT solutions which have promised much but delivered little (Allinson 1993).

The problem lies partly with GIS itself and partly with potential users. First, it can be argued that GIS (for policy analysis) desperately requires greater analytical procedures. This is the primary argument of an increasing number of GIS consultants and one which is developed further below and in later chapters (especially five and nine). However, a second argument is that planners require greater guidance on how the full potential of GIS can be realised. To this end it could be argued that there is a need for more immediately user-friendly, integrated desktop packages which can be employed quickly and easily by those in the mainstream of planning and policy development.

There are, as we have seen in chapter three, a number of planning functions carried out by LEAs on a regular basis which have a distinct geographical flavour. To supplement their more 'traditional' planning methods, a number are now looking to the potential of GIS. At present, most of the authorities which are making use of GIS have access only to packages held corporately rather than packages specifically purchased or designed for education. In fact, in many of the reviews of GIS in local authorities or urban planning, education is not one of the departments mentioned as a direct beneficiary of the technology (Ford 1995, Peel 1995, Scholten and Stillwell 1990). The remainder of this section describes the basic functionality of GIS and later sections offer a blueprint for its development in education.

At present it would seem that the use of GIS in education departments is still a new, albeit expanding, area. The actual GIS is in many cases peripheral to the main work carried out, being used as a basic mapping tool rather than for analysis. However, there is beginning to be some evidence of a more proactive use of the available technology (Ireland 1995). The brief introduction to the various processes in this section is expanded and illustrated in sections 4.4 and 4.5. The benefits of displaying data visually through maps are many, and in particular it is true that spatial patterns, which are often hidden by other display methods, become much clearer. This can then be used as the stepping stone to more detailed investigation. It is also simple to visualise the effects of changing the scale of analysis, say from a national picture to a single LEA, and then even down to an individual pupil level, depending on the availability of data. For individual schools this information could also be used in order to improve their marketing information – it would for instance be a simple process to map current 'market penetration' and extrapolate this to areas which could be targeted in future years.

Once data has been inputted into a GIS the user needs to consider ways in which 'analysis' can be performed. Although the many datasets available (see chapter three) are valuable in their own right, they can be much more valuable in combination. Data linkage is one of the most fundamental methods of adding value to data within a GIS. The first and most basic form of analysis is the use of simple arithmetic operations. This would certainly be the method used in generating the market share information mentioned above. In most GIS packages, however, the concept of polygon overlay is central to this linkage process. This includes the layering of information within a single map outline. For example, this process could be used to overlay pupil distribution in relation to census variables, which could allow authorities to begin to build social profiles of schools.

This overlay procedure is often undertaken in conjunction with spatial buffering in order to assist impact assessment. Buffering allows the user to draw bands of equal distance or travel time around points (or other map features) and thus to calculate say the population within these 'new' regions. Perhaps the most likely use of this function in education would be to estimate the school-age population within a most likely catchment area of a school. Although this is the typical approach used in GIS applications for impact assessment in retail and service planning (Grimshaw 1994, Castle 1993), there are problems with this procedure and these are discussed in later sections.

It is also possible to utilise network analysis routines in GIS. These routines are designed to calculate the 'ideal' route from one point on a network to another given maximum/minimum travel time or cost constraints. Clearly this is extremely useful for an LEA which is required to provide for free transportation for some of its pupils[20]. Routines in off-the-shelf packages such as the ALLOCATE routine in Arc/Info can also suggest the optimum route between start and end points specified by the user,

[20] Those who attend their nearest state secondary school but who live more than three miles from that school qualify for free transport provided by the LEA (see chapter three)

incorporating extra points as required. Such a facility has obvious potential in terms of experimentation with alternative school 'bus timetables, routes and pick-up points. Indeed, the Arc/Info manuals (ESRI 1992, p4.2) actually cite the example of school roll planning, using the ALLOCATE routine to assign individual pupils to their closest school. However, in some LEAs, as stated in the previous chapter, the designation of routes is left to the public service providers, on whose routes LEAs simply provide free transport for their pupils.

4.2.3 Conclusions

There are obviously many aspects of GIS technology which could be of great utility in LEAs. These are not currently in use in many cases, partly because of a lack of awareness amongst potential users (which has certainly been the case in Leeds) and in some cases because of a lack of access to the technology (another problem which has until recently been faced in Leeds). What is needed is a thorough review of the possibilities given by GIS for education planners and the increased dissemination of information to these potential users. The following sections in this chapter attempt at least the first of these by considering the real-world application of the more significant of the GIS functions using data from Leeds LEA. It should be noted that school names and postal district labels have been omitted for reasons of data confidentiality, and that some school locations have been altered in order to preserve both anonymity and ease of viewing.

4.3 Geocoding

Geocoding is the facility central to GIS which enables the storage of data (or 'attribute information') which relates to any feature which has a spatial reference (the 'geographic information') and which allows the retrieval of this information when a user highlights such a feature. Information can relate to points (school locations, for example), lines (usually roads in an education context) or areas (postal areas, for instance). It is usual for all of these to be operating together. In order to map a school catchment area, for example, pupils' home addresses need to be accurately located on a street plan or within census or postal units. The process of geocoding is made far simpler when, as in the case of education, all the data have a common geographical identity, such as postcodes. However, the simplicity of dealing with one department and thus one set of data (plus the census) is upset by the fact that it is useful to share information across departments. Thus it is likely that information will be in a variety of spatial units, often with little relation to each other, since different departments of the same council will often subdivide the city in different ways to suit their own approach. However, this problem is becoming increasingly easy to manage as more and more data is collected and held with postcodes attached. The table below demonstrates this process by listing four potential sources of information available to LEA planning officers and the scale at which the data exist. It should be compared with the data which LEAs believe to be easily available to them shown in chapter three (table 3.1 in particular).

Table 4.1: Data potentially available and useful to LEA planning officers

LEA	*Child Health Service*	*Social Services*	*Police*
Free school meals (sch)	Children with severe learning difficulties (sch)	Income support rates (pc)	Number of offenders (pc)
Ethnic composition (sch)	Special educational needs (sch, pc)	Condition of housing property register (pc)	Number of crimes (pc)
Vandalism rates (sch)	Waiting lists for health facilities (fac)	Home care information (pc)	
Exam results, standard attainment targets (SATs) *etc.* (sch, pc)	Failure-to-thrive data (pc)		
Attendance rates, unauthorised absence (sch)	Child protection numbers (pc)		
Rolls, projected rolls, historical data (sch)			
Nursery places (sch)			
Pupil/teacher ratios (sch)			
Teaching resources (*e.g.* computers: sch)			sch = school level data
Other teacher data (*e.g.* years of service: sch)			pc = postcode level data

There is clearly a great deal of data available for those working in education to contextualise their system. Some of this is easily available from colleagues within the education department, while other datasets require more complex inter-departmental negotiation. This is particularly true of the often highly sensitive information held by social services and the police force. Unfortunately, it is also the case that in many ways the data social services can provide may turn out to be the most appropriate and up-to-date support to census-based analysis, providing critical data on the likely social composition of areas served by the LEA's schools. It is therefore important for LEAs not only to develop their utilisation of GIS technology, but to nurture the links between departments which can provide considerable mutually useful information and open up the possibility for more in-depth analysis based on the best available data.

4.4 Visualisation

4.4.1 Introduction

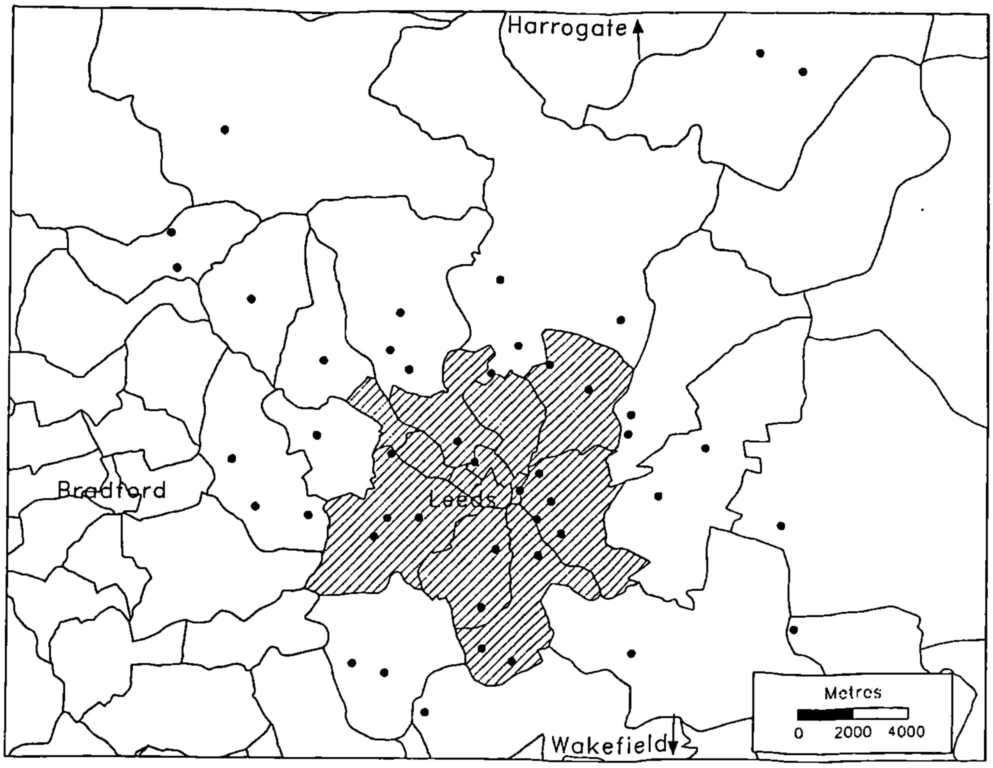
As we have seen in chapter three, one of the main rôles of an LEA is to monitor pupil numbers and plan for changes in the school-age population. This is becoming harder with the advent of full parental preference and the possibility of schools opting out of the LEA's control. In this situation it therefore seems more important than ever to utilise a system which can quickly and easily show officers where pupils live, or (given accurate predictive capabilities – see chapter five) where they will be living. This can take two basic and closely interlinked forms within GIS. The first approach is simply to look at school rolls and with time-series data it can easily be seen which schools are growing and which declining. Once 'problem areas' (in terms of growth or decline) have been noted, it is possible to assume that the area fits one of two broad categories; demographic changes (the local population is dwindling or increasing) or pull factors (a school's attractiveness to parents is increasing or the school is losing out to other facilities).

To aid the definition process it is useful to examine the catchment areas of schools. From this information it would be possible to define how individual schools change over time in terms of their pupil base and to begin to build profiles of the students at particular schools. Having begun the process described above, and reached a stage where there is a significant knowledge base regarding the locations of pupils and the changing rolls of schools, it also seems sensible to actively exploit the wide range of other data available to LEAs. Aside from data on pupil addresses, LEAs also have access to (as we have seen) large quantities of data regarding such subjects as examination results, truancy, free school meals (FSM) and special educational needs (SEN) at either a pupil or school level. It is also usual for an LEA to have access to the census of population. The following sections consider the separate uses of these various datasets with regard to the Leeds LEA, in an attempt to exemplify how useful simple mapping and display of data can be in gaining a greater understanding of the composition of and processes underlying an urban LEA.

The maps used throughout the thesis are based on the postal districts and individual secondary school locations within the general Leeds area. Some of the major features of the geography of the region are shown in figure 4.2 below. On this figure, the dots represent the 45 secondary schools within the Leeds Education Authority area while the major cities impacting on Leeds are also marked. The shaded area in the centre of the map outlines the approximate area which is referred to by the phrases 'central Leeds' or 'inner Leeds'. The schools within this area can be generally categorised as 'inner city' schools, as the following analysis will demonstrate. Leeds LEA's boundary follows approximately a line enclosing the outermost schools on the map. Given the nature of the legislative climate in which they operate and the spatial scale of the analysis which follows it does not seem entirely appropriate to map it exactly, since it may detract from the fact that pupils may as easily attend Leeds schools from outside this area as from within.

The particular reasons for selecting this geography for data display and analysis have been outlined already in section 3.3, and it suffices to reaffirm that the main aim is to match data availability from LEA and other sources. The second main purpose is to remain as far as possible within the working style of the LEA, who have switched from electoral to postal geography largely following the demise of fixed catchments and the possibility of inter-LEA pupil flows. Although the modelling work in later chapters has been carried out at a postal sector level for reasons of pupil confidentiality it was deemed appropriate to display results at the aggregate district level. For the same reason Leeds LEA, who supplied all the pupil-level data used in this thesis, requested that schools not be identified by name nor postal districts labelled. Although the addition of such labelling would certainly aid comprehension of the maps which follow, it is not necessary to have more than an idea of the general 'real' geography to understand the patterns which emerge.

Figure 4.2: Base geography of the study region



4.4.2 Facility-level data: schools

The simplest and perhaps most common use of GIS display would be to visualise the numbers of pupils at schools. Figure 4.3 shows the rolls at Leeds secondary schools in the 1992/3 academic year. It is immediately apparent that the larger schools are on the periphery of the city, especially to the north and west. The change in rolls between this date and the 1994/5 academic year can be seen in figure 4.4. It is possible to see how even in this relatively short period the inner city schools have declined while the outer ones have grown ever larger. The pattern shown is partly due to large popular schools poaching other local children away from neighbouring schools (particularly in the case of the north eastern schools, partly due to population effects (in the south west) and partly due to the continuing popularity of certain high-performing schools (all the outer sites, especially in the north and west). This suggests that the likely changes in the education system suggested in chapters one to three are correct – there is indeed beginning to be a shift of pupils outward to the higher-performing suburban schools. This conclusion can be supported by the display of relative variables, such as the proportion of places filled at the different schools. Figure 4.5 shows this for 1995/6, a pattern which, by displaying the same patterns as before confirms the suspicion that it is the inner schools which suffer from excessive surplus places while the outer schools thrive, and in some cases take on a small excess of pupils.

Figure 4.3: Leeds secondary school rolls 1992/3

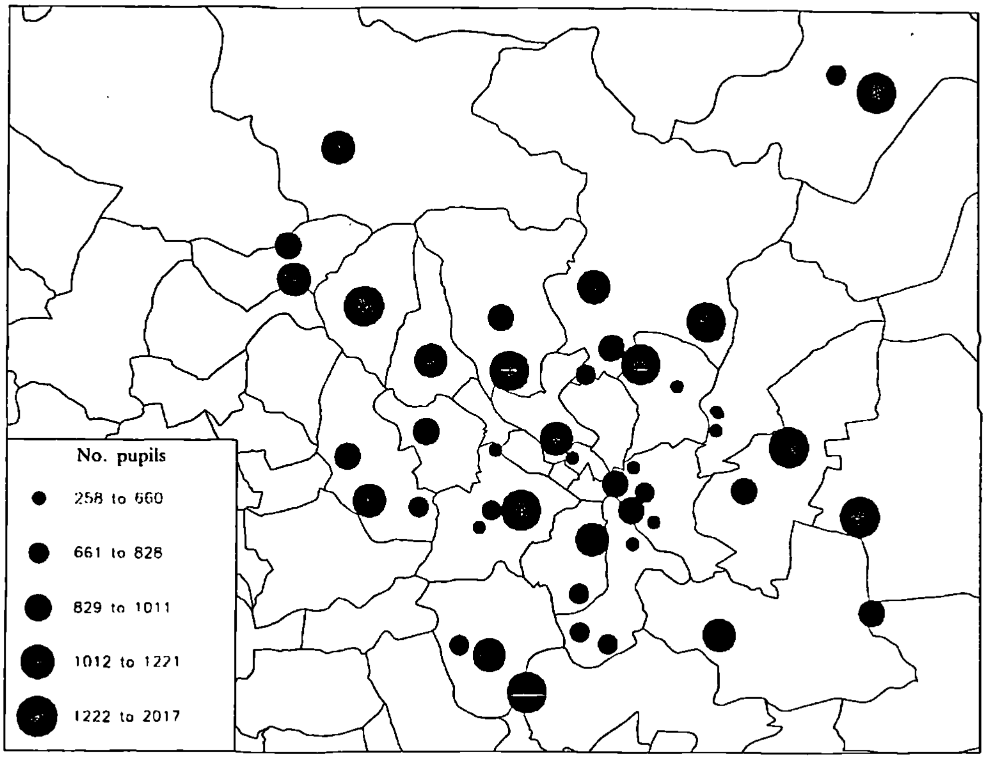


Figure 4.4: Changes in Leeds secondary school rolls 1992/3 to 1994/5

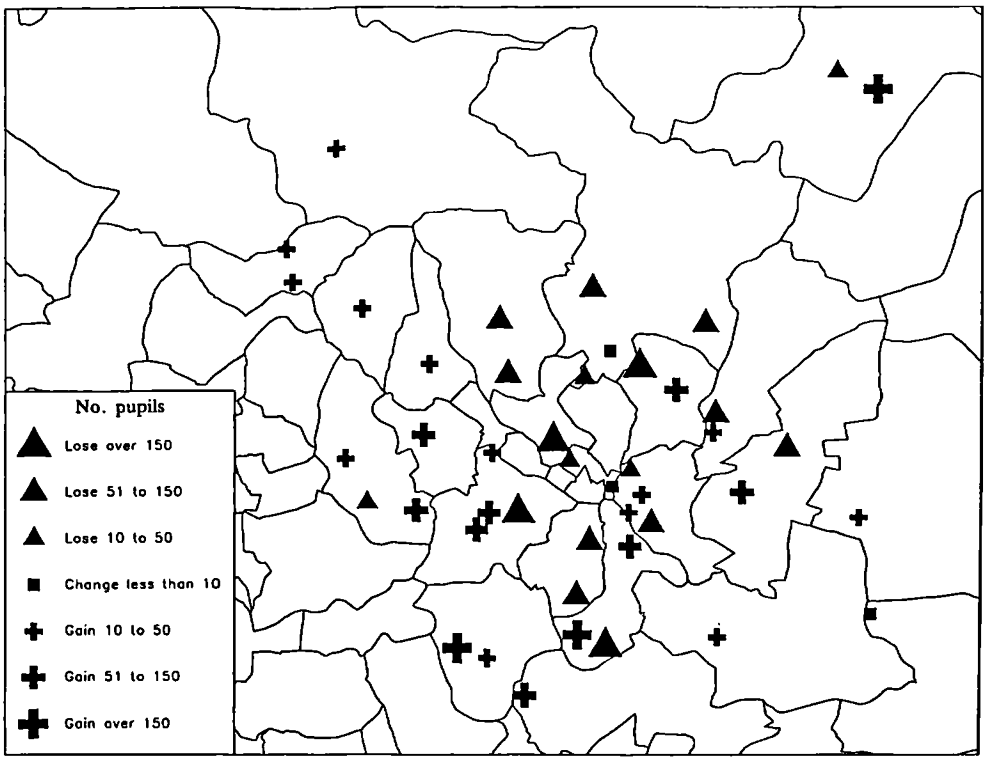
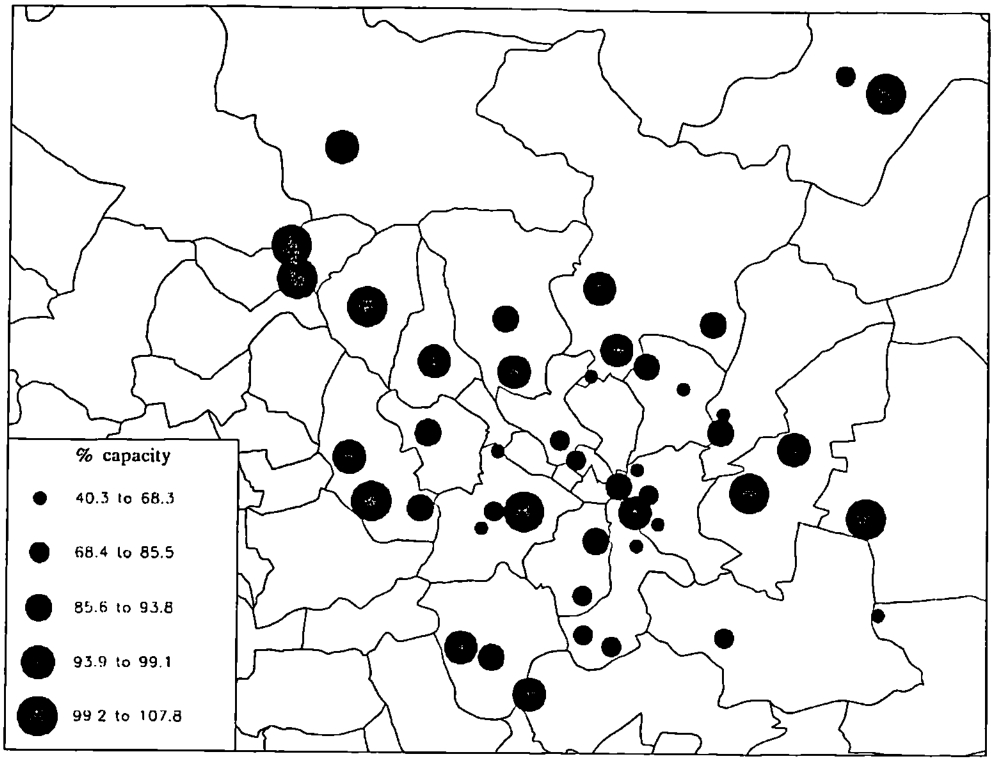
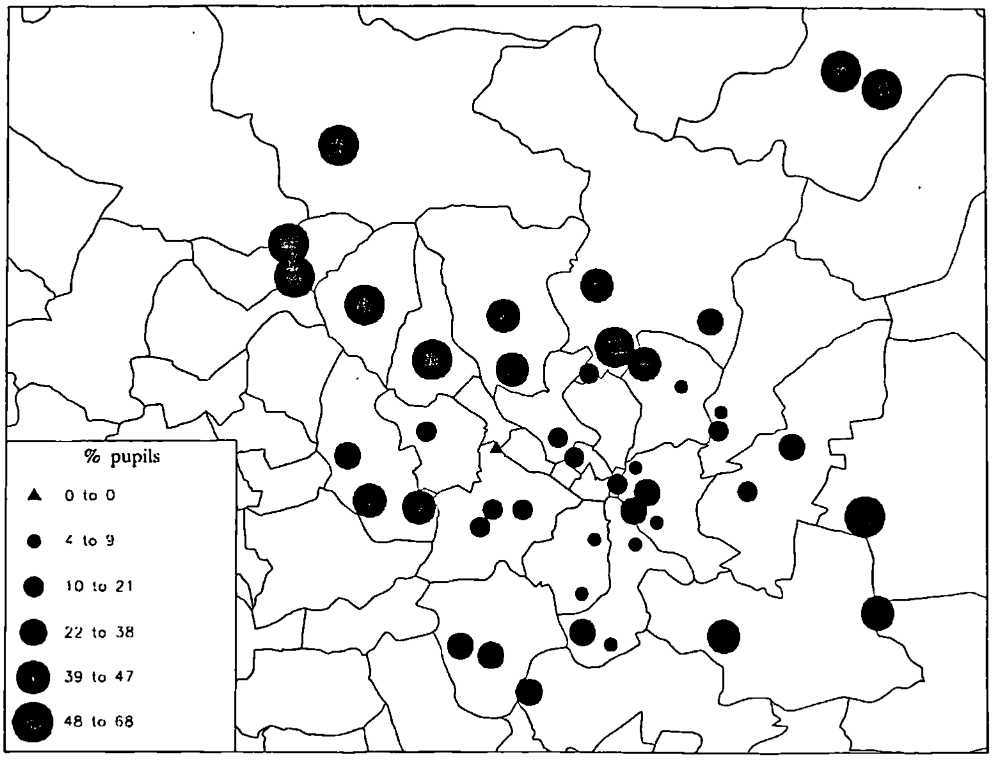


Figure 4.5: Proportion of places filled at Leeds secondary schools 1994/5



In an initial attempt to explain the variation in rolls, and remaining at the level of the school for the moment, we can map such measures as examination results and compare these with the roll maps above. It is immediately apparent by comparing figure 4.6 with the maps above that the best-performing schools in terms of GCSE results are the heavily subscribed outer, suburban schools. In contrast, the inner city schools with many surplus places have significantly lower exam pass rates.

Figure 4.6: Percent of pupils gaining 5+ GCSEs, Leeds secondary schools 1994/5



A similar inner-outer dichotomy exists with other indicators relating to schools. Figures 4.7 through 4.10 display a number of these, and in all cases it is the outer schools which show the 'best' characteristics – high exam results, low FSM and SEN rates, low truancy levels and so on. Thus we can begin to piece together a spatial image of a city's education characteristics, relating school rolls to school-level data perhaps allowing us to begin to understand what makes certain schools more popular than others.

Figure 4.7: Free school meal rates (% of pupils on roll) 1994/5

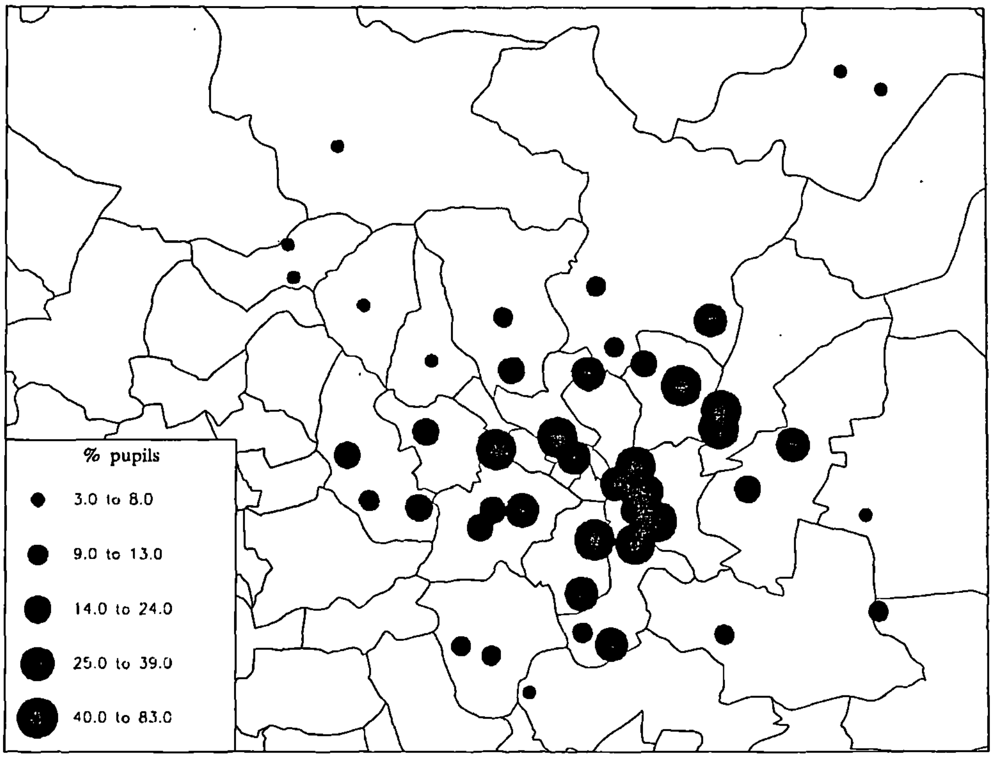


Figure 4.8: Special educational needs rates (% of pupils on roll) 1994/5

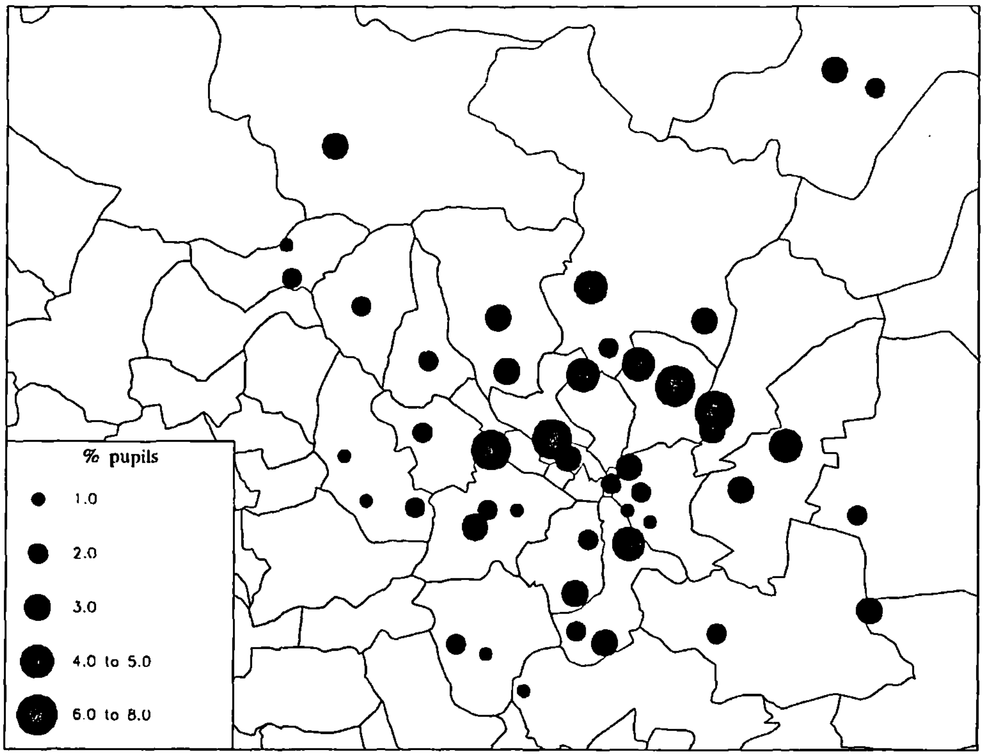


Figure 4.9: Pupil-teacher ratios 1994/5

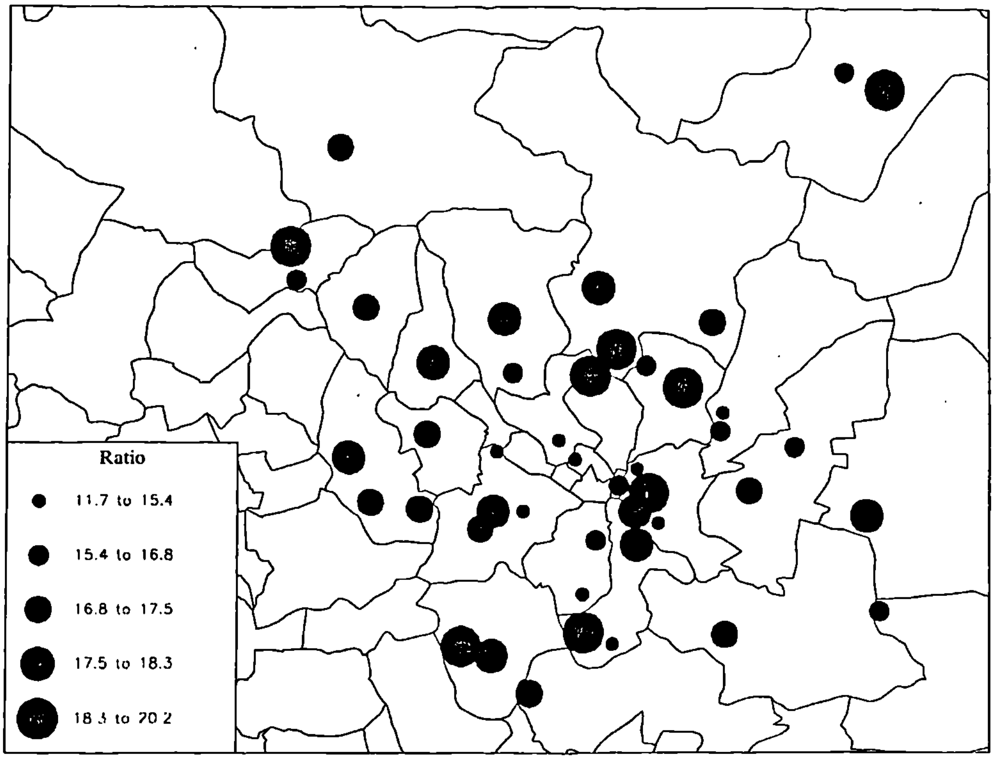
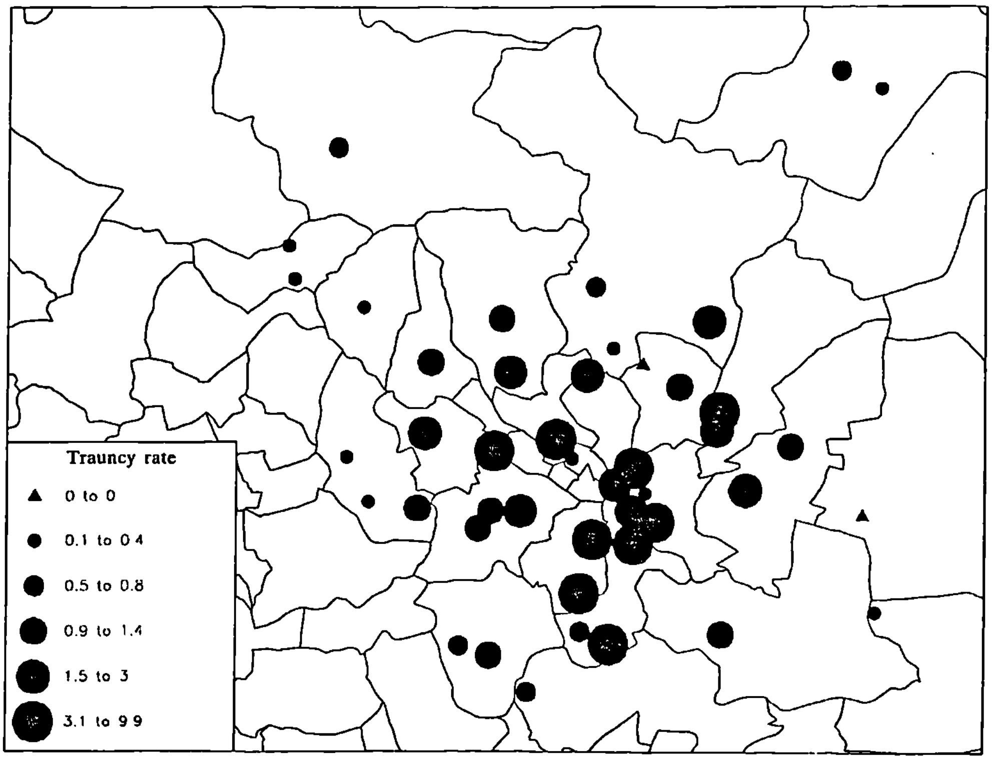


Figure 4.10: Unauthorised truancy rates 1994/5 (% half days missed)



4.4.3 Area-level data: catchments and postal areas

A further development and useful enhancement of the definition of school-level characteristics is the visualisation of school catchment areas and data associated with these. This is a particularly valuable characteristic of GIS since LEAs can no longer set the boundaries of catchments themselves. Since parents can in theory send their children to any school it is crucial for the LEA to know from where their pupils are travelling in order to define areas of the city which may not be attracting the local population. Such information could be used as another stage in the definition of 'failing' schools and could therefore inform strategies for improvement of the delivery of the education service.

Figure 6.1 shows the total pupil catchment for the 45 Leeds secondary schools. There is clearly a concentration in the inner areas, with very few pupils coming from the more northern districts (Harrogate and York) and a few from areas such as Wakefield to the south and Bradford to the west. This is to be expected. If we then go on to examine catchments of individual schools, however, some interesting patterns begin to emerge. Figures 4.11 through 4.14 show the catchments of a range of schools in both inner and outer Leeds. It is clear that the larger, fuller, outer schools have far larger catchments and pull pupils from a very wide range of areas. By contrast, the inner schools rely almost entirely on those children who live in close proximity. However, it is important to note that although the extent of the catchments varies widely, all the schools draw the majority of their students from the postal areas closest to them. Figures 4.15 and 4.16 compare the proportions of pupils from each postal district attending two schools, one inner and one outer. In this case it seems certain that although the numbers being drawn from the districts around the outer school are larger, there is relatively little difference in the proportions of pupils from these areas. Of course, this must be balanced against the fact that the sphere of influence of the outer school is far in excess of that of the inner, where there is clearly much cause for concern over the roll.

Figure 4.11: Catchment area, outer school 1

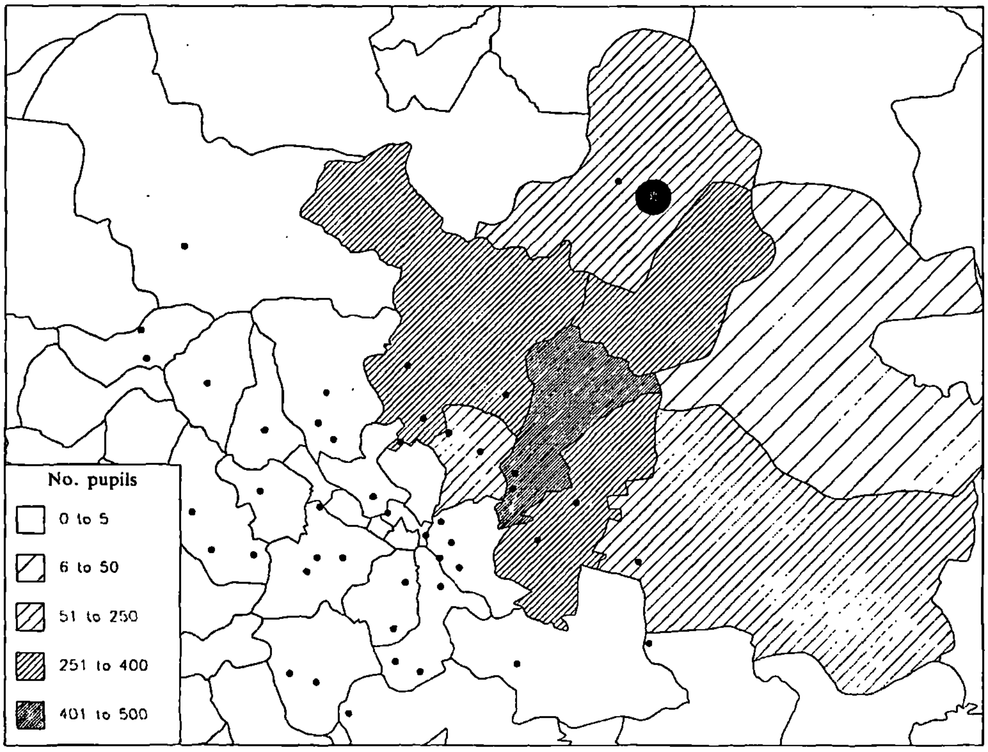


Figure 4.12: Catchment area, outer school 2

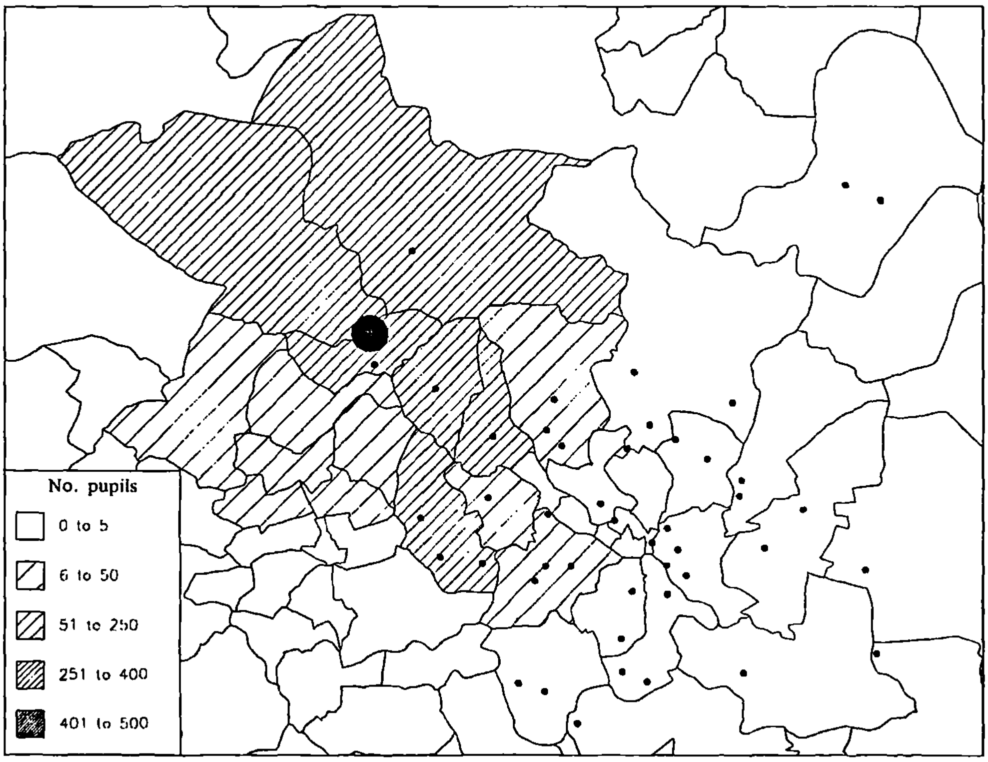


Figure 4.13: Catchment area, inner school 1

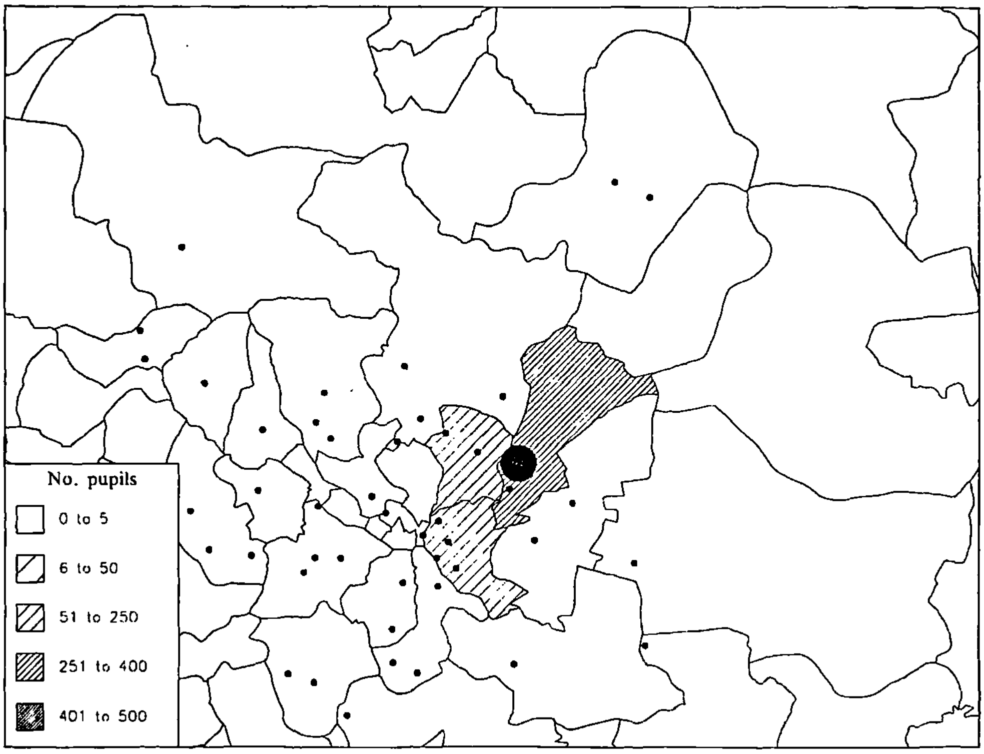


Figure 4.14: Catchment area, inner school 2

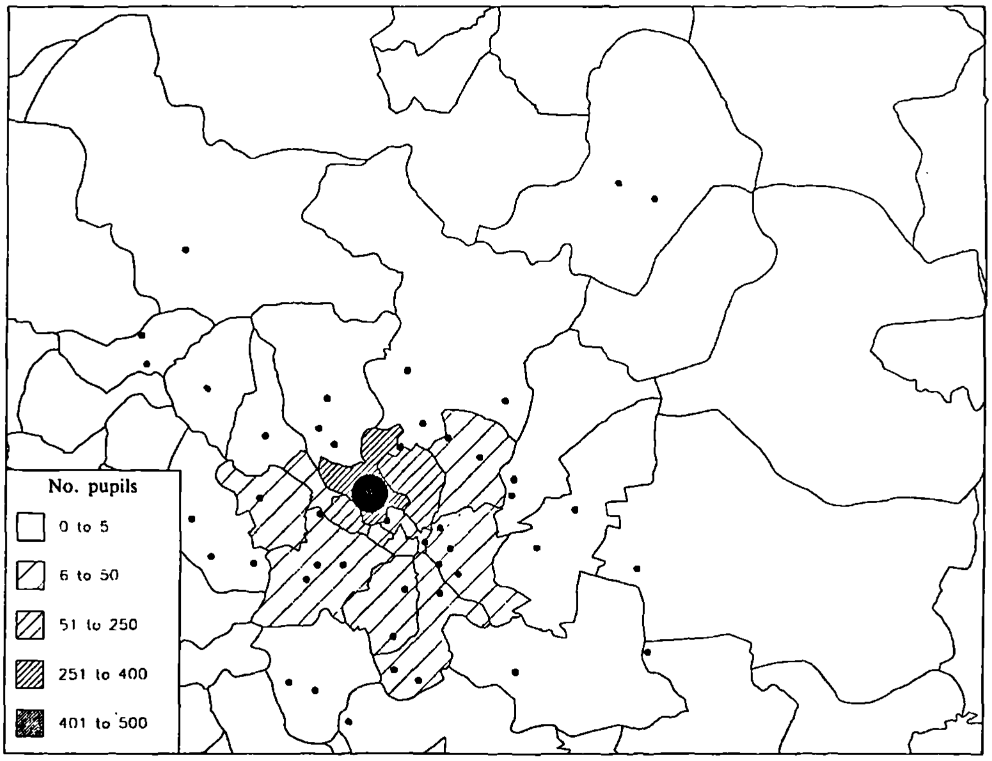


Figure 4.15: Catchment area (outer school 1), proportion of pupils attending

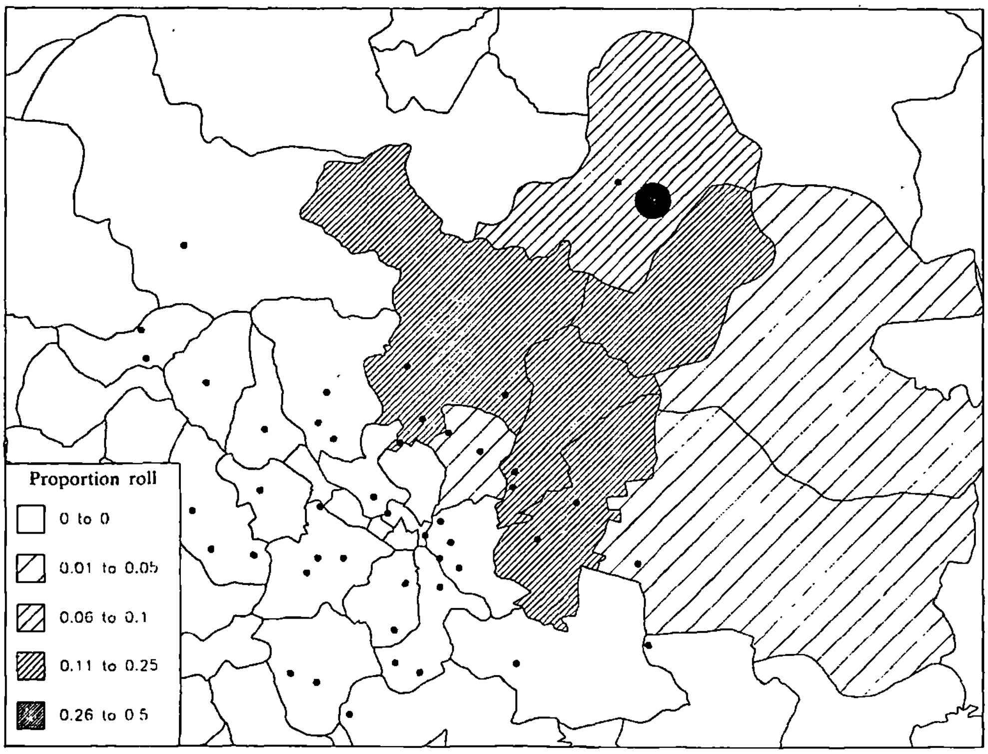
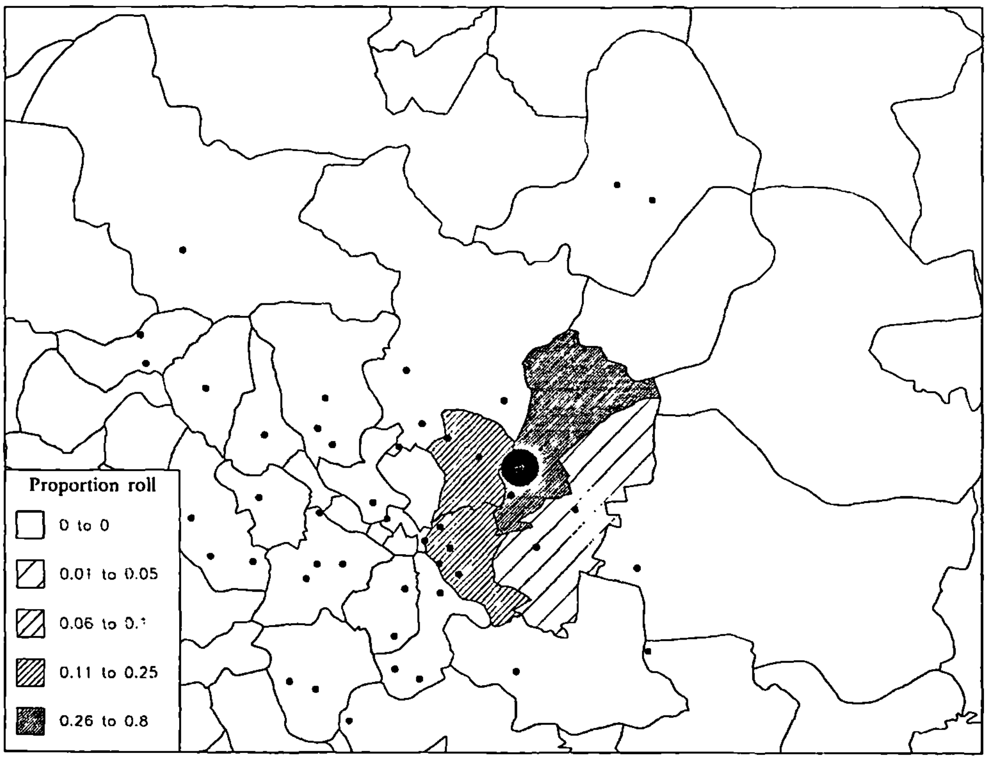


Figure 4.16: Catchment area (inner school 1), proportion of pupils attending



In order to inform this process further and perhaps give individual schools information useful for marketing it is also possible to plot actual pupil locations on a map. This technique (when coupled with maps of a more appropriate small scale than are being used in this thesis) could aid planners or marketing strategists to pinpoint particular parts of a postal area which seem not to be sending pupils to the school in question. This will allow the appropriate set of questions to be asked – why do the children of street *x* not attend our school? what makes our school so popular with the parents in area *y*? and so forth.

It is of course possible to visualise the changing shape of a catchment area over time in the same way as it is with total rolls. Figures 4.17 and 4.18 show a particular school's catchment in 1992 and 1995. It seems that although the changes are subtle and difficult to measure accurately at the spatial resolution used here, the catchment is certainly shifting away from the inner parts of the city towards the outer areas, moving slightly west and north from the starting position. To give a true picture of the changes it would be necessary to break down the 'unchanging' core catchment area and define shifts within this. In these various ways a GIS can begin to direct the thinking of planners at both a school and authority level towards the areas which may be beginning to be served poorly, or which are becoming overly popular and may require some kind of improved selection mechanism to be enacted.

Figure 4.17: Catchment area, Leeds secondary school 1992/3

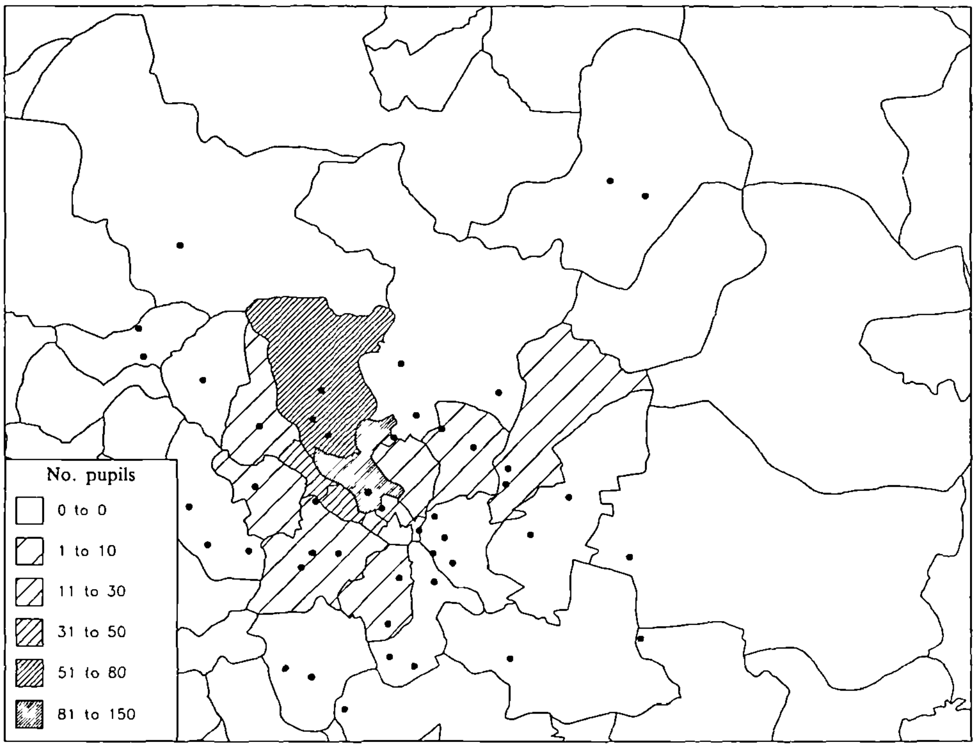
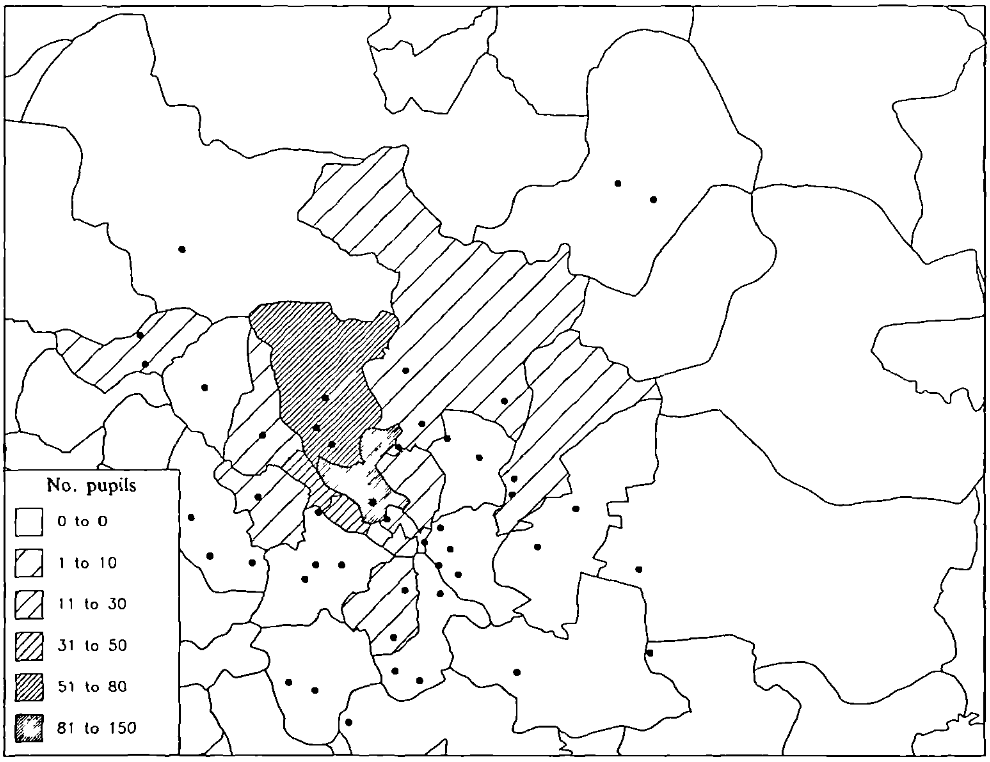


Figure 4.18: Catchment area, Leeds secondary school 1994/5



In order to develop our understanding of the system further, we can turn to another set of characteristics and data to help explain the patterns which are emerging from the work described above. By using the census it is possible to begin to draw up some basic profiles of schools and thus perhaps begin to link a school's 'performance' with potential explanatory factors concerned with residential location and background. This might involve mapping census variables and comparing them with the catchment maps produced and discussed earlier (figures 4.11 to 4.14 in particular). It is immediately apparent when figures 4.19 and 4.20 are compared with these maps that the larger, high-achieving (in terms of exam scores) schools have catchment areas which are comprised of much more socially advantaged areas. By contrast, the emptier schools with problems in terms of low exam results and high truancy rates are in and draw their pupils from areas of considerable social disadvantage. This leads on to the possibilities of overlay within GIS – see section 4.5.2.

Figure 4.19: Census data for Leeds postal districts (% households with no car)

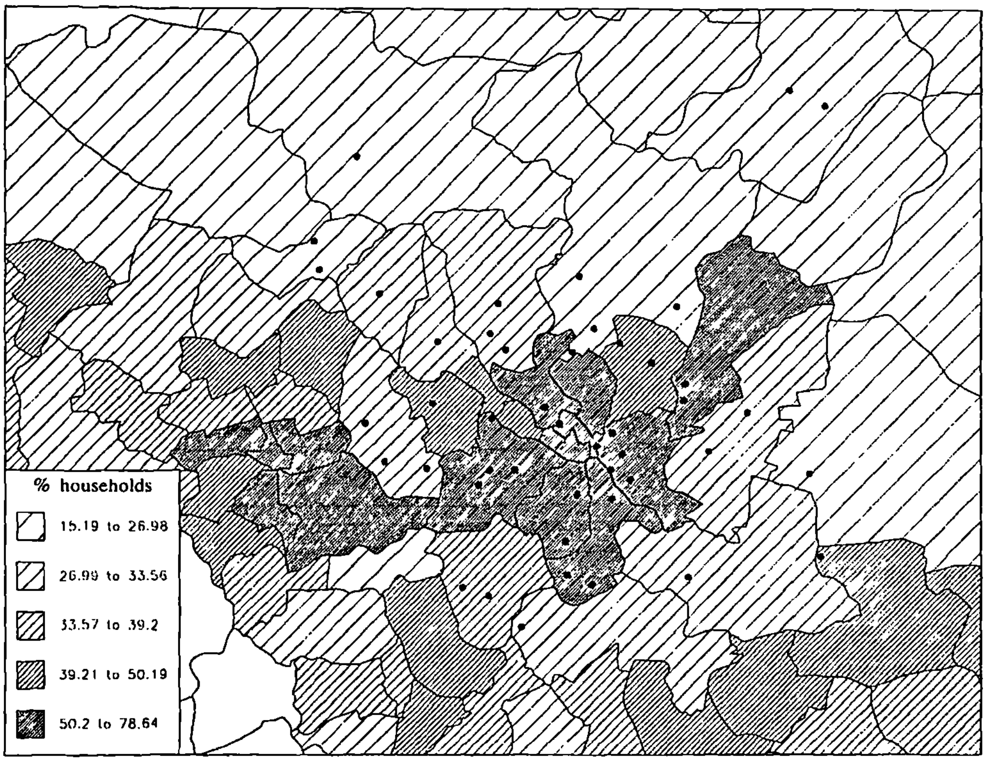
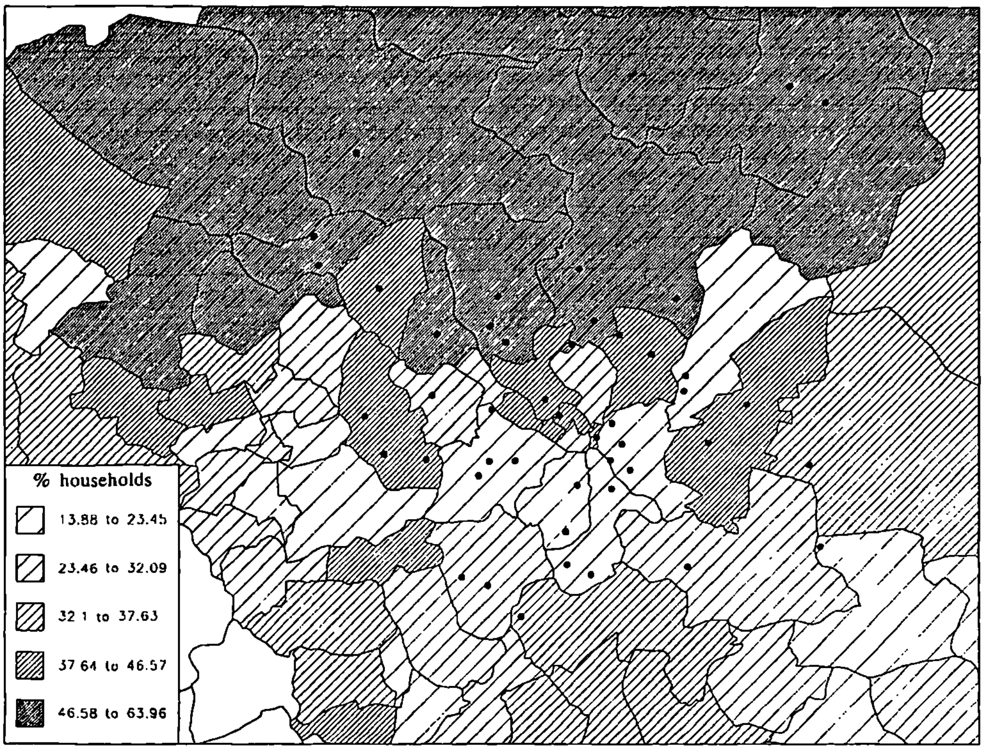


Figure 4.20: Census data for Leeds postal districts (% of households in social classes A and B)



4.5 Data linkage; beyond simple mapping

The visualisation process can begin to give us an enormous amount of information regarding the school network in an area from the vast datasets which are relatively easy for the LEA to come by. However, there are many more useful operations which can be carried out in a GIS which go beyond the simple display of data in map form. There are three main elements to this data linkage analysis; arithmetic combination, overlay and buffering. These three tasks are outlined below, and can be performed singly or in concert. Indeed, when combined the techniques begin to provide a relatively powerful set of spatial analysis tools, as discussed below.

4.5.1 Arithmetic combination

The simplest of the operations available to a GIS user is the mathematical combination of data held within the GIS. Simple arithmetic operations can give a more detailed picture of the situation than is possible by looking purely at the raw data. For example, flows to each school could be combined with residential information for school-age children to produce simple maps of 'market share' in an area. This would enable schools to approach the idea of targeting areas for marketing in much the same way as retailers might. Figures 4.21 and 4.22 demonstrate this for two of the schools displayed above. The maps show the proportion of all Leeds state secondary school pupils from an area who attend the school in question. It is clear that there is a very serious dichotomy between the catchment area of the high-performing school and that of the lower-performing facility. Maps such as these enable schools to carry out two operations; firstly to consolidate marketing and/or advertising in areas in which they have a high market share (rather than becoming complacent and having pupils 'poached' by other local schools) and secondly to step up their marketing campaigns in order to attract pupils from new geographical areas. Such techniques are, as we have seen, increasingly important in today's educational environment, and there is a rash of literature dealing with the subject (such as Barnes 1993, Davies and Ellison 1991, Devlin and Knight 1990, Evans 1995, Gaunt 1991, Pardey 1991, Smedley 1993, Webster *et al.* 1993). These 'target areas' could be selected through the use of the area definition techniques described above in order to ensure that the 'kinds' of pupil targeted match the profile desired by the school. It should be noted however that such marketing activity, although burgeoning, is not uniform and in many areas is still seen at a school level as extremely 'ungentlemanly' (particularly between LEA schools), whereas other areas are embracing the new environment with more aplomb (see Ball *et al.* 1994).

Figure 4.21: High-attaining school, 'market share'

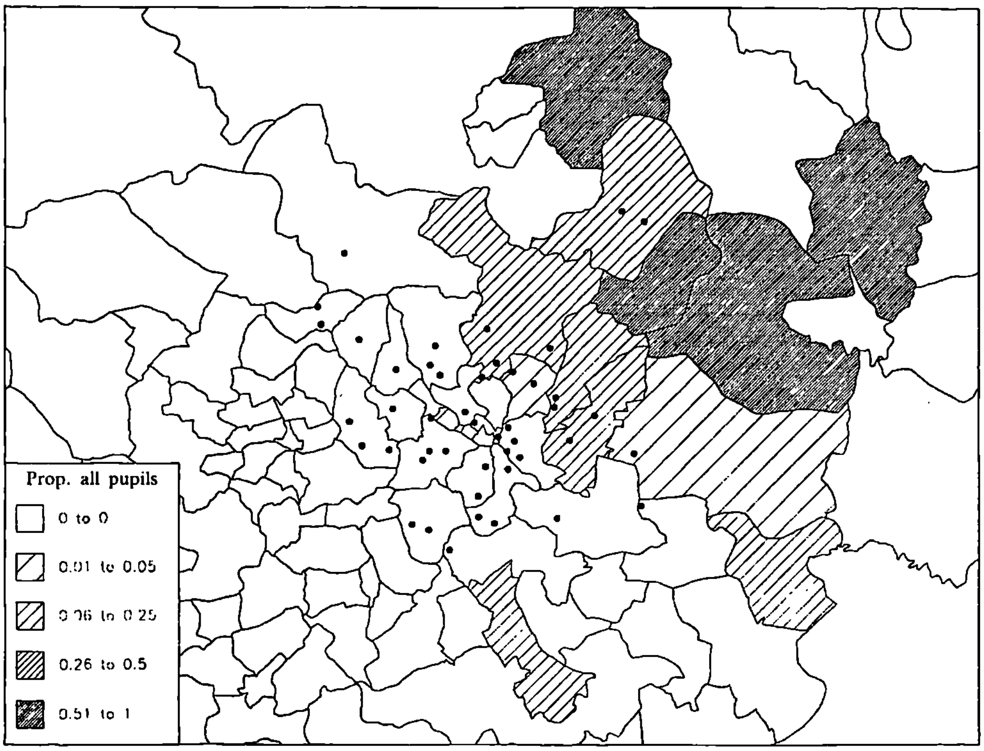
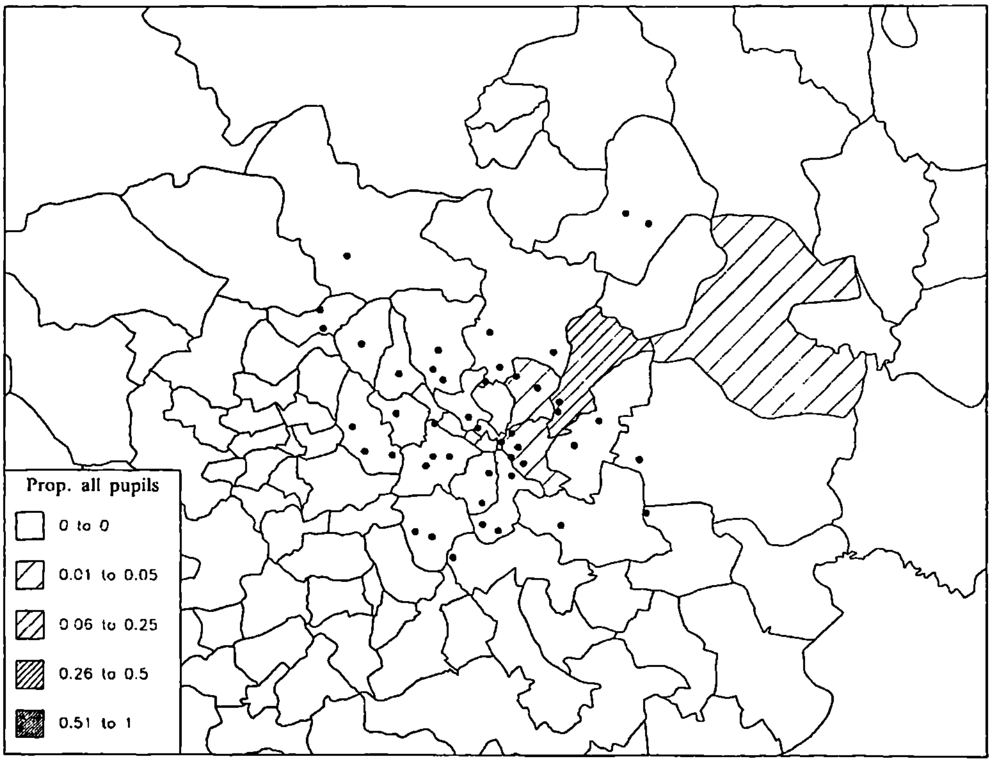


Figure 4.22: Low-attaining school, 'market share'



Other kinds of simple data combination might include searches on schools displaying certain characteristics, such as low examination scores and high truancy rates. These could be defined, searched for and plotted within a GIS and thus aid the planner in a search for areas of the city which might have particular problems. This could be a particularly powerful tool if used together with overlay, described below.

4.5.2 Overlay

In most GIS packages the concept of polygon overlay is central to the idea of data linkage. This includes the layering of information within a single map outline. For example, the overlay technique can be used in order to plot pupil distributions in relation to census data. Figures 4.23 and 4.24 demonstrate this for Leeds, although using school-level data rather than pupil-level in order to preserve anonymity. This is clearly a very crude version of the catchment area definition suggested by the overlay procedure, because as we have seen, schools are not necessarily at the centre of their catchments. However, the figures serve to illustrate the process and provides convincing evidence that schools with high exam results overall tend to be in areas with little socio-economic deprivation.

Figure 4.23: GCSE results by secondary school (1994/5) and households in social classes A and B by postal districts (1991) for Leeds

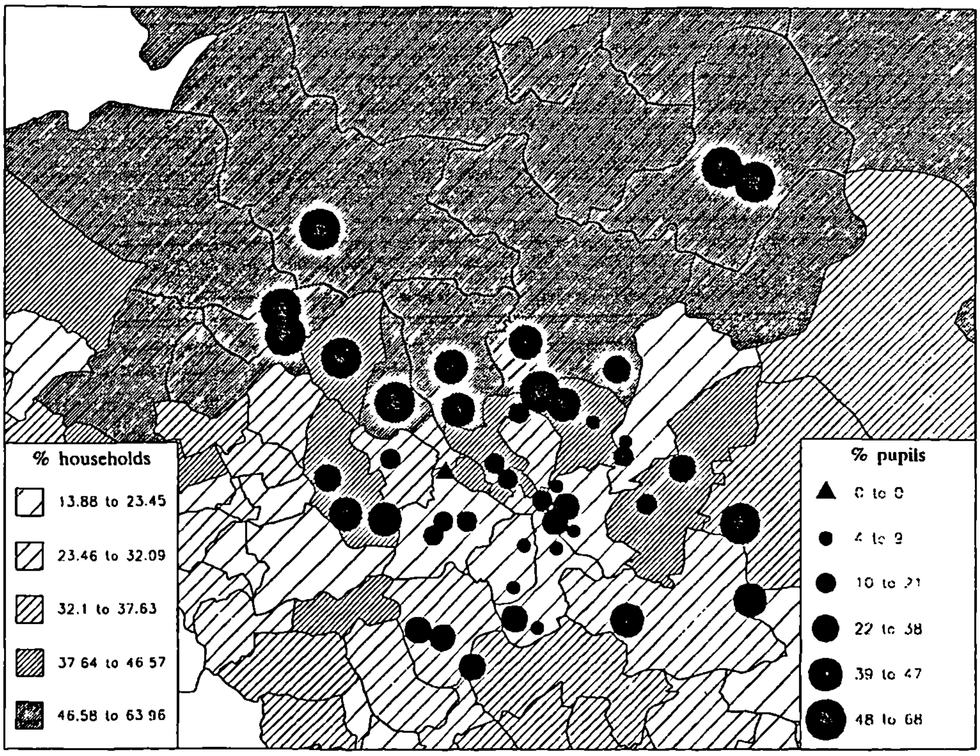
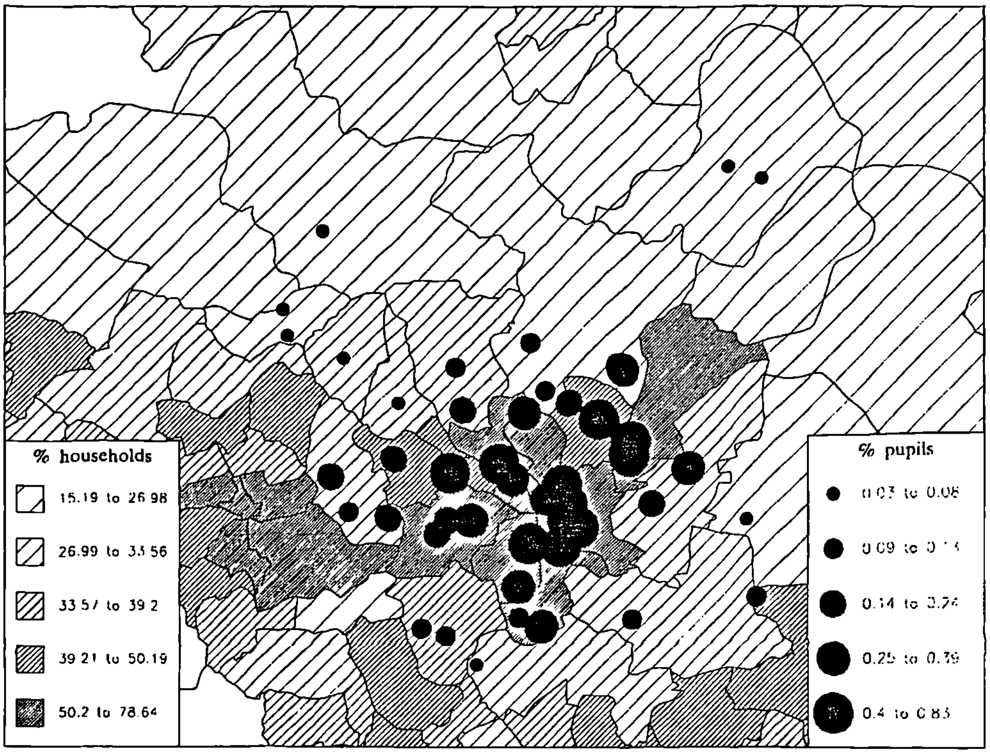


Figure 4.24: FSM rates by secondary school (1994/5) and households without cars by postal districts (1991) for Leeds



The possibility for defining individual pupil locations outlined in section 4.4.3 might be even more useful if combined with census data, as above, or even with the sorts of postcode classification available through geodemographic systems such as ACORN or SuperProfiles (see Charlton *et al.* 1985 for detail on SuperProfiles and Brown 1991 for a discussion of the importance of geodemographics). These could allow a headteacher (or authority) to allocate each individual pupil to a socio-economic 'type' and then plot this distribution, which may give even more insight into potential marketing strategies for the school. Similar work has been carried out using health authority data, particularly by Hirschfield *et al.* (1991). This aimed to use GIS-based approaches to link epidemiological characteristics of the population (and in particular data relating to food poisoning) to census variables. This allowed the definition of rates and clusters of incidence, improving the knowledge base regarding illness in the areas of study. GIS was also used in the same study to link SuperProfiles classifications to the same illness types, in order to allow a more sophisticated definition of proclivity or susceptibility. More directly akin to this work on schools is research such as that reported in Hirschfield *et al.* (1993) concerning the description and definition of GP surgeries' catchment areas. This study describes a project to identify the manner in which supply and demand for primary health care facilities (provided largely in GPs' surgeries) vary across space and social class. This made extensive use of the facilities within GIS to enhance a statistical study (concerning, for example, the correlation between social deprivation and the provision rates of various services), and applied GIS tools such as buffering and overlay to produce travel time maps and comparisons of practices in different parts of the Wirral. It is clear that much of this kind of analysis can be directly imported into an educational study

4.5.3 Buffering

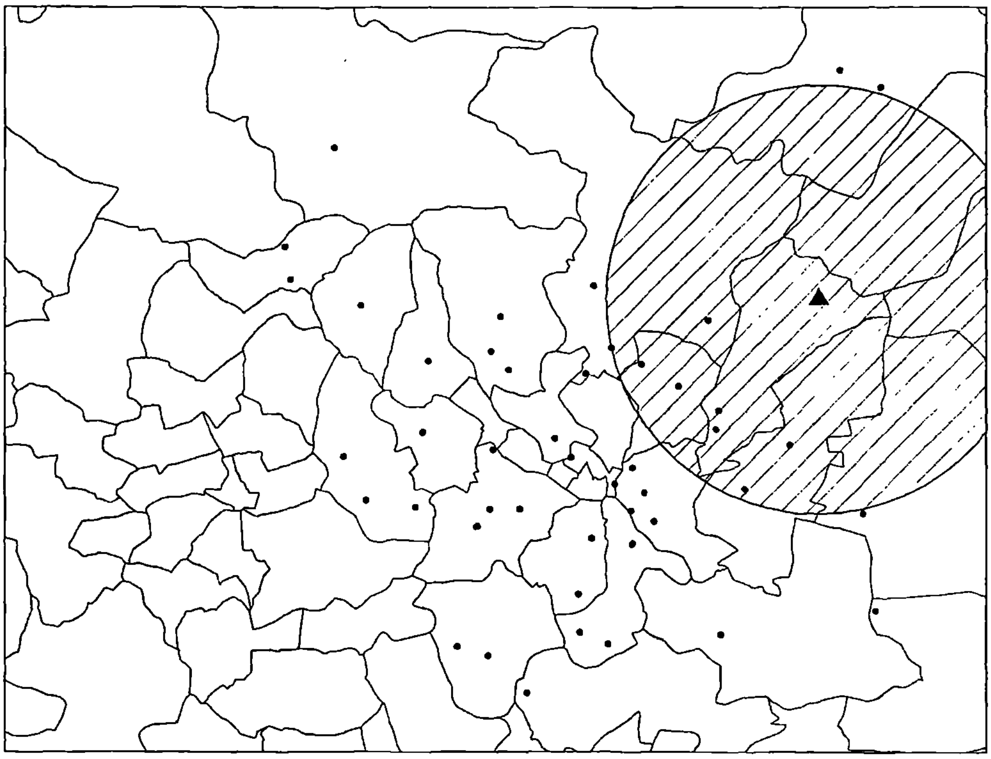
Buffering is the technique of defining bands of equal distance or time around facilities. This can be of importance to, for example, transport sections of LEAs, who could use a GIS to define a three-mile boundary around each school and then allow all pupils whose addresses fall outside these bands to receive free travel if they attend their nearest appropriate school. This process is illustrated in a very crude form in figure 4.25. This figure shows a three-mile straight line circle buffering each school, which gives a vague approximation of the actual areas covered by the three-mile rule. In reality what would be needed would be a much more detailed map covering all the roads and paths in the area, on which basis could be defined actual three-mile travel distances, which would of course not be so perfectly circular. It would also be possible to utilise this procedure to ensure that a new school, for instance, was not built within a mile of a major road or industrial facility which might cause problems for children's health or pose noise disruption to lessons.

Figure 4.25: Areas of Leeds within three miles of a state secondary school

4.6 Impact assessment

GIS has been used to an increasingly great extent in retailing in the field of impact assessment. This process involves the definition of the likely potential revenue (whether in terms of person visits or expenditure) at new stores, or across an altered network. There is a clear analogy here with education, in that it is just as vital for planners to know the likely roll at a new school as it is for retailers to know how much money is going to be spent at a new store. This kind of pre-emptive roll prediction is of increasing importance in the new legislative climate. The main means of impact assessment through GIS is by the use of the buffering and overlay methodologies described above used in combination. A facility is buffered using distance or time bands, and then the population in that area can be calculated from the data underlying the new regions. From this information it is possible to derive likely estimates of usage for a new facility. In terms of the closure of facilities, it is also possible to map the locations of current users and then reassign them to their next closest facility to predict the impacts of network reduction. The first of these techniques is illustrated very simply in figure 4.26 below. It can be calculated within the GIS that just over 9,200 current Leeds state secondary pupils live within five miles (in a straight line) of the suggested new school location, which implies that (since we also know from the distance matrix we can generate from existing data – see chapters five and six – that the average distance travelled to school in the city is 4.8 kilometres) the new location would produce a viable school and that this location is therefore one worthy of further investigation.

Figure 4.26: New school location and possible catchment population



However, the simplicity of this technique hides major drawbacks. The first of these is that it includes no indication of the likelihood of any of the 9,000 potential users actually travelling to the new facility. Clearly, although they are within easy reach of the school, there is certainly no guarantee that they will want to quit their current schools and travel to the new one (even if it is considered to be 'better' if it has newer facilities). Neither is there any inclusion of the likely impacts on other schools in the network. How can we tell from maps such as figure 4.25 whether or not the pupils travelling to the new school will mean that one of the existing schools in the area will empty and become financially unviable?

Another problem is that the GIS takes no account of the spread of population across the areas shown. Although the example uses very large spatial units to describe the population, and the problem could to some extent be alleviated by reducing the scale, it is still assumed in most GIS packages that the population is evenly distributed across these units. In reality, of course, it is quite possible that the area within five miles of the new site is entirely unpopulated (since the eastern edge of Leeds district is in fact sparsely populated). There is also the problem that all the people within any one band are treated equally in terms of their likelihood to travel. It should also be noted that there exist more complex spatial interpolation methods than these, such as those discussed by Maguire (1995). It is however at this stage not appropriate to discuss these in terms of the day-to-day utilisation by local authority officers. Although potentially powerful, such tools offer a second line of more in-depth analysis which is more academic in application than the basic set of spatial analysis tools which are described here.

4.7 Conclusions, shortcomings

GIS has a great deal to offer educational planners in terms of data display and handling. The planning process can be greatly enhanced by the implementation of mapping technology and by the use of the simple data combination facilities of most proprietary GIS packages. As we have seen, generating maps of data can be an enormous visual stimulus and can provide very significant first steps to defining not only where problems might exist in a system, but also to some extent why these problems may exist. The very rich data resources available to educationalists provide a unique opportunity to examine the composition of our cities and to improve the planning process on which the education service is based. It is also possible at the level of the individual school to take the data they hold as a matter of course and make it work for them in their marketing plans through the application of mapping and potentially in combination with geodemographic systems.

Different authorities are necessarily at considerably different stages in their implementation of GIS-based analysis and display of data. Some use it simply for mapping of catchment areas and the display of pupil origins. For many, it is not actually used but is a 'holy grail' which could in the future provide the kind of functionality they require. The argument above gives some guidance on what may be possible in the most straightforward GIS framework. However, throughout this chapter is has been necessary to hold back from all-out praise of the facilities available in GIS. Although it is undoubtedly the case that even drawing maps has until very recently been beyond all but the most sophisticated local authorities, this tool does not provide the whole answer to the sorts of policy questions outlined in chapters two and three.

The seemingly low level of spatial analysis functionality currently on offer within GIS has been the theme of a large number of GIS seminars and conferences. Openshaw (1991) goes as far as saying that there is no 'real' analysis except in a data description or cartographic sense and this is illustrated to an extent in the description above. There has been some progress towards adding more statistical routines to proprietary GIS, as well as investigating how GIS can benefit spatial analysis (Goodchild 1987, Ding and Fotheringham 1992, Goodchild *et al.* 1992, Fotheringham and Rogerson 1994). However, these seem more applicable to aiding academic research on spatial analysis rather than solving real world planning problems. This is a proposition discussed in detail in Birkin *et al.* (1996), where it is argued that GIS linked to mathematical models would be a more fruitful line of research with regard to policy issues. This theme is taken up in the following chapters.

Chapter five

Geographical modelling and educational planning

5.1 Introduction

The recent changes in the education system, as we have seen in chapter two, have created a situation where the planners nominally in control of the schools network are reduced to a much more guiding rôle. No longer able to take command of all the schools under their areal control, the impacts of resource allocation decisions can have far wider implications both for their own position (the threat of opt outs) and for the outcomes of parental choice. In such a situation the accurate prediction of the impact of a change in allocation is vital. Closing a school, for instance, is always a controversial move because of the public's loyalty at a local level (Bondi 1989). However, in the past it has always been possible for an LEA to 'use' the children thus released to reduce surplus places at other local schools simply by redistributing them around the system. This is of course now no longer possible and although the authority can recommend certain schools to parents, they must be able to predict the likely selection of these consumers from a reduced choice set. Similarly, the decision to open a new school in an area must now be taken bearing in mind the potential such a development could have to draw pupils not only from the immediate vicinity but from any neighbourhood in the authority, or indeed its fellow authorities.

Clearly therefore there is a vastly increased need for accurate predictions of the outcomes of authority planners' decisions, and indeed for some kind of ability to perform preemptive, 'what if?' type queries on the data held by LEAs. In this way it would be possible to test a variety of possible outcomes of a problem accurately and speedily and have some quantitative measure of outcome based on robust principles rather than the more subjective, possibly politically motivated predictions used at present. This is not to say that geographical modelling is presented here as a miracle cureall for LEA planners' problems, but more as a set of tools which, properly applied, can certainly facilitate the decision making process.

Academics have occasionally advocated the use of spatial models in education planning and there is a wide literature on various modelling procedures, although not explicitly linked to education. However, it is clear that very little of this has been taken on board by education planners and that such models have a very poor history of real-world application outside retailing. The reasons for this are undoubtedly numerous but there have been a few key stumbling blocks. The first is the high degree of complexity to be seen in much of the academic literature. It is only now apparent that modellers are beginning to think hard about the outputs from their research and the need for greater simplicity and ease of interpretation (see Bertuglia *et al.*, 1994). The second is the genuine difficulty of transferring much of this research from a suite of often hand-built computer programmes to a robust, easy to use, desk-top planning tool. It is here that the marriage of GIS and spatial models seems particularly appropriate: if we can provide the greater analytical power of some of these modelling environments within a IT framework which is user-friendly then we have at least a fighting chance of their successful application (see Birkin *et al.* 1996 for examples of this process). The third reason may well be the scepticism of planners over the efficacy of models and the concern as to whether they are 'ethically' sound. What follows in parts of the next chapter may sound very much as if it approaches an old-fashioned social engineering which is perhaps becoming less relevant in a market environment. However, it is certain that LEA planners are not uninterested in issues of social justice and equity (see for example Brighouse 1994, Judd 1994iv, Hofkins 1995i). As will become clear, the methods discussed here and in the following chapters may afford LEAs the opportunity to reappraise their rôle with respect to schools and as they lose direct power over schools planning they may still be able to maintain some form of influence over the development of 'segregation'. This new influence is most likely to take the form of predicting trends in advance and attempting to alleviate the 'worst-case' scenario, perhaps through the production of marketing strategies and management assistance for struggling state schools. Part of the aim of this thesis is to show a general framework for providing decision support material which offers an avenue into a second, much more investigative, analysis of the way in which the education service satisfies its 'consumers' and the consequences of its major reform. This chapter offers an insight into the development of various geographical models, and the chapters following apply the techniques outlined to the education data introduced here and in previous chapters.

A great deal of work has been carried out in academic geography since the Second World War on providing a "simplified representation of [the] reality" (Thomas and Huggett 1980, p3) of human systems such as that which we find in the case of education. This work has arguably found its most efficacious outlet in mathematical models. These models have been found extremely useful in a number of applied fields, such as retailing and migration studies, where their predictive capabilities have made them big business (Birkin *et al.* 1996, GMAP 1996). There are several types of model discussed below, each of which can be used to varying degrees to approach a different aspect of the planning problem outlined above and in chapter two. Although very little has been written on the application of these various methods to education *per se*, there are many pointers in the existing literature to the potential for such application.

Allied to much of the modelling literature is the issue of 'performance' or 'attractiveness'. In the specific case at hand this would mean defining quantifiable measures of a school's pulling power – of its attractiveness to parents as a destination for their children. This is an issue which is closely tied to the publication of league tables of examination results and other 'performance indicators' by central Government. As such, although this topic is referred to throughout this chapter, there is a much more in-depth consideration of performance indicators in chapter three. It is important to be aware while reading this chapter of the limitations of the simpler GIS-based analysis discussed in the preceding chapter. Although GIS can serve as a first step on the road to the provision of the advanced analytical techniques required in a market educational environment, we have already seen that it can only take the process so far before reaching its limitations. This chapter, therefore, seeks to provide a brief introduction to the multifarious modelling techniques found within academic geography and outlines the potential for their application to the problems faced by educational planners in the latter twentieth century.

5.2 Population forecasting methods

Perhaps the most immediately and obviously useful form of spatial modelling in an education context would be population forecasting. The forecasting of pupil numbers is clearly a function central to schools planning. All LEAs need to have some idea of likely pupil rolls for some years ahead. This need for accurate measures of demand has not been reduced by the changes in legislation. The LEAs which still plan their own schooling are clearly very much in need of accurate data, and even those where the planning capacity is partly in the hands of the Funding Agency (some 50 LEAs in early 1995; Budge 1995v) will still require a knowledge of the local area, as will the FAS officers.

At present, a variety of methods are in use to derive the accurate cohort predictions needed. Probably the most common method for this derivation is that based on the projections made by OPCS and health authorities for births and deaths coupled with various forms of annual school return. Such predictions are essentially calculated by hand, using the most basic spreadsheet functions, and can only really be said to be accurate on an authority-wide scale, although predictions for individual secondary schools <u>are</u> made by LEA planners (Leeds LEA, personal communication). <u>Trends</u> at a local scale can be fairly accurately predicted (the question of whether the school-age population will increase or decrease) but beyond this there is considerable difficulty. A further way of producing an idea of future demand for the education system is to utilise certain census variables (specifically such items as families with children). When mapped, this can clearly give education officers some idea of the sorts of area where demand is likely to be coming from, and can define patterns across a city, albeit in 'snapshot' form. This is a problem with these much simpler methods – they are static due to a reliance on data from a specific time (such as the decennial census).

However, a more sophisticated approach than this would be to use population forecasting models. In some LEAs there <u>is</u> use of more complex modelling procedures (Simpson and Lancaster 1987, Jenkins and Walker 1985), although this is usually as part of a wider council-based project and such models tend to be operated centrally, usually within the planning department. Clearly such work can be used, unmodified, by educational planners in order to produce small-scale cohort predictions for some years into the future. Such a system is clearly ideal for planners in education departments, as accurate knowledge of cohort predictions at various points in the future could aid the planning process immensely and save money in the long term closure and/or opening of schools. This sort of geographically-based cohort survival model needs good predictions of future births and therefore also population movements within a city (Stillwell 1977, Rees and Rees 1991). OPCS estimates can be linked with estimates of intra- and inter-urban migration and local authority housing statistics to provide more detailed predictions at, for instance, the level of census wards. However, the introduction of this population work serves as an example of the use of geographical modelling, and need not be developed further in this discussion, as the development of a purely demographic model falls outside the bounds of this thesis. The interested reader is directed towards work by demographers such as Newell (1988) and Schryock *et al.* (1976), as well as interaction model-based projections from work such as Birkin *et al.* (1996), who discuss population projection in far more depth than is possible or necessary here.

Population projection is essentially based on the equation;

$$P_{t+1} = P_t + \text{births} - \text{deaths} + \text{immigrants} - \text{emigrants}$$

but clearly this can then be disaggregated further by age or other group(s), and applied separately to sets of zones in the study region. This is work by demographers, but a more explicitly spatial approach has been taken by such authors as Woods and Rees (1986) and Rees and Wilson (1977). These models apply what are known as 'cohort survival methods' to the population problem. These can be stated in mathematical terms as;

$$P_i(t+1) = P_i(t) + B_i - D_i + \sum_j M_{ji} - \sum_j M_{ij} \qquad [5.1]$$

where

$P_i(t+1)$	=	Population in i at time t plus one time period
$P_i(t)$	=	Population in i at time t
B_i	=	Birth rate in i
D_i	=	Death rate in i
M_{ij}	=	Out-migration from i to j
M_{ji}	=	In-migration from j to i

Such models rely on the availability of accurate predictions of birth and death rates at the scale of analysis (which can be complex if research is concerned with a very small scale) and also of good measures of migration into and out of the study region. These migration figures can themselves be estimated through the use of spatial interaction models, discussed in section 3 below (and see the work of, for example, Stillwell 1977, 1978, 1994). It is clear that such population models could provide a strong basis for planning decisions for the future provision of education in an area and it will become clear that they are a necessary part of the accurate modelling of likely future flows of children to schools.

5.3 Spatial interaction models

5.3.1 Introduction

There are a number of other modelling approaches which are less directly linked to education and which therefore warrant a more in-depth discussion. These approaches include what is known as spatial interaction modelling, a technique from which many of the others are derived, or on which they are based. This is particularly true of, for example, dynamic modelling, which I discuss in more depth in section 5.5 below and chapter eight. Essentially, these are spatially referenced models which contain some measure of predictive capability. The kinds of model discussed are an attempt to reproduce mathematically the <u>flow</u> data between sets of zones, which in this case would be residential areas and secondary schools. It is this idea of modelling the <u>interaction</u> between places by attempting to predict the numbers of people leaving *a* for *b*, or *a* for *c*, which is central to the concept of spatial modelling. This is one of the essential differences with GIS, and is certainly something which GIS does very poorly if at all. However, although the simple replication of current flow patterns is useful in terms of defining a site's true attractiveness, spatial interaction models really come into their own if the process is taken a stage further. Once existing flows have been accurately reproduced, a major task in itself, there are a number of approaches which can be taken to perform some kind of prediction of future trends. As each model type is described, its likely application to the problems of schools planning will be briefly covered.

Spatial interaction models are a reaction to the complexity of 'human systems'. The enormous intricacy of such systems means that the study of them requires a significant degree of abstraction or simplification which may only be possible through the use of mathematical models. They are "part of an attempt to achieve a scientific understanding of cities" (Wilson 1970, p1). A spatial interaction model is essentially an

> "equation which predicts the size and direction of some flow ... using independent variables which measure some structural property of the human landscape" (Thomas and Huggett 1980, p132).

They are an attempt to measure the number of journeys from one place to another – it is this idea of the modelling of spatial movements that makes them especially important in the planning context.

Interaction data is the phrase used to refer to matrices of information about flows from place to place. The following table shows an example of such data;

	Destination 1	*Destination 2*	*Destination 3*	*Destination 4*	**Destination totals**
Origin 1	078	548	258	000	**884**
Origin 2	045	544	654	658	**1901**
Origin 3	021	541	032	156	**750**
Origin 4	000	069	987	220	**1276**
Origin 5	000	000	021	579	**600**
Origin 6	085	006	369	321	**781**
Origin totals	**229**	**1708**	**2321**	**1934**	***6192***

The row and column headers are zone labels (for instance, the names of towns against shopping centres) and the numbers contained within the matrix are the 'interactances' – the number of individual flows between the zones. Although the individual zones have their own labels, it is common to refer to origin zones generally as *i* and the destination zones as *j*. It is, as will become clear, important to know the total number of trips leaving or arriving at a particular zone, because a spatial interaction model is an attempt to reproduce the data in such matrices by mathematical means. Thus the convention has developed of referring to origin totals as O_i and destination totals as D_j. It is important in modelling that the totals balance – that the same numbers leave as arrive and *vice versa* – and that a model is based around a fully accounting framework to ensure that flow units are not 'lost' at any stage of the process. This reproduction of matrices then allows extrapolation to likely future trends.

It seems apparent that geographical models grounded in mathematics have a triple purpose. Not only do they allow for the 'abstraction and simplification' mentioned above, but as a direct result of this they allow for both the description of these systems and the prediction of likely future outcomes. The value of accurate description is clear – it is part and parcel of the groundwork for explanations of spatial phenomena; the whys to match the hows. Closely linked to description in interaction modelling is the idea of prediction. This is perhaps the area which has spurred most research on spatial interaction models. Clearly, if accurate models of flows for retail capital, population or schoolchildren can be created the impacts in a planning context will be considerable.

The ideas behind spatial interaction had been current in the mid- to late-nineteenth century when various academics recognised the potential relationship between distance and a variety of interactions (such as, particularly, migration). Johnston (1991), debates the influence of such work on later writers, suggesting that these authors were "unaware of the seeds" (p102) that had been sown by the pioneers. It does however seem clear that interest had been galvanised in a subject which was to become more significant as time went on. It took postwar work by authors such as Zipf and Stewart to develop the ideas further. These two in particular noted the 'principle of least effort' – Zipf's (1949) idea that people "organise themselves so as to minimise the amount of work which they must undertake" (Johnston 1991, p103). This 'law' was derived from Stewart's (1941) work which had found that as distance between towns and (Princeton) university increased so the number of students coming from those towns fell. Working from both these studies Stewart (1950) went on to draw the analogy between this and the law of gravity propounded by Newton in 1687. This law states that the force of attraction between two bodies is proportional to the size of those bodies and a function of the distance between them. The law of gravity takes the following form, reproduced here for the purposes of comparison with the models discussed later:

$$F = G\frac{m_1 m_2}{d_{12}^2} \qquad [5.2]$$

where;

F = gravitational force between two masses m_1 and m_2

G = gravitational constant

d = distance between the two masses m_1 and m_2

It is on the basis of this initial analogy and model that the *genre* is referred to as 'gravity modelling'. The basic analogy between this and migration is that more people will travel further to a big town than a small one. Later work, mainly in the 1960s and 1970s, began to refine the basic model by fitting it to actual data. The main applications of the mathematical and gravity approach to urban modelling were carried out under the auspices of large urban planning agencies, mainly in the USA. The principle driving forces behind this emphasis, according to Batty (1976), were essentially practical; a need for better forecasting coupled with a tradition of transportation modelling and the availability of funding. Some of the most famous applications of this early period include Lowry's work in Pittsburgh (1964), the 1959 Chicago Area Transportation Study and work carried out in the Bay Area of California. Essentially such models focused on urban transportation, migration patterns and freight flows. By the late 1960s the gravity model had been fairly thoroughly tested and fine-tuned in a variety of settings both academic and practical. In 1971 Wilson proposed a 'family' of four basic spatial interaction models on which most of the later work in this field has been based. The models were based on the principle of entropy maximising, which has its roots in the idea that that the simple Newtonian analogy[21] of earlier work can be improved and made to match reality more accurately. This method "changes the basis of the analogy and deals directly with the basic components of the system" (Wilson 1974, p393). In fact, what entropy maximising does is to take not simply the two masses *i* and *j* (say 'population' and 'number of jobs') but to assess the probability of each individual at *i* making a particular journey. The interaction between *i* and *j* is therefore, in this model type, an average probability of all individuals at a particular origin zone. These models are essentially the same as the basic spatial interaction model only using a slightly modified distance function (see Appendix IV).

Entropy maximising models produce a trip matrix

> "where the *T* trip-makers are able to rearrange themselves among the n^2 [assuming an equal number of origins and destinations] journey-to-work routes in the greatest number of ways" (Thomas and Huggett 1980, p156).

---

21 That interaction between *i* and *j* is proportional to the masses at *i* and *j* and inversely proportional to a function of the distance between the two

In fact, there is an assumption in entropy maximising models that the output will never try and predict the actual routes of the individuals with whom it is concerned. It simply maximises individuals' freedom to choose between routes and it is therefore the most likely trip matrix rather than necessarily the actual matrix. For more details see Wilson (1970). The importance of this developmental period should not be underestimated – as Haynes and Fotheringham note;

> "[the gravity model's] continued use by city planners, transportation analysts, retail location firms, shopping centre investors, land developers and urban social theorists is without precedent." (1984, p10)

It is for this reason that it seems particularly worthwhile to re-examine the potential of this approach in a newly emergent market, namely education.

5.3.2 The family of models

As the previous section relates, the very basic gravity analogy was seen to be useful for interaction research, but not sufficiently accurate for application. To this end, the model was developed mathematically by a number of researchers, mainly by applying it to real data. This development reached a defining moment with the statement of Wilson's so-called 'family' of SIMs, each with slightly differing formats and functions (for more detail see Wilson (1971, 1974) or Pooler (1994)). All of these models follow a similar format, familiar after the previous discussion of gravity (Wilson 1974, p67):

Interaction = factor(s) **x** mass **x** mass **x** distance function

It is possible to define a number of different 'types' of spatial interaction model, all of which have arisen from the basic four. I shall now discuss these briefly in turn, considering their potential for application in educational situations.

5.3.2.1 Unconstrained models

Unconstrained spatial interaction models are the "simplest, rather unrealistic" (Wilson 1974, p178) development from the basic gravity model. The unconstrained model equation takes the following form;

$$T_{ij} = k.W_i.W_j.f(d_{ij}) \qquad [5.3]$$

where;

T_{ij}	=	number of flows between zones i and j
W_i	=	'attractiveness' of origin zones i
W_j	=	'attractiveness' of destination zones j

d_{ij} = 'travel function' between zones i and j (distance, cost *etc.*)
k = a constant (or scaling factor)

The model is a relatively simple reformulation of the original gravity equation. It is used where neither trip-end total is known (*i.e.* neither total numbers leaving the origin zones i nor the total numbers arriving at destination zones j) and is thus not constrained in any way to reproduce observed data. Such models have limited applications, for it is clear that in most practical applications of a model it will be necessary to have a much more accurate idea of the trip totals than that which can be achieved with a single constant (see Wilson and Bennett 1985), which in effect means that all origin trip-end totals (O_i) and all the destination trip-end totals (D_j) and all the individual flows in the output are estimates. The simplest distance or cost function used in gravity modelling is d_{ij}^{-2}, a classic distance decay measure. The use of this function, in whatever form, in the model implies that the further a destination zone is from an origin zone the less likely it is to attract flows from that origin. It is the case however that this use of a basic negative square, although easy to implement and calculate, is less than suitable since it assumes the relationship between attractiveness and distance will remain stable regardless of the data to which the model is applied. It is therefore normal to replace the square function with a parameter, usually defined as β, which can be calculated at a different level for each new application in order to describe more accurately the distance relationship in a particular dataset. The exact form of the distance component of the spatial interaction equation, however, can be varied in many different ways depending on the exact application and type of model.

It is also common to use the fact that in almost all cases there are some data already existing about the situation under study in order to further improve the model output. In the unconstrained model the single scaling constant k is utilised to bring the model output more in line with the actual situation as far as it is known. However, in all other versions of the model this constant is dropped in favour of a variety of more complex scaling factors which ensure that either D_j, O_i or both are accurately reproduced. This is discussed more fully in the following sections. A further problem with the unconstrained model is that measures of the 'attractiveness' of both origin and destination zones must be defined. This is a complex and often subjective business, as will become clear in chapters six and seven, and as such further detracts from the model's usefulness. However, despite these criticisms, the unconstrained model is important as a mathematical basis for the other members of the 'family', and historically as the starting point for more complex consideration of interaction issues, although Wilson and Bennett describe them as "not particularly convincing" (1985, p218) when used for analysis. They do have some limited application in economics and residential location analysis; see Wilson (1974) p117-8 and p178-9 respectively for brief examples.

5.3.2.2 Singly-constrained models

Having seen the drawbacks of an unconstrained model, it is clear that for a model to accurately portray reality the observed and predicted totals should be equal. There are two ends to this possible constraint, the origin and destination totals. If we have actual flow data then we can add into the equation either O_i or D_j ensuring that, in notational form;

$$\sum_j T_{ij} = O_i \qquad [5.4]$$

(in 'layman's terms', for all zones j, the sum of the flows leaving zones i for any zone j must equal the observed total leaving i) or;

$$\sum_i T_{ij} = D_j \qquad [5.5]$$

(for all i, the sum of the flows arriving at zones j from any zone i must equal the observed total arriving at j). These are simple checking measures which ensure that a model conforms to a closer approximation of the reality of the situation. It is clear that in the unconstrained case it is not possible to apply either of the above measures, as both O_i and D_j are unknown and are thus replaced with defined 'attractiveness' values of W_i and W_j respectively. O_i is taken to be the total observed flows leaving all zones i; D_j is taken to be the total observed flows entering all zones j. For a detailed discussion of the definition of 'attractiveness' see chapters three, six and seven.

It is certainly the case that in most situations there will be at least some data regarding either origin or destination totals. If the model equation can be reformulated so that the output matrix is forced to conform to at least one of these two sets of row or column totals, then clearly the output in terms of flow totals is likely to be more accurate. This is known as *constraining* the model. Of the two types of constrained model, the simpler type is known as singly-constrained. This can then be sub-divided further into *origin* or *production* constrained, where the trip origin totals are known and must be matched, and *destination* or *attraction* constrained, where it is the trip destination totals which must be matched in output. The two equations for these are essentially similar, but differ in important ways. The output from a production-constrained model will estimate both the flow matrix and the total flows arriving at the destination zones (D_j) while the attraction-constrained model estimates flows between zones and the total flows leaving origin zones (O_i). It will be immediately apparent that in the case of an educational model the prediction of numbers of children leaving residential areas is not significantly applicable since this is one set of data which is very commonly held and which is therefore unnecessary to generate over again. However, the potential for the application of an production-constrained model is immense, since predicting the numbers of children arriving at schools in an area is very much what educational planners are concerned with.

The algebraic form of a production-constrained spatial interaction model is as follows;

$$T_{ij} = A_i . O_i . W_j . d_{ij}^{-\beta} \qquad [5.6]$$

where;

$$A_i = \frac{1}{\sum_j W_j . d_{ij}^{-\beta}} \qquad [5.7]$$

and;

T_{ij}, W_j, d_{ij} are as previously defined in [5.3]

O_i = origin total at origin i

D_j = destination total at destination j

A_i = balancing factor (replacing k) to ensure equation [5.4] is satisfied

$$\sum_j T_{ij} = O_i \qquad [5.4]$$

Perhaps the most common application of origin-constrained models is in retailing – the "journey to shop" (Wilson and Bennett 1985, p217). In this case O_i is known, whether it be the number of residents at i or the amount of money available for shopping at i. W_j in this model is a measure of the attractiveness of a particular shop or set of shops at location j. This can be a very simple measure; for instance a basic floorspace variable is often employed to define the relative 'pulling power' of different shops (Clarke 1986). Since D_j is not known in this case the model will predict not only the flow sizes between zones i and j, but also give us a prediction, in this example, of the number of people using a particular shop or of the likely turnover in that shop. Evidently, from the discussion in chapter two, retailing and education are increasingly analogous, and this gives us a wide literature from which to develop models appropriate to our case study. This analogy seems especially apt, since both shops and schools try to attract the maximum number of consumers (pupils) to maximise their profit (or funding by pupil numbers) and both must produce marketing strategies in order to effect this. Of course, the 'product' at a school is much less flexible than that in traditional retailing (the national curriculum must be delivered by all schools) but the compulsory element of even this is being reduced (Judd 1995xix) and thus the part to be played by schools' marketing teams is growing rapidly. More detail on the use of interaction models can be found in such texts as Clarke (1986), Wrigley (1988) and Birkin *et al.* (1996).

5.3.2.3 Doubly-constrained models

There will often be occasions when sufficient data is held for researchers to know both sets of trip-end totals. In this case it is possible to constrain the model to reproduce both row and column totals (to satisfy both equations [5.4] and [5.5]). This model is known as *doubly* or *production-attraction* constrained and is "purely an interactance model" (Goodall 1987, p199), as both origin and destination totals are fixed. This means that the doubly-constrained model is predicting only individual trip totals between zones and not the totals leaving from or arriving at those zones. In these terms, doubly-constrained spatial interaction models have a wide range of applications. The modelling of journey-to-work flows is one such application (Wilson and Bennett 1985). In this case both numbers of jobs (D_j) and numbers of residents in various areas (O_i) are known, the model is used to predict who leaves which residential areas for which jobs. Similarly, with migration studies it is common for numbers of out-migrants from areas (O_i) and numbers of in-migrants to areas (D_j) to be known. In this case the model estimates which out-migrants become which in-migrants by producing predictions of likely flows between the sets of areas (Wilson 1974). The same is true of many transport models, knowing where trips originate and subsequent destinations, but not having information about actual flows, which may be vital information for, say, the prediction of likely road usage. In the case of retailing, where the magnitude of flows of people or expenditure can be predicted from knowledge of residential areas and shop locations the production-attraction model is also extremely useful (Wilson 1974). However, in the case of education the full interaction matrix for the current year-group is usually known (pupil addresses arranged by school) and so the idea is to develop from that basis a prediction of the likely future distribution of flows from homes to schools. In this case, obviously, an origin-constrained model would be more appropriate since the pupil roll at any one school is not fixed.

5.3.2.4 Intervening opportunities

The idea behind the intervening opportunities style of spatial interaction model is that the flow of people or goods or expenditure from one zone i to another zone j does not exist in isolation from other possible destinations j. In other words, it takes into account the possibility that a flow from one place to another will be 'diverted' *en route* to a more attractive destination. This can be phrased thus; "there is a constant probability that a traveller will be 'satisfied' at the 'next' opportunity" (Wilson 1974, p397). As Wilson and Bennett state,

> "travel from i to j is proportional to the number of opportunities at j and inversely proportional to the sum of intervening opportunities" (1985, p233).

In practice, an intervening opportunities model is usually a singly-constrained spatial interaction model which takes account of the possibility that a tripper progressing from i to j will in fact stop at an intervening destination (taken to mean any destination with a lower trip cost function). Wilson and Bennett describe it as "an interesting relic" (1985, p235) although Pooler (1994) considers that there is still valid work to be carried out developing the model further. A standard equation is set out in Appendix IV. However, it is possible that the competing destinations approach could provide more accurate functionality in our case, and it to this which we turn next.

5.3.2.5 Competing destinations

This type of model attempts to account for the variation of accessibility or 'population potential' of destinations. It adds a further destination-specific variable to the standard model equation which weights each destination according to some measure of that location's accessibility or potential for 'customer satisfaction' in terms of numbers (or some other criterion : Pooler, 1994). In essence, what the competing destinations model is attempting to reproduce is a two-stage decision-making process;

> "the first stage is that individuals choose a broad region with which to interact. The second stage is that individuals then choose a specific destination from the set of destinations contained within the broad region." (Fotheringham 1983, p19)

It is thus possible to see how this model does in fact relate to real-world decision-making processes. In educational terms, it is possible that the choice of school is made in such a way – parents may for instance choose 'outer Leeds' first and then select a particular school on more specific grounds. However, the somewhat greater complexity of this model (see Appendix IV) could be construed as a hindrance to its easy application. We shall return to these issues in chapter nine.

5.3.2.6 Hybrid models

There are a number of simple variations on the basic spatial interaction model. What these models try to do is better represent the possibly changing nature of origin or destination totals. This means that the constraints [5.4] and [5.5] are replaced with more flexible ranges of possible values in model output. Hence;

$$O_i^L \leq \sum_j T_{ij} \leq O_i^U \qquad [5.8]$$

and/or

$$D_j^L \leq \sum_i T_{ij} \leq D_j^U \qquad [5.9]$$

where the lower and upper limits on O_i and D_j (L and U) are specified *a priori* by the user. In this case the model output would still predict flows and origin/destination totals, but it allows for a variation in the predicted totals. The distance/cost function can also be relaxed in a similar way. Clearly any part of the three basic constrained models can be thus relaxed, giving a wide range of additional models (Pooler, 1994). It is possible that a relaxed model could provide an appropriate approach to educational planning. At the same time, as discussed above, an origin-constrained model seems the most appropriate approach. However, it is possible to combine the techniques if the relaxed approach is taken to the destination constraint in a doubly-constrained model (leaving the origin constraint as in equation [5.4], and replacing [5.5] with [5.9]), then it could be possible to produce a model which took into account the fact that there is a physical maximum number of children a particular school can accept at any one time.

5.3.3 Disaggregated models and calibration

This is an approach which can be easily applied to any of the above forms of interaction model. It will often be the case that in the data which is to be modelled there are flow data for a variety of origin or destination 'types'. It is certainly the case that in, for instance, a retailing model different social groups are likely to be attracted differently to the range of available outlets (Birkin *et al.* 1996). In this case we can respecify the model including a range of disaggregate variables. For example, it should be possible to predict T_{ij}^{kdp}, where that is defined as spending on product type k by person type p from residential area i of demand type d in shopping centre j. The variables could be defined further; k could be records, books or clothes; p could be car-owning or non-car-owning; and d could be residence-based, work-based or tourist expenditure.

All variables in the original model could potentially be 'opened up' by the application of the new factors (Birkin *et al.* 1996 – chapter 5 in particular), and this would be likely to make the model output more 'realistic' assuming that appropriate measures were accessible for the various areas under examination. In the case of education, disaggregation of pupils by social class or level of prior attainment and of schools by any number of factors could help to fine-tune a basic model and therefore simultaneously inform both the modelling process and the definition of those factors which make a school attractive to parents. The idea is that if a particular factor gives a more convincing model output it is likely that this is one of the factors which parents consider to be of importance in their choice of school, whether it be examination results or the existence of a uniform. Thus disaggregation can be of immense help to planners, although it requires more data at an appropriate level and inevitably complicates the modelling process.

5.3.4 Demand and distance

It is important in interaction modelling to have a complete data set for the subject which is being considered for modelling. The definition of attractiveness is considered in the following section, but it is useful to say a few words about the other data which we need. Firstly it is of course essential to have information on the demand for a service (in our case schools), whether that be in terms of expenditure or people. Clearly in order to produce predictions of likely totals at destinations it is important to know what origin data we have. In education this is a relatively simple process since LEAs keep data on how many children already attend schools and where they live, which gives a sound basis for the estimation of demand. For a fuller picture it would be possible to use census data to incorporate all children (who are legally required to attend an educational establishment of some kind) into a model. This might allow the expansion of facility types, since knowing which children attend LEA schools allows us to model only the LEA school sector.

It is also necessary to have data on the distances or travel costs involved in the system. The distance from each origin to each destination must be calculated in order to enable the model to estimate the impacts of distance on flows. The figures used can be any travel-related figures. This means that cost of travel from *a* to *b* could be measured, the distance by road, the time taken to travel or any other suitable measure. In cases where the units used as either origins or destinations are not points but areas (which would be common, especially for origins which are likely to be postal or census units in most modelling applications) then it would be usual to define a mid-point of the area and calculate the travel variable from that point.

5.3.5 The definition of attractiveness

The specification of 'attractiveness' is, as mentioned above, a vital part of the definition of any of the types of spatial interaction model discussed thus far. This is clearly a complex task, and one which can cover a range of possibilities. It is also a task which can be useful in other areas, as will become clear, particularly when the close relationship between 'attractiveness' and 'performance' is considered. From the discussion of interaction modelling above it is evident that if a model is to work adequately the measurement of attractiveness is vital. Models are also useful as they allow for experimentation with various kinds of indicator, and the model output can give some idea of how accurate a measure of a school's attractiveness to parents a particular 'performance indicator' really is. Clearly the modelling process is also tied inextricably to the <u>definition</u> of performance indicators for schools and to the data which is published for parents. This is a complex operation since there is clearly a great deal of subjectivity implicit in choice specification, whether that be of shops, schools or some other facility. In the example of retailing it is common to use a relatively simple measure of floorspace to define the attractiveness of a store or shopping centre to consumers (Clarke 1986, Wrigley 1988). In this case the gravity analogy is particularly strong – a larger store is said to be more attractive, *ergo* it will attract a larger number of customers from a wider area. It seems certain that this simplistic size definition is unlikely to hold true as an attractiveness measure for schools. It is therefore necessary to examine more closely the work which seeks to define the relative performance of schools and thus in all likelihood their attractiveness to parents. It is likely that measures such as schools' performance at GCSE would form the basis for an initial attractiveness measure, although as we have seen there is much scope for other indicators. Chapter three has considered the theoretical background to performance indicators in more depth and chapters six and seven contain some practical experimentation with various attractiveness indicators.

5.4 Goal programming methods

There is a fairly small body of literature which discusses the potential for the application of what is known as 'goal programming' in an educational context. This method is basically catchment area-based, and attempts to define catchment areas based on certain user-specified criteria. In education the impetus was provided by demographic changes in the late 1970s and early 1980s;

> "falling rolls have necessitated the closure or merger of ... schools and the generation of a new set of catchment areas" (Sutcliffe and Board 1986, p661)

and these changes were coming at a time of increased criticism of the *ad hoc* planning procedures of local authorities. In at least one case, as Sutcliffe and Board report, there was an investigation into school catchment design by the Commission for Racial Equality. Clearly there was a need for an efficient design mechanism for catchment areas based on the lower pupil numbers and thus ways of defining 'ideal' or 'optimal' catchments through the analysis of pupil flow data.

Goal programming techniques allow such an approach. These techniques build on what is essentially a doubly-constrained spatial interaction model to produce a series of optimum flows from residential areas to destination zones. In the case of education the model described by Brown (1987; see also Irwin and Wilson 1985i) builds from a basic model constrained by pupil numbers at origins and by a 'relaxed' constraint at destination of between zero pupils and the maximum capacity of a school. A third constraint is added to these, one which 'simply' constrains the model to minimise the distance function between origins and destinations, thus ensuring that pupils have the shortest possible journey-to-school time. Brown's model then progresses in a similar way to those proposed by Sutcliffe and Board (1986) and also by Thomas (1987), who introduces work actually carried out by US education boards on producing racial balance in school catchment zones. In this development the model is further constrained by introducing greater degrees of disaggregation and then ensuring that other factors are minimised or equalised. For instance, the most common example is to produce catchment areas which not only produce minimum travel times/costs to schools but which also produce a 'balanced' school population in racial or social terms, a model which clearly begins to move from one with a purely safety remit (travel time/distance) to one which may be hard to justify from an ethical standpoint. Clearly it is very difficult for an authority to propose that certain pupils go to certain schools on the grounds of their colour or class, or indeed any other social criteria. The definition of the proportions used to create the 'ideal' catchment must be a subjective choice and would inevitably reflect the personal or political biases of the particular planners or councillors involved.

Aside from these concerns, there are more practical matters to bear in mind. The main drawback of this type of modelling approach is that it is likely to use a doubly-constrained interaction model because it is trying to model an 'optimum' given certain fixed parameters22. The implicit assumption is one of a pliant 'consumer base' which will go to whichever school the authority designates, and there is therefore no need to include any measure of 'attractiveness' since all schools must be equally attractive to pupils who are effectively assignees rather than choosers. Clearly this is not a situation which exists under recent legislative changes in Britain. Unlike in the 1970s and 1980s, an LEA no longer has the power to fix catchment areas in this way and the definition of attractiveness under the auspices of a singly constrained model appears much more

22 In other words, it assumes that authorities have the power to force pupils into all schools, rather than allowing for parental choice to deny schools an intake

relevant. Clearly this limits the usefulness of a goal programming approach. The only immediately obviously possible application of goal programming would therefore be for the monitoring of an area's population and the production of 'ideal' catchment areas for LEA officers' policy interest only. This would allow authorities to define areas of a city where the introduction of parental preference had had a particularly segregatory effect on sections of the population and perhaps allow them to target additional resources to ameliorate the situation, a far less proactive rôle for goal programming than the original authors intended.

5.5 Dynamic modelling

Dynamic models, in an educational context, would be an attempt to monitor and predict the likely consequences of parental choice and inter-school competition in the free market arena. Clearly, as LEAs have lost their ability to fix catchment areas the planning officers must look to approaches other than those such as goal programming. This is particularly the case since LEAs are fast becoming monitors of long-term implications of policy changes rather than proactive planners *per se*. It is possible that dynamic models based on an interaction framework could provide such an approach. There is certainly concern that schools with 'good' exam results as published will attract parents from upper and middle class backgrounds as they are usually portrayed as the best informed, those in the best position to afford additional transportation and those who support their offspring's education most directly through a positive home environment (Adler *et al.* 1989, Adler 1993, Judd 1995xvii and Appendix III). This, the argument runs, will leave schools which appear to be performing less well in the league tables with a reduced intake (and thus less funding), from a pupil base with parents less able to support school transfer (*cf.* Bradford 1991). The trend which is suggested by this process is clearly a spiral one – 'bad' schools will become increasingly unpopular and rolls will continue to decline, while the 'good' schools will be able to improve continually by initiating selection on ever-more stringent criteria, thus exacerbating the problems which already exist.

An approach to the problem of predicting future trends in school, suggested in a retailing context by Harris and Wilson (1978) and expanded by Clarke and Wilson (1985) is dynamic modelling. This, if respecified for an educational arena, would attempt to monitor the possibility of the sorts of segregation mentioned above occurring and highlight areas of likely concern for the future. This may mean that LEAs are placed in the position of designers of marketing packages for those schools which are seen to be most 'at risk' in the market environment in order to attract back those parents who may be 'deserting' for schools which are seen to be better, usually those in the 'leafy suburban' areas of a city. The first stages of this change in the LEA's rôle are apparent in Leeds' Advisory and Inspection Service (AIS). This service's remit is

> "to work in partnership with schools and others to raise levels of achievement and improve the quality of teaching and learning for all young people in Leeds." (LCC 1995, p39)

To achieve this they have various powers to spend approximately £2.5 million *per annum* promoting collaboration between schools, providing curriculum support, monitoring and evaluating quality in schools and informing and aiding schools with regard to this assessment and other related activities.

The dynamic modelling approach is an extension of *spatial interaction modelling*. With a dynamic approach to interaction modelling the model outputs (the predictions of destination totals D_j) calculated by a production-constrained model can be applied in further models to determine the likely future pattern of growth. Taking the arguments of Harris and Wilson (1978), the dynamic in the retail model suggests that at a point of zero growth the value of D_j will be equivalent to a function of the cost of providing a store (k_j) multiplied by the capacity of that store (W_j). In mathematical terms this (together with the dynamics) can be stated as;

If $D_j > k_j W_j$ then W_j will expand

If $D_j < k_j W_j$ then W_j will contract.

until

$$D_j = k_j W_j \qquad \Delta_j.$$

However, for education we must redefine the terms and thus reapply the model. If D_j measures the number of pupil arrivals at a school, defined by an interaction model (see above) then k_j could be redefined as the cost of supplying W_j places (where W_j is the number of places at school j). In other words, schools which are perceived as 'good' (however this is measured) will be allocated more pupils by the model at the expense of poorer-performing schools. At equilibrium, all schools will be at their 'ideal' pupil level given their attractiveness – thus the poor-performing schools may balance out with no pupils and the 'good' schools considerably over-capacity. It may be necessary to build constraints into the model so that schools are not massively over-filled, a potential pitfall with dynamic modelling, as we shall see in chapter eight. It should be noted, of course, that if we discount the size of school as a valid attractiveness measure, k_j must be redefined as the cost of providing a school of attractiveness W_j, where W still has to be defined according to the discussion in section 3.4 above and chapter seven. The discussion of dynamic modelling is expanded and illustrated in chapter 8.

5.6 Model-based performance indicators

Having introduced interaction models, it is appropriate to discuss briefly one other use to which they can be put. This is as the basis for performance indicators which take account of the origin of individuals and of factors applying both to the facility and the components of that facility. Originally constructed by Irwin and Wilson (1985i) and reiterated by Clarke and Wilson (1994ii) these can add extra knowledge of a school's performance to the indicators discussed in chapter three. Irwin and Wilson (1985) define performance indicators in the following way;

> "as criteria which demonstrate the efficiency with which resources are allocated to cater for demand. Outcome indicators [such as examination results] can be considered as criteria which demonstrate how far educational objectives are being met." (Irwin and Wilson 1985, p1)

In this respect they are taking a slightly different approach to other commentators in that the theme is one of not so much testing schools on educational criteria (the 'value added' approach) but of tackling the problem from a rather more 'economic' stance.

The approach is based on an interaction modelling framework (for more details of which see chapter five), and endeavours to produce indicators which take into account the variation over space of the various data incorporated into the indicators. Specifically, Irwin and Wilson discuss the possibility of generating indicators for facilities (schools) which measure mainly efficiency of delivery (in 'cost' terms) and the effectiveness of delivery of the service (also in terms of 'cost'). There is potential for the disaggregation of the data into pupil types, school types, individual lessons and so forth. It is thus possible that given the right data a set of indicators could be generated for an individual school suggesting the effectiveness of individual subjects, pupil groups or teachers. Some of the indicator equations they develop are outlined below;

$$\frac{\sum_{w} T_{ij}^{aw} a_j^{as} \gamma_j^s}{b_j^{as}} \quad [5.10]$$

where;

T_{ij}^{as} = number of pupils of age-group a from residential origin i at school j taking subject s

a_j^{as} = number of hours of subject s demanded by age a pupils at school j

γ_j^s = cost of providing subject s at school j

b_j^{as} = average class size for age a pupils in subject s at school j

w = measure of pupil 'type' (say social class)

Equation [3.1] therefore gives us an indication of the cost of providing a subject for a particular age group at a particular school. A more general cost indicator can be given as;

$$\frac{\sum_{isw} T_{ij}^{aw} a_j^{as} \gamma_j^s}{b_j^{as}} \quad [5.11],$$

which tells us the overall cost of providing all subjects for all pupils at school j. These pure cost indicators are taken a stage further by Irwin and Wilson to give indicators of 'efficiency' and 'effectiveness' for schools. Again these are put in terms of financial cost;

$$\frac{\left(\sum_{w} T_{ij}^{aw} a_j^{as} \gamma_j^s \Big/ b_j^{as}\right)}{\sum_{v} U_j^{vs}} \quad [5.12]$$

where;

U_j^{vs} = full-time equivalent staff of type v involved in providing subject s at school j

all other definitions are as before.

This gives us the cost *per* staff hour of providing subject s to age group a at school j. Again, a cost approach is taken to examination passes;

$$\frac{\left(\sum_{w} T_{ij}^{fw} a_j^{fs} \gamma_j^s \Big/ b_j^{fs}\right)}{E_j^s} \quad [5.13]$$

where;

f replaces a to indicate final year only is taken into account

E_j^s = number of passes in subject s at school j.

This allows a school to know the cost *per* pass in subject s for any particular year. Similar indicators can be developed to give the number of passes *per* head of catchment population (disaggregated by pupil type if desired), the cost of such passes or the pass rate *per* head of total residential population, for example. Some of these indicators, together with other catchment-area and level of service delivery indicators are beginning to be empircally examined at the level of the city. Some examples, including for primary level education, are given in Clarke *et al.* (1997), which discusses the potential for measuring how well a city's residents are served by its various facilities.

Clearly this kind of approach could be used to justify the introduction of performance-related pay (or maximising 'payback' for minimum investment), and could put undue pressure on teachers to produce 'results' in terms of good examination marks rather than taking, for example, a value added approach. This could mean that although useful for financial officers the educational value of this approach is controversial, and could certainly be added to a right-wing political agenda. It is useful, however, to consider such an approach since this method could produce useful results on which to analyse the relative performance of schools based on certain restricted criteria. At the same time it is also true that data which is to be used in interaction models should, it could be argued, be simple enough for the users of the data (*i.e.* the parents of 10- to 18-year-olds and LEA officers) to readily understand or it is likely that any research will be marginalised by its own complexity. For these reasons it is the case that research of this type is not appropriate for this thesis – its data requirements alone (that data be available at the level not just of the individual schools in an authority but also at the level of the individual pupils within those schools) make it a thesis in its own right – but certainly a subject worthy of acknowledgement and future research in this area.

5.7 Conclusions

It is clear from the above analysis that geographical modelling has a great deal to offer the educational planner. This is true both in terms of the study of existing school systems and in a more proactive, policy-driven sense. Not only can planners quickly and relatively easily determine population levels and migration patterns, but their ability to gauge the rolls at particular schools in their area is increased as well. Given this improvement in the data which is available to LEAs and other schools planners, it is possible that the decisions which have to be made regarding provision of places can be taken in a more informed way, possibly avoiding more than in the past the possibility of costly mistakes. Certainly the employment of dynamic modelling techniques can allow planners to take a longer-term view of the system and make decisions which are informed by the 'most likely' development of a system under the *status quo*. In addition, the static modelling techniques outlined here can begin to allow planners to see quickly and relatively simply the likely impacts of decisions regarding the system – whether that be closing, opening or rationalising the school network – or the likely destinations of in-migrants with regard to school facilities.

It is however likely that such modelling developments will only be taken on board by planners if they are both simple to use and the output is readily understood. This is an argument made previously by Clarke and Langley (1995, 1996) but one which stands reiteration here. What is required is the integration of the models outlined here with the kind of GIS-based display techniques covered in chapter four. In this sense the development of fully integrated 'spatial decision support systems' (see for example Densham 1991 or Birkin *et al.* 1996) is clearly critical to a wider uptake of these more complex methodologies. Such systems enable the user to take the results of models calibrated outside a GIS and display them within the same system which is used for other kinds of mapping and analysis, ideally in a user-friendly and portable manner. This argument is developed further in chapter nine. However, the main conclusion which can be drawn from this chapter is that there exists a suite of models which seem appropriate for application to the extremely hard problems facing educational planners. The main barriers to their implementation would appear to be threefold; *a.* lack of awareness on the part of planners; *b.* the definition of school attractiveness and; *c.* complex and potentially user-unfriendly output. These are not, though, significant difficulties. The first problem is slowly being overcome as councils develop a more IT- and GIS-oriented approach to planning and thus awareness of the potential for these techniques spreads. The third problem has already been addressed briefly above – it is perfectly possible to integrate models into other systems as SDSS. The middle of the three is perhaps the most complex problem, but the use of modelling techniques is an important way to begin to develop accurate measures of school performance and attractiveness. This is a subject dealt with in more depth in chapters six and seven but it is clear that the two processes – the development of robust models and of accurate performance/attractiveness measures – go hand in hand and should be an integral part of the planning process in education.

Chapter six

Interaction modelling in education: from theory to practice

6.1 Introduction

In chapter five a variety of geographical modelling procedures were outlined. It is the purpose of this chapter to apply the most appropriate of these methods, as outlined in the previous chapter, to Leeds and report the results of the modelling task. Taking the background of Leeds LEA and secondary school provision in the city as outlined in chapters three and four, it is clear that there is a rôle for interaction modelling in the policy and planning stages of school provision. To this end the chapter here concentrates on the spatial interaction model – demographic and population models are methods for a different thesis (but see chapter five for an outline).

It has been made clear that there are three main reasons for including interaction modelling in the brief of an LEA's planning department, which it is useful to reiterate briefly. The first of these is an attempt to improve planning officers' knowledge of the potential impacts of changes in the numbers of pupils at schools (if, say, a new housing estate is planned or there are major demographic changes) or in the physical infrastructure of the school system (a new school is opened or an existing one closed). These are the situations for which spatial interaction models were really developed in an applied sense and can obviously and immediately enhance the relevant authority's knowledge base.

The second major reason for the implementation of spatial interaction models in education would be to test the impacts of changes in the information available to parents with regard to schools. This would cover the testing of measures intended to explain parental choice. In other words, if a model is predicting the current pupil flows to an acceptable degree of accuracy, it would be possible to change the attractiveness values and view the likely impacts if new measures of school performance were to become available. It could also be used to test the accuracy of indices of school attractiveness intended to reflect the current situation, as long as these were quantifiable. Clearly, if such an index were to be compiled and was tested as the W_j term in a spatial interaction model the accuracy of the predictions would be of immense help in deciding on the accuracy of the index. This is discussed in slightly more depth in section 6.2.2.2 below and in chapter seven following.

The third main reason for the implementation of spatial interaction models is to consider the likely change in school populations over time. This is the goal of dynamic modelling and since that is the subject of chapter eight, it will not be discussed here.

This chapter is divided into several related but distinct sections. Since the most immediately appropriate model type would seem to be a production constrained spatial interaction model (see chapter five, section 5.3.2.2), the implementation of this type of model is discussed first, at some length. This is followed by a consideration of the impacts of disaggregation by social group on the results obtained from the basic model, and a brief analysis of the impact of varying model type on the results. This chapter deals largely with the basic model calibration ('fitting' the model to actual pupil flows) – the issue of 'what if?' modelling is considered in chapter seven. The final part of the chapter considers the main problems encountered and the ease of application of these techniques to Leeds' specific problems.

6.2 The production constrained spatial interaction model

6.2.1 Introduction

The production constrained spatial interaction model is arguably the most widely applied model of this type that there is. It is particularly widely used in retail planning (see Clarke 1986, Wrigley 1988) and its popularity lies in that it works with known origin data to produce predictions of destination and flow totals (in other words it acts as a location model). This means that starting from a fixed population base at origin and a 'most likely' attractiveness value for each destination the model is an attempt to reproduce or estimate the total arrivals at the destinations and the flows between origin and destination.

In this case two slightly different models were used, one a simple one-parameter spatial interaction model (using only the β (beta) parameter in the distance function) and the other using α (alpha) as well, to more accurately scale the W_j values[23]. The model was run a number of times using a variety of attractiveness values, as discussed in section 6.3 below.

6.2.2 Data requirements

6.2.2.1 Origin (demand) data

The demand data forms perhaps the most crucial part of the spatial interaction model's data requirements. It is this which the model uses both to calculate origin totals and to measure the accuracy of its predictions (through one of the possible error functions). The data used here comes from Leeds LEA. They supplied data on pupil postcodes and the secondary school attended by each pupil. There were, in the 1993/4 school year, some 41,905 pupils attending Leeds secondary schools, including all the year groups (known as '7' through '13', covering ages 11 to 18). This data needed to be aggregated into usable origin zones, for which postal sectors were selected. This gives both a reasonable spatial scale and also a workable number of origin zones (283 in this dataset – the number of different postal sectors from which pupils are drawn). The destination zones clearly had to be the secondary schools, of which there are 45 in Leeds[24]. Postal sectors are also a convenient unit to use since the 1991 census data is available at this scale and some social information on the pupils at different schools can therefore be built up, as discussed in chapter four. The map at figure 6.1 shows the residential location of the children attending Leeds LEA secondary schools and figure 6.2 shows the rolls at the forty-five schools.

---

[23] See Appendix IV for full model equations

[24] Counting only those schools which come under the *aegis* of the LEA. All the authority schools (39) and Church-aided schools (1 C. of E., 5 R.C.) are included in the modelling task. The schools which are excluded comprise; one GM school, six independent secondaries, one Roman Catholic sixth form college and eleven special schools

Figure 6.1: Leeds secondary schools, with postal districts; home locations of all Leeds state secondary pupils 1993-4 academic year

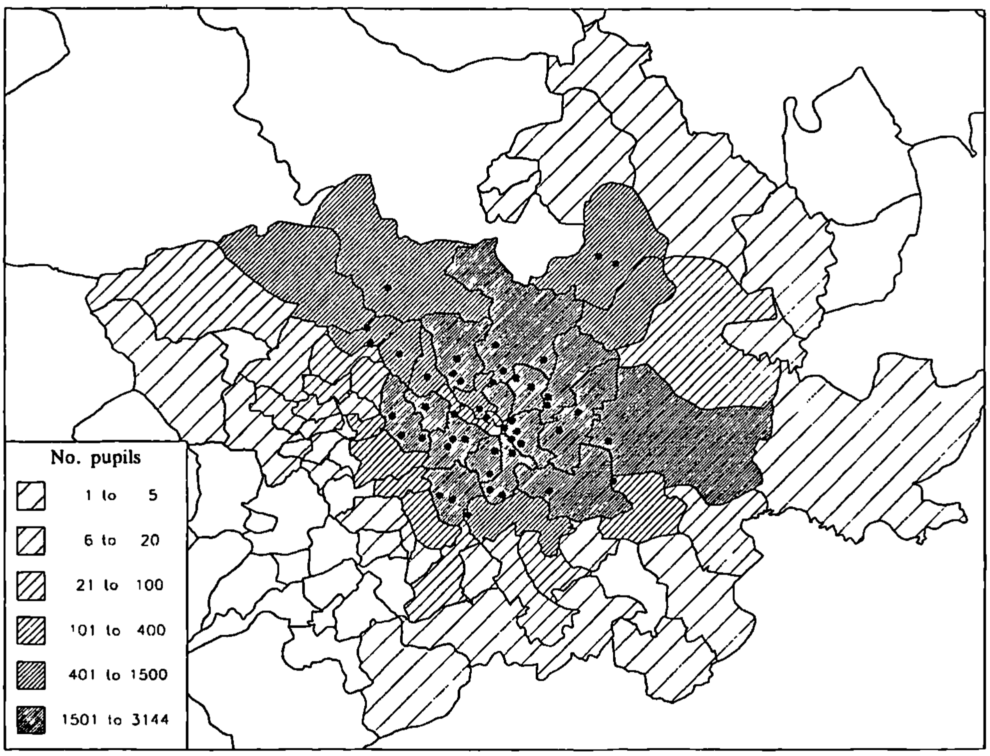
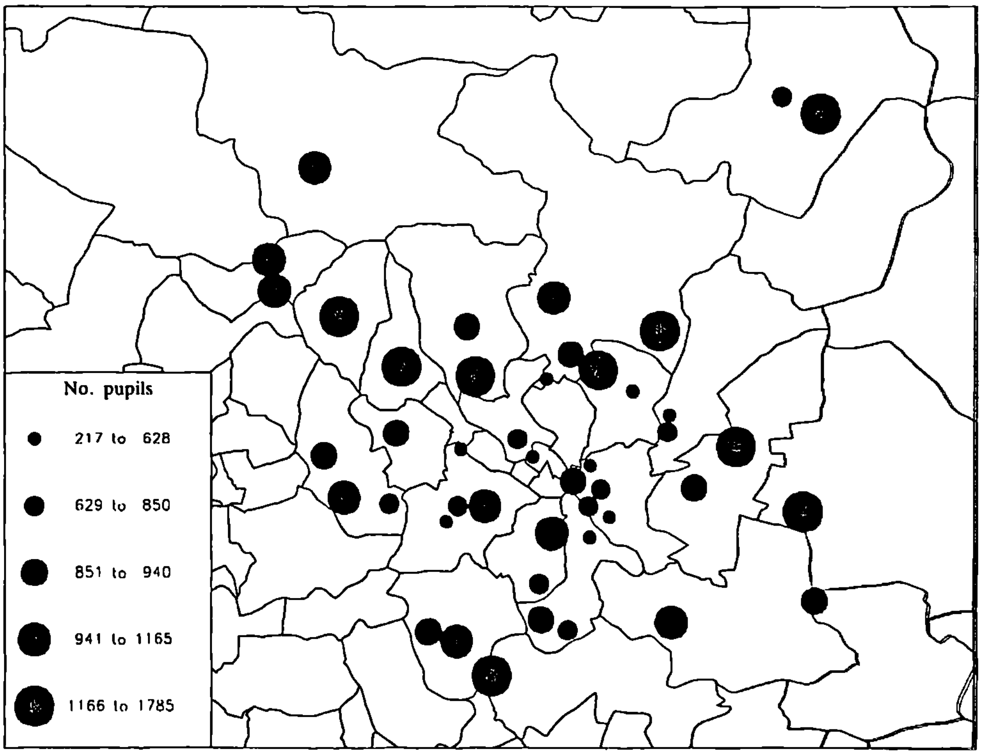


Figure 6.2: Leeds secondary schools, with postal districts; total school rolls 1993-4 academic year



6.2.2.2 Attractiveness

One crucial aspect of all the models used here is the definition of the attractiveness of destinations to origins. Clearly distance plays its part in this, but as mentioned in chapter five, attractiveness is more complicated than this. In the specific example used here the definition of what makes one school attractive to parents rather than another is a complex issue and is the subject of a wide range of educational literature (see Adler *et al.* 1989, Ball *et al.* 1994, 1995, Hirsch 1995, Strickland 1994i and Appendix III). In this particular instance, however, it seems less important to know exactly *why* any individual parent chooses a particular school than to define a reasonable quantitative proxy which allows the model to predict the correct numbers of pupils on roll at any given school.

Clearly there is a great deal of scope within the framework of interaction modelling to 'test' a range of measures which might be thought to represent parental choice. Once a model has been properly defined and calibrated to a dataset, the value of W_j can be replaced by any number of other figures in order to observe the impacts on pupil flows. Some of the measures initially tested are discussed here, and the discussion of W_j and alternative 'performance indicators' is expanded in chapter seven.

Normally, in retailing, attractiveness is defined by the size of a facility. The various measures of attractiveness used in this definition of an educationally-specific spatial interaction model are based on school level data. These data have been obtained partly from the Department for Education and Employment (or DfEE, as the DfE became in 1995) and partly from Leeds City Council's Education Department. Those obtained from the DfEE relate purely to examination results and truancy rates and are published annually in the public domain. The DfEE data used here are as follows:

% pupils obtaining 5+ GCSEs at grades A*-C
% pupils obtaining 1+ GCSEs at grades A*-G
Average A-Level points per candidate taking 2+ A-Levels
% half days missed through authorised absence
% half days missed through unauthorised absence

These results show the proportion of pupils achieving sufficient qualifications at age 16 to progress to further education, the proportion of pupils achieving any academic qualification at age 16 (which can be inverted to give the proportion of pupils gaining no GCSE qualifications – no formal academic qualifications) and the success of those students in secondary school sixth forms at age 18. The truancy data give an indication of attendance at a school, but serious concerns over collection and definition issues (see Abrams 1993iv, Abrams and Judd 1993, Bennett 1994) mean that these data must be treated circumspectly.

Data from the LEA include such measures as;

Number of pupils in receipt of free school meals (FSM)
Number of pupils with statements of special educational needs (SEN)
Number of pupils from ethnic backgrounds
Numbers of teachers, their age and length of service in the authority
Number of pupils on roll, by year group
School capacity

From this information it is clearly possible to calculate more useful measures such as percentage rates of FSM, SEN and ethnic pupils, pupil-teacher ratios and surplus places. This latter can be calculated both as actual numbers of places and as a proportion of capacity. There are, therefore, a wide range of values which can be employed as attractiveness measures in the spatial interaction model, and a large number of these were in fact tested, as discussed in section 3 below.

6.2.2.3 Distance deterrence

The final dataset which is required is of course the distance or cost matrix. Clearly this measure could easily take a number of forms, including straight line distances, actual travel distances along roads, journey times on foot, by car or by public transport, some more complex measure of accessibility (say, proximity to direct bus routes, traffic congestion at peak times and so on) or a combined index including some or all of these factors. For the purposes of this exercise, however, in order to make the study as simple as possible, only straight line distances between origins and destinations will be used.

These are calculated in kilometres from the grid reference of the postal sector centroids to the locations of the schools.

It is clear that the impact of distance on the outcome of the model is critical. In many ways it is the most important element in the model equation, especially in the simplest one-parameter PC spatial interaction model. However, it is less certain that the effects of distance will be the same for all pupils, or that all schools will exhibit the same properties when it comes to pulling power. In other words, some schools will be able to attract pupils from a much wider range than others, a fact which is partly represented by the consideration of the W_j term, discussed above. The later sections of this chapter consider the different impacts on the model if data is entered in disaggregate format, with pupils from different classes being assigned different parameter values. As we shall see in the discussion which follows, the impact of varying attractiveness and parameter values can affect the impact of distance and thus the model outcomes a great deal.

6.2.3 Conclusions/summary

These, then, are the data which have been assembled for the modelling exercise. It is of course crucial that the data used in initial model calibration are as accurate as it is possible to be. To this end, perhaps the most important element is to ensure that the data used are from the same date, or from as narrow a period as is possible. Clearly the census is constrained to be 1991, which is the latest source of the sorts of social data which interest us here. However, there is a wealth of school-level data from several recent years (although good historical data do not exist as far back as 1991 so comparisons are necessarily based on differing years), a pool of data which is growing ever larger, and it is important to ensure that the data used as attractiveness values match the date of the interaction matrix. In this we have been lucky that Leeds LEA has collated a great deal of information which is from the same time as the information contained in the nationally-published league tables. This gives us valuable resources with which to work, and over time will begin to build into useful time-series data concerning the travel of children in Leeds to secondary schools. It is crucial to note that all the data used in the model are from the same academic year, although when it comes to disaggregation by social group the proportions used to split the pupil data are from the census three years previously.

6.3 Calibration, model application

6.3.1 Introduction

This section relates the definition of interaction models specific to education and the results obtained from model runs based on the data described above. For a more technical approach to the issues of model specification and calibration the interested reader is directed to Wilson (1974, 1981). This chapter is presented in a relatively non-technical manner since it is the purpose of this thesis to concentrate on the potential solution of some educational problems rather than to define 'new' interaction models. As this is the case the discussion concentrates on the accuracy of the models' predictions rather than the theoretical basis of the models used to produce the predictions.

The examples given in this section deal with an aggregate model. In other words, no distinction is drawn between pupil 'types'. All pupils are treated the same, and distance is assumed to have the same impact on all children from all areas of the city. In modelling terms, this means that a single β value is used for the entire dataset, although this will be refined in later sections.

In mathematical terms, the model takes the following form, first outlined in the previous chapter;

$$T_{ij} = A_i . O_i . W_j . e^{-\beta . c_{ij}} \qquad [6.1]$$

where;

$$A_i = \frac{1}{\sum_j W_j . e^{-\beta . c_{ij}}} \qquad [6.2]$$

where;

T_{ij}	=	number of flows between zones i and j
O_i	=	population at origin zones i
W_j	=	'attractiveness' of destination zones j
d_{ij}	=	'travel function' between zones i and j (distance, cost *etc.*)
A_i	=	balancing factor to ensure equation [6.3] is satisfied

$$\sum_j T_{ij} = O_i \qquad [6.3]$$

In order to attempt to produce the best possible fit with the real data, the model uses what is termed an 'error function' which it works to minimise in order to produce a 'best fit' model with the best possible parameter values. The evaluations here use one of two error functions, one which attempts to minimise the sum of squared differences between observed and predicted trip totals and the other of which minimises the difference between the average distance travelled by pupils in the observed and predicted trip matrices. The mathematical definition and equations for these functions can be found in Appendix IV.

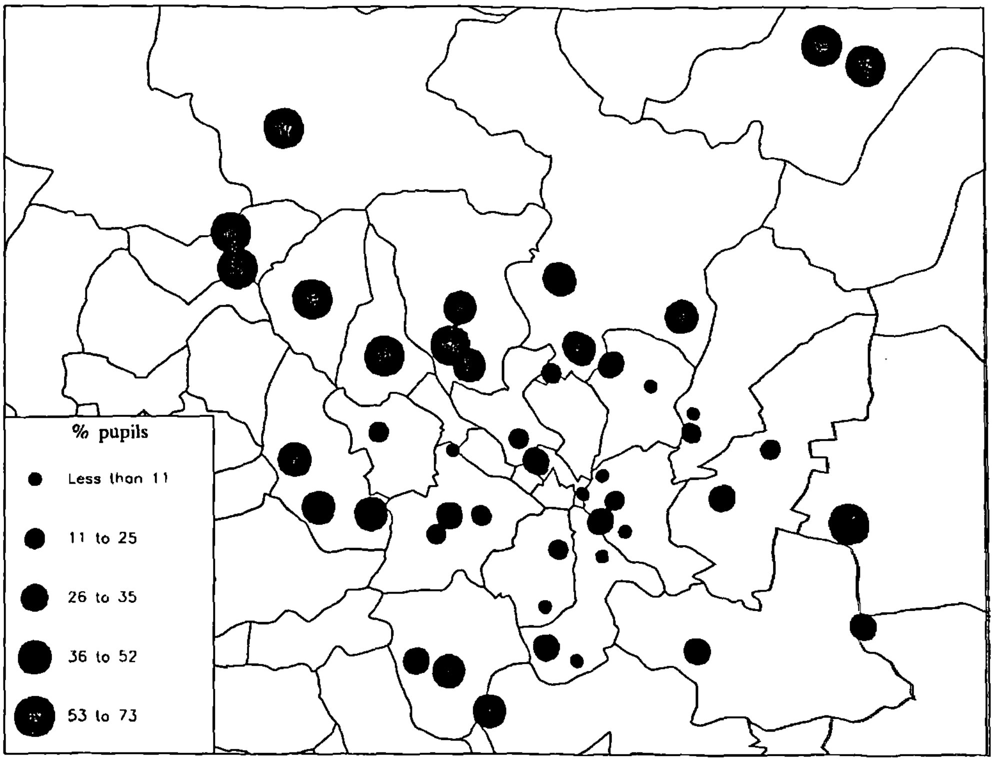
With the first error function the predictions of the initial model run are compared with the actual data which the model has access to, and the closer to zero the error function (the difference between actual and predicted trip totals) is, the closer to a 'perfect' prediction the model is assumed to be. The parameter values of one model run will be altered according to the error value and another evaluation carried out on this basis until a minimum error value is reached. That is, they are solved iteratively.

The second error function is concerned with distance deterrence. The essential goal of this method is to minimise the difference between the actual and predicted distance *per* interaction (or mean trip distance). Of course, this does mean it is prey to problems such as there being several long journeys in the predicted matrix (particularly where certain schools are what is known as 'spatial outliers'), which might contain the correct average journey time but in fact assign all the pupils to a single school. However, it provides a useful alternative to the sum of squares error method.

6.3.2 *Application – some results (varying α and β)*

The model was run a number of times using a variety of parameter values, and the simple attractiveness measure of GCSE pass rates. This is used first as a reasonable proxy of attractiveness to parents. The Government's rhetoric says that schools' attractiveness will be defined in terms of the league tables and therefore I have used this as the initial attractiveness value in the model. These values are shown in the map at figure 6.3. There is a potential pitfall with using this type of data which the results here illustrate – one of the schools had *no* pupils with five or more GCSE passes in 1994, which means that the roll is consistently predicted as zero. This problem could potentially be overcome by the definition of more complex indicators such as those discussed in chapter seven following. In this chapter the school is given a default attractiveness of 1.0. The effect of the β parameter is to scale the impact of distance on the population at the origin zones. A higher β increases the effect of distance deterrence, meaning that people are less willing to travel long distances to a destination, and are more likely to be satisfied at a closer school. The lower β is, the less effect distance has on the population under study, until at zero it has no effect and the model is predicted using only the impact of school attractiveness.

Figure 6.3: Pass rates at GCSE, 1994, Leeds state secondary schools (% pupils gaining 5 or more GCSEs at grades A*-C)



Firstly, the model used was the simpler, one parameter version. Some of the results are shown in table 6.1 (β and error value). The table shows that altering β has a significant impact on the quality of the predictions, in the general terms that the error value gives us. The first value in the table uses automatic calibration, while the other values show the results for a variety of other β values as comparison. Clearly these figures are not on their own sufficient as a definitive guide to the overall picture given by a model, since it is the accuracy of the actual flow and roll predictions which is of interest. Therefore, table 6.2 shows a selection of the destination predictions against the actual rolls for the secondary schools. This is further highlighted in figures 6.4 and 6.5, which show some of the same data visually.

Table 6.1: Beta and error values for 1-parameter model using GCSE results as W_j

β value	*Average error value* per *trip*
-0.12	0.01515
-5.00	0.03883
-1.00	0.02264
-0.80	0.02060
-0.60	0.01856
-0.40	0.01665
-0.20	0.01530
-0.10	0.01516

Table 6.2: Predicted rolls at Leeds secondary schools using simple 1-parameter model, % 5+ GCSEs as W_j

School	*Actual roll*	β = *-5.00*	β = *-1.00*	β = *-0.40*	β = *-0.20*	β = *-0.12*
1	887	342	320	295	261	234
2	1689	1149	1244	1379	1348	1270
3	1125	2583	2023	1565	1522	1518
4	338	184	38	39	39	37
5	1374	18	428	987	1289	1425
6	1765	834	789	772	790	914
7	217	359	921	1157	1150	1083
8	885	105	664	718	651	666
9	888	624	640	718	761	8
10	619	153	1592	1974	1962	1866
11	793	2395	827	691	647	601
12	680	1005	804	670	605	548
13	718	630	350	288	280	269
14	777	1184	1219	1090	967	873
15	420	410	830	1056	1115	1126
16	430	158	103	92	83	75
17	471	237	122	116	112	105
18	1785	1095	716	606	576	551
19	1093	2336	2070	1905	1641	1559
20	1187	552	1033	1056	1120	1181
21	939	822	1002	1084	1188	1326
22	1496	1175	1267	1587	1770	1801
23	1551	798	715	655	665	656
24	1099	1193	1140	927	833	787
25	362	702	1075	1286	1330	1283
26	658	2570	1352	855	741	673
27	940	284	1084	1213	1143	1058
28	1108	15	77	126	144	148
29	850	904	927	1040	1102	1159
30	686	1647	1696	1517	1345	1214
31	935	1104	569	542	523	491
32	509	2623	1486	1073	1070	1125
33	1165	392	524	489	435	390
34	1074	491	454	521	734	961
35	903	1958	1726	1620	1654	1646
36	874	22	506	883	1002	1025
37	1204	721	1047	1261	1358	1361
38	983	2291	1414	903	846	851
39	1001	1271	1207	1225	1314	1489
40	628	1339	1456	1244	1124	1018
41	874	361	765	960	929	875
42	1154	598	833	779	719	666
43	730	712	746	749	775	891
44	1389	346	613	853	976	1071
45	645	1010	1291	1136	1062	1000

Figure 6.4: Predicted rolls, 1-parameter SIM, β = -1.00

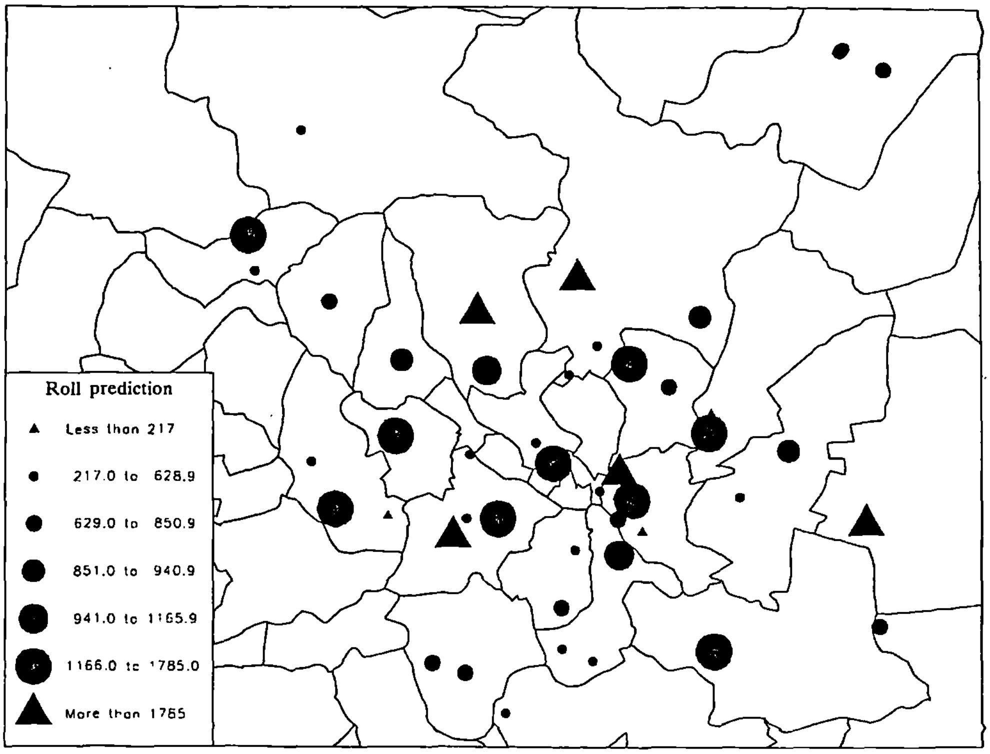
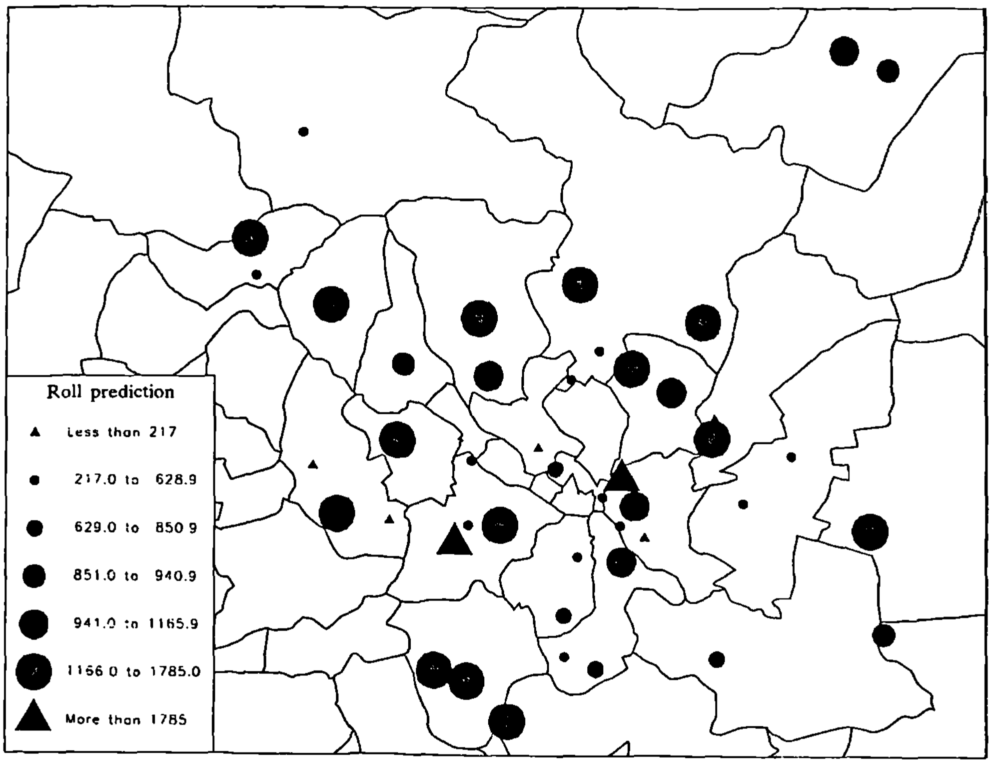


Figure 6.5: Predicted rolls, 1-parameter SIM, β = -0.12



It is immediately clear that there are certain areas of the city which suffer from poor predictions, however good the overall fit. These problems are basically allied to the effect of distance. The outer schools away from major population centres (especially those in the north east of the city) are being seriously underpredicted, while the schools in the central area are being overpredicted. This simply means that the distance effect is stressed too highly in the model when compared with the effect of attractiveness. In other words, there are some people who are willing to go to some schools regardless of the distances involved. It is however worth noting that even with this simple model it is possible to get some of the roll predictions very close to the actual rolls. Again, it is the disaggregated modelling below which attempts to address this problem of assigning the same parameter values to all trippers, regardless of their origin or individual characteristics.

This is where the two parameter model comes in. This model includes a second parameter, α, which scales the effect of attractiveness. This has the same effect on attractiveness that β has on distance. In other words, a high α means that attractiveness is very important, and a low α mean that attractiveness has little impact (and suggests that distance may be a more important factor). Therefore, it is possible to produce predictions which take into account not only the fact that distance may not be entirely important to the group under study, but also that the effect of attractiveness can be variable. Some of the initial attempts to vary α as well as β are shown in tables 6.3 and 6.4 and figures 6.6 and 6.7.

Table 6.3: Parameter and error values, 2-parameter spatial interaction model using GCSE results as W_j

Final α value	*Final β value*	*Average error* per *trip*
+0.34	-0.14	0.01504
+5.00	-2.00	0.03359
+2.00	-1.00	0.02363
+1.00	-0.80	0.02060
+0.80	-0.20	0.01522

Table 6.4: Predicted rolls for Leeds schools; 2-parameter spatial interaction model; % pupils with 5+ GCSEs as W_j

School	*Actual roll*	$\alpha = +5.00$; $\beta = -2.00$	$\alpha = +1.00$; $\beta = -0.80$	$\alpha = +0.80$; $\beta = -0.20$	$\alpha = +0.36$; $\beta = -0.13$
1	887	1	319	364	706
2	1689	968	1288	1334	1212
3	1125	2370	1877	1436	1199
4	338	0	37	78	360
5	1374	167	557	1199	1021
6	1765	864	780	730	600
7	217	530	1000	1169	1134
8	885	218	719	667	685
9	888	215	663	775	824
10	619	3519	1745	1798	1378
11	793	61	765	750	963
12	680	62	758	715	955
13	718	10	318	368	657
14	777	591	1203	1029	1084
15	420	907	914	1100	1042
16	430	0	101	144	461
17	471	0	117	180	497
18	1785	133	682	664	868
19	1093	2780	2079	1457	1036
20	1187	1008	1055	1077	985
21	939	728	1015	1099	899
22	1496	1743	1330	1613	1260
23	1551	227	678	742	907
24	1099	973	1077	879	921
25	362	1295	1127	1317	1211
26	658	1263	1156	827	979
27	940	1368	1159	1160	1119
28	1108	0	90	207	482
29	850	1369	960	1043	936
30	686	3084	1674	1340	1214
31	935	58	546	619	846
32	509	1914	1347	1041	963
33	1165	12	523	548	842
34	1074	486	449	693	672
35	903	1986	1688	1545	1256
36	874	564	614	985	952
37	1204	1588	1104	1294	1123
38	983	1718	1234	853	856
39	1001	1612	1206	1177	897
40	628	1405	1389	1174	1181
41	874	401	836	968	995
42	1154	283	836	807	975
43	730	696	742	721	[illegible]
44	1389	672	682	921	[illegible]
45	645	1852	1262	1094	1096

Figure 6.6: Predicted rolls, 2-parameter SIM, α = +1.00; β = -0.80

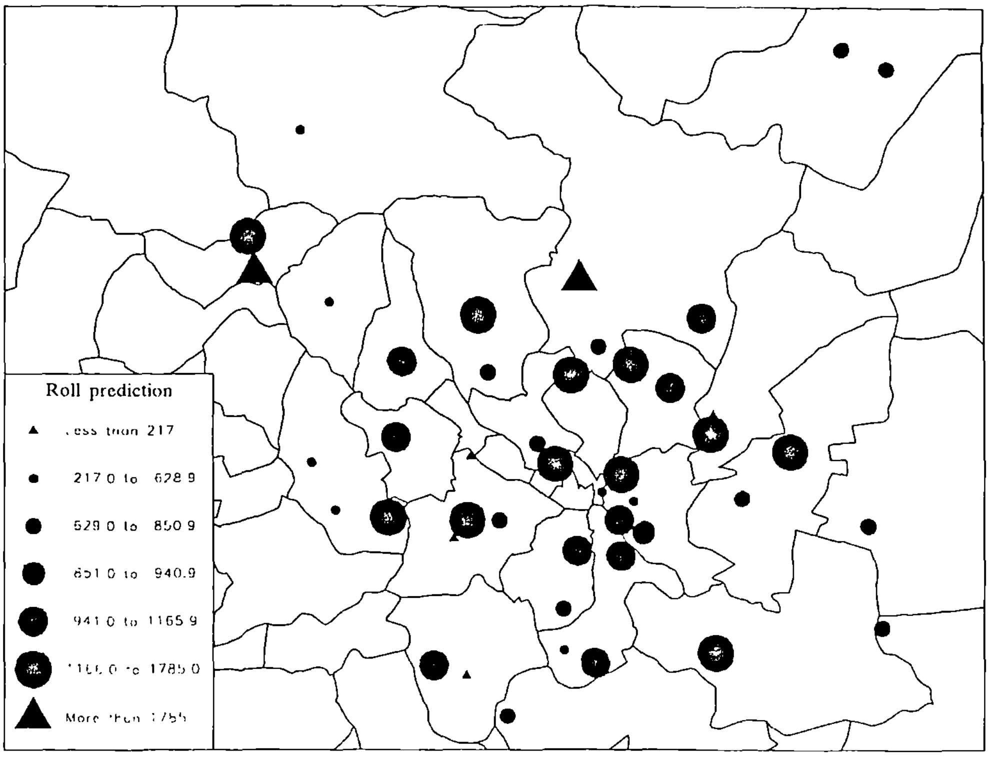
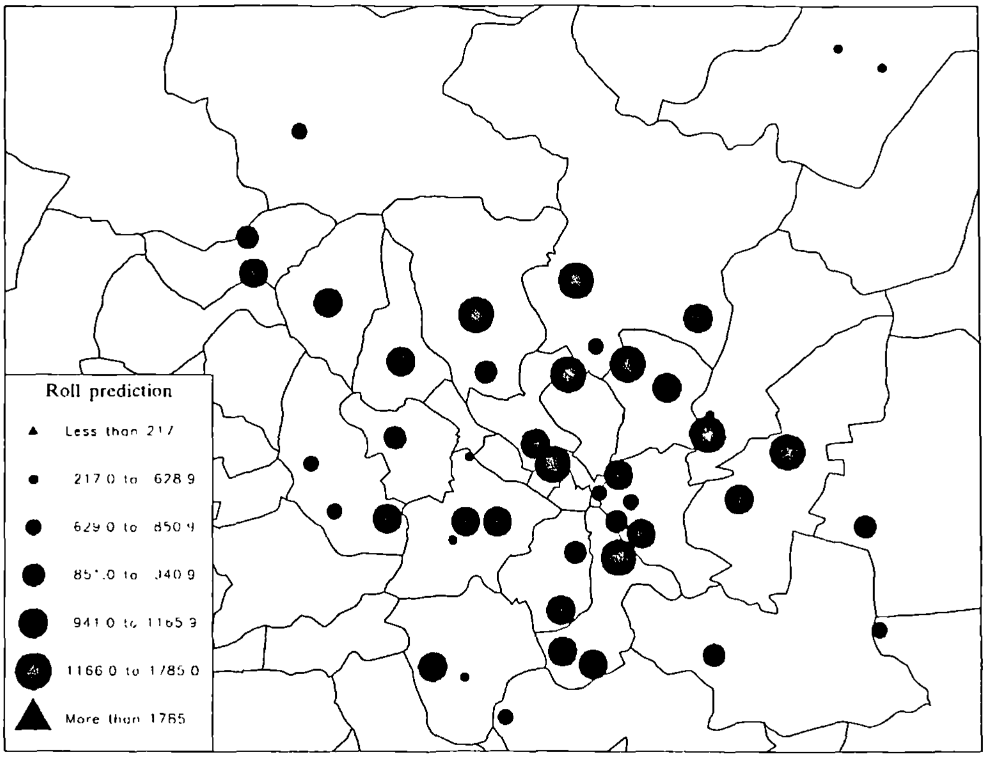


Figure 6.7: Predicted rolls, 2-parameter SIM; α = +0.36; β = -0.13



Clearly the predictions are, generally speaking, 'better' than they were with the simpler model (the error values are on the whole lower), but that the same problems exist with the overall pattern of prediction. That is, the outer schools tend to be losing out to the inner schools, except where the W_j of the northern schools is very high indeed. Clearly there is a great deal of scope for improvement of these predictions, although adding the extra parameter has been a step in the right direction.

While all these models may be able to give reasonable predictions of school rolls, this is of course only a part of what the spatial interaction model is about. There is also the question of accurately reproducing the *flow* of pupils to school – the catchments. This is a more complex problem, because the model must not only reproduce the correct number of pupils actually arriving at a school, but also accurately reproduce their origins. Figure 6.8 shows some of the catchments for some of the schools, predicted by various of the model runs described above. It is immediately clear that there is a problem with using the single β value for the whole dataset. The predicted catchments are roughly the same shape and size, and are largely circular, regardless of the location and attractiveness of the school. This is clearly not the case, as we have seen in previous chapters. There would seem therefore to be a case for some kind of refinement in the model to reduce this problem. This is covered in section 4 below.

Figure 6.8a: Catchment prediction, 1-parameter aggregate SIM, 'good' school, β = -0.12

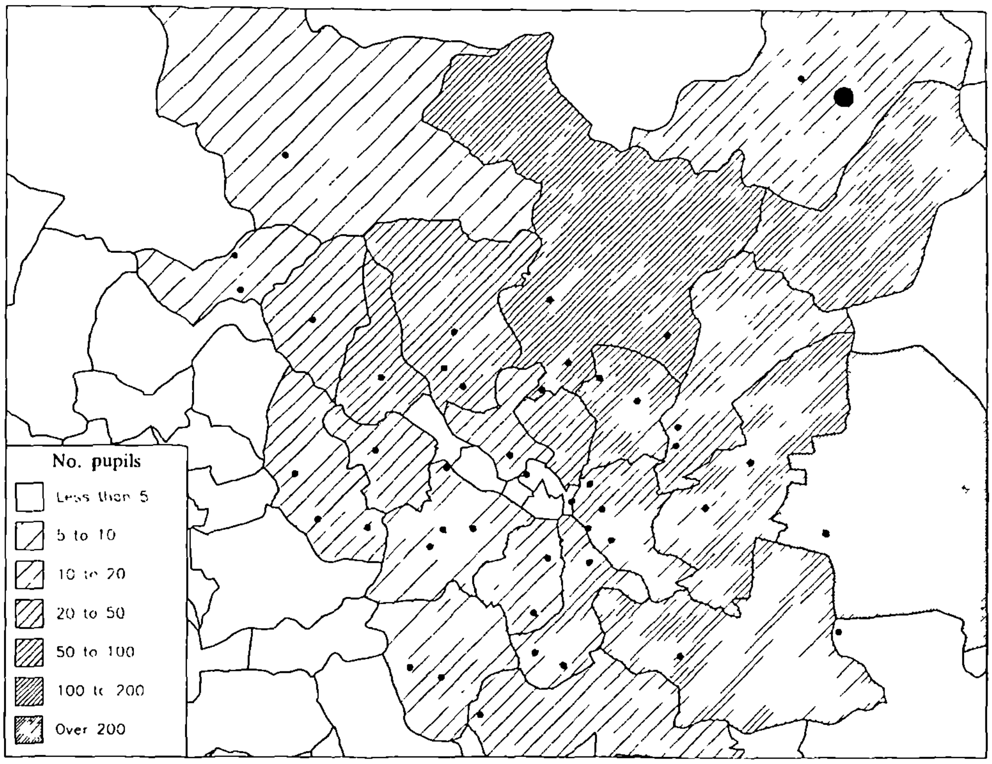
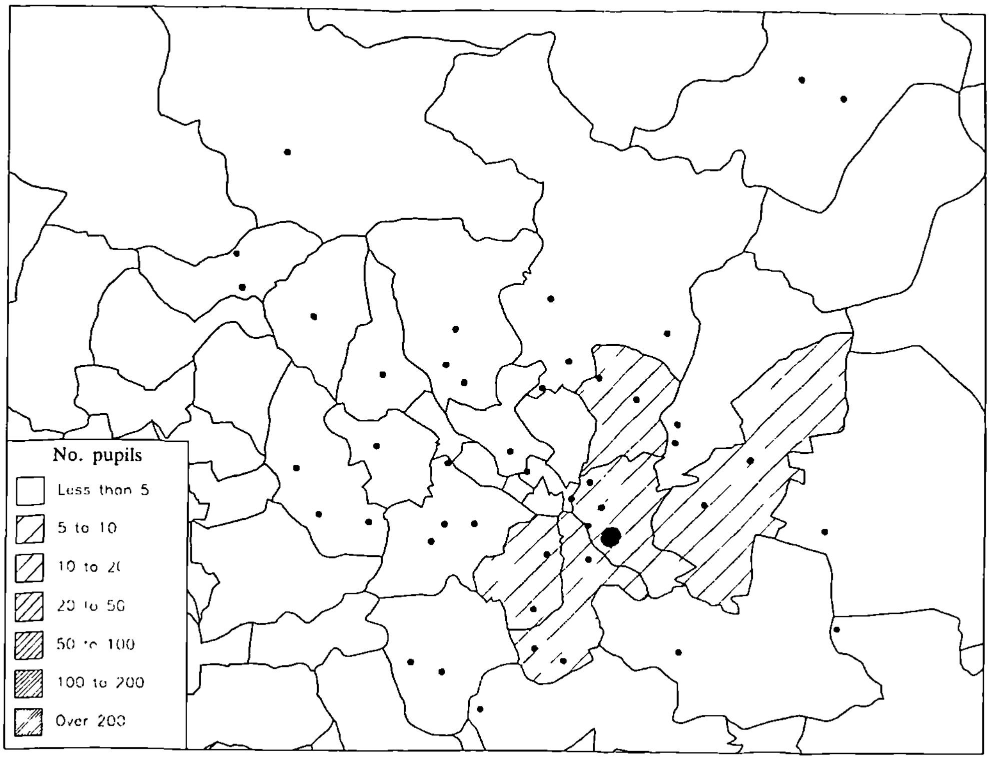


Figure 6.8b: Catchment prediction, 1-parameter aggregate SIM, 'poor' school, β = -0.12



6.3.3 Varying the attractiveness

The next step is clearly to try the same models but with a variety of attractiveness measures, to see whether a simple indicator such as GCSE pass rates can be improved upon. There are, as we have seen, a wide range of these in existence, and table 6.5 outlines briefly what was modelled here. All the attractiveness measures were applied to a two parameter model, since this gave consistently better results in the initial test outlined above.

Table 6.5: A selection of the attractiveness values tested in the model

School	*Capacity*	*Roll*	*Pupils with 5+ GCSEs grades A*-C*	*Pupils with 1+ GCSEs grades A*-G*	*Surplus places*	*% of total capacity filled*	*% pupils in receipt of FSM*	*% pupils described as 'ethnic' on Form 7*	*% pupils with SEN*
1	950	908	6.0%	70.0%	-42	95.6%	33.8%	9.3%	2.0%
2	1810	1719	35.0%	94.2%	-91	95.0%	18.3%	44.7%	3.1%
3	1020	1128	47.0%	96.8%	108	110.6%	9.1%	13.8%	3.4%
4	780	345	0.0%	80.0%	-435	44.2%	41.4%	0.9%	7.5%
5	1308	1392	55.0%	97.2%	84	106.4%	4.7%	2.6%	1.1%
6	1409	1791	60.0%	97.5%	382	127.1%	4.5%	1.1%	2.0%
7	580	224	30.1%	91.4%	-356	38.6%	36.2%	25.0%	7.1%
8	1287	885	29.0%	96.0%	-402	68.8%	12.9%	1.5%	3.3%
9	876	941	29.0%	88.0%	65	107.4%	11.2%	2.1%	2.3%
10	900	897	52.0%	98.0%	-3	99.7%	10.5%	9.3%	1.9%
11	1260	633	16.0%	71.0%	-627	50.2%	31.6%	25.8%	3.8%
12	960	859	14.0%	74.0%	-101	89.5%	44.2%	51.2%	4.4%
13	780	686	8.0%	79.0%	-94	87.9%	35.0%	11.4%	2.5%
14	900	721	23.0%	94.0%	-179	80.1%	22.6%	3.5%	2.2%
15	900	778	36.0%	93.0%	-122	86.4%	15.2%	4.8%	1.3%
16	930	434	2.0%	49.0%	-496	46.7%	45.6%	2.8%	1.4%
17	930	440	3.0%	55.0%	-490	47.3%	53.6%	1.4%	5.0%
18	780	476	16.0%	92.0%	-304	61.0%	27.7%	2.7%	1.9%
19	1800	1813	60.0%	99.0%	13	100.7%	4.6%	1.2%	1.0%
20	948	1091	42.0%	97.0%	143	115.1%	9.7%	4.2%	1.4%
21	911	1090	61.0%	99.0%	179	119.6%	6.0%	3.3%	1.3%
22	1170	1189	57.0%	96.0%	19	101.6%	5.0%	2.6%	1.7%
23	950	959	20.0%	84.0%	9	100.9%	25.4%	2.9%	1.7%
24	1600	1553	25.0%	90.0%	-47	97.1%	23.3%	3.4%	3.3%
25	1636	1575	36.0%	89.0%	-61	96.3%	15.3%	15.4%	3.4%
26	1110	1143	18.0%	72.0%	33	103.0%	35.3%	26.6%	2.3%
27	750	366	29.0%	94.6%	-384	48.8%	41.5%	3.6%	4.6%
28	780	707	5.0%	73.0%	-73	90.6%	43.1%	2.3%	[illegible]
29	1119	1132	42.0%	89.0%	13	101.2%	12.6%	1.7%	[illegible]
30	900	860	32.0%	93.0%	-40	95.6%	20.0%	3.1%	[illegible]
31	810	692	14.0%	79.0%	-118	85.4%	58.7%	33.5%	[illegible]
32	927	943	41.0%	92.0%	16	101.7%	12.8%	15.6%	1.1%
33	800	509	10.0%	81.0%	-291	63.6%	81.1%	74.5%	[illegible]
34	1132	1193	55.0%	96.0%	61	105.4%	6.0%	0.9%	[illegible]
35	1000	898	50.0%	92.0%	-102	89.8%	12.2%	6.8%	[illegible]
36	1274	871	34.0%	86.0%	-403	68.4%	11.5%	2.2%	[illegible]
37	1380	1229	43.0%	90.0%	-151	89.1%	28.1%	26.5%	[illegible]
38	1147	1070	30.0%	94.0%	-77	93.3%	10.7%	1.6%	[illegible]
39	1020	1020	73.0%	99.0%	0	100.0%	5.4%	1.2%	[illegible]
40	750	638	26.0%	87.0%	-112	85.1%	29.2%	18.5%	[illegible]
41	960	883	26.0%	81.0%	-77	92.0%	24.3%	3.2%	[illegible]
42	980	1187	18.0%	90.0%	207	121.1%	21.4%	12.0%	[illegible]
43	920	737	58.0%	98.0%	-183	80.1%	4.1%	2.0%	[illegible]
44	1420	1408	42.0%	96.0%	-12	99.2%	9.4%	2.6%	[illegible]
45	820	656	28.0%	90.2%	-164	80.0%	23.5%	[illegible]	[illegible]
Average	1053	948	31.9%	87.6%	-105	88.2%	23.1%	10.9%	2.5%

There is, it should be noted, a clear correlation between many of these indicators and the social composition of the school. Since this is the case, it could be argued that different W_js in an aggregate model could be utilised as proxy measures of the social information contained in a disaggregate model. The table below summarises some of the more interesting relationships.

Table 6.6: Correlation coefficients[1] for selected in-school variables, Leeds secondary schools 1993-4 academic year

	Surplus places[3]	% pupils with 5+ GCSEs grades A*-C	Roll	% pupils in social classes A & B[2]	% pupils in *social* classes D & E[2]
% pupils AB[2]		+0.646	+0.477	-	-0.877
% pupils DE[2]		-0.641	-0.444	-0.877	-
5+ GCSEs A*-C	+0.536	-	+0.567	+0.646	-0.641
1+ GCSEs A*-G	+0.504	+0.786	+0.451	+0.475	-0.539
Roll	+0.689	+0.567	-	+0.477	-0.444
Capacity			+0.852	+0.392	
% capacity full	+0.961	+0.544	+0.761		
Unauth. truancy		-0.633	-0.405	-0.508	+0.493
% pupils SEN	-0.529	-0.415	-0.434		
% pupils FSM	-0.534	-0.806	-0.605	-0.498	+0.566
No. teachers		+0.384	+0.610	+0.512	-0.533

Note 1: All correlations shown are significant at 99% confidence limits

Note 2: Social data calculated using 1991 census, all other data are from 1993-4 school year; social classes are defined fully in section 6.4.2.1 below

Note 3: Surplus place relationships are the opposite of the implied one as a positive number of 'surplus' places indicates a school which is over capacity. Therefore, for example, higher GCSE results occur in schools with fewer surplus places and there are higher proportions of FSM pupils at schools with more surplus places

Clearly what we are seeing here is a pattern whereby the larger schools are attracting a larger proportion of AB students (see section 6.4.2.1 for a definition of the classification system used) and that they are performing better in GCSEs and seeing less problem with unauthorised truancy. However, although these relationships exist, the actual cause/effect relationship is less clear – do large schools perform well because they have much higher proportions of AB students or do AB students perform better because they attend larger schools with a consequent better access to wider ranges of resources? It is also clear that the number of surplus places at a school has a significant impact on examination outcomes, or that schools which perform badly at GCSE fail to attract parents. These are findings which are broadly very similar to those of previous studies (Farnsworth *et al.* 1994, Higgs *et al.* forthcoming). The table incorporates some slightly more complex indicators, where the effects of GCSE results and roll or capacity are combined into a single value. It is interesting to note that these indicators give lower error values than others, although given the model used they do not necessarily produce significantly better results.

Table 6.7: Effects of varying attractiveness (W_j, parameters and error values for a number of model runs)

W_j	*Final* α	*Final* β	*Average error* per *trip*
Actual number of surplus places	+0.40	-0.10	0.01545
% capacity filled	+1.28	-0.14	0.01500
Capacity	+0.90	-0.14	0.01503
Number of pupils from ethnic minorities	+0.01	-0.14	0.01511
% pupils receiving FSM	-0.37	-0.13	0.01501
% 5+ GCSEs/capacity, standardised and added	+0.66	-0.13	0.01494
% 5+ GCSEs/roll, standardised and added	+0.53	-0.13	0.01495
Number on roll	+0.77	-0.14	0.01497
% pupils with SEN	-0.41	-0.14	0.01507
% pupils gaining 5+ GCSEs grades A*-C	+0.35	-0.13	0.01504
% pupils gaining 1+ GCSEs grades A*-G	+1.03	-0.13	0.01506
Surplus places (+1000 so all positive)	-1.15	-0.14	0.01502
Truancy data (% half days, unauthorised)	-0.06	-0.13	0.01510

The differences are again striking between the model runs. Indeed, again, some schools are being very accurately reproduced on some runs, regardless of the poor predictions at other destinations. Table 6.8 shows some of the predictions of rolls at the schools for a number of the attractiveness values. A selection of these are shown in map form at figures 6.9 and 6.10. It seems certain that none of these simple measures give significantly better predictions than the GCSE results used initially. It is interesting to note though that the schools' physical capacity (in the same way as floorspace in retailing) would appear to be a good general proxy for their attractiveness. Having said that, this does not take into account the fact that the outer schools, which are over capacity, are being underestimated while the central schools (which have serious surplus place problems) are again being overestimated. This opens up a number of possible arguments on cause and effect; does a school have large capacity because it is historically popular or is it popular because it is large and can therefore offer many things a smaller school cannot?

Changing the attractiveness values can clearly improve the predictive capabilities of the model to an extent, although it appears to have very little impact on either the extent on clustering demonstrated in catchment areas. It is certainly the case that some of the lowest error values are returned by using the two combined attractiveness measures in table 6.8 above (when the GCSE pass rate is standardised and combined with either roll or capacity). However, the impacts would not seem to be so great as using slightly more complex versions of the model, such as when the α parameter was added. This is the direction which is adopted by section 4 below.

Table 6.8: Predicted rolls *vs.* actual rolls for the various W_j measures

School	*Actual roll*	*W_j = total roll; α = +0.77; β = -0.14*	*W_j = % capacity filled; α = +1.28; β = -0.14*	*W_j = total capacity; α = +0.90; β = -0.14*	*W_j = % 5+ GCSEs & capacity (std./added); α = +0.66; β = -0.13*	*W_j = % pupils with FSM; α = -0.37; β = -0.13*	*W_j = % pupils gaining 1+ GCSEs A*-G; α = +1.03; β = -0.13*
1	*887*	1169	1311	1066	723	906	925
2	*1689*	1785	1218	1787	1871	1068	1179
3	*1125*	1156	1319	960	1203	1238	1091
4	*338*	526	457	855	491	790	1007
5	*1374*	1103	998	994	1217	1276	891
6	*1765*	743	728	580	706	739	510
7	*217*	364	378	625	666	814	1124
8	*885*	627	480	763	857	734	717
9	*888*	803	998	669	919	934	787
10	*619*	1074	1284	946	1060	1305	1221
11	*793*	863	560	1349	781	903	918
12	*680*	1134	1213	1095	443	825	991
13	*718*	786	975	747	797	754	876
14	*777*	942	1007	976	1050	1018	1207
15	*420*	826	898	821	517	972	988
16	*430*	628	497	991	564	772	609
17	*471*	593	477	926	433	682	646
18	*1785*	623	636	790	1901	854	1074
19	*1093*	1293	933	1227	947	1268	877
20	*1187*	960	1156	774	1169	1030	927
21	*939*	782	987	619	516	984	778
22	*1496*	1189	1152	1085	1396	1514	1065
23	*1551*	1040	1177	926	1624	851	954
24	*1099*	1391	1072	1338	890	831	957
25	*362*	1661	1218	1638	860	1125	1104
26	*658*	1321	1358	1164	489	846	900
27	*940*	530	505	787	956	772	1155
28	*1108*	688	867	638	893	603	694
29	*850*	926	925	835	871	892	796
30	*686*	1079	1263	976	669	1066	1194
31	*935*	841	1018	817	1149	659	938
32	*509*	849	976	754	390	913	870
33	*1165*	747	778	911	1720	651	1074
34	*1074*	638	640	572	523	770	581
35	*903*	998	1032	975	1183	1133	1063
36	*874*	825	617	1017	946	1012	839
37	*1204*	1180	966	1197	1318	785	972
38	*983*	904	870	859	886	974	864
39	*1001*	697	736	644	962	958	732
40	*628*	901	1136	875	774	964	1169
41	*874*	960	1060	900	784	872	911
42	*1154*	1360	1662	1045	1300	1015	1132
43	*730*	380	409	401	573	777	521
44	*1389*	987	814	931	1069	909	779
45	*645*	831	940	861	648	946	1096

Figure 6.9: W_j = % capacity filled; $\alpha = +1.28$; $\beta = -0.14$

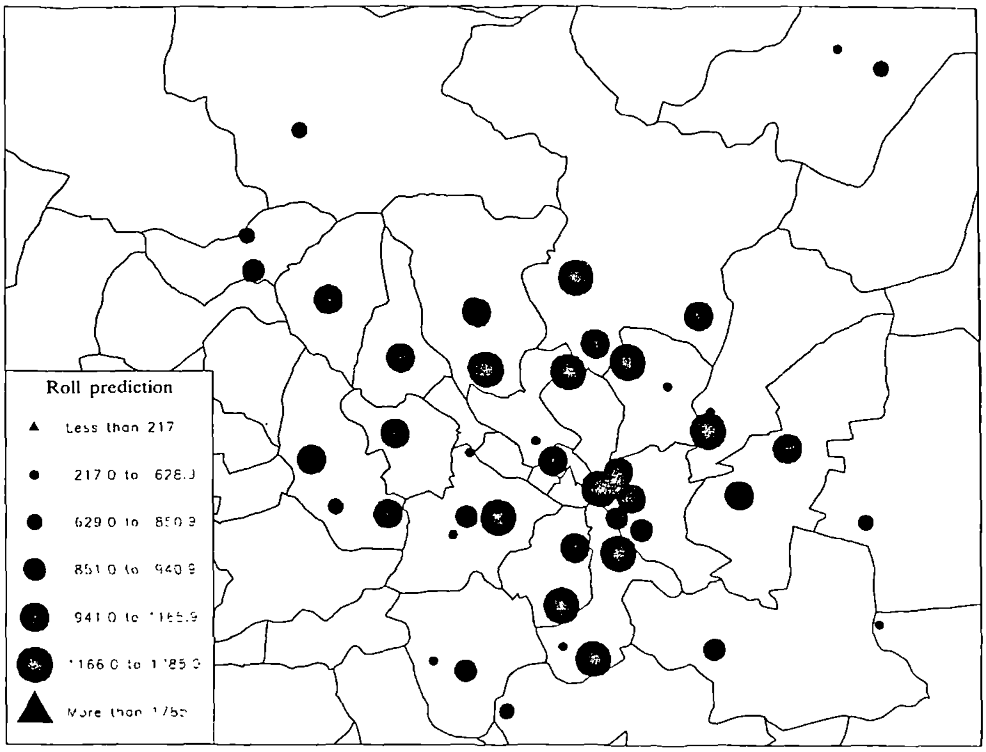
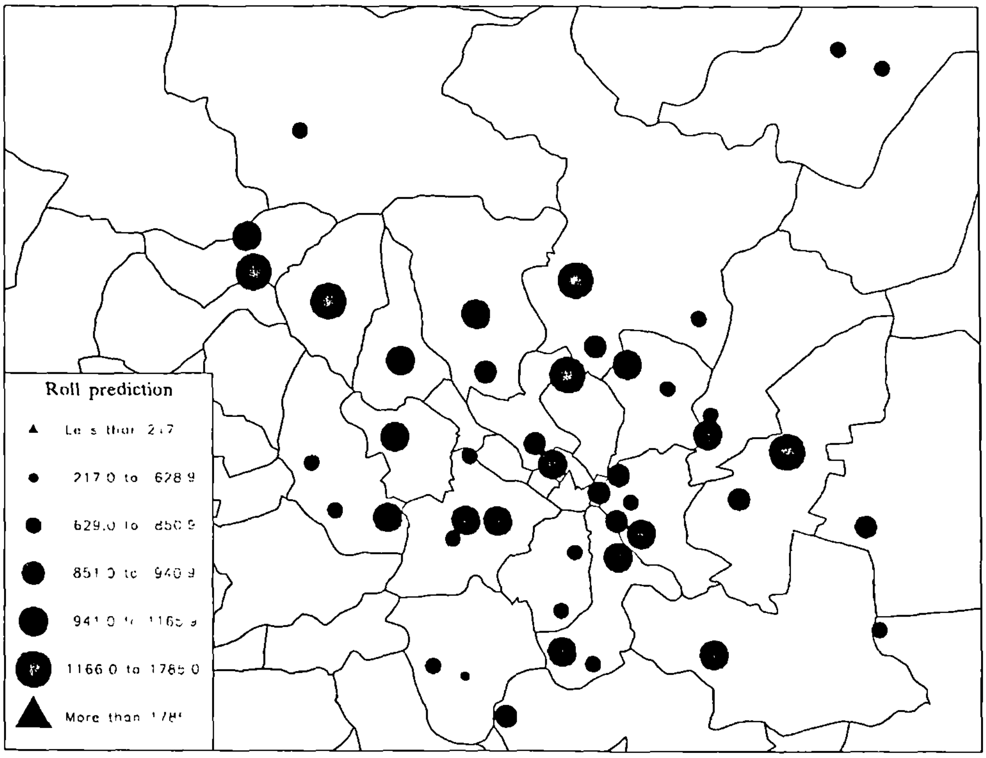


Figure 6.10: W_j = % pupils receiving FSM; $\alpha = +0.37$; $\beta = -0.13$



6.3.4 Conclusions

In conclusion, it would seem that the aggregate model can give a reasonable indication of school rolls at an acceptable proportion of schools, although it does rather fall down where the prediction of catchments is concerned. There is also the problem that the outer schools are consistently losing out to the inner schools with regard to predicted rolls, probably partly because the inner schools are more accessible to pupil addresses. This is a particular problem in certain sectors, especially the north east (where a very popular school is being seriously underpredicted) and for some of the 'failing' central schools, which have been consistently overpredicted by the model thus far. It would therefore seem appropriate to rehearse the arguments for the implementation of a number of strategies which might improve calibration and therefore give us a model which was more useful from the point of 'what if?' modelling.

6.4 Improving calibration

6.4.1 Introduction

There are a number of methods for the improvement of the simple models outlined in section 3. The first of these would be to disaggregate the data by pupil 'type' and the second would be to try out the usefulness of more complex models. This section outlines both these procedures in more depth, using the same data as section 3, in an attempt to produce 'better' results and certainly more accurate catchment predictions.

There are of course a number of caveats on increasing a model's complexity. The more disaggregate it becomes the more data is required, and the more difficult it becomes to prepare a model for use. Equally, as the more elaborate models are introduced, the problem of explanation becomes harder. It is important to stress the importance not only of using a model which works, but also one which is relatively simple for LEA officers to understand and one which can be simply implemented, with the minimum of data pre-preparation. However, since the crucial part of using these models is to produce useful output, it would certainly not be inappropriate to examine these techniques. The aim is to increase the accuracy of calibration and thus ultimately the ease of application to real-world problems.

6.4.2 Disaggregation

6.4.2.1 Introduction (data requirements)

In order for a disaggregate model to work, there clearly has to be some data available to describe the population and form it into the groups which this method requires. Social class groupings from the census were selected in this instance, as a reasonable proxy for a wide range of income and attitudinal factors which are generally considered to impact on school choice (see above, Bradford 1991, Gordon 1996, Higgs *et al.* forthcoming). Research has shown that middle class parents in particular are better informed about different schools and are also more likely to take a direct interest in their children's' education. It is therefore useful to use social class as a basis for the disaggregation, in order to suggest a whole range of factors from the child's physical environment to the likelihood of parental support throughout schooling. Clearly, as with any general proxy measure, this variable cannot give the whole picture, but for our simple exemplification of the process, it is useful.

In modelling terms this means that children in more privileged social groups are more likely to show less sharp distance decay than other groups, and they will consequently have lower β values. They are more likely to travel further to a 'better' school than the less privileged groups. The more privileged students thus take more account of attractiveness while those in less privileged social groups find that the distance factor is critical to their choice of school. It is these arguments which can be used in broad terms to explain the larger catchment areas of the suburban, high-attainment secondaries in Leeds, as described in chapter four.

The disaggregation required data from the 1991 census, the most recent source of such social information, and a certain amount of calculation. Using the six main classifications used in the census, covering social classes A through E[25]. These are defined in the following way;

[25] From the 10% census data, table S90, where class is defined on the basis of the occupation of the household head, where the head is economically active

Social class	Definition
A	Professional *etc.* occupations
B	Managerial and technical occupations
C1	Skilled non-manual occupations
C2	Skilled manual occupations
D	Partly skilled occupations
E	Unskilled occupations

Using these six classifications, each flow was multiplied by the proportion of each group in the origin zone[26]. This means that some pupils are unfortunately missed (those in, for example, armed forces households) and the dataset is reduced to around 96% of its original size. This gives us a matrix of 283 origins by 45 destinations (as before) containing 40,202 pupils, divided in the following manner;

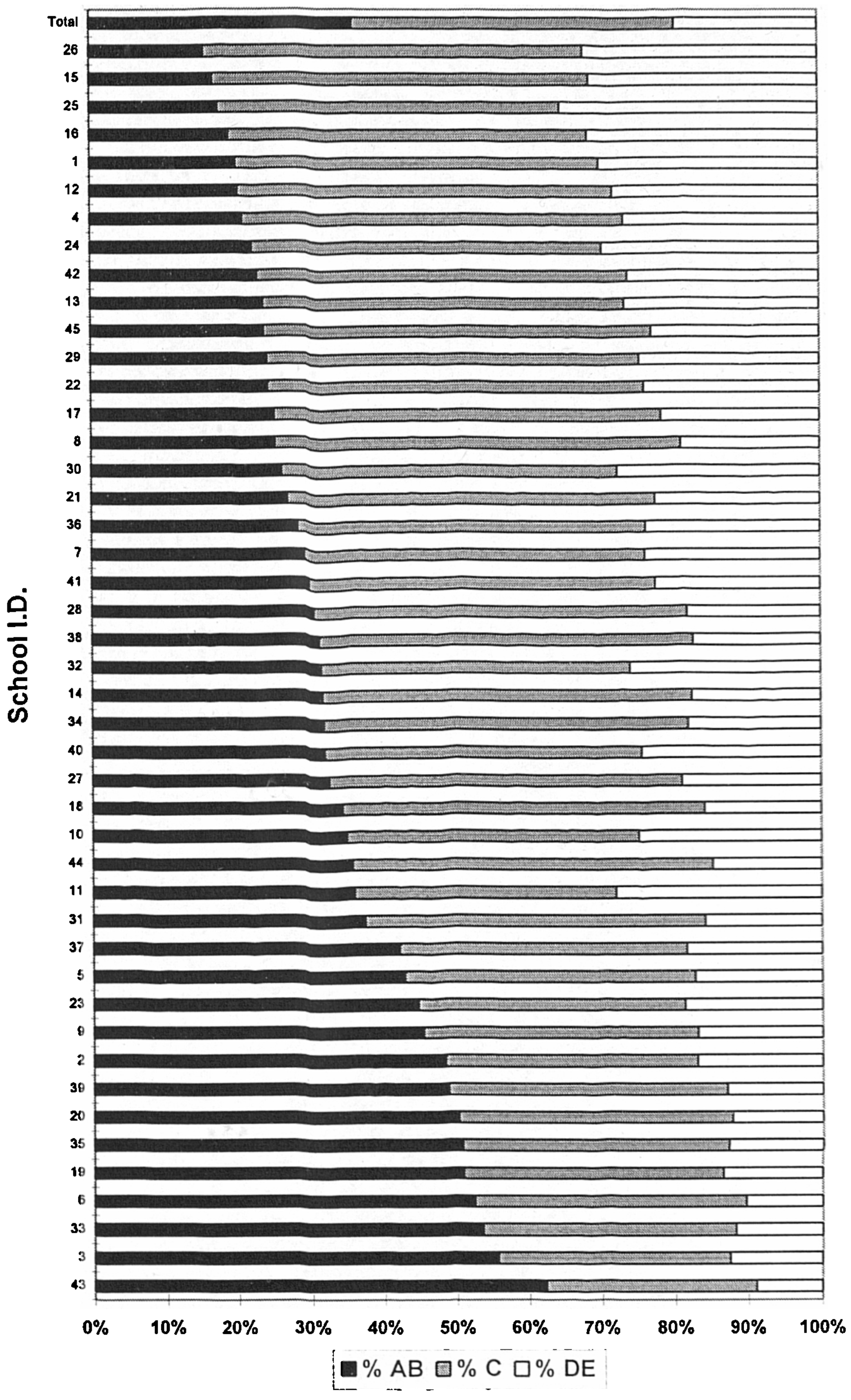
Social class grouping	Number of pupils
A and B	14494 36.05%
C1 and C2	17845 44.39%
D and E	7863 19.56%

The individual schools of course show different proportions of these class groupings. The graph at figure 6.11 shows how the social composition of the schools varies. This kind of analysis is discussed in greater detail in chapter four. For the purposes of this chapter it is sufficient to restate that the schools with higher proportions of pupils in social classes A and B tend to be those on the periphery of the city, especially on the northern edge and that the northern part of the city shows greater proportions of ABs in residence than the inner and eastern areas, where DEs dominate. The graph shows calculated proportions based on pupil origin and census data. Pupils from each postal district sending attending a school were split according to the 1991 census characteristics of that postal district. The data is thus inevitably no more than a 'most likely' snapshot of the pupils based on social class data some years older than the pupil data. Clearly it would be ideal to classify the actual pupils by means of a contemporaneous survey of individuals and their home circumstances, impossible in a study of this scope.

---

[26] Where groups A and B were combined, as were C1 and C2 and groups D and E, to give three broad social classifications

Figure 6.11 : Social composition of Leeds secondary schools



There are a number of interesting points which can be made about the disaggregate data. Firstly there is the clear correlation between social class composition and 'performance' in raw terms which is outlined above. Secondly, it is possible to draw certain conclusions from the disaggregated data by distance travelled to school. All postal sectors show an element of distance decay, in that the majority of journeys are to the nearest school. However, the different social groupings show markedly different patterns moving away from this basic 'rule'. The postal sectors with the highest proportions of AB residents have a 'double peak', one at the closest possible travel distance and another some distance further away. As the proportion of ABs increases, the more marked this becomes, and the further from the minimum travel distance both peaks move. This characteristic is shared only by those sectors with the very highest proportion of Cs, while the majority of C-dominated sectors shows a more 'traditional' distance decay picture. The pattern cannot be seen at all in those sectors which are dominated by DEs. This reinforces the theory that it is the better-off socio-economic groups which are most willing and able to travel further to school.

6.4.2.2 The application of disaggregation: some results

The new data is now put into the model, where O_i has been replaced with the more complex O_i^k, representing that the origin data is divided by both location (i) and class (k). Both parameters α and β are similarly disaggregated, to become α^k and β^k. The results of some initial model runs using a two-parameter model are shown in table 6.9. All the results in this section use percentage pupils obtaining five or more GCSEs at grades A*-C as the W_j measure.

Table 6.9: Disaggregate data; a selection of parameter and error values for disaggregate 2-parameter SIM

Social class	α	β	*Average error* per *trip*
A and B	+1.50	-0.40	0.00694
	+1.00	-0.20	0.00672
	+1.80	-0.20	0.00684
C1 and C2	+1.00	-0.50	0.00736
	+1.00	-0.40	0.00710
	+0.60	-0.40	0.00690
D and E	+0.50	-0.60	0.00324
	+0.30	-0.50	0.00309
	+0.40	-0.40	0.00300

It is clear that the error values are lower than before, even when compared *per* trip, but this is due to the fact that the values being fit are lower (since they are only a subset of the full roll in each case). It is more important to examine the variation in parameter values which is occurring. That the 'best' predictions begin to show generally lower β values for the more advantaged social groups is significant. However, it is perhaps equally interesting to look at the α values, as these show more variation between the groups. For the AB group, the 'best' predictions are given where α is very high, suggesting that attractiveness is very important for this group, whereas for the DEs α is consistently low and β is higher than for other social groupings, suggesting the opposite conclusion – that this group is affected more by distance than attractiveness. However, the relatively small changes in β between the groups is interesting, and this is something which is considered further in the conclusions below (after table 6.11).

This evidence suggests that the dataset we are using here can support the conclusions drawn by Ball *et al.* (1995) and reaffirmed more recently by research on pupils in London secondary schools (reported in Ward 1997vi, Judd 1997v). Middle class parents (the 'ABs') do indeed take into account the information contained in the league tables (or other information), while parents from lower social groups are much more less interested in such data, meaning that the effects of distance are greater for this group. They are constrained to send their children to the closest school, regardless of its attractiveness. The various roll predictions obtained here are summarised in table 6.10 and the maps in figures 6.12 and 6.13. The data presented here also include varying measures of attractiveness, in order to begin to determine whether different factors have a greater or lesser impact on different social groups and the three 'models' used are defined as footnotes to table 6.10.

Table 6.10: Actual and predicted *rolls*, *Leeds* secondary schools, 2-parameter disaggregate spatial interaction model

School	*Actual roll*	*Model A*	*Model B*	*Model C*
1	887	339	825	886
2	1689	1292	2284	2482
3	1125	1244	1275	1239
4	338	114	644	341
5	1374	1323	1288	1374
6	1765	630	779	848
7	217	1169	684	394
8	885	679	639	668
9	888	758	816	739
10	619	1912	834	677
11	793	596	816	810
12	680	598	764	746
13	718	362	754	671
14	777	958	1008	972
15	420	1115	662	460
16	430	178	508	432
17	471	208	577	528
18	1785	577	1479	2001
19	1093	1908	1332	1255
20	1187	1112	1241	1238
21	939	1128	587	594
22	1496	1839	1038	1400
23	1551	659	1757	1932
24	1099	866	898	1002
25	362	1231	670	433
26	658	748	740	713
27	940	1147	993	1092
28	1108	233	813	951
29	850	1124	616	638
30	686	1325	943	817
31	935	596	1097	1155
32	509	1001	590	423
33	1165	490	1740	1766
34	1074	754	544	584
35	903	1519	1118	1071
36	874	1127	765	812
37	1204	1231	1024	1116
38	983	844	767	823
39	1001	1320	870	835
40	628	1053	904	768
41	874	1001	934	977
42	1154	709	1009	1156
43	730	615	383	311
44	1389	1043	892	1066
45	645	1024	799	507

Model A: AB pupils: Wj = % pupils with 5+ GCSEs A*-C; α = +1.67; β = -0 22
C pupils: Wj = % pupils with 5+ GCSEs A*-C; α = +0 95; β = -0 26
DE pupils: Wj = % pupils with 5+ GCSEs A*-C; α = +0.29; β = -0 29
Model B: AB pupils: Wj = total roll (all ABs); α = +1.63; β = -0 26
C pupils: Wj = % pupils with 1+ GCSEs A*-G; α = +1.01; β = -0 31
DE pupils: Wj = % capacity filled; α = +0.55; β = -0 28
Model C: AB pupils: Wj = total roll (all ABs); α = +1.63, β = -0.26
C pupils: Wj = total roll (all Cs); α = +0.98; β = -0.28
DE pupils: Wj = % pupils with 5+ GCSEs A*-C; α = +0.29, β = -0 29

Figure 6.12: Roll predictions, Leeds secondary schools, Model A

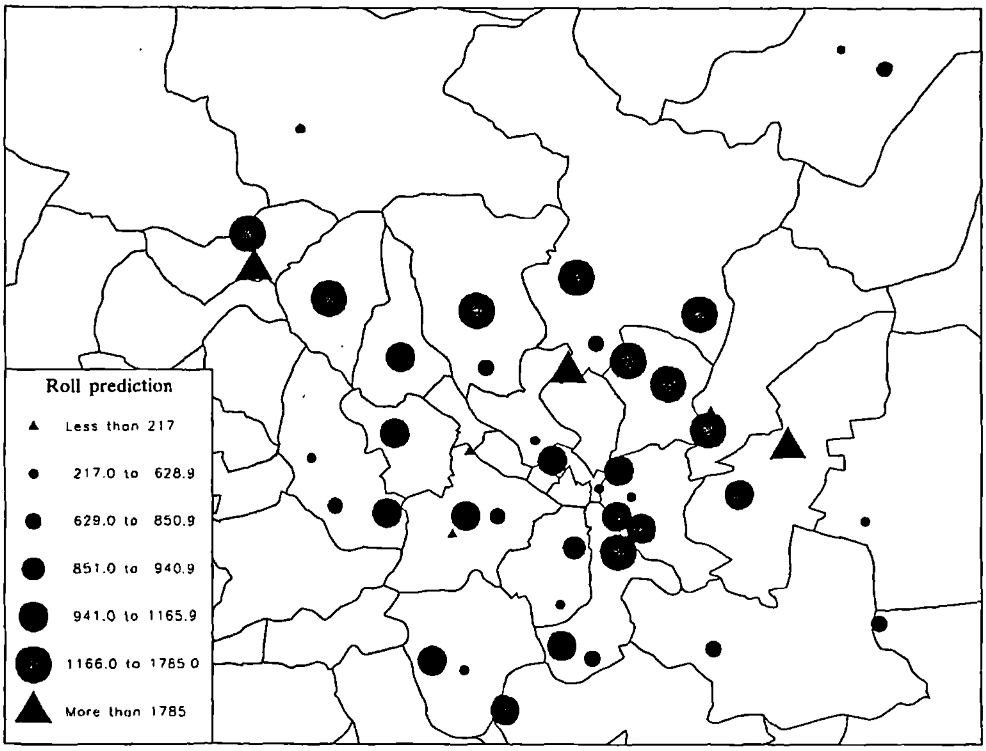
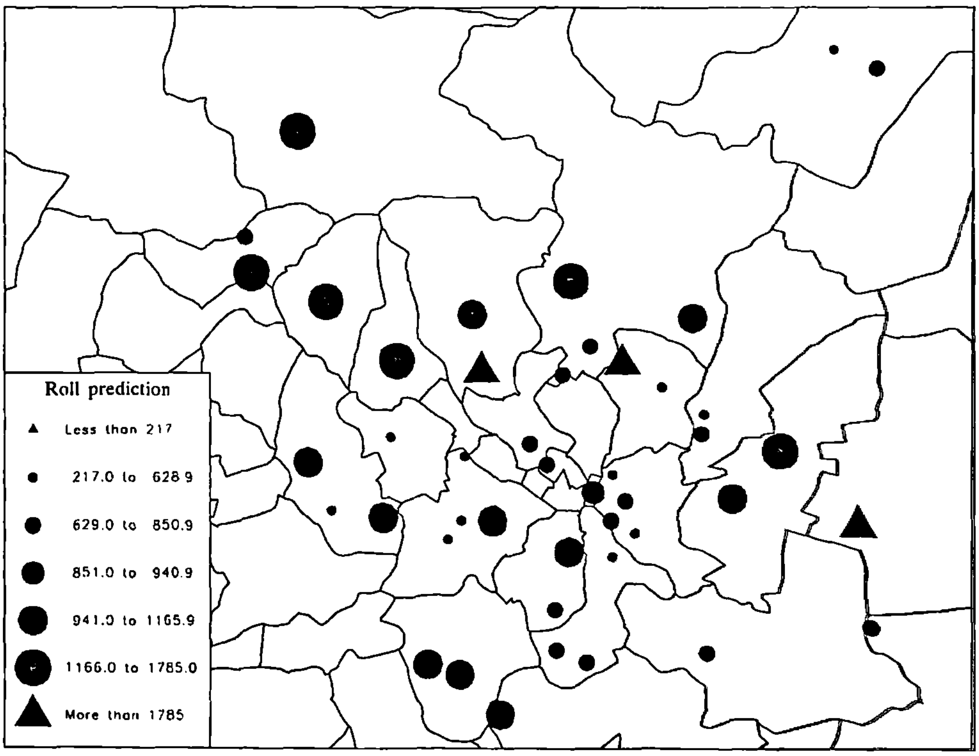


Figure 6.13: Roll predictions, Leeds secondary schools, Model C



Clearly there are some schools which still suffer from consistently poor predictions, but while this is of course a problem, it seems likely that no mathematical representation of a human system can ever be entirely accurate. Indeed, it is generally considered acceptable to follow the '80:20' rule whereby at least 80% of predicted rolls should be within 20% of the actual roll. These results are generally beginning to approach satisfaction of this general 'rule', particularly in the third case in table 6.10 above. However, the accuracy of this data must be questioned since we are dealing with disaggregation based not on data for the actual 1993 pupil intake but on assumed social information based on the 1991 census. This means that it is inevitable there will be variations in the data which will not match reality and thus that without more accurate individual pupil-level data the results cannot be as accurate as it might be hoped. However, although the proportions of social groups on which the disaggregation is based are not from the same time period as the data which is being disaggregated it is reasonable to assume that Leeds has not changed significantly at the relatively large scale of study here and therefore that the data give a good overall picture of the city's social composition.

There is also the question of school catchment areas. Are the predictions of these improved noticeably by disaggregating the data? The predictions are considerably improved in terms of catchments, although they are still not entirely perfect. The core part of the catchment is certainly being picked up by the model, and the spread across the city is much reduced in comparison to the previous models. In reality, as we have seen, the catchment area of a secondary school (at least in Leeds) is fairly tightly defined around the school, with a few 'stragglers' coming from areas away, especially for the larger, more popular schools on the outskirts, and the disaggregate model is beginning to suggest just this. It would seem to be clear therefore that dividing the school population along class lines in the model does produce much improved predictions over the aggregate model. The final 'best' parameter values using a standard attractiveness value (such as exam results at age 16) are shown in table 6.11 and final roll and catchment predictions using these values are shown in figures 6.14 and 6.15.

Table 6.11: Final 'best' parameter values for a 2-parameter production constrained education SIM using data disaggregated by social class and using % pupils with 5+ GCSEs grades A*-C as W_j

Social class	α	β
A and B	+1.65	-0.25
C1 and C2	+1.00	-0.28
D and E	+0.40	-0.30

It is perhaps most revealing that the greatest variation seems to be in the variation of α and therefore in the relative importance of attractiveness. It is important that distance appears to play a relatively insignificant rôle in the model. The nature of the data must be considered when seeking an explanation for this. It is the truth, as the previous chapters have shown, that high performing schools tend to be in relatively affluent areas of the city. Assuming that the popular schools are more difficult to gain places at and that the main criterion for allocating places is through home proximity to school (as it is in Leeds and most other authorities) then it is likely that the pupils at these popular schools will be those drawn from the affluent areas surrounding the school. The catchment maps have all demonstrated that while people are willing to travel to a school the vast majority of the pupils are drawn from the immediate vicinity. This means that the distance parameter will remain fairly consistent across the social groups while the fact that the AB population tends to inhabit the areas around the 'good' schools and thus attend them means that they will be shown to be taking attractiveness into account because they tend to attend the more attractive schools. The fact that the attractive schools do pull some pupils from further afield and that these do tend to be ABs or Cs is reflected in the slight variation in β. It should also be remembered of course that (as we saw in the section on correlation above) the attractive schools are also the larger schools and thus inevitably have a wider sphere of influence.

In addition, the journey to school is more complex than, say, a journey to work or shop. In both the latter cases the tripper tends to have more control over their mode of travel (since these relate to adult journeys) and end location – a supermarket cannot refuse to serve you if you arrive to shop, for example. In the case of schooling the situation is rather different. The vast majority of pupils do not have their own cars (except a few older sixth form pupils) to make long journeys, and therefore the choice-set for parents is reduced by the proximity of bus routes to home and school or of schools to their own journey to work. There is also the situation unique to state-provided schooling that people living far from a facility, no matter how much they want to attend that facility, may not be awarded the right to study there. Clearly this argument simplifies the many factors involved in the journey to school, but the conclusion to be drawn from the model analysis and from the situation existing in the data is that although middle class parents may have access to better transportation resources and information on transport they do not necessarily use them because they choose to utilise these resources to live close to the 'better' schools in order to stand a better chance of obtaining places at them for their children.

Figure 6.14a: Catchment prediction, 2-parameter disaggregate SIM, 'good' school; total catchment all classes using 'best' parameter estimates and % pupils with 5+ GCSEs grade A*-C as W_j

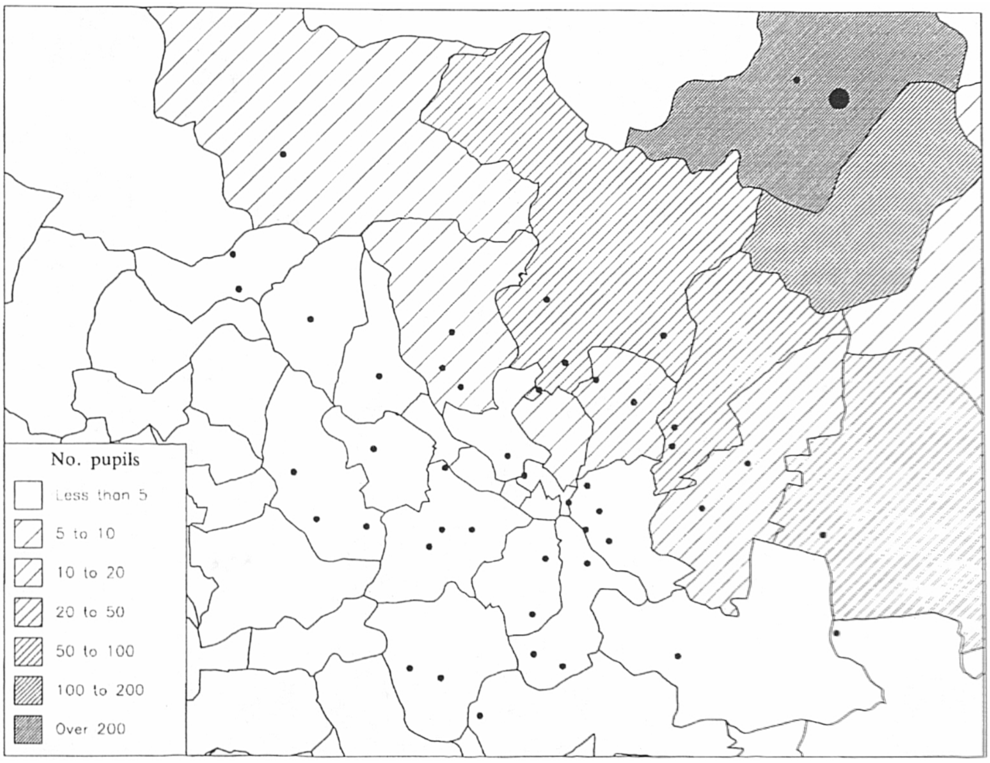


Figure 6.14b: Catchment prediction, 2-parameter disaggregate SIM, 'poor' school; total catchment all classes using 'best' parameter estimates and % pupils with 5+ GCSEs grade A*-C as W_j

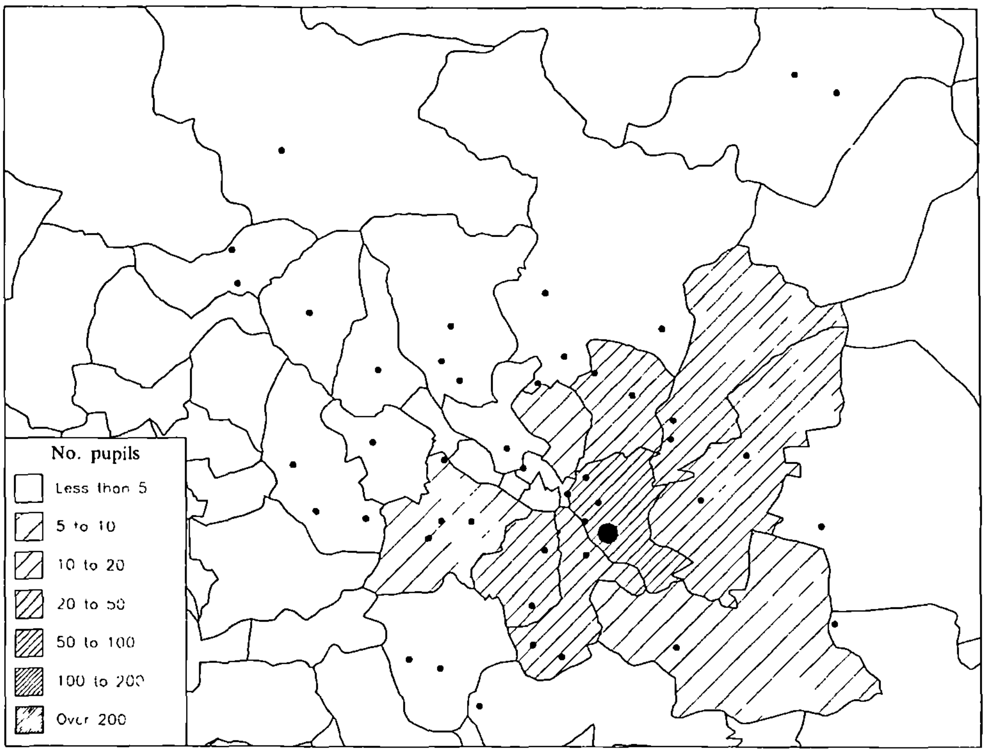
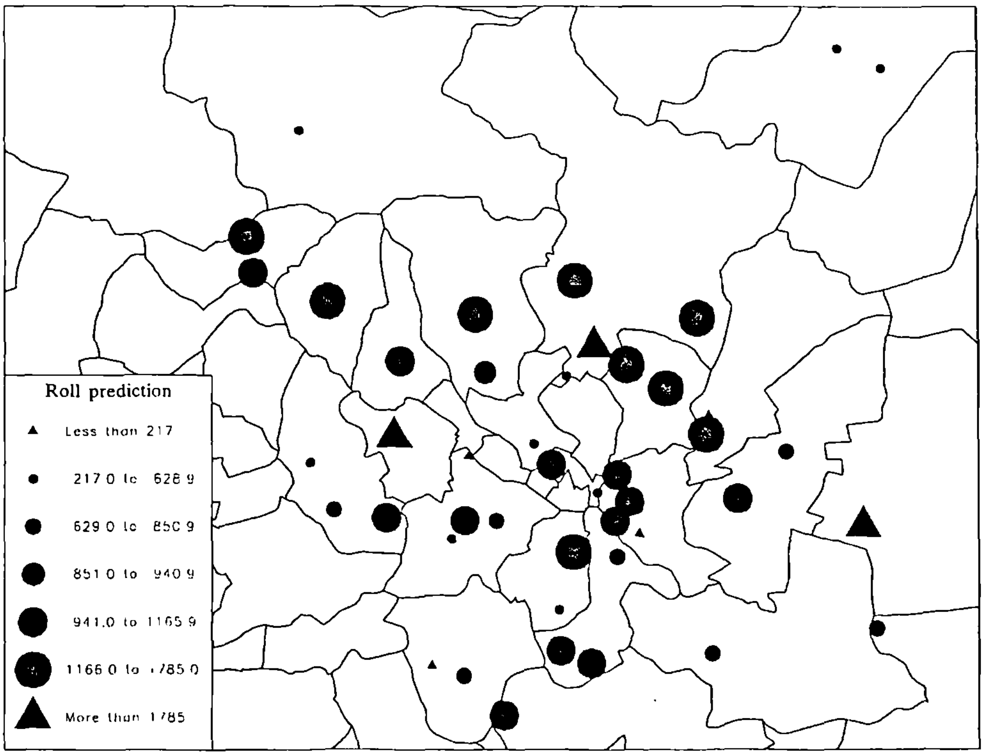


Figure 6.15: Roll prediction, disaggregate model, total all classes using 'best' parameter estimates and % pupils with 5+ GCSEs grade A*-C as W_j



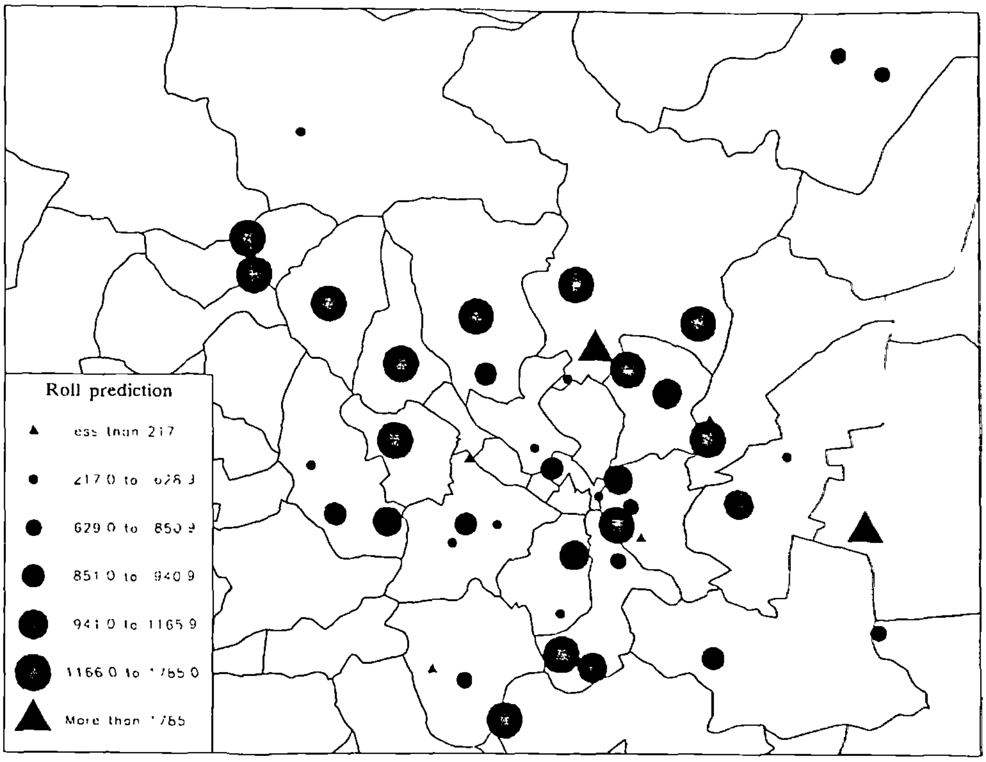
6.4.3 The intervening opportunities spatial interaction model

The intervening opportunities spatial interaction model described in chapter five is a more complex model which takes account of the likelihood of a tripper being 'satisfied' at the next destination which he or she comes across. Using the disaggregated education data above in a two-parameter intervening opportunities model, the various parameter values produced the results shown in table 6.12 and figure 6.16.

Table 6.12: Parameter and error values for intervening opportunities model run using disaggregate trip data (W_j = % pupils with 5+ GCSEs 1994)

Social class	β	γ	*Average error per trip*
A & B	-0.26	-0.00	0.00668
C1 & C2	-0.30	+0.02	0.00687
D & E	-1.22	+0.16	0.00337

Figure 6.16: Roll prediction, all classes, 2-parameter disaggregate IO SIM



It is clear from this that the intervening opportunities model does not necessarily produce improved results when compared with the simpler production constrained model. A comparison of catchment predictions shows that they have reverted to resemble those of the aggregate model more than those of the disaggregate, clearly not an improvement.

The results here would seem to bear out the conclusions drawn in chapter five that the basic tenets of the intervening opportunities spatial interaction model do not seem to fit with the perceived general pattern for school choice in Britain today. Certainly the results produced by these runs of the intervening opportunities model do not produce any improvement on the simpler production constrained spatial interaction model, and it seems unlikely therefore that this model should be considered in future research.

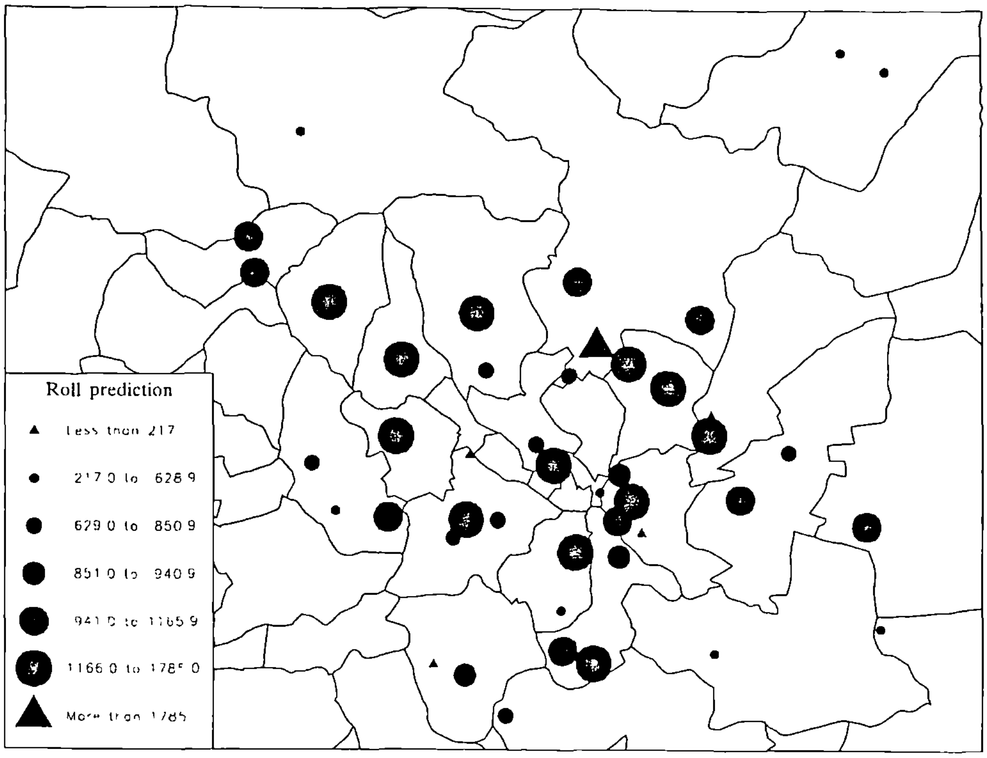
6.4.4 The competing destinations spatial interaction model

The competing destinations spatial interaction model continues the trend set by the production constrained spatial interaction model, in that the results are still far from perfect, but they do show a slight improvement. The competing destinations model used here is a three parameter variation, shown in Appendix IV. Table 6.13 displays the parameter values and the errors for a number of runs. Figure 6.17 shows this graphically. Clearly we are still getting the same general problems as before, in that the inner schools are having larger rolls predicted at the expense of the actual rolls at the outer schools.

Table 6.13: Parameter and error values for disaggregate CD SIM using % pupils with 5+ GCSEs as W_j

Social class	β	δ	σ	*Average error* per *trip*
A & B	-0.30	+0.57	-0.63	0.00672
C1 & C2	-0.26	+0.50	-0.49	0.00691
D & E	-0.27	+0.56	-0.28	0.00301

Figure 6.17: Roll prediction, all classes, 3-parameter disaggregate CD SIM



While the roll predictions seem reasonable, when catchment areas are considered, as with the intervening opportunities model they have taken a backwards step from the simple disaggregate PC model and are demonstrating too unclustered a pattern to be useful in predictive terms.

The competing destinations model seems to provide a sight improvement over the simple PC spatial interaction model, although it is highly debatable whether the minor improvement in predictive accuracy for rolls is worth the increase in both complexity and model run time and the lack of improvement in catchment prediction.

6.5 Conclusions

There is clearly a long way to go before any of these models could be considered in any way a perfect representation of the true situation. However, they are beginning to show that it is possible to use spatial interaction models to reproduce the flow of pupils to schools. What is interesting is that it is the models whose basic principles seem to fit with the theory of school choice which best predict the rolls at secondary schools. The production constrained and competing destinations spatial interaction models both have a great deal to offer in terms of confirming the manner in which schools are chosen, simply because of the principles on which they are defined.

One approach is further refinement of the model's detail. This could take a number of forms. Firstly, increasing the level of disaggregation might help to make the predictions more accurate. This could simply mean using each social group as a separate 'type', or perhaps introducing more variables into the equation, disaggregating on more than one variable. The pupils could be disaggregated into religious groups, a factor which may well have an impact on the choice of school (there are several denominational schools and single sex schools in the city, included at present in with all the other schools). It would be possible to define children specifically as having SEN and then define a measure of attractiveness of schools to pupils with those needs – clearly some schools will support them better than others.

The second possible strategy would be to try an exhaustive search through the possible universe of parameter values for the various models. This would of course be a very tedious process, but one which could be automated. Although the improvements we would be likely to see would probably be fairly minor, it might be another useful step towards defining the 'ideal' model for this data and could produce some interesting outcomes. It might also improve the performance of the intervening opportunities and competing destinations models in particular, whose catchment predictions may be let down by the fact that the β values are consistently low.

Alternatively, and perhaps the refinement which the initial results shown here would seem to suggest would make the biggest difference, is the implementation of destination-specific parameter values. That is, each school would have its own β value rather than the βs being specific only to social groups. Thus it might be that while β was high at all schools for the DE group, it varied widely for the AB group, as these people might be willing to travel a long way to specific schools, but would only travel to others if they were very close. This would appear to be the next step in the modelling process, and any further investigation should include a study of the impacts of the process on model outcomes, although limitations of space and time mean it cannot be covered here. It might also be possible to perform a similar disaggregation of β but for origin zones, so that the effect of distance was scaled according to where people lived rather than having people willing to travel further only to certain schools.

As the models stand, it seems that it is possible to produce generally acceptable roll predictions from the data available and catchment predictions can provide a basic guide to the possible extent of a school's pulling power for parents. Within the limits of the '80:20' rule it is clear that the models can be calibrated to produce useful output. Although there is room for improvement, as an initial step on the road to providing interaction models for educational planning purposes this study has shown that there is indisputable potential.

Chapter seven

Post-calibration modelling: 'what if?' querying

7.1 Introduction

The previous chapters have been concerned with the definition and calibration of interaction models appropriate to educational application. In particular, chapter six provided us with a calibrated model which predicts the flows of children from homes to schools in Leeds. The purpose of this chapter is to demonstrate the wider potential of such a model; a practical application of some of the possibilities discussed in chapters four and five. To this end, the chapter deals with the possible impacts on a network of the opening or closure of facilities, or of changes in the population which is served by that network.

Overall, the chapter aims to demonstrate the vast potential of the model outlined in chapter six for the improvement of the data on which LEA planning decisions are made. It is clear from chapters three and four that there are many ways in which the current decision-making process could be 'improved' and we have also seen the limitations of a purely GIS-based impact assessment system. The following sections provide an explication of the ways in which modelling could be used in a city such as Leeds.

7.2 'What if?' modelling

7.2.1 Introduction

A central part of an LEA's work is to provide sufficient schools in the appropriate locations for all children to have access to an education. This is, as we saw in chapters two and three, enshrined in the 1944 Education Act and is the *raison d'être* of local authority education planning sections. In order to plan for such provision, officers must monitor demographic changes and the quality of education provided in the schools which comprise the current network. It may be that falling rolls in certain areas of a city mean that schools are no longer financially viable, whether the decline comes about for demographic or parental preference reasons. In this case, the impacts of closure or amalgamation must be considered and the various possibilities assessed from the point of view not only of finance, but also for the redistribution of the pupils already at the schools. Potential future problems also have to be considered; for instance, will new housing mean that a school will become viable again in five or ten years' time? This is something which has recently been considered in Leeds, since the reorganisation which was carried out in the 1980s (see chapter 3). While consideration was given to the short-term in the revised school network (by removing many hundreds of surplus places) the Leeds Schools Commission (1993) considered the longer term for the city and this is something which is now firmly in the ethos of the demographic planning unit – all decisions are based on population projections for at least ten years hence (personal communication, Leeds LEA).

Clearly there are a great number of issues here which must be considered by the LEA. Many of these, such as likely demographic shifts and the planning of new housing, are outside their jurisdiction, and are developments which they can only monitor. They are also developments which are outside the scope of this thesis, although as we saw in chapter five interaction-style models can be applied in a demographic context. What does concern us here is the ability of officers to predict and plan for the impacts of such changes on the school network. It is clearly critical that planners know which school children will attend if there is an influx of new families to an area, and equally it is critical to know which existing schools would absorb those children attending schools identified as 'failing', however this were defined, and which were thus earmarked for closure. It is for this purpose that interaction models have mainly been developed (especially in a retailing context), and this is where the calibration performed in chapter six can be applied to 'real' problems facing a city. Although much of the hypothesis contained within this chapter may seem unlikely, particularly that concerning the opening and closure of schools, it is the case that this sort of activity does go on in British LEAs, as evidenced by the reorganisation of schools in Leeds in the late 1980s and in Warwickshire in the mid-1990s (Lepkowska 1995iv).

This section is divided into four main subsections, each dealing with a different aspect of the potential application of spatial interaction models. These cover the three most common uses of 'what if?' querying – closure, opening and demographic shifts – but also consider the potential for using spatial models to consider the impacts of less easily quantifiable, attitudinal changes or changes predicated by the implementation of different PIs. Although the examples used here are simply possible scenarios for change in the city, they do have some basis in the reality of Leeds, being based on suggestions made by LEA planning officers.

7.2.2 Coping with change I: demographic shifts

The first line of 'defence' an LEA has in the battle to provide sufficient places in the right places is a knowledge of the demographic trends in their area. Armed with accurate predictions of where pupils will be living five or even ten years hence they can begin to make intelligent decisions based on the likely destinations of these children as they reach school age. In order to aid this process it would seem sensible to introduce spatial modelling into the system. In this way, planners will know not only *where* pupils are likely to live (predicted by demographic models such as those outlined in chapter five) but also which school they are likely to attend. In this way they will be more aware of where pressures on the network may develop and where the most likely areas for development or rationalisation are.

This kind of application is one for which production constrained spatial interaction models in particular are ideally suited. Once they have been calibrated to the existing data, then it is a very simple process to 'plug in' new demographic data concerning the likely rise or fall in population numbers in various areas for a series of years in advance. The model will use the parameter values already ascertained (see table 7.1 for a recap) and apply them to the new data, producing a set of results demonstrating the likely destination of new residents or the schools which will lose pupils if the trend is for outmigration or a shrinking school-age population.

The following examples utilise the model calibrated in chapter six to demonstrate two possible scenarios. The first is of new housing in an area, and a consequent increase in the school-age population in one area while the second demonstrates the opposite, a decline in population in an area leading to a reduction in the school-age population.

Table 7.1: 'Best' parameter values from model calibration in chapter 6 (using 2-parameter spatial interaction model and 5+ GCSEs as attractiveness)

Social class	α	β
A and B	+1.65	-0.25
C1 and C2	+1.00	-0.28
D and E	+0.40	-0.30

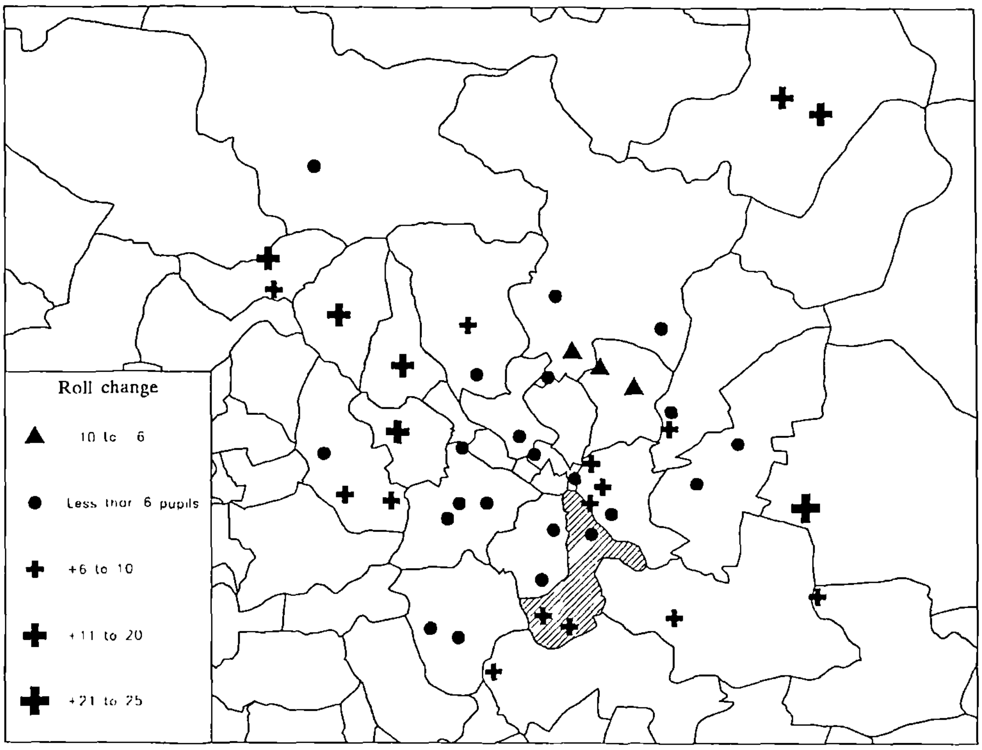
7.2.2.1 Increased population

The following example is guided by suggestions from Leeds LEA for actual areas of population growth in the city. It would also of course be possible to tackle other, less concrete examples, such as the possibility of an A1-M1 link road increasing housing stock, but for the purposes of illustration just the one example is used here. For ease of interpretation only one area of the city has been selected for change, and thus the revised figures represent a relatively simplistic population change. In the selected area, a postal district in south central Leeds the population has been increased by 200 people, assumed to be divided along the same class boundaries as the existing population. In reality, LEA officers would be aware of the more subtle shifts in population and demographics in a real city and would thus be in a better position to analyse smaller numerical changes in the area's population and incorporate the more dynamic nature of a city's inhabitants. Table 7.2 and figure 7.1 show the altered rolls for the schools in Leeds following such a change. In order to make a better comparison the altered figures are compared to the predictions for the current data rather than the actual figures for Leeds. The schools are listed with a 'before' and 'after' rank rather than as roll figures, to show the relative change in sizes.

Table 7.2: Actual rolls and predicted rolls for population increase scenario, school size ranks (largest = 1, smallest = 45)

School	*Normal position*	*Increase position*
1	40	40
2	8	8
3	5	5
4	45	45
5	11	11
6	27	27
7	15	15
8	32	32
9	31	30
10	1	1
11	34	34
12	36	36
13	41	41
14	21	21
15	18	18
16	44	44
17	42	43
18	37	37
19	2	2
20	16	16
21	12	12
22	3	3
23	35	35
24	25	25
25	10	10
26	29	29
27	13	13
28	43	42
29	17	17
30	7	7
31	38	38
32	20	20
33	39	39
34	33	33
35	4	4
36	22	22
37	9	9
38	26	26
39	6	6
40	14	14
41	24	24
42	30	31
43	28	28
44	23	23
45	19	19

Figure 7.1: Roll changes following population increase in marked postal district



As we might expect, the schools in the area with increased population show an increase in roll. This occurs regardless of the school's attractiveness in the model and is clearly an effect largely of proximity. However, this may not be so unlikely, as it is still common for people to choose a local school, and although the increases calculated are even across the social groups, the proportions of each group living in the area are still the same as before. There is also a small rise in the rolls at all other schools, perhaps an effect of displaced children from the now much more in demand schools in the south. The fact that some schools appear to decline in roll size could be due to the increased 'pull' factor of the newly expanding schools – it is likely that growing schools with increased budgets would indeed have a potentially damaging impact on other schools as they exapnd their spheres of influence. It is clear from figure 7.1 that the change in population is sufficient to produce a fairly widespread shift in roll patterns as the repercussions of the influx of pupils expands outwards from the area of increased population. It can be seen from table 7.2 that in fact the changes in school rolls with such a small increase in population makes relatively little difference to the ranking of the schools, although some are increased sufficiently to move their rank upwards by one.

It is also possible to imagine a situation whereby a population increase affected just one of the three broad social groupings considered in the disaggregation here. In the following two figures the same population increase (+200 pupils) is considered, except that they are assumed to fall into the same social group. Therefore figure 7.2 shows the likely change in roll if all the 'new' pupils are in social group DE and 7.3 shows the likely changes if all are in group AB. Although the figures show fairly similar patterns (that the largest increases will be in the schools closest to the new population) there are significant differences between the maps. The first shows a situation where the increase is concentrated very much in the city centre schools immediately around the area where the new population resides. However, in the second there is clearly far more likelihood that the new pupils will travel further out to school, particularly to the attractive schools in the inner north, the far east and the central south. In this respect the two populations behave in the manner which would be expected from the results thus far presented.

Figure 7.2: Roll changes at Leeds secondary schools when 200 new 'DE' pupils are introduced

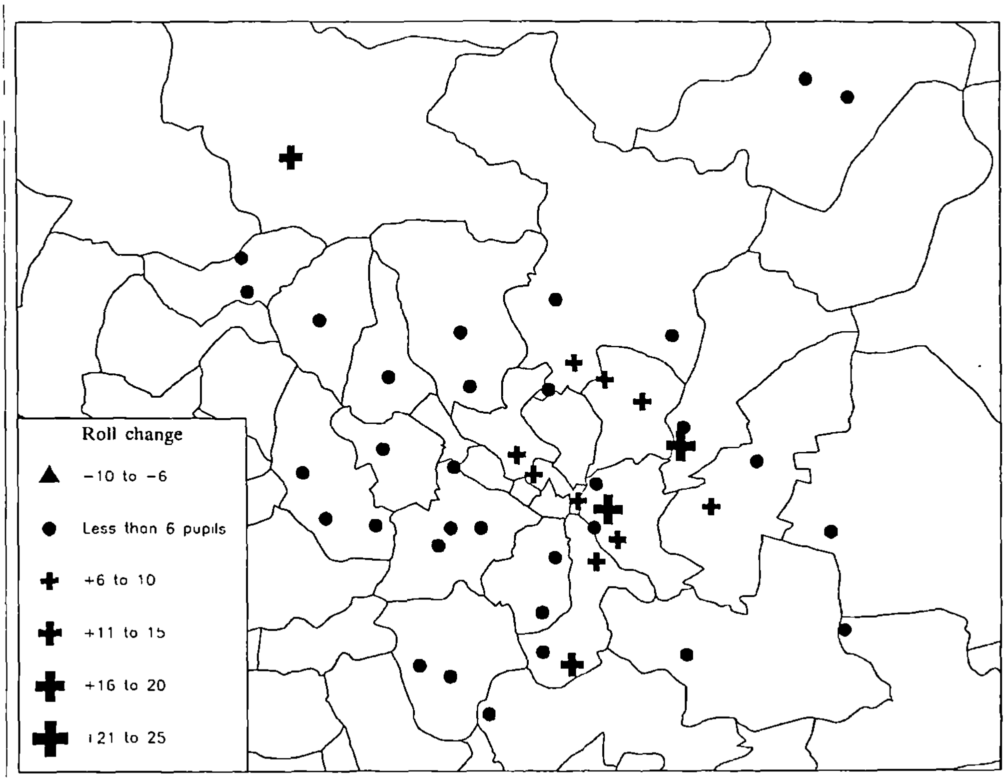
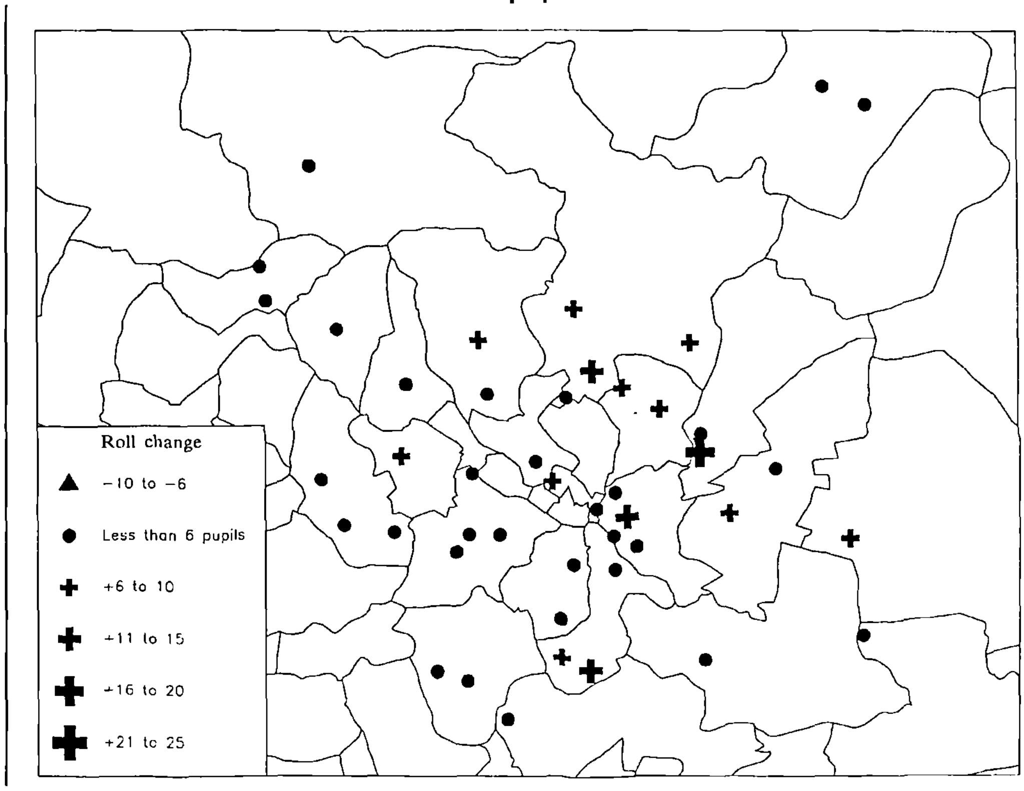


Figure 7.3: Roll changes at Leeds secondary schools when 200 new 'AB' pupils are introduced



7.2.2.2 Decreasing population

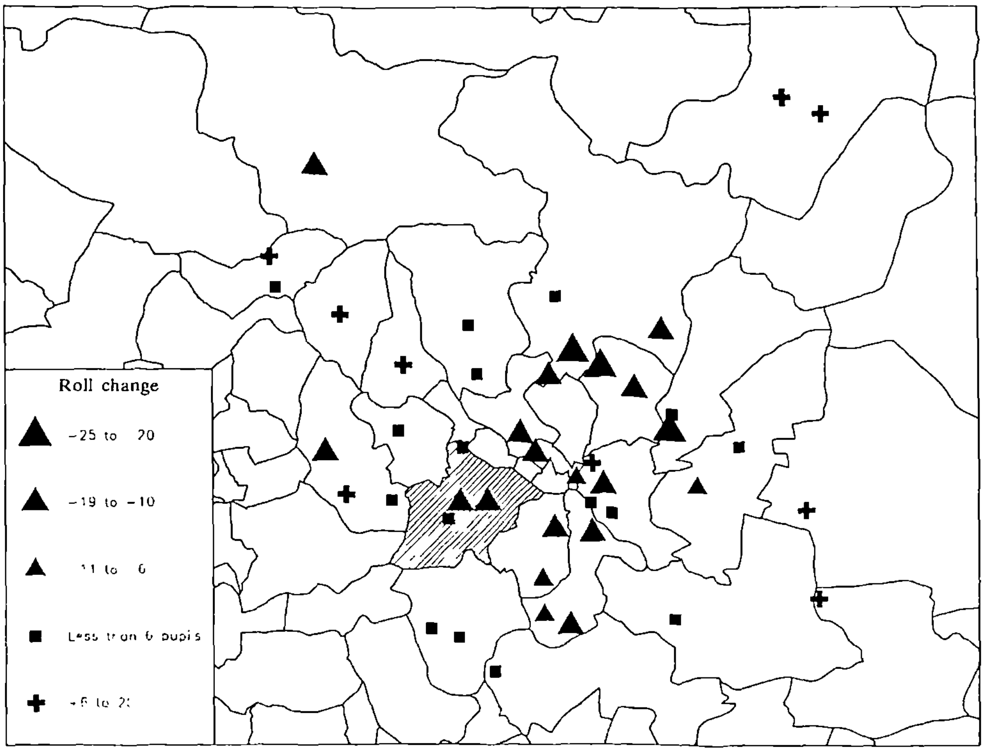
It is also possible that populations of cities will decline in certain areas, for two main reasons; either naturally or through a process of out-migration. Whatever the reason, if a population is predicted to decline then the LEA must be in a position to compensate for the changes and plan for the reduction of the surplus places which will be an inevitable consequence. As we have already seen, surplus places are very costly, and so it is in the interests of the authority to remove as many of these as possible, within certain limits sufficient to permit parental choice. It is therefore imperative that officers have a reasonable idea of where such surpluses will occur given a shifting population The principle is the same as with an increased population, and indeed as in any 'what if?' modelling scenario. Alternative data is fed into the model, which then uses the pre-calibrated parameter values to predict a 'most likely' set of rolls and catchment areas for the schools given the reduced pupil base. Table 7.3 and figure 7.4 demonstrate an example of this process.

The area has been chosen on the same principle as for the increased population, and covers an area adjacent to that shown in the previous example. The population in the eastern central part of Leeds is projected to decline, so this example has taken the postal area most central to the projected decline and reduced the population by 200 people, again proportionately by social class. As before, this gives a rather more simplistic, 'one time' view of population decline, and as noted above, in a real LEA the fluctuations would be more widespread across the city. However, this does allow us to gain more immediate insights into the potential for 'what if?' modelling in education.

Table 7.3: Actual rolls and predicted rolls for population decrease scenario, school size ranks (largest = 1, smallest = 45)

School	*Normal position*	*Decrease position*
1	40	40
2	8	8
3	5	5
4	45	45
5	11	11
6	27	27
7	15	15
8	32	32
9	31	30
10	1	1
11	34	35
12	36	36
13	41	41
14	21	21
15	18	18
16	44	44
17	42	42
18	37	37
19	2	2
20	16	16
21	12	12
22	3	3
23	35	34
24	25	25
25	10	10
26	29	29
27	13	13
28	43	43
29	17	17
30	7	7
31	38	38
32	20	19
33	39	39
34	33	33
35	4	4
36	22	22
37	9	9
38	26	26
39	6	6
40	14	14
41	24	24
42	30	31
43	28	28
44	23	23
45	19	20

Figure 7.4: Roll changes following population decline in marked postal district



Once again, the impacts of demographic change can be felt across the city. Many schools take a small cut in their rolls, although the change is of course greatest in those schools that receive more of their pupils from the areas directly involved, not necessarily those schools actually located in the area of decline. Again the population shift has a widespread effect, and indeed the redistribution of pupils in fact causes small increases at some popular schools on the outskirts, possibly for the opposite reasons to those noted in the population increase example above. The schools whihc lose most pupils will also lose funding and are likely to become increasingly associated with a declining area, thus making more distant, already attractive schools more so to the remaining local pupils. This kind of analysis can clearly begin to offer some insights into the likely impact of shifting demographics on a school network, even though the changes which would occur in a real city would in all likelihood be more widespread than the extreme examples given here.

Once the impacts of demographic change have been assessed, it may be that the LEA decides there is a case for a change in the school network, either through closure, opening or amalgamation. In this instance, there is further potential for the application of spatial interaction models, and it to these possibilities that we now turn.

7.2.3 Rationalising a network: school closure or capacity reduction

One of the most controversial, and therefore hardest, parts of a local authority's remit involves the closure of schools. This is generally done because of falling rolls and a consequent financial disincentive to the retention of a school. The reasons behind falling rolls can now be two-fold; it is possible that depopulation of an area through outmigration or population redistribution has reduced the number of people in a school's nominal catchment area, or alternatively the chance for parental preference in school selection may mean that certain unpopular or unsuccessful schools lose out to more popular schools, usually those with 'better' examination results (this is the essence of chapter eight following). Whatever the reason, once a school reaches whatever the LEA decides is a critical threshold then something must be done about its roll 'problem'. This could involve a re-evaluation of the reasons for its unpopularity or, although it is clearly a last-ditch measure, the school could be closed. The reasons for its unpopularity can to a certain extent be assessed through interaction models, as has been partly discussed before and is expanded below (sections 7.2.6 and 7.3). However, this section is concerned solely with the potential of spatial interaction models for predicting the impacts of closure on a network.

The traditional methods of dealing with school closure can tell an LEA how many children will be 'released' into the system by a school closure, and use of a GIS can tell them where those children live, and which is their closest alternative school. However, this method is still geared towards a situation where children could be allocated to schools by the LEA. In other words, there is no mechanism for dealing with the fact that parents can choose any other school in the authority (or outside it) to send their children. It is this aspect of the problem with which spatial interaction models are designed to cope. In fact, dealing with network reduction is perhaps the simplest aspect of 'what if?' querying, in that to perform such a task the attractiveness value of the school to be closed simply has to be reduced to zero and the model run with the same parameter values as have already been calibrated. All the children in the system will then be allocated to those schools with non-zero W_js. The LEA will therefore be able to gain a fairly accurate picture of a 'most likely' scenario of pupil redistribution and new catchment areas.

Pupils are generally speaking, in the current climate, told that they will be guaranteed a place at certain other schools in the authority if they choose to relocate to those schools (see for example Leeds Education 1994, 1995), but there is no other way that an LEA can 'force' pupils into set schools. The closure of a school is therefore not a guarantee of reducing the problem of surplus places in an area, as it may simply push more parents out towards the popular suburban schools rather than move their children from one inner city school to another.

In the example scenarios below the schools have been chosen for closure because they are schools already targeted by the LEA for closure or rationalisation. Since these changes to the network have at the time of writing already begun to take place, the figures given here will provide an interesting comparison with the actual 1997/8 figures for the remaining Leeds schools. The schools are identified for closure in part because of falling rolls and in part because of unsatisfactory performance. This latter is particularly the case with one of the three schools in question. There are three potential scenarios. The first closes all three schools outright. The second closes the 'failing' school and leaves one of the other sites open, while the third scenario leaves the other of the two merging sites open. The model output for the three runs is shown below.

Table 7.4: Actual and predicted rolls for schools in the three closure scenarios

School	*Normal*	*S1*	*S2*	*S3*
1	318	326	323	323
2	1324	1340	1334	1332
3	1527	1537	1534	1532
4	81	0	0	0
5	1220	1224	1223	1223
6	806	809	809	807
7	1117	1133	1127	1124
8	649	656	653	652
9	713	719	716	717
10	2043	2060	2054	2051
11	622	631	628	627
12	612	622	618	618
13	306	311	309	310
14	986	1002	995	996
15	1064	1072	1069	1070
16	146	0	149	0
17	162	0	0	164
18	565	572	569	570
19	1829	1845	1840	1835
20	1074	1079	1078	1078
21	1187	1190	1189	1189
22	1797	1806	1803	1803
23	613	619	617	617
24	834	848	843	839
25	1278	1288	1284	1284
26	764	776	770	772
27	1144	1159	1152	1154
28	160	163	161	162
29	1072	1079	1076	1077
30	1381	1400	1391	1392
31	527	538	534	532
32	1034	1039	1038	1038
33	474	484	479	480
34	640	642	642	641
35	1668	1678	1675	1674
36	940	950	945	947
37	1314	1328	1324	1319
38	826	835	831	831
39	1383	1385	1385	1384
40	1121	1135	1130	1130
41	914	928	922	920
42	716	725	721	722
43	783	786	785	784
44	922	929	926	927
45	1048	1058	1054	1055

The major problem, as can readily be seen from table 7.4 is that the three schools earmarked for closure are already very small and that therefore the other schools in the system are easily able to absorb the 'freed' pupils. Indeed, the numbers at other schools change only very slightly in any of the scenarios, suggesting that the closure of near-empty schools may not have a very large impact on a network as a whole, despite the potentially extremely vociferous objections of the parents of those schools. As can be seen from table 7.5, closing a larger and more popular school has a more profound effect on the other schools in the network, but in fact this is mainly due to there being more 'floating' pupils available. Figures 7.5 and 7.6 show the effects of two of these four scenarios on the other schools by recording the change in roll.

Table 7.5: Actual and predicted rolls for schools when a large and popular school is closed

School	*Normal*	*Total*
1	318	330
2	1324	1389
3	1527	1571
4	81	81
5	1220	1232
6	806	896
7	1117	1191
8	649	813
9	713	731
10	2043	2125
11	622	641
12	612	628
13	306	316
14	986	1042
15	1064	1080
16	146	152
17	162	173
18	565	575
19	1829	0
20	1074	1087
21	1187	1194
22	1797	1823
23	613	621
24	834	974
25	1278	1305
26	764	792
27	1144	1208
28	160	167
29	1072	1101
30	1381	1462
31	527	572
32	1034	1044
33	474	494
34	640	646
35	1668	1701
36	940	992
37	1314	1415
38	826	927
39	1383	1391
40	1121	1155
41	914	1032
42	716	732
43	783	870
44	922	960
45	1048	1069

Figure 7.5: Changes in school rolls when three 'problem' schools are closed

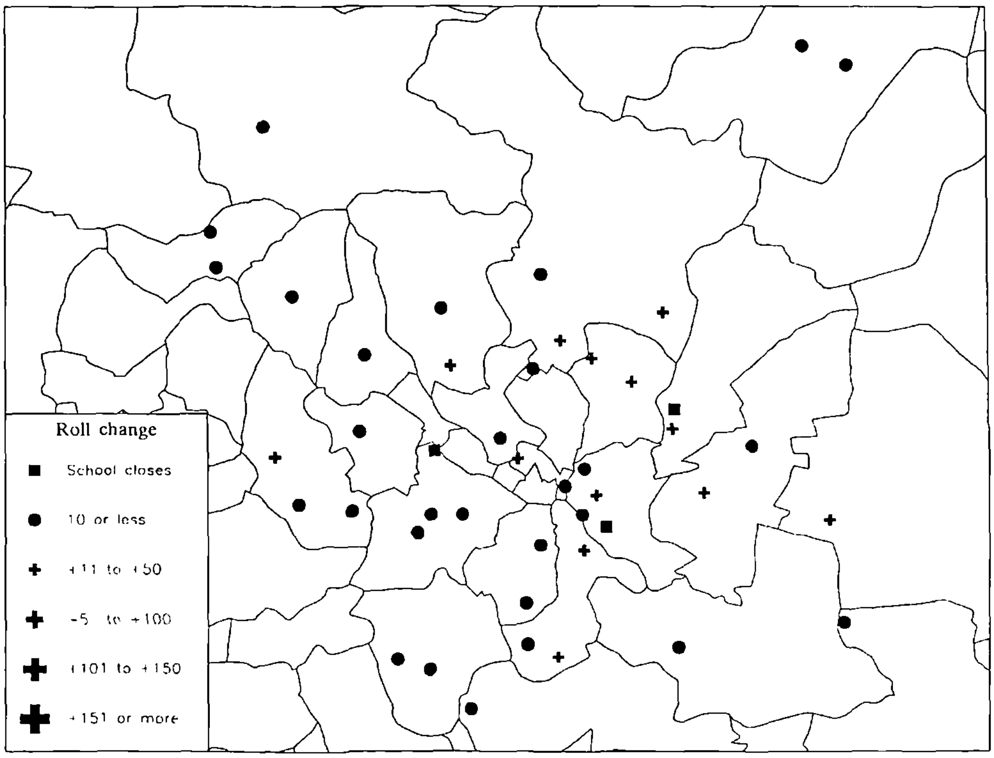
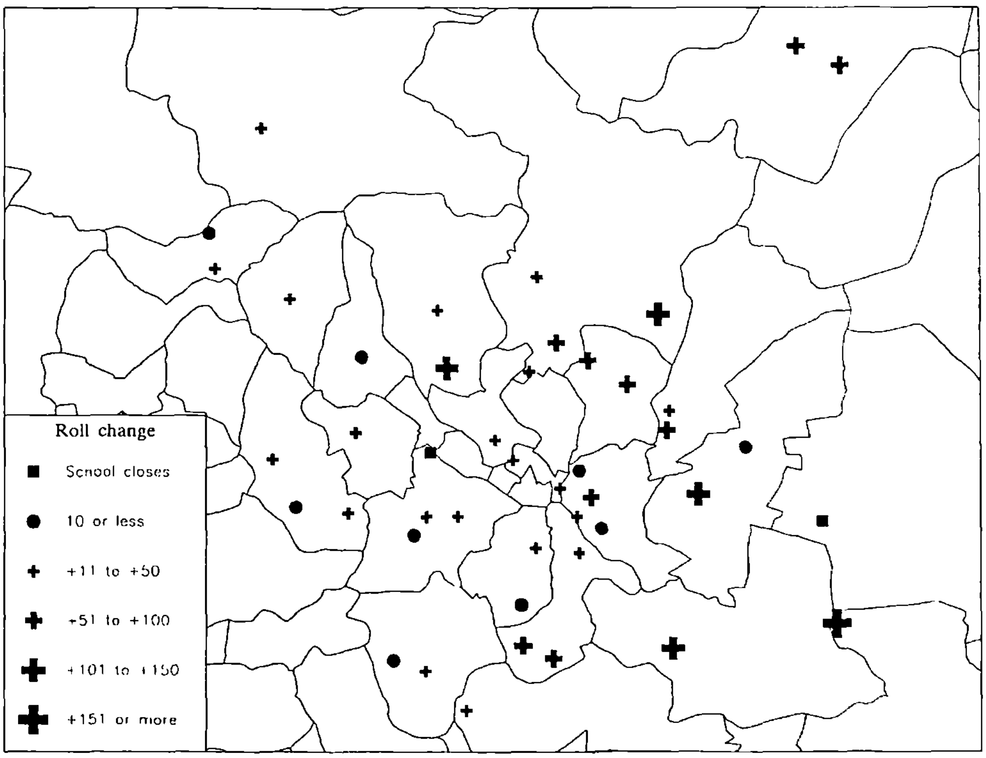


Figure 7.6: Changes in school rolls when one large school is closed



Clearly the closure of one large school in fact has a greater impact on the market than the closure of three relatively small and unattractive schools. In both cases, however, the pupils who are released into the system are redistributed fairly evenly around the remaining schools, although there is a definite bias towards those schools which are closer to the school which has been closed.

7.2.4 Expansion and growth: opening schools, adding new capacity

The second task an LEA may have to carry out is that of opening new schools. This would be most likely to be carried out in an area of expanding population, where roll predictions suggested an excessive strain on local schools. Clearly, if the residents of new housing were shown to be unlikely to utilise local facilities, then it would be a more likely response (and a better use of resources) for the LEA to renovate such schools or otherwise make existing facilities more attractive. The cost of new developments such as schools mean that many other possibilities have to be considered before funding can be justified for entirely new premises. A further use of this facility for an LEA might be to judge the impacts on 'their' schools of a new GM school, a prospect far more likely under the new market system, which gives greater incentives to the development of such schools than of mainstream LEA schools. It would also be important in a fully operational system to ensure an appropriate balance between schools at the various levels (particularly the primary/secondary split) to ensure that pupils remaining in an area could enjoy consistency in their education in terms both of the journey to school and the other pupils with whom they would be taught. In fact, school openings rarely if ever occur in a modern LEA. It is more common for schools to be 'closed' and then reopened on the same site, perhaps with some new teaching facilities. The demographic situation is such that schools tend to be amalgamated into a single site rather than completely new sites being developed. However, it is still quite feasible that a situation could arise where a new school were needed and it is certainly important for an LEA to have the facility to analyse the potential value of a new site.

However, once it has been decided that a new school is definitely required in an area, then the potential of models becomes clear. If there are a number of feasible sites available to an authority (and there is generally more than one to consider) then the implementation of spatial interaction models would seem to be the ideal way to compare the likely impacts of a new school at the various sites. As we have seen previously (chapter 4) it is extremely difficult to use GIS on its own to predict the likely rolls and impacts of new schools. The hardest part of the modelling process would clearly be the definition of likely attractiveness values for new schools, especially if any measure other than the use of physical capacity is used. In retailing it is usual to apply floorspace as the W_j factor, but as we saw in the previous chapter, size in education is not necessarily as good an indicator of a school's attractiveness as other measures (such as examination results).

In this situation a method for establishing the likely attractiveness of a school would have to be developed, perhaps relying on the composition of the local population to determine possible exam outcomes. It may be that an average value for the city as a whole could initially be applied to a new school, in lieu of any concrete knowledge of how a school will develop. The most likely scenario however is the use of a range of values over a series of model runs – perhaps one run with the best outcomes for the city, one with average outcomes and one with the worst. This would enable planners to determine how a school's roll and catchment would look however it performs in examinations, and thus gain a more general but more accurate view of the range within which a school is likely to develop in the long term. In this sense the model results will be more useful than with a single run (and W_j value) because it gives a 'worst case' and 'best case' scenario outcome.

In the examples below there are six different potential new school sites under test. One of these (new school 6) is the site used in chapter four, while the other five have been selected because they are in areas close to other schools which they may affect strongly or because the sites demonstrate a particular point about modelling.

This is particularly true of site 3. This is located on the very edge of the Leeds LEA area, and although the model, as we shall see, suggests that it may be successful, this shows us only a very small part of its potential. As it is situated on the edge, and as it is therefore extremely close to the schools of Wakefield, a school in such an area could be located with a mind to 'poaching' pupils (and funding) from Wakefield schools into Leeds. Such a scheme is increasingly likely under the new legislation, but it is a potential which is missed by a model such as this one which treats Leeds as an essentially closed system with no outside competition and a fixed pupil base.

All six sites are marked on figure 7.7 below, showing the geographic spread around the city. The model was run three times for each site, once with very high attractiveness (75% of pupils obtaining five or more GCSEs at grades A*-C), once with the average for the other Leeds secondaries (32%) and once with a nominal value for attractiveness (just 1%). What the results make clear perhaps more than anything is the very great importance of the attractiveness of a school in pulling in students. All the new sites would appear to be of great potential if they achieve very good exam results, while any school with attractiveness close to zero is unlikely to attract enough pupils to support more than a couple of teachers. The tables below show the rolls for the schools in the system under 'high'-, 'average'- and 'low'-attractiveness new site scenarios.

Figure 7.7: Locations of the six proposed new schools (marked by triangles)

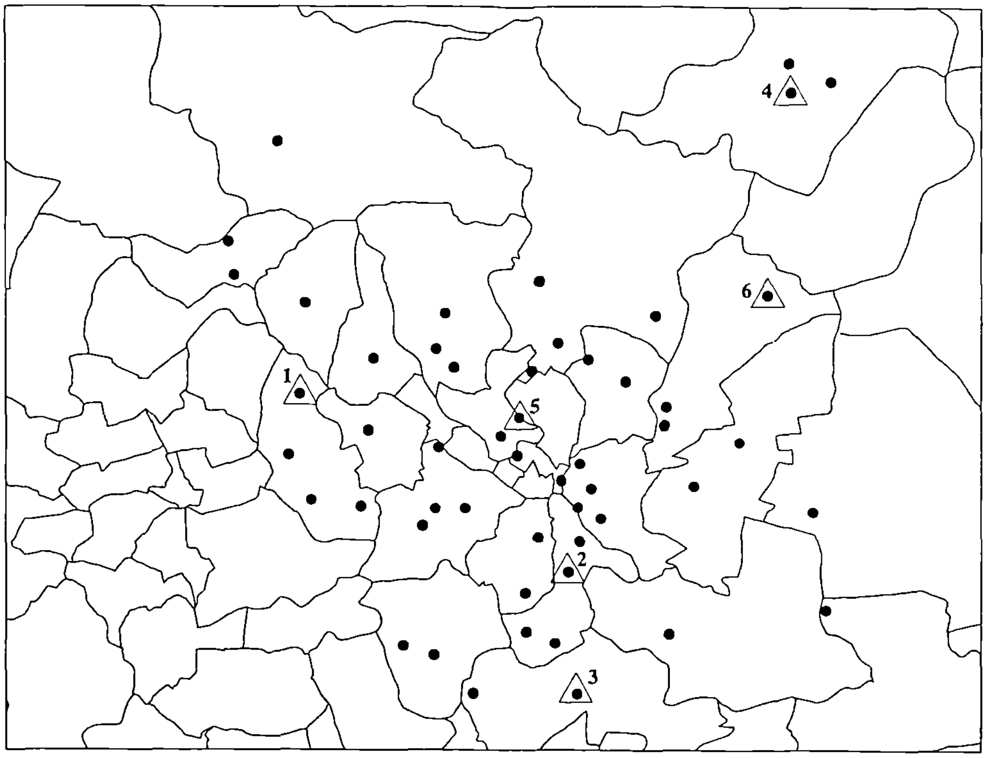


Table 7.6: Projected rolls of the 6 new school sites with varying attractiveness values

Site	*Attractiveness*	*Projected roll*
1	High	2171
	Average	850
	Low	57
2	High	3990
	Average	1939
	Low	192
3	High	2895
	Average	1539
	Low	166
4	High	758
	Average	293
	Low	17
5	High	4037
	Average	1689
	Low	130
6	High	2040
	Average	868
	Low	64

If this set of runs were to be used in this form, as a general guide to a site's potential, then clearly we could say that any site would probably be worth investing in with the possible exception of site 4, assuming that an extremely high attractiveness could be guaranteed. However, since this cannot be guaranteed by any manager it might be more realistic to look at the figures for predictions using average attractiveness. Under these conditions, it is perhaps fair to say (given the generally very high predictions for these schools) that sites 2, 3 and 5 offer the greatest potential for further development. It is worth noting that all three of these schools are located in areas of Leeds where population is densest and also where high-performing schools are perhaps at more of a premium.

Site 4 would be likely to fail because it is in an area of low-density population between two schools which are very successful and which already attract from a wide area. Thus a school at this location would have to be very special indeed to succeed in roll terms only. The school at site 1 suffers a similar problem – although it is in an area of relatively high population, the neighbouring schools are already popular and close at hand, so it is harder to pull pupils away from them. Site 6, as was suggested in chapter four, is in an area with a relatively low population and thus needs to be extremely attractive to pull pupils over the great distances they would have to travel. It is possible that if the full data for Bradford were included then site 1 might become viable by attracting more pupils from the schools of the next LEA to the west, and possibly site 4 might benefit from more data on the Harrogate schools' population. However, we have already discussed this problem, and noted that figures produced in this way should serve as a guide at best.

One factor which is common across these model runs and which sets the use of spatial interaction models apart from GIS as discussed in chapter four has only been implicit in the above discussion. This is the ability of models to predict the impact of a new school on those which already exist in the network. It is possible to see from table 7.6 above that the schools on the new sites might be very successful indeed if they were to open and achieve high examination results. However, this would not be satisfactory from the point of view of the LEA if this success meant that other schools suffered badly and were forced to close because their pupils were all travelling to the newer school. Clearly this is less of an issue if the new schools are unsuccessful, as in the third example for each. If a single school were to lose all the pupils who attended a school with a roll in the 50s it would not matter a significant amount. However, if a school is going to attract 1500 or more pupils then someone has to lose out significantly. Figures 7.8 and 7.9 below demonstrate some of the potential losses at schools around the new sites when their attractiveness is high (the new schools are marked by arrows).

Figure 7.8: Roll changes at existing schools when new school 2 (marked by a star) is highly attractive

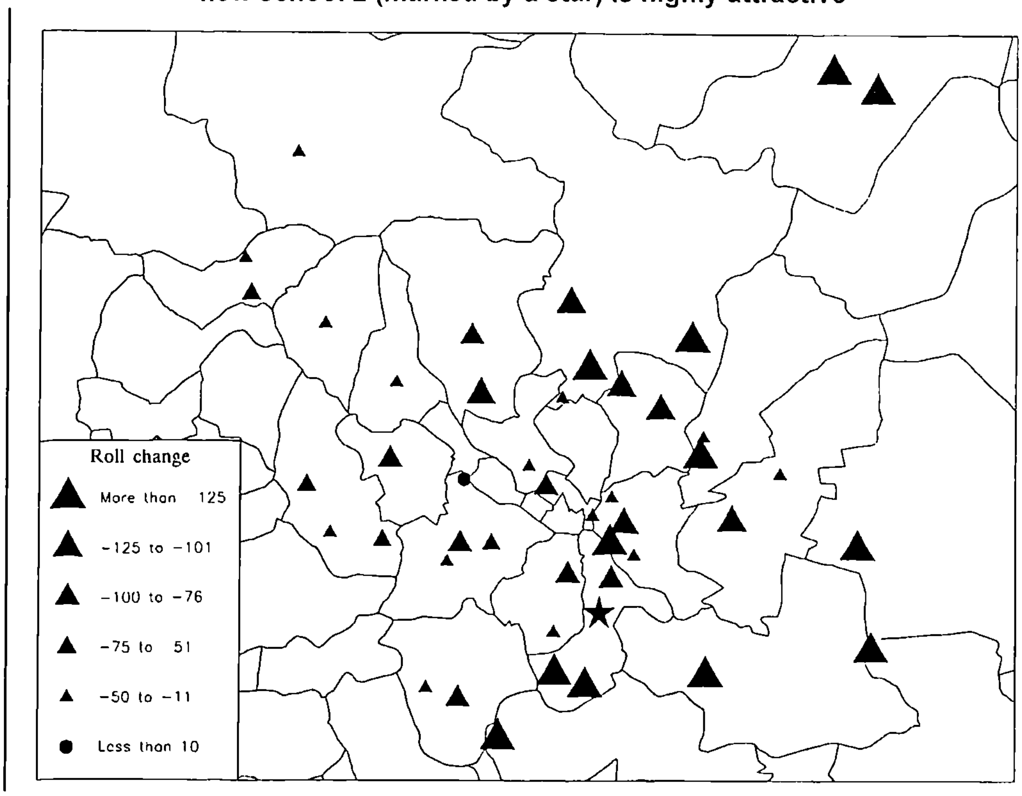
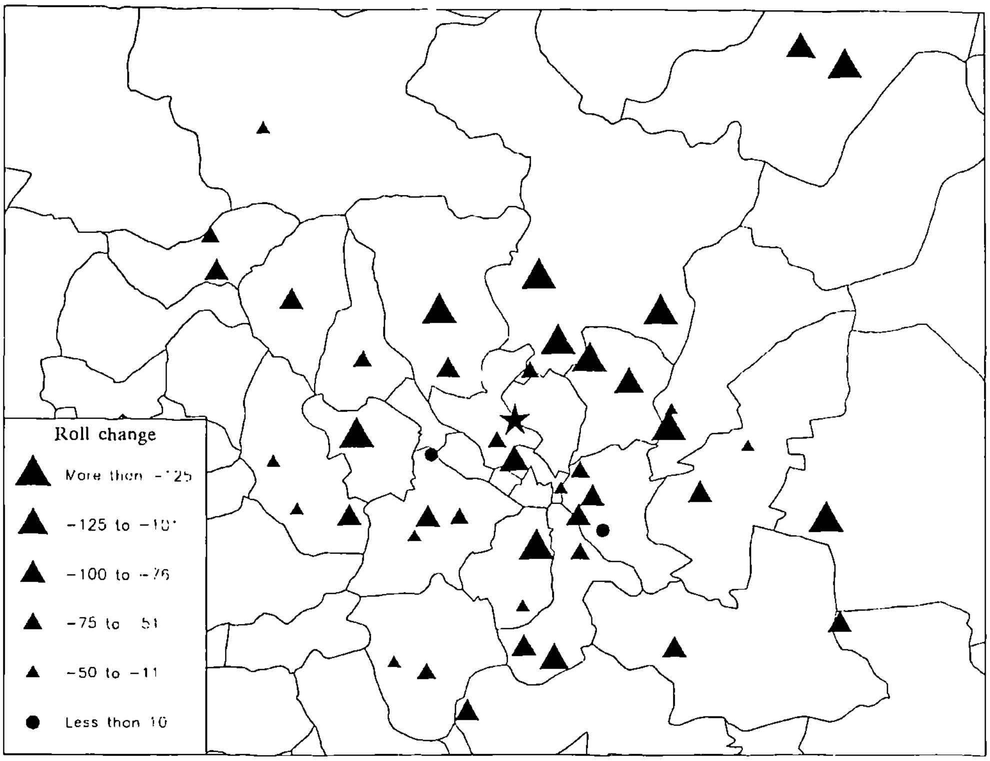


Figure 7.9: Roll changes at existing schools when new school 5 (marked by a star) is highly attractive



The main conclusion to draw from these figures is that it is the schools, as we would expect, closest to the new site which tend to lose out the most, although these attractive new sites also hit the outlying schools hard. In some senses this is realistic since the new schools in this scenario are far more popular than those around them and it is thus likely that they would cause pupils who would normally travel to stay. However, it seems unlikely that they would impact so heavily on the traditionally popular (and large) schools on the northern periphery of the city. Nonetheless, the model clearly gives us valuable pointers towards the sorts of effect we could expect to see if such schools were to be developed. It could also be used by bodies such as the FAS or indeed private speculators (operating in the state system) in order to judge which of the available sites would be the best to select to attract the maximum roll from neighbouring state schools.

7.2.5 Coping with change II: attitudinal and information fluctuation

Another possible application of the calibrated spatial interaction model is to try and model the likely impact on the network if parents are given different information about the schools in the city. Although parents rely fairly heavily on non-quantitative personal information (such as word-of-mouth recommendations, general impressions, hearsay *etc.*) there is increasingly a tendency to look at published data for schools in addition. Since this data currently comprises examination results and truancy data, these tend to reinforce people's attitudes about school 'quality' and thus in turn reinforce the stereotypes of the outer suburban schools being 'best'. However, there is an argument to suggest that if more information, or certainly more 'value added' information, was made available then the pattern of school attraction could be altered and possible imbalances in catchment composition and rolls could begin to be addressed.

A certain amount of this work has been suggested by the previous chapter, where a number of different W_js were tested in order to produce the 'best' calibration of the model. However, this section comes from a rather different perspective, looking at what the differences in pupil distribution would be, given fixed parameter values (because different pupil 'types' are unlikely to change their attitude to travelling or the relative importance of school-based information), if the data on which decisions were based were different. Thus the data from section 6.3.3 is again used, in combination with the 'best' parameter values outlined in table 7.1 above. In this sense, this section provides a brief introduction to the more complex consideration of the application of 'performance indicators' such as those discussed in chapter 3. Although it takes a rather more simplistic viewpoint of what information could be made available to parents it begins to provide some kind of indication of what could be achieved <u>if</u> new data could be made available to parents and <u>if</u> they could be persuaded that it was actually more significant in educational terms than simple average GCSE results.

Table 7.7: Roll predictions with varying W_j

School	Actual roll	Capacity	% of pupils gaining 1+ GCSE grades A*-G	% capacity filled	Surplus places	Number on roll
1	887	1044	932	1313	1289	1157
2	1689	1992	1171	1201	1117	2195
3	1125	734	873	1026	1009	941
4	338	833	1017	551	689	424
5	1374	1125	942	1000	1011	1282
6	1765	559	460	627	663	762
7	217	581	1183	494	805	286
8	885	777	771	564	488	608
9	888	617	734	897	874	748
10	619	834	1163	1198	1174	959
11	793	1335	870	609	446	718
12	680	1058	971	1196	1178	1077
13	718	743	899	1003	1017	748
14	777	949	1229	1050	1055	881
15	420	820	992	896	895	776
16	430	970	627	608	641	538
17	471	964	710	627	660	537
18	1785	754	1056	678	762	519
19	1093	1465	1027	1083	1079	1731
20	1187	762	907	1071	1045	974
21	939	605	786	932	907	769
22	1496	1155	1106	1150	1136	1288
23	1551	964	993	1195	1174	1073
24	1099	1495	1039	1160	1114	1699
25	362	1799	1075	1165	1113	1940
26	658	1170	899	1316	1294	1396
27	940	754	1168	605	743	447
28	1108	646	727	908	916	672
29	850	802	743	839	827	917
30	686	949	1214	1267	1247	1054
31	935	835	1032	1150	1164	831
32	509	711	621	890	876	784
33	1165	885	1102	870	952	658
34	1074	625	639	639	639	677
35	903	879	984	940	926	862
36	874	1099	878	692	596	847
37	1204	1063	837	842	778	1080
38	983	808	827	834	813	877
39	1001	667	757	715	710	679
40	628	815	1154	1129	1160	790
41	874	932	[illegible]	1175	1157	999
42	1154	1029	1121	1550	1514	1445
43	730	327	471	349	339	248
44	1389	942	737	751	737	1064
45	645	833	1089	947	974	746

It is clear from the table that varying the attractiveness measure (effectively varying the information used by parents to choose a school) can make an impact on the roll predictions. If parents were to favour one single piece of information over others when selecting a school for their offspring then the distribution of pupils across a city could be altered significantly, as we can see. If we were to make this process employ more complex indicators than those shown above the results again show a dramatic change. Table 7.8 shows the results of some model runs using indicators based on the data above. The first two columns show the results if the 'improvement index' introduced in chapter three (figures 3.3a-c) is reconstructed to give individual values to each school rather than simply assigning each school to one of two groups depending on whether it has improved or not. The second two columns give results for indicators which combine a school's GCSE results with their roll or size respectively. Again, as before, these results show that there could be some dramatic reversals in schools' fortunes if different, more 'value added' information were utilised by parents in their choice of school. Many of the smaller inner schools would have vastly improved rolls while some of the larger outer schools might take a cut in pupil numbers.

Table 7.8: School roll predictions using new 'performance indicators' to measure attractiveness

School	Actual roll	New indicator 1	New indicator 2	New indicator 3	New indicator 4
1	887	4119	3040	724	1091
2	1689	211	22	2139	4282
3	1125	109	36	396	151
4	338	2027	5	3172	2065
5	1374	358	572	1698	1604
6	1765	44	30	1165	794
7	217	2362	119	1125	951
8	885	480	263	34	261
9	888	121	40	9	173
10	619	181	33	251	114
11	793	148	601	1176	93
12	680	133	50	789	847
13	718	146	222	1451	2129
14	777	304	422	398	421
15	420	112	262	95	150
16	430	22	207	2824	1303
17	471	6226	7769	2949	1407
18	1785	690	428	2305	2068
19	1093	121	68	3482	4383
20	1187	195	272	97	67
21	939	1257	900	546	150
22	1496	1046	1741	1016	861
23	1551	56	109	262	581
24	1099	189	56	498	880
25	362	285	209	1893	3276
26	658	343	143	53	139
27	940	2511	191	780	467
28	1108	8463	12675	1140	1560
29	850	602	586	45	1
30	686	236	36	160	62
31	935	29	111	754	1050
32	509	120	399	140	38
33	1165	347	96	2017	1797
34	1074	116	16	828	746
35	903	4370	4989	129	113
36	874	365	913	230	45
37	1204	357	253	281	575
38	983	327	351	8	33
39	1001	139	14	1145	1099
40	628	753	1477	605	965
41	874	477	1131	286	400
42	1154	164	25	677	175
43	730	439	224	53	82
44	1389	110	29	936	1098
45	645	496	569	944	1158

New indicator 1: Change in proportion of pupils gaining 5+ GCSEs at grades A*-C 1992-5 and change in proportion of pupils gaining no GCSEs 1992-5 (as used in indicators shown in chapter 3, figures 3.3a-c), both standardised, added together and the total squared

New indicator 2: Change in proportion of pupils gaining 5+ GCSEs at grades A*-C 1992-5 and change in proportion of pupils gaining no GCSEs 1992-5 (as used in indicators shown in chapter 3, figures 3.3a-c), standardised, change in % without GCSEs reversed, both added together and the total squared

New indicator 3: Proportion of pupils gaining 5+ GCSEs grades A*-C and number of pupils on roll, both standardised, added together and the total squared

New indicator 4: Proportion of pupils gaining 5+ GCSEs grades A*-C and school capacity, both standardised, added together and the total squared

If this process is taken to its logical conclusion it could be suggested that if an LEA wanted to try and influence the rolls at schools then if information matching the 'ideal' rolls could be found and sufficiently well publicised then the authority could have an impact on where children went to school. By the same token, if schools are deemed to be failing and thus losing pupils then it would be appropriate for a local authority to attempt to bolster those factors which parents do seem to take into account (such as exam results, as we saw in chapter six) in order to influence the numbers on roll.

7.3 Conclusions

It is clear from the sections above that a model-based analysis can add greatly to the knowledge base of LEA planning officers. With the difficult problems associated with schools planning it is essential that decision-makers have as much good information as possible on which to base their decisions. The more traditional methods based on experience and the legislative control required to 'force' a system to fit a perceived ideal (by allocating pupils to schools) are at best vague and almost certainly, it would seem, made obsolescent by a fully market-oriented approach to school selection. Given that this is the case, it seems sensible to apply the methods outlined here in order to produce 'most likely' outcomes of planning decisions. These methods have a long history of real-world application (mainly in retailing: see for example Birkin *et al.* 1996) and as we have seen, they also work in an educational context. Whether schools are to be closed, opened or amalgamated, or the population projected to decline or increase, or the information available to parents remain static or change these interaction modelling-based methodologies give rapid and accurate projections of pupil rolls. On this evidence, the only possible conclusion appears to be that models are an appropriate technology to support the long-term planning of a school network and could, on that time scale, be of immense help in preventing the sorts of costly development errors which LEAs can ill-afford to make.

Chapter eight

Beyond static models: a dynamic approach to school roll prediction

8.1 Introduction

We have seen in the previous chapter how static spatial interaction models can be applied to education data in order to predict school rolls under any number of projected scenarios. However, while these are extremely useful in their own right, and can be argued to be crucial to educational planners in a market environment, they provide only a 'snapshot' view of impacts. There is clearly room in the modern planning environment for a modelling procedure which can suggest the likely progress of a network through time. This is where the dynamic models outlined briefly in chapter five come into their own.

As discussed in that chapter, dynamic models are based on the same principles as static spatial interaction models, except that they have rules for the growth and decline of facilities, and sometimes for the 'birth' and 'death' of similar units. In essence, a dynamic model will take the results of a static model, apply the set of rules governing the expansion or contraction of facilities and then run the model again with revised attractiveness measures and/or sizes. This process continues until the system has reached an equilibrium state and no more significant changes are predicted.

In terms of education this could become a very useful practice, since it allows planners to spot the 'weak links' in a system and perhaps catch problem schools before problems become really serious. It can be used as a form of advance warning of those schools which are likely to suffer the most from a policy of parental choice and permit LEAs to introduce coping strategies before the problem gets too serious to remedy. It also allows them to see where pressure for places is likely to be the greatest and could therefore help authorities to plan for the provision of extra accommodation more accurately.

In this chapter two variations of the dynamic modelling approach are discussed and applied. The first is the Harris/Wilson model introduced in chapter five and the second is a rules-based variation known as the 'business potential model' (Michell forthcoming). The Harris/Wilson model, as stated previously, takes as its starting point a model prediction of D_j, as calibrated and calculated in chapter six. From here it uses a simple cost *versus* revenue rule to redefine W_j (which is usually assumed to be the same as D_j) and iteratively run the model in this way. The model moves directly towards its equilibrium point and changes in facility size are not regulated or stepped. Thus changes in any iteration can range from one size unit up or down to complete closure or a very large increase (see Wilson 1981 for more discussion on this issue). The business potential model differs mainly in that changes are constrained to 'steps' (in this instance of whole classrooms *cf.* the individual pupils of the Harris/Wilson model) and it is more feasible because of the wider ranging rule-based approach to use attractiveness terms other than ones which are essentially economic (*e.g.* school capacity, revenue *etc.*). The following sections discuss the two models in more detail and apply them to the Leeds dataset. The business potential model was developed by Rebecca Michell, also of the University of Leeds and adjusted for application to the example of education using rules and parameter settings based on the author's suggestions, and initially tested by the author. Much supporting mathematical justification for the models and results and complimentary analysis can be found in Michell (forthcoming).

8.2 The Harris/Wilson model

8.2.1 Introduction and description

Originally proposed by Harris and Wilson (1978), these models were designed to produce an equilibrium state in a retailing system. Using floorspace as W_j together with revenue and cost terms, the models produce an equilibrium where revenue balances costs for a given floorspace. In the movement towards this equilibrium (the equation is solved iteratively), if revenue exceeds costs then a centre j will expand and, conversely, if costs exceed revenue a centre will contract. The *reductio ad absurdum* of this process is that all traffic (revenue) will eventually end up in just one very large centre j, as "If becomes very large" (Harris and Wilson 1978, p372) and this is a potential problem which is widely acknowledged with the Harris/Wilson dynamic approach (see for example Cardwell 1996, Clarke 1986, Michell forthcoming). However, in educational terms, it does serve to begin to highlight areas which may be suffering from a natural decline which may therefore benefit from outside assistance to promote roll growth.

The model is based on a production constrained spatial interaction model as outlined and calibrated in previous chapters (five and six). In addition, a dynamic Harris/Wilson model incorporates a subset of rules for expansion and contraction of destinations j. These are, as stated in chapter five;

if $D_j < kW_j$ then j contracts

if $D_j > kW_j$ then j expands

and if $D_j = kW_j$ equilibrium has been achieved

where;

D_j = demand at j calculated by SIM (revenue)

W_j = size (attractiveness) of destination j

k = cost *per* unit of capacity at j

Essentially this means that if the cost of providing W_j exceeds the revenue as predicted by the initial model then destination j will contract, and if the reverse is true it will expand. The equation is solved and equilibrium achieved when costs and revenues are equal. The model used here follows this basic format, as described in general terms in Appendix IV and with;

D_j = number of pupils at school j (defined by model)

W_j = school capacity (in numbers of pupils)

k = cost *per* pupil of providing schools

The model as defined is justified mathematically in Harris and Wilson (1978), Wilson (1985) and Michell (forthcoming), where more technical descriptions of model development can be found.

The following section takes this model as defined here and applies it to the data which has already been introduced in previous chapters, for Leeds secondary schools. The chapter then discusses the 'business potential model' and applies it before drawing some comparative conclusions about the two sets of results and the differing models.

8.2.2 Results for Leeds schools

This section takes two approaches. Firstly a dynamic version of the production constrained SIM calibrated in chapter six is applied to the Leeds data and secondly a slight variant on this model is used for comparison with the business potential model. The first set of model runs uses the parameter values derived from chapter six and uses disaggregate data. The model used is the first dynamic model defined in appendix IV. based on Harris and Wilson (1978) and Clarke and Clarke (1984). This takes the data for the three disaggregated social groups AB, C and DE and utilises the parameter values described at table 6.11. The dynamic variable k is assumed at 1.3, a cost *per* pupil of £1,300 *per annum*. This figure is based on data on the financing of Leeds schools in the Leeds Schools' Commission report (LSC 1993). Since this model is closely based on retail dynamics the attractiveness values are school capacity (this being the W_j most analogous with floorspace). The results from this model run are presented in table 8.1 (which also shows the development over the iterations) and figures 8.1a-c.

Table 8.1: Output from a dynamic disaggregate production constrained spatial interaction model

school	*iteration 1*	*iteration 5*	*iteration 10*	*iteration 15*	*iteration 20*	*Equilibrium*
1	1187	1594	1466	1660	1812	5404
2	1090	1411	576	495	434	224
3	993	1420	271	217	189	149
4	1097	1454	895	915	914	230
5	786	315	185	150	129	100
6	533	166	143	142	144	72
7	1057	911	591	510	447	230
8	656	223	139	112	103	97
9	681	233	150	124	114	109
10	1083	1785	498	417	361	206
11	1165	3381	15714	15783	15749	15240
12	1206	2569	1463	1634	1822	2972
13	902	537	403	316	264	200
14	1128	1191	1227	1285	1299	343
15	878	458	334	265	221	146
16	1105	1099	1109	1117	1088	288
17	1032	816	692	638	590	237
18	993	766	699	649	591	207
19	840	554	540	555	573	312
20	785	299	196	152	132	114
21	787	485	374	425	471	712
22	964	884	441	404	374	155
23	1000	958	714	770	828	1681
24	962	765	774	833	902	2059
25	1083	2174	614	523	474	201
26	1103	1123	1182	1237	1246	778
27	1028	827	730	631	540	255
28	701	235	149	127	122	120
29	681	233	150	124	114	109
30	1128	1191	1227	1285	1299	343
31	1032	816	692	638	590	237
32	821	376	279	231	198	120
33	1186	1598	1422	1595	1730	1970
34	473	45	34	34	34	34
35	1028	1913	424	366	330	162
36	722	258	164	138	130	127
37	891	403	230	185	166	150
38	736	297	193	152	134	120
39	751	379	277	278	271	98
40	1203	2420	1435	1642	1829	3251
41	968	710	614	549	492	198
42	1095	1146	1113	1193	1235	1299
43	538	169	148	150	155	222
44	574	136	89	82	80	80
45	1052	981	941	974	980	340

Figure 8.1a: Roll values for dynamic model after iteration 1

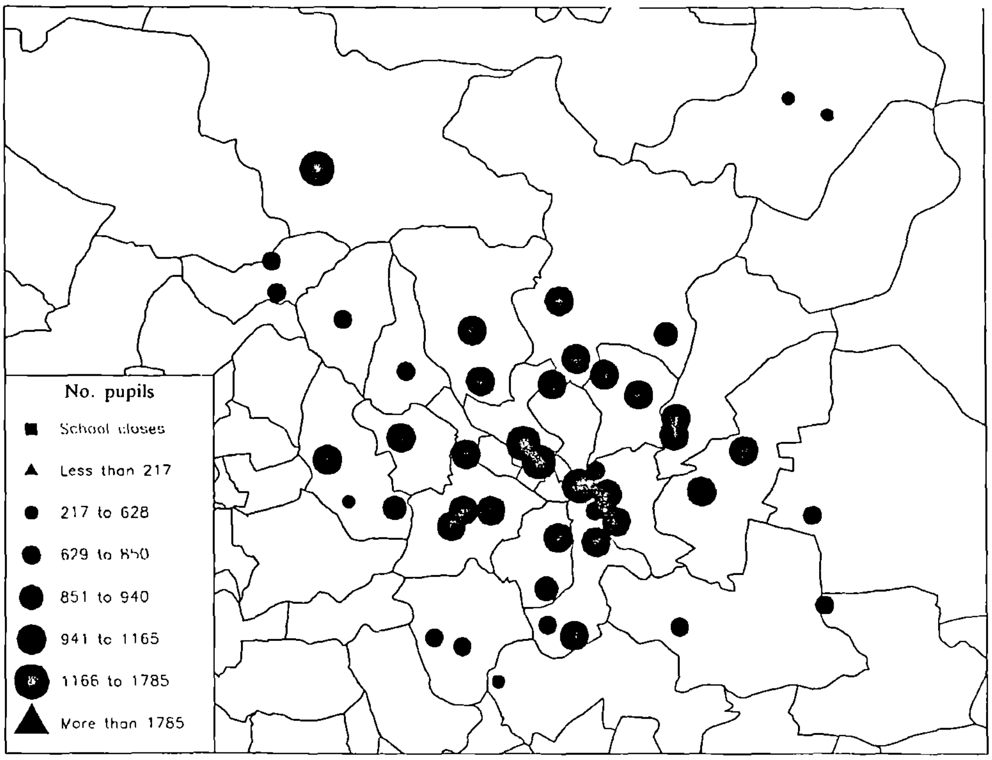


Figure 8.1b: School rolls at iteration 10, using 2-parameter disaggregate dynamic spatial interaction model

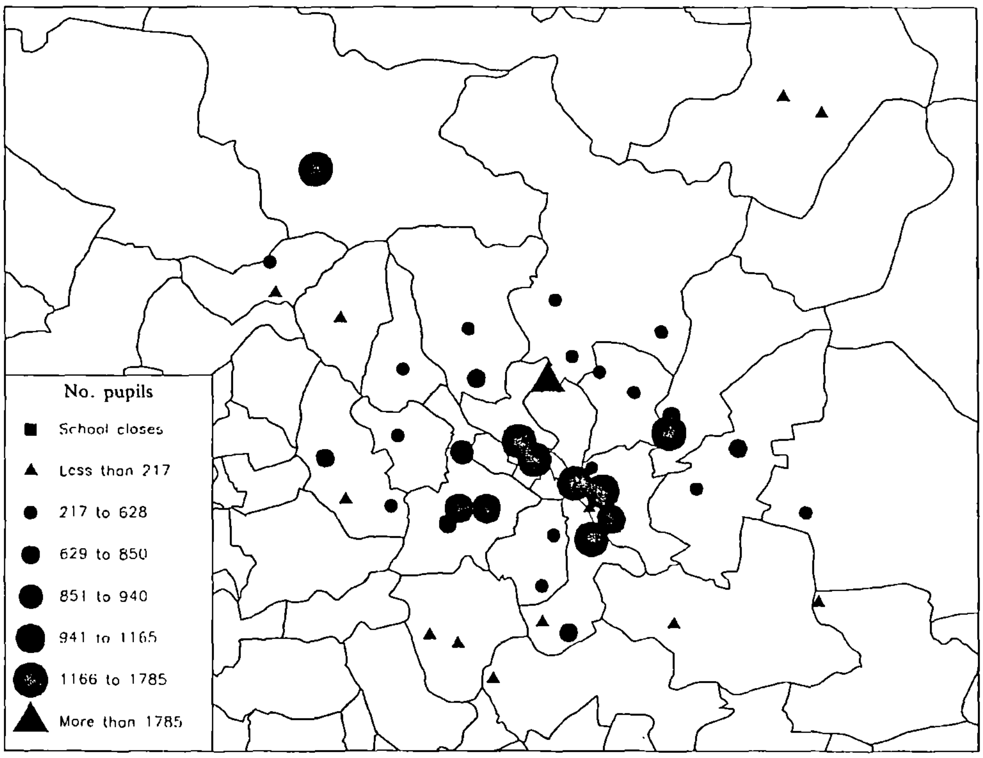
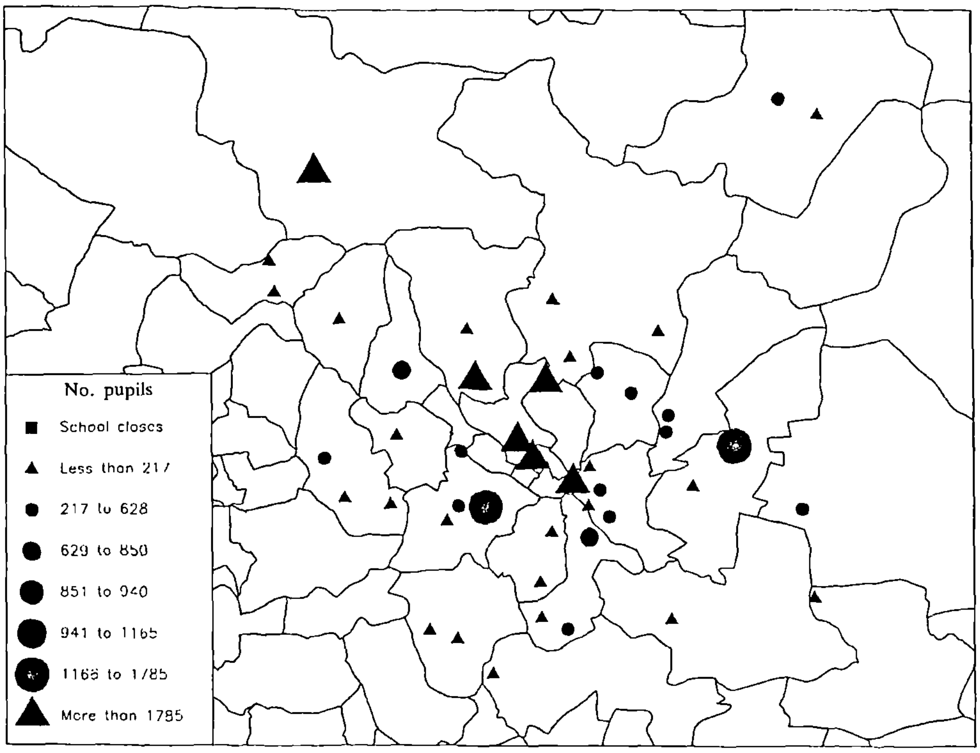


Figure 8.1c: School rolls at equilibrium, using 2-parameter diaggregate production constrained dynamic model

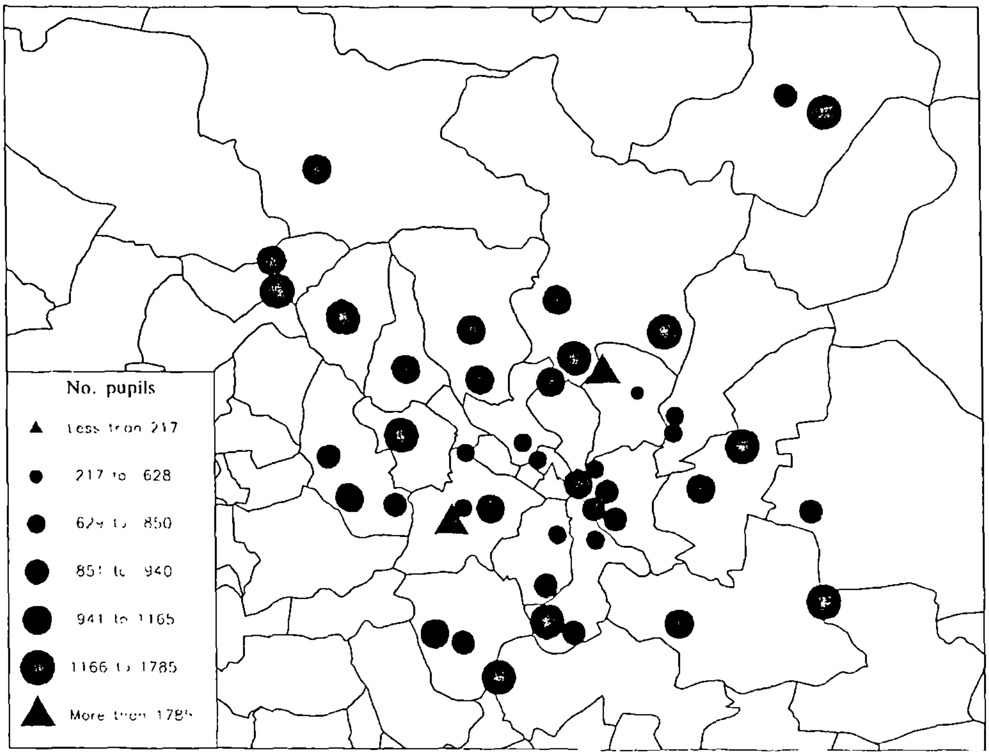


The results show that eventually the pupils are most likely to concentrate in two general areas of the city. The first and largest concentration is in inner Leeds, to which most pupils are closest. The second is a concentration in some of the more outer schools, such as that in the east, the far north west and two towards the northern edge of the city centre. The first cluster appears because of the distance effect, and comprises largely the pupils from the DE and C social groups, while the second cluster comprises largely those pupils in the AB and C social groups. The fact that none of the schools closes entirely (assuming a roll must fall to zero before a school will close) is due almost entirely to the fact that at equilibrium the pupils from the middle social groups (the C1s and C2s) are spread across the city in far less concentrated a manner than the other social classes. In actual fact it would seem from the figures that the vast majority of schools in the 'equilibrium' state here would be uneconomic and would in fact close. It is perhaps the case that in such a model it would be the middle iterations which could tell us most about the actual likelihood of development in a city, and where the actual 'flash points' in terms of roll problems would be most likely to occur. Clearly though this model, although imperfect, does show the kind of development which might be expected in a real city under a market system – conglomerations of high-achieving pupils at successful outer schools and similar groupings of more socio-economically disadvantaged pupils at the low-achieving but close to home inner city schools. The following sections of this chapter attempt to provide methods for fine-tuning this basic model to give perhaps more realistic output.

The following section of this description of the Harris/Wilson model is based around the model described by Michell (forthcoming). This is a 2-parameter production-constrained spatial interaction model as outlined in chapter five and explained above. The model uses aggregate pupil data rather than the model above which disaggregates the pupil data, in order to compare more easily with the business potential model. The model takes the form described in [A4.25]-[A4.27]. The static parameter values used are $\alpha = 0.50$ and $\beta = 0.29$ (see chapter six). Other assumptions of parameter values are that $k = 1.3$ (or that the cost of providing for one average pupil is £1,300 *per annum* – as in the previous model specification) and that $c = 250$ (an estimate that the fixed costs of running a school are £250,000 *p.a.*). Funding *per* head (O_i) is generated at a rate of £1,600 *per* pupil. In the first example below ε is set at 0.005, while in the second (which does not produce a small number of large centres) $\varepsilon = 0.001$.

From this starting point the model first runs the initial, static spatial interaction model to provide figures for the roll at each of the 45 schools, shown at figure 8.2 and in table 8.3. In the dynamic part of the model, revenue is assumed to come in the form of funding *per* head, while costs are a combination of teaching costs (an average figure multiplied here by the number of pupils) and classroom costs (assumed to include overheads, teaching materials *et al.* as described above). The model has been run under a number of different circumstances to provide a range of results.

Figure 8.2: Starting roll values for dynamic model after iteration '0', values from static 2-parameter aggregate spatial interaction model



The first version of this model uses capacity as attractiveness, which immediately puts the model into a classic dynamic feedback loop. As a school becomes larger so it becomes more attractive and so becomes larger still. This is the situation which often leads to Harris/Wilson models reaching an equilibrium with a very small number of very large centres. When the model is thus defined, the spatial interaction model must be run continually, at each iteration, since the attractiveness value is constantly changing. The results of any model can be affected by the specification of the variable ε in the equation (see [A4.25]). In the first example below, where the classic pattern of small numbers of large centres is reproduced, $\varepsilon = 0.005$. In this case just two schools remain open after a very small number of iterations. However, the second example sets $\varepsilon = 0.001$ and produces a network with a much more reasonably distributed school population not massively dissimilar from the starting point (see figure 4.2 and 4.3). In this case the number of iterations taken is also much larger, suggesting a slower development over time. It is important to note that the retrograde step (in terms of model development) of reaggregating the pupil data means that the model output has returned to a situation where distance is overly important in the equation and that therefore the 'equilibrium' solution gathers all the pupils in towards central Leeds. This is a problem which could begin to be addressed through disaggregation, as we have seen in previous chapters.

It is also possible to alter the specification of attractiveness in this version of the Harris/Wilson model, and the final column in table 8.3 shows what happens when equation [A4.26] is replaced with [A4.27] to allow GCSE results to take the place of school capacity as the attractiveness measure. In this case, the interaction model need only be run once, at the first iteration, since the attractiveness of the school will not change and therefore the predicted size need not be fed back into the model. Each further iteration simply reapplies the rules for growth or decline based on revenue, which is in turn based on the pupil roll as predicted. The differing steps taken by the model depending on the attractiveness value are shown at table 8.2. The various results are shown graphically in figures 8.3 to 8.5.

Table 8.2: Steps taken by dynamic model with and without classic feedback loop

Attractiveness = capacity [feedback loop]	
1.	SIM is run to predict school capacity
2.	Rules for growth/decline based on revenue (dependent on capacity) are applied
3.	Predicted capacity is returned into model as new attractiveness value ($W_j = D_j$)
4.	Repeat from step 1 until convergence criteria are met.
Attractiveness = GCSE results [no feedback loop]	
1.	SIM is run to predict school capacity
2.	Rules for growth/decline based on revenue (dependent on capacity) are applied
3.	Repeat step 2 as capacity changes through revenue-based rules until convergence criteria are met (but crucially $W_j \neq D_j$)

Table 8.3: Equilibrium values for Leeds school rolls using an aggregate Harris/Wilson-type dynamic spatial interaction model

School	*Starting rolls calculated in static SIM*	*Equilibrium rolls, Wj = capacity,* $\varepsilon = 0.005$ (iterations = 4)	*Equilibrium rolls, Wj = capacity,* $\varepsilon = 0.001$ (iterations = 32)	*Equilibrium rolls, Wj = GCSEs,* $\varepsilon = 0.001$ (iterations = 14)
1	780	0	1334	606
2	876	0	1121	1402
3	750	0	497	1020
4	900	0	1327	625
5	780	0	907	1122
6	980	0	318	515
7	820	0	1226	1288
8	1800	0	452	851
9	1600	0	1004	1449
10	810	0	1200	717
11	780	0	1352	745
12	960	0	1008	428
13	1636	25632	1230	1119
14	1110	0	913	1052
15	1000	0	1201	444
16	960	0	1287	229
17	1810	0	1043	510
18	1020	0	890	1370
19	950	0	641	875
20	1308	0	1153	1382
21	1170	0	1217	800
22	1132	0	1004	1098
23	920	0	1175	1384
24	1409	0	1194	1010
25	911	0	1106	1249
26	1147	0	752	508
27	1119	0	477	835
28	927	0	477	786
29	948	0	1230	1584
30	930	0	1287	893
31	1020	16266	614	985
32	750	0	1377	685
33	780	0	370	725
34	1260	0	671	914
35	1380	0	924	1181
36	580	0	790	835
37	930	0	542	1003
38	900	0	475	836
39	800	0	627	956
40	950	0	1344	1117
41	900	0	1159	928
42	1287	0	1217	1532
43	1420	0	353	538
44	1274	0	250	947
45	900	0	1161	820

Figure 8.3: Equilibrium values for Leeds school rolls using a Harris/Wilson dynamic aggregate spatial interaction model (W_j = school capacity, ε = 0.005)

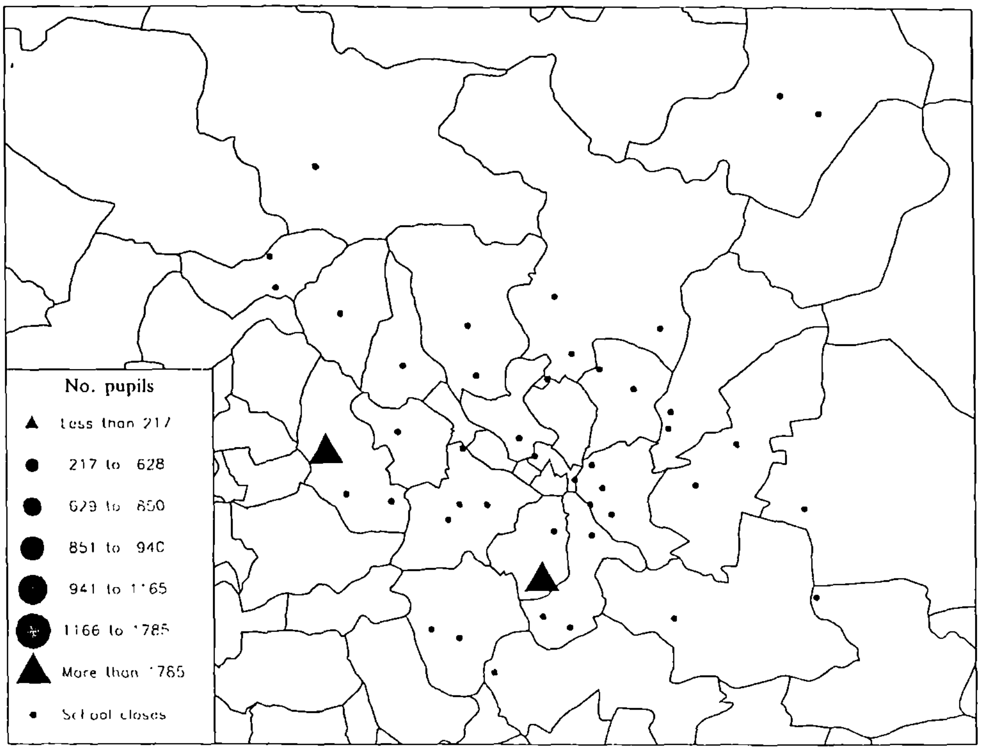


Figure 8.4: Equilibrium values for Leeds school rolls using a Harris/Wilson dynamic aggregate spatial interaction model (W_j = school capacity, ε = 0.001)

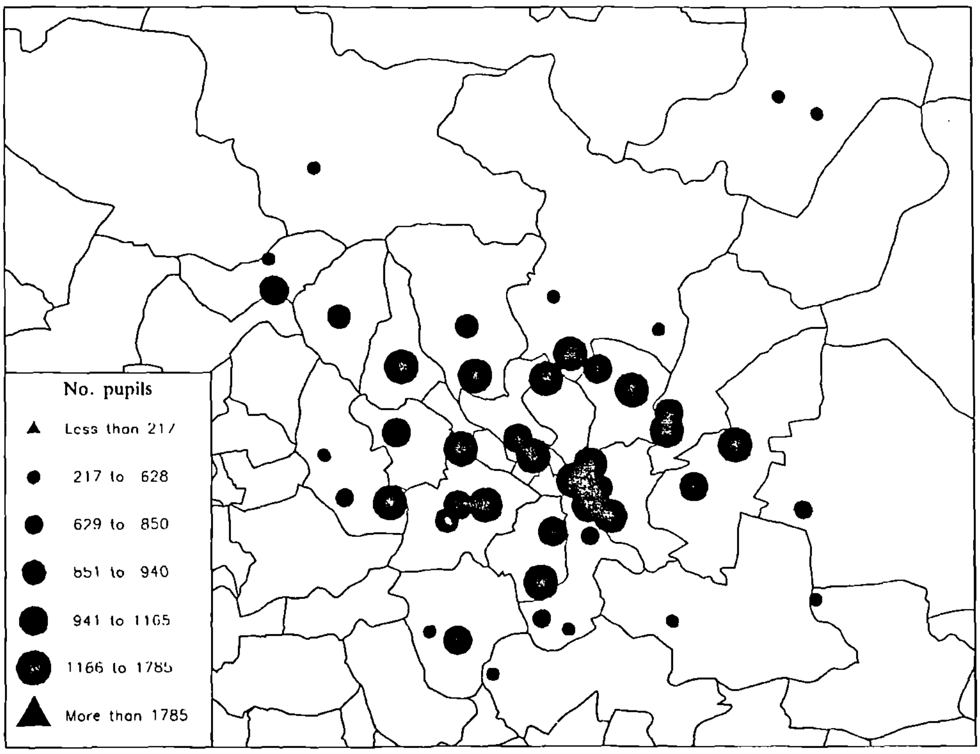
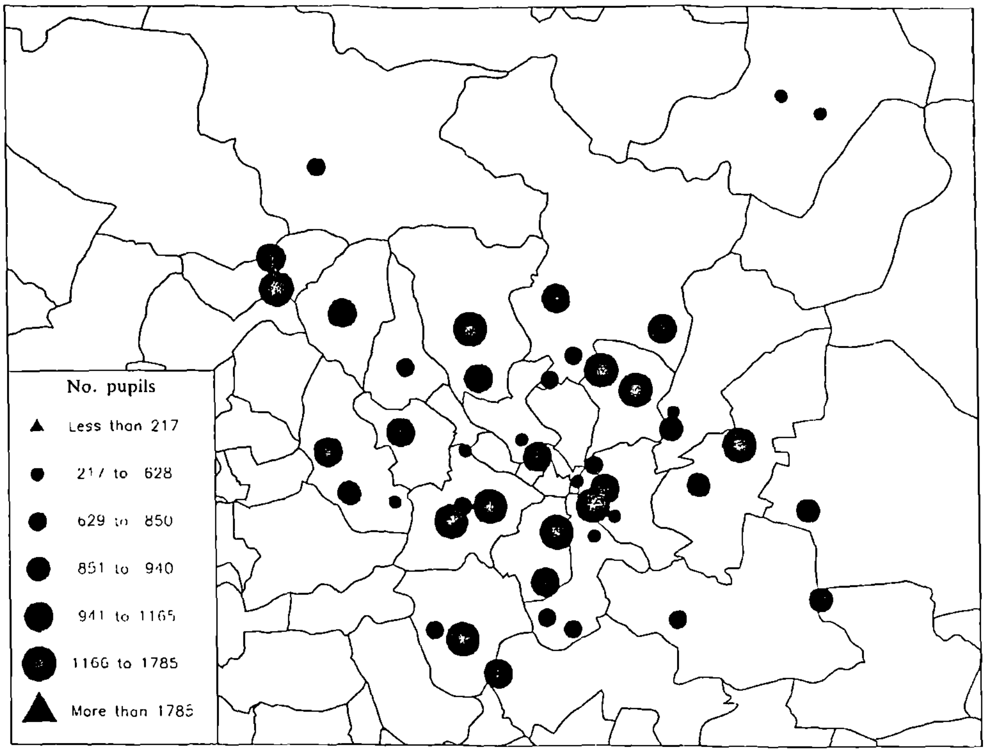


Figure 8.5: Equilibrium values for Leeds school rolls using a Harris/Wilson dynamic aggregate spatial interaction model (W_j = GCSE results, $\varepsilon = 0.001$)



The results show that although the initial spatial interaction model reproduces the current situation across the city with reasonable accuracy, both the latter models, as previously stated, concentrate pupils in inner Leeds, a problem noted with the first, most simple models in chapter six. It is clear that these models require merging with the disaggregate data before they become truly applicable in a real planning environment.

8.3 The business potential model

8.3.1 Introduction and description

The business potential model was developed by Michell (forthcoming), based on the Harris/Wilson approach. The crucial difference between the approaches is that the business potential model allows for the definition of more complex rule-sets which mean that it is simpler to utilise more than size as the attractiveness constraint. It is also different in that there is the possibility of defining a stepped approach to facility expansion and contraction rather than the linear approach usually taken in the Harris/Wilson case. There are threshold boundaries for change, which trigger the 'stepped' expansion or contraction, rather than the single equation of cost and revenue used in the Harris/Wilson model. However, the equilibrium solution remains the same as that for the Harris/Wilson model, at a point where costs and revenues are balanced.

The changes in facility size rely on a set of user-defined thresholds for expansion or contraction. If the facility remains within the boundaries then no change occurs and the facility will remain at the same size. However, exceeding the maximum threshold triggers expansion and falling short of a minimum threshold causes contraction. It is also important to note that the business potential model separates the financial and physical aspects of a facility. In the Harris/Wilson approach, financial information (relating to costs and revenues) directly affects the size of a destination (which in the retailing application is measured in terms of potential revenue – making D_j and W_j equal). However, in the business potential model such information is monitored constantly and does still have a direct impact on facility size, but it is now possible to have small changes in relative profitability without triggering changes in the physical size of facilities. This means that it is possible to define a site in terms of size rather than revenue since the two elements (financial and physical) of the system are linked but separated.

Initial demand (D_j) for a facility is calculated in essentially the same way as in the Harris/Wilson model, through a spatial interaction model calibrated in the usual way. However, rather than simply using this figure in the balancing equations outlined above, the figure is used to calculate a new variable, business potential or P_j. This is defined mathematically as;

$$P_j = (F.D_j) - \left((H + CC)\left(W_j / Av\right)\right) - C \qquad [8.2]$$

where;

P_j	=	business potential function
F	=	funding *per* head of school roll
D_j	=	total potential demand for school (from spatial interaction model)
H	=	average teacher salary
CC	=	cost *per* classroom
W_j	=	school size (capacity)
Av	=	average class size
C	=	overhead costs *per* school

In simpler terms, this equation can be written as;

Business potential = potential revenue – current costs

or;

$$P_j = \text{(revenue)} - \text{(roll factored costs)} - \text{(fixed overheads)}$$

where;

revenue	=	potential demand (pupils) * funding *per* head
roll factored costs	=	(cost of classroom and teacher)*(no. of classes)
fixed overheads	=	costs immaterial of school size (*e.g.* assembly hall, gym *etc.*)

This equation is then applied and compared with the threshold levels of P_j. In this case the upper and lower thresholds were set at;

$$P_j min = 0$$

$$P_j max = H + CC$$

If the minimum threshold is not exceeded (*i.e.* if costs exceed revenue) then the school will close (although this can be altered to accommodate such alternative solutions as mothballing classrooms or change of use of surplus capacity). The maximum threshold is the cost of providing an extra classroom and teacher so that if a school is sufficiently 'profitable' to expand it will do so by an entire class, a more realistic scenario than the linear increase suggested by the Harris/Wilson model.

Another important factor to be considered in comparing the two model types is the initial definition of D_j. In the Harris/Wilson model, as has already been noted, attractiveness and facility size are usually equal and identical. However, although this may be the case in retailing, where facility size is a good proxy for facility attractiveness (big shops or centres are more attractive than small ones – see Clarke 1986) in education this is not necessarily the case. Although the more popular schools <u>do</u> tend to be the larger ones (see chapter six for a discussion of correlations of in-school factors) the relationship is likely to be that a school is large <u>because</u> it is popular rather than *vice versa*. In this case, as we have seen in previous chapters, the use of examination results can provide a more accurate and realistic proxy for a school's attractiveness for parents. Although it is possible with the straight Harris/Wilson model to utilise other measures, the added functionality in the business potential model means that it is better suited to utilise other measures as the attractiveness value for facilities in the initial model. This makes it much more flexible when examining systems where economics do not necessarily provide the entire explanation for the functioning of those systems.

It is also important to note that the business potential model cannot converge at an equilibrium where capacity is higher than demand, a situation which is quite feasible in the Harris/Wilson model if revenue remains higher than costs. The mathematical structure of the business potential model also disallows chaotic behaviour of model output (Michell forthcoming). In other words, with the Harris/Wilson model a facility's size can fluctuate between growth and decline or show a random pattern, neither of which can occur in the business potential model.

8.3.2 Results for Leeds schools

In this section the rules outlined above have been applied to the data for Leeds secondary schools in order to produce a comparative set of results for the possible evolution of the Leeds school network. Table 8.4 and figures 8.7 and 8.8 show the equilibrium values for Leeds schools using the two attractiveness measures introduced before and the parameter values outlined above (see section 8.2.2).

Table 8.4: Equilibrium values for Leeds school rolls using a business potential dynamic spatial interaction model

School	*Starting rolls calculated in static SIM*	*Equilibrium using capacity*	*Equilibrium using GCSEs*
1	780	1306	606
2	876	1140	1402
3	750	496	1020
4	900	1307	625
5	780	915	1122
6	980	594	515
7	820	1230	1288
8	1800	458	851
9	1600	1026	1449
10	810	1197	717
11	760	1319	745
12	960	1003	428
13	1636	1221	1119
14	1110	922	1052
15	1000	1194	444
16	960	1279	229
17	1810	1050	510
18	1020	912	1370
19	950	634	875
20	1308	1159	1382
21	1170	1210	800
22	1132	1029	1098
23	920	1178	1384
24	1409	1189	1010
25	911	1107	1249
26	1147	729	508
27	1119	448	835
28	927	470	786
29	948	1221	1584
30	930	1279	893
31	1020	616	985
32	750	1355	685
33	780	379	725
34	1260	664	914
35	1380	935	1181
36	580	766	835
37	930	567	1003
38	900	471	836
39	800	623	956
40	950	1315	1117
41	900	1162	928
42	1287	1209	1532
43	1420	0	538
44	1274	450	947
45	900	1165	820

Figure 8.6: Equilibrium values for Leeds school rolls using a business potential dynamic spatial interaction model (W_j = school capacity)

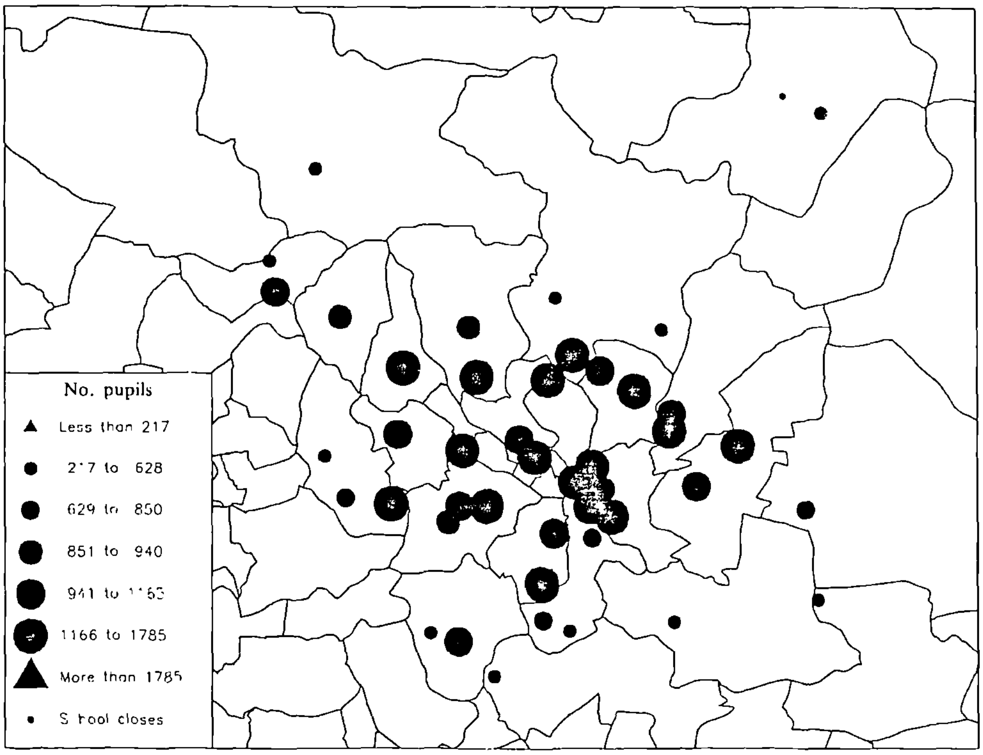
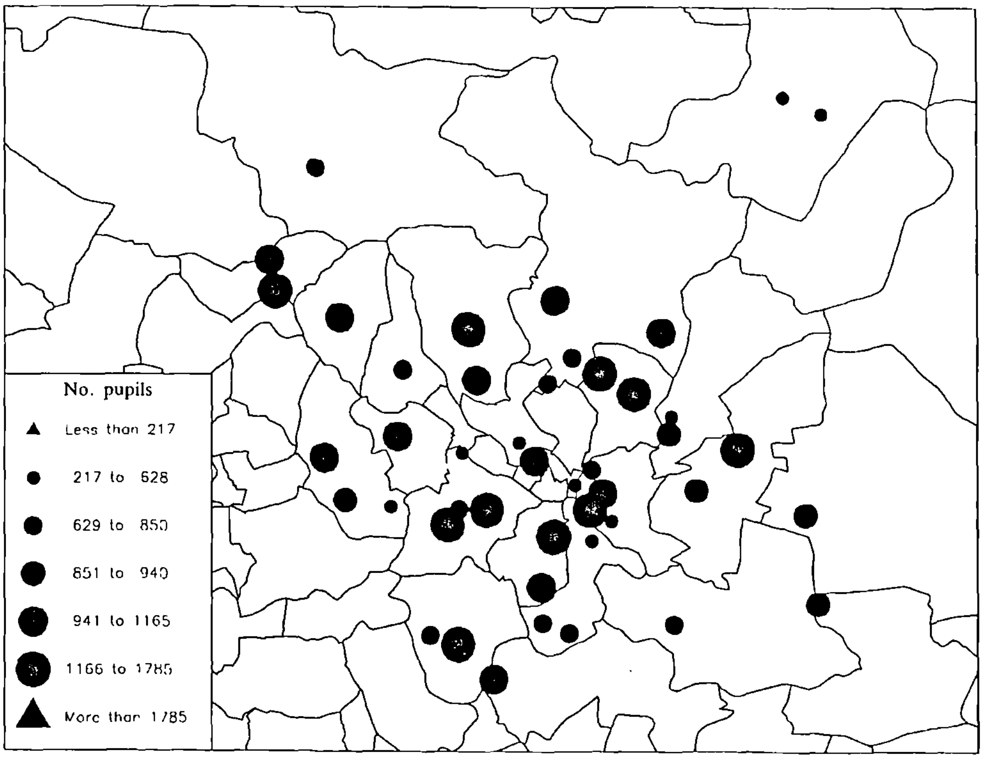


Figure 8.7: Equilibrium values for Leeds school rolls using a business potential dynamic spatial interaction model (W_j = GCSE results)



Here, as with the Harris/Wilson model, we can see that the pupils are reasonably well-spread across the city, although in one single case a school is projected to close. However, the model (especially when facility size = attractiveness) is still producing an equilibrium which places far too much emphasis on the inner schools because of the distance factors rather than the outer schools which the experience of previous chapters tells us are in fact far more likely to expand over time.

8.4 Conclusions

This chapter has sought to build on the basic introduction to dynamic interaction modelling given in chapter five and to compare three variant models. Without the benefit of real time-series data it is extremely difficult to draw any concrete conclusions about the relative quality of the models except in very general terms. Having described the concepts of spatial interaction models and shown how it is possible to use these as the base on which to hang rules-based projection it seems certain that dynamic models can potentially be a powerful tool incorporating a great deal of information regarding the economics of school running and the decision-making process of parents. The models can begin to produce reasonably 'realistic'-appearing cityscapes in terms of the equilibrium values, although the quality of the results here, especially in later sections, is hindered by the use of aggregate pupil and attractiveness data. Although there is clearly more work required to refine the models as they currently stand this is an important first step to demonstrate the potential of this kind of activity in the field of school provision.

A further research area worth pursuing is a dynamic approach to 'what if?' modelling. If a school network is to be changed, there is no reason to stop at modelling the changes statically and outlining the way in which a modified network could develop over time would be of enormous informational value to planning officers, headteachers and councillors alike. Thus the 'what if?' approach to model application outlined in chapter seven might be usefully developed by applying a dynamic modelling approach.

It seems certain that education provides an ideal arena in which to apply dynamic models. It is an area where few changes are made in the facilities network, but where changes are both expensive and irreversible. Education authorities, perhaps unlike large retailing companies, cannot afford to locate a school in even slightly the wrong area, and since monitoring of the system is now a major part of an LEA's remit, dynamic models can provide essential developmental information to officers and councillors. The results here show that there is definite potential for the application of a suite of such models given the sorts of data held by education planners and results which can very quickly begin to highlight areas of concern in terms of the under- or over-provision of school places.

Chapter nine

Conclusions

9.1 Introduction

The previous chapters have described an array of problems facing educational planners in Britain and a set of techniques which could be employed to solve them. The most prominent and hardest problems have arisen from the changes in the way that state education is delivered. The shift has taken place from a locally-determined and producer-controlled system where local education authorities have the power to control the flow of pupils in their areas to a market-driven system where LEAs must react to the vagaries of parental choice and accommodate the plans of other agencies. This means that there is now more than ever a pressing need for a powerful set of predictive and analytical tools.

The initial chapters described the development of a legislative system which supports a relatively free market in education, albeit one which is self-regulating to the extent that schools can accept only a finite number of pupils, however popular they may be, which is one important difference between education and a 'standard' retail market. However, it is likely that the current system will remain much the same as it currently is for some considerable time and therefore LEAs must ensure that they are prepared to function efficiently and effectively in such a consumer-led environment. Indeed, with the recent advent of primary school performance 'league tables' (Abrams 1997i, Judd 1997iii; *cf.* chapters two and three on secondary-level PIs) it seems as if the policy of choice based on centrally-published PIs is set to expand rather than contract, at least in the near future. This makes it even more important that planners have access to up-to-date predictive tools to help remain competitive in an ever-strengthening market. Chapter three makes it clear that most LEA planners still operate in much the same way as they did when their remit was more to control and 'force' the system than it has become. Thus there is a great deal of scope for the implementation of the kinds of tools which are outlined in the latter part of the thesis.

The major part of the thesis introduced a wide range of methodologies drawn from analytical and applied geography which are appropriate to the problems outlined. These range from the relatively simple, such as mapping, to the more complex, for instance dynamic interaction modelling, but all can be used to add a great deal to the information base on which educational planning decisions are made. The purpose of this chapter is to summarise the main conclusions drawn during the application of these techniques to the example of Leeds' secondary schools and to suggest possible directions for refinement and further research. To this end the chapter is divided into three main sections dealing with GIS, spatial modelling and the integration and extension of the entire set of tools.

9.2 Geographical information systems: a flawed diamond?

There are many benefits to the implementation of a planning policy based on GIS. Its use can immediately add value to the data stored by LEAs and allow for the much more proactive utilisation of the vast amount of spatially referenced data which is available. It is relatively (depending on the exact specifications of the package in question) easy to use, and the results are returned instantly, usually in the form of maps. This has the advantage of making results simpler to comprehend and to disseminate, an important fact to consider when those making the decisions are not necessarily those with the training to analyse complex data sets. In other words, the use of GIS could help planning officials put their case in a more intelligible manner to parents, teachers and councillors than is possible with charts and tables alone. The importance of geography to the decision-making process should be clear to any reader of this thesis, and thus the fact that GIS usage emphasises the spatial nature of the problems in hand can only be a benefit of the technology.

The benefits of GIS accrue not only to the higher-level authorities. Schools themselves have access to a great deal of spatial data, and the mapping techniques available in GIS can allow them to better understand the dynamics of their catchment areas – where do their pupils come from?, what kinds of children are attracted to the school? and ultimately, where are the areas to target for new pupils? These sorts of questions can be answered quickly and easily by overlay techniques (such as locating individual pupil addresses over maps of census variables) which are available in almost all GIS and certainly through the use of geodemographic software, often at very affordable prices.

Overlay procedures can be used in combination with spatial buffering in order to define drive-time areas around facilities, perhaps to assess the length of the standard journey-to-school (see chapter four). This can also be used to assess the likely sphere of influence of a new school, if it decided that such development is required. However, it is when we consider this more complex analysis that the problems with GIS become apparent. Although GIS can show how many people of a particular group (say under 18s in social classes A and B) live within a set travel time or distance of a facility or proposed facility, it cannot show the impacts of this on other, similar, facilities. In education this is particularly important, since the network of state schools is essentially non-competitive at the level of the LEA. Although individual schools may be in the business of fighting for the 'best' pupils, the LEA's task remains to ensure that there is adequate provision for all pupils across the area. In this sense then it is crucial to know what the likely effect of a change in size or attractiveness of one school will be on the others in the network. As with the example in chapter four, it is possible to see that there would be a large number of pupils within easy reach of the new school site, but what cannot be shown is how many of these pupils are currently well-served by other schools and whether these schools could be adversely affected by the opening of a new school.

Given these problems with GIS, there is, we have seen, a clear case for the introduction of more advanced techniques from applied geography. The most appropriate of these would seem to be the spatial modelling tools developed originally for migration and transport analysis in the 1960s and more recently mainly applied to retail location problems. Since these problems are now mirrored very closely by the problems faced in educational planning (see chapter five), it seems extremely appropriate to analyse the potential such models have for use by LEAs and others.

9.3 Spatial modelling: from data to information

The models as defined in chapter five and calibrated and applied in chapters six to eight prove that there is definitely scope for the wider application of such techniques in education. The benefits have two dimensions; an enhanced ability to examine and understand existing school systems and the development of an ability to approach policy-making in a more proactive, information-supported manner. Not only will planners have an increased ability to track population trends (see 5.2) but they also gain the ability to forecast accurately the rolls at the schools in their area with the added benefit of the development of longer-term planning systems which bring dynamic models into play. Chapter six showed how static spatial interaction models can be used, particularly in the 2-parameter production constrained variant, to produce roll predictions which fulfil the '80:20' rule. These can be tested by planners and other interested parties to find the 'ideal' measure of parental preference in the current market. It is clear from the results in chapter six that the simple measures utilised there are not perfect representations of the attractiveness of schools to parents. It is also clear that the proportion of pupils obtaining five or more GCSEs at grades A* to C is a reasonable proxy for the more complex set of possible measures actually used by parents when they select a school for their children.

Given this state of current research, one of the ideal opportunities for further development work is the development of more complex indicators of parental preference for schools, and the testing of these measures in the model to see if they really can outperform the simple measures tested here. These measures could perhaps begin to test the possibilities of less explicitly quantitative indicators, possibly ultimately incorporating regularly-updated survey data covering the reasons behind why parents of particular 'types' select particular schools for their offspring. Indeed, the potential dataset for this kind of analysis, as chapter three suggests, is enormous. Interaction models allow planners and researchers alike to test as many of these measures as can be generated and check quickly and easily whether they do indeed give accurate representation of school attractiveness. In this single application alone, the ability to vary the W_j measure could potentially be of enormous benefit to local authorities and to schools themselves – if the reasons why a particular school is popular or successful then it is more likely that other schools will be able to follow the same kind of process and thus improve their own success.

This is only one of many possible uses of a properly calibrated spatial interaction model. As chapter seven demonstrates for Leeds secondary schools the predictive capabilities of such models are extremely powerful. Far from the purely descriptive potential of a GIS, a model can tell a user not only how many people would be likely to use a new school, but also from where these children would be drawn and thus allow planners to gauge the impacts on the existing network of schools. In this way models are a much more proactive planning tool than GIS because they can allow planners to vary constantly the parameters in a projected scenario in order to judge the likely impacts of a whole set of possibilities. To stay with the new school example, it would be possible to test the impacts on the network with a school of different attractiveness levels. Thus an LEA can see that if a school is very popular it will have one effect on the city, and if it is unpopular then it will have an entirely different effect. This can allow appropriate contingency measures to be put in place to handle the fall-out from such construction.

However, the building of new schools is not a common activity in British education, and it is far more usual that LEAs and others have to contend with shifting patterns of population and the need for fewer places (certainly in the past two decades) in fewer schools. This is something with which spatial modelling can help and where GIS fails. It is a relatively simple process to plug new data into a model which has been calibrated on a representation of the existing situation and see what the distribution of pupils would be if the origin data (the number of pupils eligible to attend the schools under study) changed. In this way it is possible, as chapter seven showed, to predict the rolls at schools over the course of several years simply by using the predictions of population which come out of other models or from other sources[27]. Equally it is possible to see how a school closure would affect the system and to where the pupils from a school scheduled for closure would be most likely to be redistributed.

---

[27] such as the Office for National Statistics – the body formed in 1996 from the Office for Population Census and Surveys and the Central Statistical Office

The development of dynamic modelling techniques can give planners a further powerful tool in the struggle to provide education where it is needed. Being able to see at a glance how the network may develop given certain fixed parameters (such as population base, attractiveness and likelihood of pupils travelling) can give the long-term provision of school places an enormous boost, and enable planners to spot potential problems or 'weak links' in the educational chain before they develop. This may give LEAs or other agencies the chance to address such problems in a more proactive way rather than relying on a 'quick fix' approach once the system is already under strain. In this way planners can approach the problems of ensuring sufficient places for all pupils in a city with better information and a better ability to 'practice' making decisions and changes before enacting real change, thus potentially saving a great deal of money and minimising the negative impacts of decision making. It is also the case that they could, by using such techniques, approach other agencies (such as parents) with more concrete evidence supporting the case for changes they wish to make. Thus it may be possible to pour oil on the often troubled waters of educational change.

Although spatial modelling has, as we have seen, many benefits, there are also drawbacks to its use. These stem perhaps less from limitations of the basic capabilities and output than from the complexity and comprehensibility of the various model types. First and foremost is the fact that spatial interaction modelling is not a technique which has penetrated into the consciousness of planners in the same way as GIS. GIS provides a simple to understand set of tools which give simple responses (such as '2000 people live within five miles of your school') and present them in a graphical form, usually as a map. SIMs on the other hand are less crude, having a more theoretical basis and producing 'best guess' answers based on the data which they are fed by the user. This is the essential difference between the 'what is' description of GIS and the 'what if' of modelling. The output also has a tendency to be in text format which must be passed into another system in order to be mapped and thus fully understood. In this sense, then, spatial models are not, on their own, as immediate a technology as GIS, although their potential utility is far greater.

Models of the type described here also suffer from the fact that they are often best if specifically tailored to the task in hand. Thus a model appropriate for educational planning may not be suitable for the study of migration patterns. However, this problem is less of a hindrance, since we are talking here about the applicability of models to one kind of system, and once a model has been defined which is appropriate for educational uses then it should be fairly portable to any region or scale. However, it is certainly the case that the definition of attractiveness is likely to be a very local issue, and what attracts parents to schools in one area is unlikely to be identical to that which attracts them in another. Indeed, it is possible to reduce this argument to the statement that what attracts parents to one individual school is not necessarily that which attracts parents to a different, equally popular, school in the same area. Thus there is, as we have seen and will see in the next section, scope for a great deal of refinement in terms of the definition of appropriate W_js for educational modelling.

9.4 Integration and the future: new directions for research

This thesis has shown that there is enormous potential for the application of the various geographical techniques discussed within the field of educational planning. This is particularly the case in the years since the development of an education system based around the idea of a free market (although as chapter two showed, the market cannot be said to be entirely 'free', based as it is on preference rather than out-and-out choice). However, these demonstrations of the techniques available go only as far as is possible within the scope of a single thesis. This means that there is a great deal of potential for further research, particularly into the refinement of the models described here. The potential of GIS is unlikely, it would seem, to increase beyond the point described here, although there is scope for more research into how it can be easily, quickly and cheaply integrated into the day-to-day activities of schools planning departments. This is of course not to dismiss GIS as a decision-support tool. It can be phenomenally powerful when used in conjunction with the data resources available to educationalists, although as the discussions in chapter four and above suggest, it does not go as far as might be hoped in the solution of the particular planning problems faced in schools provision.

With regard to spatial modelling, the possible avenues for further research can be divided into two broad areas; testing model variants and increasing the data available to the model and thus hopefully the accuracy of the predictions. The first of these would most profitably involve the more exhaustive testing of the models described here and the universe of parameter values available to them. As has already been discussed in this chapter, improvement of the attractiveness measures (W_j) could enhance the performance of the model, but it is also possible that further 'tweaking' of the α and β parameters could affect the performance advantageously. It should also be high on the list of priorities to consider the potential of other model refinements discussed in chapter five. In particular, the use of hybrid models (see section 5.3.2.6) would allow planners to constrain the predicted school rolls to certain value ranges. Thus no school could be projected to have a roll greater than its physical capacity (although that would need to be properly defined, since it is perfectly possible for schools to a certain extent to 'buy in' extra capacity in the form of portable classrooms), and the model predictions for D_j values would necessarily be more accurate, although this is not to say that such changes would necessarily improve the flow predictions as well. It is possible that the development of hybrid models based on the competing destinations framework could provide a valuable source of alternative data to the relatively simple production constrained models presented here.

With regard to the utilisation of additional data in the model, the main thrust of this would be to increase the level of disaggregation used and thus move towards a more accurate representation of reality within the model. The first step in this direction might be to include data for all school types rather than treating the LEA school system as closed. This would involve gathering flow and pupil data for grant maintained schools and independent schools, data not normally available to an LEA, but potentially available to more central bodies such as the DfEE. It would also be important to include some measure of the likelihood of pupils resident in the area of study travelling outside the boundaries of that area, for instance from Leeds to schools in Harrogate, Bradford or Wakefield, and equally the chances of Leeds schools attracting pupils in from other authority areas. At the same time it would be more accurate if the model were to be broken down into several sections, one for each level of the education system. For example, in the data given here all schools which offer education from ages eleven to eighteen are considered as a single unit, although in reality this incorporates at least two choices for parents and pupils – the move from primary education into secondary at eleven and the move from secondary into sixth form at sixteen or seventeen. This division would clearly entail the definition of two separate sets of attractiveness measures, since the reasons for selection of a sixth form will undoubtedly differ markedly from the selection procedures at eleven. This would also mean that the model would have to include the sixth form colleges and colleges of further education in the area as well as the schools themselves.

The further disaggregation of pupils into a variety of 'types' would also no doubt aid the model's accuracy. The examples here have used a simple three-way split of pupils based on 1991 census data for the entire population of the area. Thus the split, although broadly representative, cannot be said to be as accurate as might be hoped. It is possible that planners could subdivide the populations along the lines of more sophisticated geodemographic systems which include more groupings, or even base the division along 'real' choice-making boundaries, perhaps defined by surveys with parents, teachers and pupils. Each pupil type could then be allocated its own parameter value, origin-specific α and β values, meaning that pupils of varying types are more or less likely to accord distance and attractiveness importance in their decision-making process. It would equally be possible to add destination-specific parameter values, making individual schools more likely to pull pupils from longer or shorter distances, and affecting the relative value of their attractiveness.

Clearly all these changes will mean that the model begins to approach a representation of the 'real' situation which exists in British education. However, it will also be clear that such changes would make the models much more complex than they have been to date, and thus make comprehension and application more difficult. The more parameters and variables included in a model, the greater the chance for errors thrown up by inaccurate data or mis-specified parameters, and the longer it would take for the output to be fully understood by the end user. It is of course possible to produce a program which simply asks for certain data at a certain spatial scale and then produces a single grid of projected total pupil flows. In this sense the increased complexity of the model poses no problems to planners, but it is also important in the context within which most education provision decisions are made to be able to explain why the choices which have been made have been made. To this end it is important to strike the right balance between model accuracy (which should of course be paramount) and the ability to explain what is going on to non-expert users and viewers.

It is not only static models of chapters six and seven which could benefit from such disaggregation. The dynamic models described in chapter eight are also based on a similar model and could thus be improved by the same techniques. Indeed, as chapter six showed, the relatively simple act of disaggregating the origin data into three bands caused a noticeable improvement in model output and the models on which the dynamic projections are based use aggregate origin data. Thus they have, in a sense, taken a step 'backwards' from the models already specified in the earlier chapters. Therefore the primary task of future research in dynamic modelling should be first to work with disaggregate data and then to try some of the other changes suggested above for static models.

It is also clear that there are two other avenues which need to be tested if this research is to be of lasting use to schools planners. The first would be to test the models calibrated here on data for other local authorities and test whether there are universal measures for school attractiveness and willingness to travel. This would also give the opportunity to spread awareness of the existence of these techniques beyond the relatively limited confines of Leeds LEA. Also in order to prepare the techniques described for a wider audience and more directly practical application on a regular basis is work to improve the interface between data and end user. A great deal has been written on the potential for spatial decision support systems or 'SDSS' rather than using these two technologies (GIS and spatial modelling) in isolation from one another (see chapters one, five and six and Densham 1991, Birkin *et al.* 1996) and this would seem to be an ideal application for such systems. The potential market for a working SDSS in education is huge, and if the technologies of GIS and spatial modelling were married in one easy-to-use package with good display facilities and clear directions then the usefulness would increase by being attractive to the potential end user. It seems unlikely that the technology will be accepted in the educational world unless it can be adopted with the minimum of disruption to regular normal practice and unless it can be seen to be of immediate practical benefit to the officers who will have to use it and who cannot afford long periods of complex re-skilling.

There are other, more policy-centred questions which can be addressed using the research here as a base. These cover a range of policy areas but are all central either to the work of planners, policy-makers, schools themselves or some combination of the three. The first question would address the limits to and implications of school growth and decline in Britain's cities. This question highlights the need to examine further what the potential 'end state' of school networks could be – would or will schools really close because of competitive pressure? How far should popular schools be allowed to develop their capacity and how big could such schools get before their size begins to negatively affect their attractiveness?

Following on from this is a study of the methods adopted by popular schools in terms of selection. Chapters two and three have shown that the legislation is beginning to exist in order to allow schools to select and that some schools are indeed introducing selection by ability alongside the more traditional factors of home proximity to school and siblings already attending. This can be extended to a more general consideration of such selectivity in some schools and the effects on the provision of education generally in the city. Is it, for example, likely to lead to the scenario of social segregation portrayed in chapter three? These concerns regarding the continuing provision of equitable education in British cities are very real, with the possibility of middle class parents using their greater knowledge and access to resources to withdraw to the middle-class 'heartland' of the better-performing suburban schools, leaving a residual inner city population with more limited access to information and transportation constrained to accept places in 'sink' schools. Ball *et al.* (1994) in London and Clarke and Langley (1996) and this thesis in Leeds have certainly begun to show that this process is already one entrenched in the life of British schools. There is unequivocal evidence that outer schools with higher examination results are more heavily subscribed than central schools with lower examination results.

Given this situation with regard to market dynamics and these concerns, the time seems ripe to develop the performance indicator research discussed at various points here in order to inform research into the future of financial resourcing of schools. Since, as chapter three discusses, each school and local authority is now funded through the medium of a formula which usually includes some measure of the socio-economic status of a school or region (*i.e.* there tend to be additional funds available for less advantaged areas or schools) then it is clear that this gives enormous potential for LEAs to try and redress some of the imbalances created by a market system. Although most of the financial resources devolved to schools follow the pupils there is leeway to allow other resources to be allocated according to other criteria. Perhaps it would also be possible for local planners to provide additional support to school management teams in terms of marketing or other specialist services. In this way the most negative or inequitable aspects of the market may begin to be addressed.

On similar lines, also with regard to the development of performance measures for schools which could ultimately supersede the publication of raw examination results would be the development of more widespread (and more widely accepted) 'softer' indicators of school performance which reflect the relative socio-economic composition of schools amongst other factors. Chapter three has highlighted a wide range of such measures and the modelling chapters have shown how this could be used by planners to perform 'what if?' projections and define exactly what it is that makes a school attractive. However, there is also an argument for such indicators to be made more widely available to parents in place of (or alongside) the measures currently published. If they could be made sufficiently simple to understand (and there is evidence that the current 'league tables' have not made as much impact as might have at first been thought – Judd 1997ii, Ward 1997iii) and new tables are statistically and ethically acceptable then it might be that this new information could be used to shift the market centres away from the traditional core of high-performing (usually) suburban schools.

It is important to note that the techniques described are not without their drawbacks. These come in two general areas, technical and human. On the technical side there are a variety of potential problems. LEAs and other bodies often store data in a range of locations, making the production of unified systems complicated and time-consuming, not least because of the range of people and bureaucracy which is involved in data-sharing at any level. It is also the case that often one section is unaware of what is stored by others, leading to data duplication and further confusion. Lack of software is a further hurdle. Although GIS exists in most local authorities it is often not available to LEAs except through other departments. There is thus the cost of purchasing appropriate mapping software to execute even the simplest techniques outlined here. Spatial modelling software needs in most cases to be custom-written, a lengthy and expensive operation, and as has already been noted, the output can be confusing to the untrained eye. Therefore it is important that any software written be linked in to mapping facilities, adding to the expense and complexity. On the human side there are again several issues. The introduction of new technology requires reskilling and training on the part of the officers who are to use the software. Apart from the simple training required to make the programs work, with spatial modelling in particular there is a need to ensure that people understand what is being outputted. It would be very easy for officers to fall into the trap of believing model output to be 100% accurate predictions of future trends, and it always has to be stressed that such output is simply a 'best guess' based on certain rules and the data which are input. LEA and other planners are in the main extremely busy professionals with much enthusiasm for new techniques and technology but very little time to learn how to utilise and understand such developments. Any introduction of the tools described in this thesis thus needs to be carried out with extreme caution and cannot be limited to a simple software product.

However, bearing in mind these caveats, the time is clearly ripe for further development of the tools outlined in this thesis. This work functions as a definition of the problems in educational planning and a feasibility study for the application of a variety of geographical techniques. There is a real requirement for policy makers and academics to take this work forward in partnership, partly to ensure the maximum degree of data and skills sharing, and partly in order to make any final product (in terms of properly integrated SDSS) user-friendly and incorporated into planning bodies who are geared up to accept such new technology. It is vital to remember that what is being offered here is not a decision-making tool *per se* but a set of decision-support facilities which can underpin the decision-making which already takes place at the Funding Agency for Schools, the DfEE, LEAs and schools. All levels of the educational establishment could benefit enormously from the implementation of techniques such as these presented here and there is a strong case for their use from the viewpoint of social equity and the fair distribution of educational resources. It is critical that this initial study be extended to include the primary schools which ultimately feed into the secondary sector and also that it expand to incorporate all schools, whether in the state-provided or independent sectors. Only when GIS and spatial models have a full dataset with which to operate will the real benefits of the techniques be seen by planners. As it is, the results presented here prove beyond a shadow of a doubt that these are important and exciting times for educational planning and education provision into the next century will require that use be made of the powerful predictive capabilities which are offered by these geographical tools. Only then will local and national planners have the information they require to make sound long-term decisions regarding the future for the education of British children.

Bibliography

Abrams, F. (1993iv); "Truancy league tables scorned" *The Independent* 12th November, p8

Abrams, F. (1995); "Independent Catholic schools set to 'opt in'" *The Independent* 6th July, p8

Abrams, F. (1995vi); "Truants given 'study leave'" *The Independent* 12th April, p10

Abrams, F. (1996v); "Pupils dumped in exam race" *The Independent* 21st August, p1

Abrams, F. (1996vi); "Weaker pupils sacrificed in grades chase" *The Independent* 22nd August, p2

Abrams, F. (1997i); "Tories scorn Major's nursery revolution" *The Independent* 13th March, p1

Abrams, F. and Judd, J. (1993); "Heads say figures for truancy do not add up" *The Independent* 17th November, p6

Adler, M. (1993); "Parental choice and the enhancement of children's interests" **in** Munn, P. (Ed.) "Parents and schools" (Routledge, London)

Adler, M., Petch, A. and Tweedie, J. (1989); "Parental choice and education policy" (Edinburgh University Press, Edinburgh)

Allinson, J. (1993); "The breaking of the Third Wave: the demise of GIS" *Planning Practice and Research* 8(2), pp30-33

Antenucci, J.C., Brown, K., Croswell, P.L., Kevany, M.J. and Archer, H. (1991); "Geographic information systems: a guide to the technology" (Van Nostrand Reinhold)

Appalraju, J. (1979); "Educational facilities planning spatial inter-relations" (UNESCO Division of Educational Policy and Planning, Paris: reports studies S.57)

Armytage, W.H.G. (1970); "Four hundred years of English education" (second edition: Cambridge University Press, Cambridge)

Audit Commission (1988); "Surplus capacity in secondary schools: a progress report" (HMSO, London)

Ball, D. and Babbage, R. (Eds.: 1989); "Geographical information systems: defence applications" (Pergamon Press, London)

Ball, S.J., Bowe, R. and Gewirtz, S. (1994); "Market forces and parental choice: self-interest and competitive advantage in education" **in** Tomlinson, S. (Ed.); "Educational reform and its consequences" (IPPR/Rivers Oram Press, London)

Ball, S.J., Bowe, R. and Gewirtz, S. (1995); "School choice, social class and distinction: the realization of social advantage in education" *Journal of Educational Policy* vol.11 no.1, pp89-112

Barber, M. (1994); "Table manners" *Guardian Education* 3rd May, p4

Barker, B. (1995ii); "Labour is locked into league tables" *The Times Educational Supplement* 5th May, p14

Barnes, C. (1993); "Practical marketing for schools" (Blackwell, Oxford)

Batty, M. (1976); "Urban modelling: algorithms, calibrations, predictions" (CUP, Cambridge)

Bellin, W., Farrell, S., Higgs, G. and White, S. (1996); "A strategy for using census information in comparison of school performance" *The Welsh Journal of Education* vol.5(2), pp3-25

Bennett, G. (1994); "The truth behind the tables..." *The Times Educational Supplement* Section II 9th December, p2

Bertuglia, C.S., Clarke, G.P. and Wilson, A.G. (1994; Eds.); "Modelling the city: performance, policy and planning" (Routledge, London)

Birkin, M, Clarke, G.P., Clarke, M. and Wilson, A.G. (1996); "Intelligent GIS" (GeoInformation International, Cambridge)

Board of Education (1927); "The education of the adolescent: report of the Consultative Committee [known as 'The Hadow Report']" (HMSO, London)

Board of Education (1931); "Report of the Consultative Committee on the primary school [also known as 'The Hadow Report']" (HMSO, London)

Board of Education (1938); "Report of the Consultative Committee on secondary education with special reference to grammar schools and technical high schools [known as 'The Spens Report']" (HMSO, London)

Board of Education (1943); "Curriculum and examinations in secondary schools: report of the Secondary School Examinations Council [known as 'The Norwood Report']" (HMSO, London)

Bolster, N. (1994); "Desperate for the right address" *The Times Educational Supplement* 23rd September, p6

Bondi, L. (1989); "Selecting schools for closure: theory and practice in 'rational' planning" *Journal of Education Policy* vol.4 no.2, pp85-102

Bondi, L. and Matthews, M.H. (Eds.: 1988); "Education and society: studies in the politics, sociology and geography of education" (Routledge, London)

Boseley, S. (1995); "Early learning" *Guardian Education* 23rd May, pp2-3

Bowe, R. and Ball, S.J. with Gold, A. (1992); "Reforming education and changing schools: case studies in policy sociology" (Routledge, London and New York)

Bradford, M.G. (1991); "School performance indicators, the local residential environment and parental choice" *Environment and Planning A* vol.23, pp319-32

Bradford, M.G. (1994); "Diversification and division in the English education system: towards a post-Fordist model?" SPA Working Paper 29, School of Geography, University of Manchester

Bradford, M.G., Robson, B.T. and Tye, R. (1995); "Constructing an urban deprivation index: a way of meeting the need for flexibility" *Environment and Planning A* vol.27, pp519-33

Brighouse, T. (1994); "Magicians of the inner city" *The Times Educational Supplement* Section II, 22nd April, pp2-3 [abridged text of 1994 TES Greenwich lecture]

Bromley, R. and Coulson, M. (1989); "The value of corporate GIS to local authorities" *Mapping Awareness* vol.3 no.5, pp32-5

Brown, P.J.B. (1987); "Trade-off and compromise in secondary school reorganisation schemes: a goal programming approach" *Papers of the Regional Science Association* vol.61, pp115-130

Brown, P.J.B. (1991); "Exploring geodemographics" **in** Masser, I. and Blakemore, M. (Eds.); "Handling geographic information" (Longman, Harlow)

Brown, S. (1994); "School effectiveness research and the evaluation of schools" *Evaluation and Research in Education* vol.8 nos.1&2, pp55-68

Budge, D. (1995v); "A secretive partner who demands too much" *The Times Educational Supplement* 24th March, p14

Budge, D. (1996ii); "Primary tables go ahead despite protests" *The Times Educational Supplement* 3rd May, p6

Burstall, E. (1995iii); "Plea for value added in league tables" *The Times Educational Supplement* 10th November, p6

Butler, R.A. (Lord) (1971); "The art of the possible" (Hamish Hamilton, London)

Buxton, R. (1989); "Integrated spatial information systems in local Government – is there a financial justification?" *Mapping Awareness* vol.2 no.6, pp14-16

Campbell, H. (1994); "How effective are GIS in practice? A case study of British local Government" *International Journal of GIS* vol.8 no.3, pp309-26

Castle, G. (1993); "Profiting from a GIS" (GIS World, Fort Collins, USA)

Charlton, M., Openshaw, S. and Wymer, C. (1985); "Some new classifications of census enumeration districts in Britain: a poor man's ACORN" *Journal of Economic and Social Measurement* vol.13, pp69-96

Clarke, G.P. (1986); "Retail centre usage and structure: empirical and theoretical explorations" (unpublished PhD thesis, School of Geography, University of Leeds)

Clarke, G.P. and Langley, R.J. (1994); "The potential for GIS and SDSS for planning in education" Paper presented at GIS and Public Policy conference, University of Ulster, 24th-27th May 1994. Copies from the authors at School of Geography, University of Leeds, Leeds LS2 9JT

Clarke, G.P. and Langley, R.J. (1995); "The potential of GIS and spatial modelling for planning in the new education market" Working Paper 95/10, School of Geography, University of Leeds, Leeds LS2 9JT

Clarke, G.P. and Langley, R.J. (1996); "A review of the potential of GIS and spatial modelling for planning in the new education market" *Environment and Planning C* vol.14, pp301-23

Clarke, G.P. and Wilson, A.G. (1994ii); "A new geography of performance indicators for urban planning" **in** Bertuglia, C.S., Clarke, G.P. and Wilson, A.G. (Eds.: 1994); "Modelling the city: performance, policy and planning" (Routledge, London)

Clarke, G.P., Hall, R., Winnett, C. and Wilson, A.G. (1997); "New indicators for territorial competition between and within urban areas" (Working Paper, School of Geography, University of Leeds)

Clarke, M. and Wilson, A.G. (1985); "The dynamics of urban spatial structure: the progress of a research programme" *Transactions of the Institute of British Geographers*, vol.10(4), pp427-51

Corbett, A. (1994); "A measurement of how the lycées fare" *The Times Educational Supplement* 9th December, p11

Council for Scientific Policy (1968); "Enquiry into the flow of candidates in science and technology into higher education [known as 'The Dainton Report']" (HMSO, London)

Craig, T. (1994); "Voting for local democracy" and "For council read quango" *Guardian Education* 3rd May, pp10-11

Crookes, J. (1994); "Comparative GCSE and A/AS level table for Leicestershire Schools and Colleges" correspondence with headmasters, Leicestershire Upper schools, 31st October (unpublished, Leicestershire County Council education Department, Advice and Inspection Unit)

Dale, R. (1989); "The state and education policy" (Open University Press, Milton Keynes)

Davies, B. and Ellison, L. (1991); "Marketing the secondary school" (Longman, Harlow)

Dean, C. (1994); "Patten hints at end of opt-out vote" *The Times Educational Supplement* 22nd April, p6

Dean, C. (1995i); "Parents' opt-out vote at risk" *The Times Educational Supplement* 27th October, p1

Dean, C. (1995ii); "GM quango eager to build schools" *The Times Educational Supplement* 1st December, p9

Densham, P.J. (1991); "Spatial decision support systems" **in** Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (Eds.); "Geographical information systems: principles and applications" (vol. 1: Longman, London)

Densham, P.J. and Rushton, G. (1988); "Decision support systems for local planning" **in** Gollege, R. and Timmermans, H. (Eds.); "Behavioural modelling in geography and planning" (Croom Helm, London)

Department for Education (1992i); "Choice and diversity: a new framework for schools" (HMSO, London)

Department for Education (1992ii); "The implementation of Local Management of Schools: a report by H.M. Inspectorate 1989-92" (HMSO, London)

Department for Education (1994); "Final report on the Natonal Curriculum and its assessment; the Government's response" (DfE, London)

Department for Education (1995i); "Value added in education" (DfE, London)

Department for Education (1995ii); "GCSE to GCE A/AS value added: briefing for schools and colleges" (DfE, London)

Department for Education and Employment (1996ii); "Shephard rewards Grant Maintained schools for excellence in sports and community work" (DfEE press release 100/96, 25th March)

Department for Education and Employment (1996xi); "Self-Government for schools [White Paper]" (HMSO, London)

Department of Education and Science (1967); "Children and their primary schools [known as 'The Plowden Report']" (HMSO, London)

Department of the Environment (1994); "Index of Local Conditions: an analysis based on 1991 census data" (DoE, London)

Devlin, T. and Knight, B.A. (1990); "Public relations and marketing for schools" (Longman, Harlow)

Ding, Y. and Fotheringham, A.S. (1992); The integration of spatial analysis and GIS" *Computers, Environment and Urban Systems* vol.16, pp3-19

Doe, B. (1995); "They also can achieve who live in the lower ranks" *The Times Educational Supplement* Section II, 27th October, p6

Duncan, C., Jones, K. and Moon, G. (1996); "Health-related behaviour in context: a multilevel modelling approach" *Social science and medicine* vol.42 no.6, pp817-30

Education (1994); "Ofsted backs input-output exam study" *Education* 23rd September, p228

Education Act 1944 (HMSO, London)

Education Reform Act 1988 (HMSO, London)

ESRI (1992); "ARC/INFO version 6.1 user's guide: Network Analysis, modeling network systems" (reprinted at Manchester Computer Centre as CST805: MCC, Manchester)

Evans, I.G. (1995); "Marketing for schools" (Cassell, London)

Farnsworth, S., Everett, S. and Jesson, D. (1994); "Beyond league tables: a value-added analysis of GCSE and A level perfromance in Nottinghamshire in 1993" (Nottingham County Council Education Department, Nottingham, England)

Fitz-Gibbon, C. (1994); "Three routes to the wrong answer" *The Times Educational Supplement* 9th December, p11

Ford, N. (1995); "The best-laid plans..." *Mapping Awareness* March, pp34-7

Fotheringham, A.S. (1983); "A new set of spatial-interaction models: the theory of competing destinations" *Environment and Planning A* vol.15, pp15-36

Fotheringham, A.S. and Rogerson, P. (Eds.: 1994); "Spatial analysis and GIS" (Taylor and Francis, London)

Garner, C. (1988); "Educational attainment in Glasgow: the role of neigbourhood deprivation" **in** Bondi, L. and Matthews, M.H. (Eds.); "Education and society: studies in the politics, sociology and geography of education" (Routledge, Chapman and Hall, London)

Garner, C. and Raudenbush, S.W. (1989); "Neighbourhood effects on educational attainment: a multilevel analysis" (Centre of Educational Sociology, University of Edinburgh, Edinburgh)

Garner, R. (1994); "'Failures' top of the class" *The Daily Mirror* 16th March, p6

Gaunt, H. (1991); "Could do better: creating a marketing strategy for your school" (Horton, Bradford)

GMAP (1996) Annual report and accounts 1996 (GMAP Ltd., Cromer Terrace, Leeds)

Goldstein, H. (1987); "Multilevel models in educational and social research" (Charles Griffin and Co., London)

Goodall, B. (1987); "The Penguin dictionary of human geography" (Penguin, Harmondsworth)

Goodchild, M.F. (1987); "A spatial analytical perspective on geographcial information systems" *Intenational Journal of GIS* vol.1 no.4, pp327-34

Goodchild, M.F., Haining, R. and Wise, S. (1992); "Integrating GIS and spatial data analysis" *Intenational Journal of GIS* vol.6, pp407-23

Goodwin, M. (1992); "The changing local state" **in** Cloke, P. (Ed.) "Policy and change in Thatcher's Britain" (Pergamon Press, Oxford)

Goodwin, S. (1995); "Party rejects call to abolish grant-maintained schools" *The Independent* 5th October, p10

Gordon, I. (1996); "Family structure, educational achievement and the inner city" *Urban Studies* vol.33 no.3, pp407-23

Gordon, P., Aldritch, R. and Dean, D. (1991); "Education and policy in England in the twentieth century" (The Woburn Press, London)

Gosden, P.H.J.H. (1976); "Education in the second world war: a study in policy and administration" (Methuen, London)

Gray, J. (1994); "Relative values" *The Times Educational Supplement* 16th December, p15

Gray, J. and Wilcox, B. (1994); "Performance indicators: flourish or perish? " **in** Riley, K.A. and Nuttall, D.L. (Eds.); "Measuring quality: education indicators – United Kingdom and international perspectives" (The Falmer Press, London)

Griggs, C. (1983); "The Trades Union Congress and the struggle for education 1868-1925" (The Falmer Press, Lewes)

Grimshaw, D. (1994); "Bringing GIS into business" (Longman, Harlow)

Hackett, G. (1995); "Churches oppose speedier opt-out" *The Times Educational Supplement* 3rd November, p3

Hackett, G. (1995xx); "Inner-city pupils fall behind" *The Times Educational Supplement* 15th December, p1

Hackett, G. (1995xxi); "A flawed spur to improve" *The Times Educational Supplement* 15th December, p12

Hargreaves, D. (1990); "Making schools more effective: the challenge to policy practice and research" *Scottish Educational Review* vol.22 no.1, pp5-14

Harris, B. and Wilson, A.G. (1978); "Equilibrium values and dynamics of attractiveness terms in production-constrained spatial-interaction models" *Environment and Planning A* vol.10, pp371-88

Haylock, D. (1994); "The fruits of multiplying value" *The Times Educational Supplement* Section II 2nd December, p2

Haynes, K.E. and Fotheringham, A.S. (1984); "Gravity and spatial interaction models (vol.2): scientific geography series" (Sage, Beverly Hills, Ca.)

Higgs, G., Bellin, W., Farrell, S. and White, S. (forthcoming); "Educational attainment and social disadvantage: contextualising school league tables" *Regional Studies*

Higgs, G., Webster, C.J. and White, S.D. (forthcoming); "The use of geographical information systems in assessing spatial and socio-economic impacts of parental choice" *Research Papers in Education*

Hirsch, D. (1995); "School choice and the search for an educational market" *International Review of Education* vol.41 nos.3&4, pp239-57

Hirschfield, A., Brown, P.J. and Marsden, J. (1991); "Database development for decision support and policy evaluation" **in** Worrall, L. (Ed.); "Spatial analysis and spatial policy using geographic information systems" (Belhaven Press, London)

Hirschfield, A., Brown, P.J. and Bundred, P. (1993); "Doctors, patients and GIS: a spatial analysis of primary health care provision on the Wirral" *Mapping Awareness* vol.7 no.9, pp9-12

Hofkins, D. (1995i); "Deprivation is the common factor" *The Times Educational Supplement* 10th February, p14

House of Commons (1970); "Report on teacher training: a report of the House of Commons Select Committee on Education and Science" (House of Commons, London)

House of Commons (1976); "Policy making in the DES: 10th report from the Expenditure Committee, Session 1975-6 [known as 'The Fookes Report']" (House of Commons, London)

Ireland, P. (1995); "Making the grade in Lothian" *Mapping Awareness* April, pp24-7

Irwin, S. and Wilson, A.G. (1985a); "Modelling school systems – a framework for planning for falling rolls" Working Paper 412, School of Geography, University of Leeds

Jenkins, J. and Walker, J.R. (1985); "School roll forecasting" **in** England, J.R. (Ed.); "Information systems for policy planning in local Government" (Longman, Harlow)

Johnston, R.J. (1991); "Geography and geographers: Anglo-American human geography since 1945" (4th edition: Edward Arnold, London)

Jones, K. and Bullen, N. (1993); "A multilevel analysis of the variations in domestic property prices: southern England 1980-87" *Urban Studies* vol.30 no.8, pp1409-26

Jones, K. and Duncan, C. (1994); "People and places: the multilevel model as a general framework for the quantitative analysis of geographical data" paper presented at 'Spatial modelling and GIS' workshop, Bristol (England), June 1994

Joseph, C. (1994); "Showpiece city college 'is failing its pupils'" *The Independent* 15th February, p5

Jowett, P. and Rothwell, M. (1988); "Performance indicators in the public sector" (Macmillan, Basingstoke)

Judd, J. (1994); "Patten 'hedges' on compulsory opting out call" *The Independent* 20th April, p6

Judd, J. (1994iv); "Selling out on ideals to attract a better class" *The Independent* 29th January, p33

Judd, J. (1995); "Church protest delays opt-out plans" *The Independent* 16th November, p6

Judd, J. (1995xix); "Curriculum 'stifles schools'" *The Independent* 25th September, p7

Judd, J. (1995xvii); "Middle classes get wise over schools" *The Independent* 18th September, p7

Judd, J. (1996vi); "Schools 'cull A-level hopefuls to keep league table position'" *The Independent* 30th September, p5

Judd, J. (1997ii); "League tables lost on half of parents" *The Independent* 13th February, p9

Judd, J. (1997iii); "Poor marking flaws primary tests, says study" *The Independent* 6th March, p4

Judd, J. (1997v); "The parents who cheat for their children" *The Independent* 17th April, p6

Langley, R. (1995); "The use of GIS and spatial modelling for educational planning" Proceedings of the Joint European Conference on Geographical Information, The Hague, Netherlands, March 26th-31st, vol.1 pp547-52

Lawrence, I. (1992); "Power and politics at the Department of Education and Science" (Cassell, London and New York)

Lawson, D. (1993); "Housebuyers drawn into schools' magnetic field" *The Independent* 27th November, p48

LCC (1995); Minutes of the Quality Assurance Sub-Committee of the Education Department, held Civic Hall, Leeds on 27th June (Leeds City Council, Leeds)

Lee, T. (1991); "Additional Educational Needs and LMS: methods and money 1991-2" (unpublished report: Centre for the Analysis of Public Policy, Bath)

Leeds Education (1994); letter to parents and consultation document "The future of high schools in the east area of Leeds (Leeds City Council, Education Department, Merrion Centre, Leeds LS2 8DT)

Leeds Education (1995); letter to parents and consultation document "The future of the Benjamin Gott high school" (Leeds City Council, Education Department, Merrion Centre, Leeds LS2 8DT)

Leeds Schools Commission (1993); "The new partnership: quality, governance, choice and resources (second and final report)" (Leeds Schools Commission)

Lepkowska, D. (1995iv); "Shephard approves massive overhaul" The Times Educational Supplement 30th June, p3

Longley, P. and Clarke, G.P. (Eds.: 1995); "GIS for business and service planning" (Geoinformation International, Cambridge)

MacLeod, D. (1991); "A truer way to chart progress" *The Independent* 10th October, p17

MacLeod, D. (1996); "'Harman factor' fear as schools seek selection" *The Guardian* 2nd September, p2

Maclure, S. (1986); "Educational documents: England and Wales 1816 to the present day" (5th edition: Methuen, London and New York)

Maclure, S. (1992); "Education re-formed: a guide to the Education Reform Act" (3rd edition: Hodder and Stoughton, London)

Maguire, D.J. (1991); "An overview and definition of GIS" **in** Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (Eds.); "Geographical information systems: principles and applications: volume 1, principles" (Longman, Harlow)

Maguire, D.J. (1995); "Geographical analysis and proprietary GIS: state-of-the-art functionality" **in** Longley, P. and Clarke, G.P. (Eds.); "GIS for business and service planning" (GeoInformation International, Cambridge)

Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (Eds.: 1991i); "Geographical information systems: principles and applications: volume 1, principles" (Longman, Harlow)

Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (Eds.: 1991ii); "Geographical information systems: principles and applications: volume 2, applications" (Longman, Harlow)

Matthews, M.H., Airey, A. and Tacon, L. (1988); "Catchments, schools and the characteristics of teachers" **in** Bondi, L. and Matthews, M.H. (Eds.); "Education and society: studies in the politics, sociology and geography of education" (Routledge, London)

Michell, R.J. (forthcoming); "Mathematical models for the spatial interaction and dynamics of consumer populations" (unpublished PhD thesis, School of Mathematics, University of Leeds)

Middleton, N. and Weitzman, S. (1976); "A place for everyone: a history of state education from the end of the eighteenth century to the 1970s" (Victor Gollancz, London)

Ministry of Education (1954); "Early leaving: a report of the Central Advisory Council for Education (England) [known as 'The Gurney-Dixon Report']" (HMSO, London)

Ministry of Education (1959); "15 to 18: a report of the Central Advisory Council for Education, vols. I and II [known as 'The Crowther Report']" (HMSO, London)

Ministry of Education (1960); "Secondary school examinations other than GCE: a report of the Secondary Schools Examination Council [known as 'The Beloe Report'] (HMSO, London)

Ministry of Education (1963); "Half our future: a report of the Minister of Education's Central Advisory Council [known as 'The Newsom Report'] (HMSO, London)

Morris, R. (Ed.: 1990); "Central and local control of education after the Education Reform Act 1988" (Longman, Harlow and British Education Management and Administration Society, London)

Morris, R., Reid, E. and Fowler, J. (1993); "Education Act 93: a critical guide" (Association of Metropolitan Authorities, London)

Mortimore, J. and Blackstone, T. (1983); "Disadvantage and education" (Heinemann, London)

Moulden, M. and Bradford, M.G. (1984); "Influences on educational attainment: the importance of the local residential environment" *Environment and Planning A* vol.16(1), pp49-66

Murphy, R. (1995); "Social class and the birth rate influence exam grades" *The Independent* section II, 31st August, pp14-15

National Commission on Education (1993); "Learning to succeed: a radical look at education today and a strategy for the future, the report of the Paul Hamlyn Foundation National Commission on Education" (Heinemann, London)

Newell, C. (1988); "Methods and models in demography" (Belhaven Press, London)

O'Connor, M. (1996i); "Look to the needs of the individual" *The Times Educational Supplement* 16th February, p17

O'Leary, J. (1993i); "Protests dog school league tables" *The Times* 17th November, p1-2

Openshaw, S. (1991); "A view on the GIS crisis in geography, or using GIS to put Humpty Dumpty together again" *Environment and Planning A* vol.23, pp621-8

Pardey, D. (1991); "Marketing for schools" (Kogn Page, London)

Passmore, B. (1994iii); "Researchers let loose on value added" *The Times Educational Supplement* 13th May, p8

Passmore, B. (1994iv); "Indexing improvement" *The Times Educational Supplement* 2nd December, p10

Paterson, L. (1991); "An introduction to multilevel modelling" **in** Raudenbush, S.W. and Willms, J.D. (Eds.); "Schools, classrooms and pupils: international studies of schooling from a multilevel perspective" (Academic Press, San Diego and London)

Peel, R. (1995); "Fast track to GIS – PC-based systems in local Government" *Mapping Awareness* March, pp30-3

Petch, A. (1988); "Rezoning: an exercise in compromise" **in** Bondi, L. and Matthews, M.H. (Eds.); "Education and society: studies in the politics, sociology and geography of education" (Routledge, London)

Pooler, J. (1994); "An extended family of spatial interaction models" *Progress in Human Geography* vol.18 no.1, pp17-39

Pryke, R. (1993); "Opting into irrelevance" *The Times Educational Supplement* 1st October, pp12-13

Pyke, N. (1996); "Americans warned off UK reforms" *The Times Educational Supplement* 26th April, p4

Rees, G. and Rees, P.H. (1991); "A ward population information system for Swansea City Council" (GMAP Ltd., Leeds)

Rees, P.H. and Wilson, A.G. (1977); "Spatial population analysis" (Edward Arnold, London)

Rhind, D.W. (1981); "GIS in Britain" in Wrigley, N. and Bennett, R.J. (Eds.); "Quantitative geography: a British view" (Routledge, London)

Riley, K.A. and Nuttall, D.L. (1994); "Measuring performance – national contexts and local realities" in Riley, K.A. and Nuttall, D.L. (Eds.); "Measuring quality: education indicators – United Kingdom and international perspectives" (The Falmer Press, London)

Rogers, M. (1992); "Opting out: choice and the future of schools" (Lawrence and Wishart, London)

Rogers, R. (Ed.: 1986); "Education and social class" (Falmer Press, London)

SCAA (1994); "Value added performance indicators for schools: a report by the SCAA for the Secretary of State for Education" SCAA Ref.:COM/94/151 (SCAA/COI, London)

Schagen, I. (1994); "Multilevel analysis of the Key Stage 1 National Curriculum assessment data in 1991 and 1992" *Oxford Review of Education* vol.20 no.2, pp163-71

Scholten, H.J. and Stillwell, J.C.H.S. (Eds.: 1990); "Geographic information systems for urban and regional planning" (Kluwer, Dordrecht)

Schryock, H.C., Siegel, J.S. and Associates (1976); "The methods and materials of demography" (Condensed Edition (Ed. E.G. Stockwell): Academic Press, San Diego)

Sharratt, T. (1993); "Smiles and scorn at 'spurious' league tables" *The Guardian* 17th November, p4

Shaw, A. (1996); "Bending the school rules" *The Electronic Telegraph* 14th September (http://www.telegraph.co.uk/)

Simpson, S. and Lancaster, D. (1987); "Forecasting pupil numbers for educational planning" Report to Department of Education and Science, Sheffield City Polytechnic, Sheffield

Smedley, D.A. (1993); "Marketing schools to parents" Papers in education series, Department of Education, Loughborough University

Sofer, A. (1994); "Results need their context" *The Times Educational Supplement* 21st January, p23 [letter]

Statham, S. and Mackinnon, D. with Cathcart, H. and Hales, M. (1991); "The education factfile: a handbook of education information in the UK" (second edition: Hodder and Stoughton, London and Open University Press)

Stewart, J.Q. (1941); "An inverse distance variation for certain social influences" *Science* vol.93, pp89-90

Stewart, J.Q. (1950); "The development of social physics" *American Journal of Physics* vol.18, pp239-53

Stillwell, J.C.H. (1977); "Some historical tests of spatial interaction models for inter-area migration. Part I: inter-county migration" Working Paper 185, School of Geography, University of Leeds, Leeds, England

Stillwell, J.C.H. (1978); "Interzonal migration: some historical tests of spatial-interaction models" *Environment and Planning A* vol.10, pp1187-1200

Stillwell, J.C.H. (1994); "Monitoring intercensal migration in the United Kingdom" *Environment and Planning A* vol.26 no.11, pp1711-30

Strickland, S. (1994i); "Parents look beyond the figures" *The Independent* 24th November, p34

Sutcliffe, C.M. and Board, J.L. (1986); "Designing secondary school catchment areas using goal programming" *Environment and Planning A* vol.18, pp661-675

Swainston, R.A. (1993); "GIS in local Government ; GIS at the crossroads" Proceedings of the 'GIS 93' conference Birmingham, May, pp57-66

Tawney, R.H. (1922); "Secondary education for all: a policy for Labour" (George Allen and Unwin, London)

Taylor, D.R.F. (1991); "Geographic information systems: the microcomputer and modern technologies" **in** Taylor, D.R.F. (Ed.); "Geographic information systems: the microcomputer and modern technologies" (Pergamon Press, London)

Thomas, R.W. (1987); "Developments in mathematical programming models and their impact on the spatial allocation of educational resources" *Progress in Human Geography* vol.11, pp207-26

Thomas, R.W. and Huggett, R.J. (1980); "Modelling in geography: a mathematical approach" (Harper and Row, London)

Thomas, S., Goldstein, H. and Nuttall, D. (1993); "Number-crunching" *Guardian Education* 30th November, pp 3-4

Townsend, P., Phillimore, P. and Beattie, A. (1988); "Health and deprivation: inequality and the north" (Croom Helm, London)

Walsh, K. (1994); "Quality, surveillance and perfomance measurement" **in** Riley, K.A. and Nuttall, D.L. (Eds.); "Measuring quality: education indicators – United Kingdom and international perspectives" (The Falmer Press, London)

Ward, L. (1996); "GM schools top A-level cost league" *The Times Educational Supplement* 28th June, p3

Ward, L. (1997iii); "Parents urged to be wary of league tables" *The Independent* 7th March, p10

Ward, L. (1997vi); "How middle class families win the game" *The Independent* 17th April, p6

Waslander, S. and Thrupp, M. (1995); "Choice, competition and segregation: an empirical analysis of a New Zealand secondary school market" *Journal of Education Policy* vol.10 no.1, pp1-26

Webster, A., Owen, G. and Crowe, D. (1993); "School marketing: making it easy for parents to select your school: the lessons from a research project on parents' choice of state secondary education" (Avec Designs, Bristol)

Whitty, G. and Menter, I. (1991); "The progress of restructuring" **in** Coulby, D. and Bash, L. (Eds.: 1991); "Contradiction and conflict: the 1988 Education Act in action" (Cassell Educational Limited, New York)

Whitty, G., Edwards, T. and Gewirtz, S. (1993); "Specialisation and choice in urban education: the City Technology College experiment" (Routledge, London)

Willms, J. and Echols, F. (1992); "Alert and inert clients" *Economics of Education Review* vol.11 no.4, pp339-50

Wilson, A.G. (1970); "Entropy in urban and regional modelling" (Pion, London)

Wilson, A.G. (1971); "A family of spatial interaction models and associated developments" *Environment and Planning A* vol.3, pp1-32

Wilson, A.G. (1974); "Urban and regional models in geography and planning" (John Wiley, London)

Wilson, A.G. (1981); "Geography and the environment: systems analytical methods" (John Wiley, Chichester)

Wilson, A.G. and Bennett, R.J. (1985); "Mathematical methods in human geography and planning" (John Wiley, Chichester)

Wilson, P. (1961); "Views and prospects from Curzon Street: seven essays and addresses on the future of education" (Blackwell, Oxford)

Wintour, P. and Macleod, D. (1994); "U-turn by Labour on schools" *The Guardian* 21st November, p1

Woods, R. and Rees, P. (1986); "Population structures and models: developments in spatial demographics" (Allen and Unwin, London)

Worrall, L. (1990); "Information systems for urban and regional planning in the United Kingdom: a review" *Environment and Planning B* vol.17 no.4, pp451-62

Wright, J. (1988); "The plain fellow's guide to geographic information systems" *The Geographic Journal* vol.154 no.2, pp

Wrigley, N. (1988); "Store choice, store location and market analysis" (Routledge, London)

Zipf, G.K. (1949); "Human behaviour and the principle of least effort" (Addison Wesley Press, Cambridge, Mass.)

Bibliography

Abrams, F. (1993iv); "Truancy league tables scorned" *The Independent* 12th November, p8

Abrams, F. (1995); "Independent Catholic schools set to 'opt in'" *The Independent* 6th July, p8

Abrams, F. (1995vi); "Truants given 'study leave'" *The Independent* 12th April, p10

Abrams, F. (1996v); "Pupils dumped in exam race" *The Independent* 21st August, p1

Abrams, F. (1996vi); "Weaker pupils sacrificed in grades chase" *The Independent* 22nd August, p2

Abrams, F. (1997i); "Tories scorn Major's nursery revolution" *The Independent* 13th March, p1

Abrams, F. and Judd, J. (1993); "Heads say figures for truancy do not add up" *The Independent* 17th November, p6

Adler, M. (1993); "Parental choice and the enhancement of children's interests" **in** Munn, P. (Ed.) "Parents and schools" (Routledge, London)

Adler, M., Petch, A. and Tweedie, J. (1989); "Parental choice and education policy" (Edinburgh University Press, Edinburgh)

Allinson, J. (1993); "The breaking of the Third Wave: the demise of GIS" *Planning Practice and Research* 8(2), pp30-33

Antenucci, J.C., Brown, K., Croswell, P.L., Kevany, M.J. and Archer, H. (1991); "Geographic information systems: a guide to the technology" (Van Nostrand Reinhold)

Appalraju, J. (1979); "Educational facilities planning spatial inter-relations" (UNESCO Division of Educational Policy and Planning, Paris: reports studies S.57)

Armytage, W.H.G. (1970); "Four hundred years of English education" (second edition: Cambridge University Press, Cambridge)

Audit Commission (1988); "Surplus capacity in secondary schools: a progress report" (HMSO, London)

Ball, D. and Babbage, R. (Eds.: 1989); "Geographical information systems: defence applications" (Pergamon Press, London)

Ball, S.J., Bowe, R. and Gewirtz, S. (1994); "Market forces and parental choice: self-interest and competitive advantage in education" **in** Tomlinson, S. (Ed.); "Educational reform and its consequences" (IPPR/Rivers Oram Press, London)

Ball, S.J., Bowe, R. and Gewirtz, S. (1995); "School choice, social class and distinction: the realization of social advantage in education" *Journal of Educational Policy* vol.11 no.1, pp89-112

Barber, M. (1994); "Table manners" *Guardian Education* 3rd May, p4

Barker, B. (1995ii); "Labour is locked into league tables" *The Times Educational Supplement* 5th May, p14

Barnes, C. (1993); "Practical marketing for schools" (Blackwell, Oxford)

Batty, M. (1976); "Urban modelling: algorithms, calibrations, predictions" (CUP, Cambridge)

Bellin, W., Farrell, S., Higgs, G. and White, S. (1996); "A strategy for using census information in comparison of school performance" *The Welsh Journal of Education* vol.5(2), pp3-25

Bennett, G. (1994); "The truth behind the tables..." *The Times Educational Supplement* Section II 9th December, p2

Bertuglia, C.S., Clarke, G.P. and Wilson, A.G. (1994; Eds.); "Modelling the city: performance, policy and planning" (Routledge, London)

Birkin, M, Clarke, G.P., Clarke, M. and Wilson, A.G. (1996); "Intelligent GIS" (GeoInformation International, Cambridge)

Board of Education (1927); "The education of the adolescent: report of the Consultative Committee [known as 'The Hadow Report']" (HMSO, London)

Board of Education (1931); "Report of the Consultative Committee on the primary school [also known as 'The Hadow Report']" (HMSO, London)

Board of Education (1938); "Report of the Consultative Committee on secondary education with special reference to grammar schools and technical high schools [known as 'The Spens Report']" (HMSO, London)

Board of Education (1943); "Curriculum and examinations in secondary schools: report of the Secondary School Examinations Council [known as 'The Norwood Report']" (HMSO, London)

Bolster, N. (1994); "Desperate for the right address" *The Times Educational Supplement* 23rd September, p6

Bondi, L. (1989); "Selecting schools for closure: theory and practice in 'rational' planning" *Journal of Education Policy* vol.4 no.2, pp85-102

Bondi, L. and Matthews, M.H. (Eds.: 1988); "Education and society: studies in the politics, sociology and geography of education" (Routledge, London)

Boseley, S. (1995); "Early learning" *Guardian Education* 23rd May, pp2-3

Bowe, R. and Ball, S.J. with Gold, A. (1992); "Reforming education and changing schools: case studies in policy sociology" (Routledge, London and New York)

Bradford, M.G. (1991); "School performance indicators, the local residential environment and parental choice" *Environment and Planning A* vol.23, pp319-32

Bradford, M.G. (1994); "Diversification and division in the English education system: towards a post-Fordist model?" SPA Working Paper 29, School of Geography, University of Manchester

Bradford, M.G., Robson, B.T. and Tye, R. (1995); "Constructing an urban deprivation index: a way of meeting the need for flexibility" *Environment and Planning A* vol.27, pp519-33

Brighouse, T. (1994); "Magicians of the inner city" *The Times Educational Supplement* Section II, 22nd April, pp2-3 [abridged text of 1994 TES Greenwich lecture]

Bromley, R. and Coulson, M. (1989); "The value of corporate GIS to local authorities" *Mapping Awareness* vol.3 no.5, pp32-5

Brown, P.J.B. (1987); "Trade-off and compromise in secondary school reorganisation schemes: a goal programming approach" *Papers of the Regional Science Association* vol.61, pp115-130

Brown, P.J.B. (1991); "Exploring geodemographics" **in** Masser, I. and Blakemore, M. (Eds.); "Handling geographic information" (Longman, Harlow)

Brown, S. (1994); "School effectiveness research and the evaluation of schools" *Evaluation and Research in Education* vol.8 nos.1&2, pp55-68

Budge, D. (1995v); "A secretive partner who demands too much" *The Times Educational Supplement* 24th March, p14

Budge, D. (1996ii); "Primary tables go ahead despite protests" *The Times Educational Supplement* 3rd May, p6

Burstall, E. (1995iii); "Plea for value added in league tables" *The Times Educational Supplement* 10th November, p6

Butler, R.A. (Lord) (1971); "The art of the possible" (Hamish Hamilton, London)

Buxton, R. (1989); "Integrated spatial information systems in local Government – is there a financial justification?" *Mapping Awareness* vol.2 no.6, pp14-16

Campbell, H. (1994); "How effective are GIS in practice? A case study of British local Government" *International Journal of GIS* vol.8 no.3, pp309-26

Castle, G. (1993); "Profiting from a GIS" (GIS World, Fort Collins, USA)

Charlton, M., Openshaw, S. and Wymer, C. (1985); "Some new classifications of census enumeration districts in Britain: a poor man's ACORN" *Journal of Economic and Social Measurement* vol.13, pp69-96

Clarke, G.P. (1986); "Retail centre usage and structure: empirical and theoretical explorations" (unpublished PhD thesis, School of Geography, University of Leeds)

Clarke, G.P. and Langley, R.J. (1994); "The potential for GIS and SDSS for planning in education" Paper presented at GIS and Public Policy conference, University of Ulster, 24th-27th May 1994. Copies from the authors at School of Geography, University of Leeds, Leeds LS2 9JT

Clarke, G.P. and Langley, R.J. (1995); "The potential of GIS and spatial modelling for planning in the new education market" Working Paper 95/10, School of Geography, University of Leeds, Leeds LS2 9JT

Clarke, G.P. and Langley, R.J. (1996); "A review of the potential of GIS and spatial modelling for planning in the new education market" *Environment and Planning C* vol.14, pp301-23

Clarke, G.P. and Wilson, A.G. (1994ii); "A new geography of performance indicators for urban planning" **in** Bertuglia, C.S., Clarke, G.P. and Wilson, A.G. (Eds.: 1994); "Modelling the city: performance, policy and planning" (Routledge, London)

Clarke, G.P., Hall, R., Winnett, C. and Wilson, A.G. (1997); "New indicators for territorial competition between and within urban areas" (Working Paper, School of Geography, University of Leeds)

Clarke, M. and Wilson, A.G. (1985); "The dynamics of urban spatial structure: the progress of a research programme" *Transactions of the Institute of British Geographers*, vol.10(4), pp427-51

Corbett, A. (1994); "A measurement of how the lycées fare" *The Times Educational Supplement* 9th December, p11

Council for Scientific Policy (1968); "Enquiry into the flow of candidates in science and technology into higher education [known as 'The Dainton Report']" (HMSO, London)

Craig, T. (1994); "Voting for local democracy" and "For council read quango" *Guardian Education* 3rd May, pp10-11

Crookes, J. (1994); "Comparative GCSE and A/AS level table for Leicestershire Schools and Colleges" correspondence with headmasters, Leicestershire Upper schools, 31st October (unpublished, Leicestershire County Council education Department, Advice and Inspection Unit)

Dale, R. (1989); "The state and education policy" (Open University Press, Milton Keynes)

Davies, B. and Ellison, L. (1991); "Marketing the secondary school" (Longman, Harlow)

Dean, C. (1994); "Patten hints at end of opt-out vote" *The Times Educational Supplement* 22nd April, p6

Dean, C. (1995i); "Parents' opt-out vote at risk" *The Times Educational Supplement* 27th October, p1

Dean, C. (1995ii); "GM quango eager to build schools" *The Times Educational Supplement* 1st December, p9

Densham, P.J. (1991); "Spatial decision support systems" **in** Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (Eds.); "Geographical information systems: principles and applications" (vol. 1: Longman, London)

Densham, P.J. and Rushton, G. (1988); "Decision support systems for local planning" **in** Gollege, R. and Timmermans, H. (Eds.); "Behavioural modelling in geography and planning" (Croom Helm, London)

Department for Education (1992i); "Choice and diversity: a new framework for schools" (HMSO, London)

Department for Education (1992ii); "The implementation of Local Management of Schools: a report by H.M. Inspectorate 1989-92" (HMSO, London)

Department for Education (1994); "Final report on the Natonal Curriculum and its assessment; the Government's response" (DfE, London)

Department for Education (1995i); "Value added in education" (DfE, London)

Department for Education (1995ii); "GCSE to GCE A/AS value added: briefing for schools and colleges" (DfE, London)

Department for Education and Employment (1996ii); "Shephard rewards Grant Maintained schools for excellence in sports and community work" (DfEE press release 100/96, 25th March)

Department for Education and Employment (1996xi); "Self-Government for schools [White Paper]" (HMSO, London)

Department of Education and Science (1967); "Children and their primary schools [known as 'The Plowden Report']" (HMSO, London)

Department of the Environment (1994); "Index of Local Conditions: an analysis based on 1991 census data" (DoE, London)

Devlin, T. and Knight, B.A. (1990); "Public relations and marketing for schools" (Longman, Harlow)

Ding, Y. and Fotheringham, A.S. (1992); The integration of spatial analysis and GIS" *Computers, Environment and Urban Systems* vol.16, pp3-19

Doe, B. (1995); "They also can achieve who live in the lower ranks" *The Times Educational Supplement* Section II, 27th October, p6

Duncan, C., Jones, K. and Moon, G. (1996); "Health-related behaviour in context: a multilevel modelling approach" *Social science and medicine* vol.42 no.6, pp817-30

Education (1994); "Ofsted backs input-output exam study" *Education* 23rd September, p228

Education Act 1944 (HMSO, London)

Education Reform Act 1988 (HMSO, London)

ESRI (1992); "ARC/INFO version 6.1 user's guide: Network Analysis, modeling network systems" (reprinted at Manchester Computer Centre as CST805: MCC, Manchester)

Evans, I.G. (1995); "Marketing for schools" (Cassell, London)

Farnsworth, S., Everett, S. and Jesson, D. (1994); "Beyond league tables: a value-added analysis of GCSE and A level perfromance in Nottinghamshire in 1993" (Nottingham County Council Education Department, Nottingham, England)

Fitz-Gibbon, C. (1994); "Three routes to the wrong answer" *The Times Educational Supplement* 9th December, p11

Ford, N. (1995); "The best-laid plans..." *Mapping Awareness* March, pp34-7

Fotheringham, A.S. (1983); "A new set of spatial-interaction models: the theory of competing destinations" *Environment and Planning A* vol.15, pp15-36

Fotheringham, A.S. and Rogerson, P. (Eds.: 1994); "Spatial analysis and GIS" (Taylor and Francis, London)

Garner, C. (1988); "Educational attainment in Glasgow: the role of neigbourhood deprivation" **in** Bondi, L. and Matthews, M.H. (Eds.); "Education and society: studies in the politics, sociology and geography of education" (Routledge, Chapman and Hall, London)

Garner, C. and Raudenbush, S.W. (1989); "Neighbourhood effects on educational attainment: a multilevel analysis" (Centre of Educational Sociology, University of Edinburgh, Edinburgh)

Garner, R. (1994); "'Failures' top of the class" *The Daily Mirror* 16th March, p6

Gaunt, H. (1991); "Could do better: creating a marketing strategy for your school" (Horton, Bradford)

GMAP (1996) Annual report and accounts 1996 (GMAP Ltd., Cromer Terrace, Leeds)

Goldstein, H. (1987); "Multilevel models in educational and social research" (Charles Griffin and Co., London)

Goodall, B. (1987); "The Penguin dictionary of human geography" (Penguin, Harmondsworth)

Goodchild, M.F. (1987); "A spatial analytical perspective on geographcial information systems" *Intenational Journal of GIS* vol.1 no.4, pp327-34

Goodchild, M.F., Haining, R. and Wise, S. (1992); "Integrating GIS and spatial data analysis" *Intenational Journal of GIS* vol.6, pp407-23

Goodwin, M. (1992); "The changing local state" **in** Cloke, P. (Ed.) "Policy and change in Thatcher's Britain" (Pergamon Press, Oxford)

Goodwin, S. (1995); "Party rejects call to abolish grant-maintained schools" *The Independent* 5th October, p10

Gordon, I. (1996); "Family structure, educational achievement and the inner city" *Urban Studies* vol.33 no.3, pp407-23

Gordon, P., Aldritch, R. and Dean, D. (1991); "Education and policy in England in the twentieth century" (The Woburn Press, London)

Gosden, P.H.J.H. (1976); "Education in the second world war: a study in policy and administration" (Methuen, London)

Gray, J. (1994); "Relative values" *The Times Educational Supplement* 16th December, p15

Gray, J. and Wilcox, B. (1994); "Performance indicators: flourish or perish? " **in** Riley, K.A. and Nuttall, D.L. (Eds.); "Measuring quality: education indicators – United Kingdom and international perspectives" (The Falmer Press, London)

Griggs, C. (1983); "The Trades Union Congress and the struggle for education 1868-1925" (The Falmer Press, Lewes)

Grimshaw, D. (1994); "Bringing GIS into business" (Longman, Harlow)

Hackett, G. (1995); "Churches oppose speedier opt-out" *The Times Educational Supplement* 3rd November, p3

Hackett, G. (1995xx); "Inner-city pupils fall behind" *The Times Educational Supplement* 15th December, p1

Hackett, G. (1995xxi); "A flawed spur to improve" *The Times Educational Supplement* 15th December, p12

Hargreaves, D. (1990); "Making schools more effective: the challenge to policy practice and research" *Scottish Educational Review* vol.22 no.1, pp5-14

Harris, B. and Wilson, A.G. (1978); "Equilibrium values and dynamics of attractiveness terms in production-constrained spatial-interaction models" *Environment and Planning A* vol.10, pp371-88

Haylock, D. (1994); "The fruits of multiplying value" *The Times Educational Supplement* Section II 2nd December, p2

Haynes, K.E. and Fotheringham, A.S. (1984); "Gravity and spatial interaction models (vol.2): scientific geography series" (Sage, Beverly Hills, Ca.)

Higgs, G., Bellin, W., Farrell, S. and White, S. (forthcoming); "Educational attainment and social disadvantage: contextualising school league tables" *Regional Studies*

Higgs, G., Webster, C.J. and White, S.D. (forthcoming); "The use of geographical information systems in assessing spatial and socio-economic impacts of parental choice" *Research Papers in Education*

Hirsch, D. (1995); "School choice and the search for an educational market" *International Review of Education* vol.41 nos.3&4, pp239-57

Hirschfield, A., Brown, P.J. and Marsden, J. (1991); "Database development for decision support and policy evaluation" **in** Worrall, L. (Ed.); "Spatial analysis and spatial policy using geographic information systems" (Belhaven Press, London)

Hirschfield, A., Brown, P.J. and Bundred, P. (1993); "Doctors, patients and GIS: a spatial analysis of primary health care provision on the Wirral" *Mapping Awareness* vol.7 no.9, pp9-12

Hofkins, D. (1995i); "Deprivation is the common factor" *The Times Educational Supplement* 10th February, p14

House of Commons (1970); "Report on teacher training: a report of the House of Commons Select Committee on Education and Science" (House of Commons, London)

House of Commons (1976); "Policy making in the DES: 10th report from the Expenditure Committee, Session 1975-6 [known as 'The Fookes Report']" (House of Commons, London)

Ireland, P. (1995); "Making the grade in Lothian" *Mapping Awareness* April, pp24-7

Irwin, S. and Wilson, A.G. (1985a); "Modelling school systems – a framework for planning for falling rolls" Working Paper 412, School of Geography, University of Leeds

Jenkins, J. and Walker, J.R. (1985); "School roll forecasting" **in** England, J.R. (Ed.); "Information systems for policy planning in local Government" (Longman, Harlow)

Johnston, R.J. (1991); "Geography and geographers: Anglo-American human geography since 1945" (4th edition: Edward Arnold, London)

Jones, K. and Bullen, N. (1993); "A multilevel analysis of the variations in domestic property prices: southern England 1980-87" *Urban Studies* vol.30 no.8, pp1409-26

Jones, K. and Duncan, C. (1994); "People and places: the multilevel model as a general framework for the quantitative analysis of geographical data" paper presented at 'Spatial modelling and GIS' workshop, Bristol (England), June 1994

Joseph, C. (1994); "Showpiece city college 'is failing its pupils'" *The Independent* 15th February, p5

Jowett, P. and Rothwell, M. (1988); "Performance indicators in the public sector" (Macmillan, Basingstoke)

Judd, J. (1994); "Patten 'hedges' on compulsory opting out call" *The Independent* 20th April, p6

Judd, J. (1994iv); "Selling out on ideals to attract a better class" *The Independent* 29th January, p33

Judd, J. (1995); "Church protest delays opt-out plans" *The Independent* 16th November, p6

Judd, J. (1995xix); "Curriculum 'stifles schools'" *The Independent* 25th September, p7

Judd, J. (1995xvii); "Middle classes get wise over schools" *The Independent* 18th September, p7

Judd, J. (1996vi); "Schools 'cull A-level hopefuls to keep league table position'" *The Independent* 30th September, p5

Judd, J. (1997ii); "League tables lost on half of parents" *The Independent* 13th February, p9

Judd, J. (1997iii); "Poor marking flaws primary tests, says study" *The Independent* 6th March, p4

Judd, J. (1997v); "The parents who cheat for their children" *The Independent* 17th April, p6

Langley, R. (1995); "The use of GIS and spatial modelling for educational planning" Proceedings of the Joint European Conference on Geographical Information, The Hague, Netherlands, March 26th-31st, vol.1 pp547-52

Lawrence, I. (1992); "Power and politics at the Department of Education and Science" (Cassell, London and New York)

Lawson, D. (1993); "Housebuyers drawn into schools' magnetic field" *The Independent* 27th November, p48

LCC (1995); Minutes of the Quality Assurance Sub-Committee of the Education Department, held Civic Hall, Leeds on 27th June (Leeds City Council, Leeds)

Lee, T. (1991); "Additional Educational Needs and LMS: methods and money 1991-2" (unpublished report: Centre for the Analysis of Public Policy, Bath)

Leeds Education (1994); letter to parents and consultation document "The future of high schools in the east area of Leeds (Leeds City Council, Education Department, Merrion Centre, Leeds LS2 8DT)

Leeds Education (1995); letter to parents and consultation document "The future of the Benjamin Gott high school" (Leeds City Council, Education Department, Merrion Centre, Leeds LS2 8DT)

Leeds Schools Commission (1993); "The new partnership: quality, governance, choice and resources (second and final report)" (Leeds Schools Commission)

Lepkowska, D. (1995iv); "Shephard approves massive overhaul" The Times Educational Supplement 30th June, p3

Longley, P. and Clarke, G.P. (Eds.: 1995); "GIS for business and service planning" (Geoinformation International, Cambridge)

MacLeod, D. (1991); "A truer way to chart progress" *The Independent* 10th October, p17

MacLeod, D. (1996); "'Harman factor' fear as schools seek selection" *The Guardian* 2nd September, p2

Maclure, S. (1986); "Educational documents: England and Wales 1816 to the present day" (5th edition: Methuen, London and New York)

Maclure, S. (1992); "Education re-formed: a guide to the Education Reform Act" (3rd edition: Hodder and Stoughton, London)

Maguire, D.J. (1991); "An overview and definition of GIS" **in** Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (Eds.); "Geographical information systems: principles and applications: volume 1, principles" (Longman, Harlow)

Maguire, D.J. (1995); "Geographical analysis and proprietary GIS: state-of-the-art functionality" **in** Longley, P. and Clarke, G.P. (Eds.); "GIS for business and service planning" (GeoInformation International, Cambridge)

Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (Eds.: 1991i); "Geographical information systems: principles and applications: volume 1, principles" (Longman, Harlow)

Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (Eds.: 1991ii); "Geographical information systems: principles and applications: volume 2, applications" (Longman, Harlow)

Matthews, M.H., Airey, A. and Tacon, L. (1988); "Catchments, schools and the characteristics of teachers" **in** Bondi, L. and Matthews, M.H. (Eds.); "Education and society: studies in the politics, sociology and geography of education" (Routledge, London)

Michell, R.J. (forthcoming); "Mathematical models for the spatial interaction and dynamics of consumer populations" (unpublished PhD thesis, School of Mathematics, University of Leeds)

Middleton, N. and Weitzman, S. (1976); "A place for everyone: a history of state education from the end of the eighteenth century to the 1970s" (Victor Gollancz, London)

Ministry of Education (1954); "Early leaving: a report of the Central Advisory Council for Education (England) [known as 'The Gurney-Dixon Report']" (HMSO, London)

Ministry of Education (1959); "15 to 18: a report of the Central Advisory Council for Education, vols. I and II [known as 'The Crowther Report']" (HMSO, London)

Ministry of Education (1960); "Secondary school examinations other than GCE: a report of the Secondary Schools Examination Council [known as 'The Beloe Report'] (HMSO, London)

Ministry of Education (1963); "Half our future: a report of the Minister of Education's Central Advisory Council [known as 'The Newsom Report'] (HMSO, London)

Morris, R. (Ed.: 1990); "Central and local control of education after the Education Reform Act 1988" (Longman, Harlow and British Education Management and Administration Society, London)

Morris, R., Reid, E. and Fowler, J. (1993); "Education Act 93: a critical guide" (Association of Metropolitan Authorities, London)

Mortimore, J. and Blackstone, T. (1983); "Disadvantage and education" (Heinemann, London)

Moulden, M. and Bradford, M.G. (1984); "Influences on educational attainment: the importance of the local residential environment" *Environment and Planning A* vol.16(1), pp49-66

Murphy, R. (1995); "Social class and the birth rate influence exam grades" *The Independent* section II, 31st August, pp14-15

National Commission on Education (1993); "Learning to succeed: a radical look at education today and a strategy for the future, the report of the Paul Hamlyn Foundation National Commission on Education" (Heinemann, London)

Newell, C. (1988); "Methods and models in demography" (Belhaven Press, London)

O'Connor, M. (1996i); "Look to the needs of the individual" *The Times Educational Supplement* 16th February, p17

O'Leary, J. (1993i); "Protests dog school league tables" *The Times* 17th November, p1-2

Openshaw, S. (1991); "A view on the GIS crisis in geography, or using GIS to put Humpty Dumpty together again" *Environment and Planning A* vol.23, pp621-8

Pardey, D. (1991); "Marketing for schools" (Kogn Page, London)

Passmore, B. (1994iii); "Researchers let loose on value added" *The Times Educational Supplement* 13th May, p8

Passmore, B. (1994iv); "Indexing improvement" *The Times Educational Supplement* 2nd December, p10

Paterson, L. (1991); "An introduction to multilevel modelling" **in** Raudenbush, S.W. and Willms, J.D. (Eds.); "Schools, classrooms and pupils: international studies of schooling from a multilevel perspective" (Academic Press, San Diego and London)

Peel, R. (1995); "Fast track to GIS – PC-based systems in local Government" *Mapping Awareness* March, pp30-3

Petch, A. (1988); "Rezoning: an exercise in compromise" **in** Bondi, L. and Matthews, M.H. (Eds.); "Education and society: studies in the politics, sociology and geography of education" (Routledge, London)

Pooler, J. (1994); "An extended family of spatial interaction models" *Progress in Human Geography* vol.18 no.1, pp17-39

Pryke, R. (1993); "Opting into irrelevance" *The Times Educational Supplement* 1st October, pp12-13

Pyke, N. (1996); "Americans warned off UK reforms" *The Times Educational Supplement* 26th April, p4

Rees, G. and Rees, P.H. (1991); "A ward population information system for Swansea City Council" (GMAP Ltd., Leeds)

Rees, P.H. and Wilson, A.G. (1977); "Spatial population analysis" (Edward Arnold, London)

Rhind, D.W. (1981); "GIS in Britain" in Wrigley, N. and Bennett, R.J. (Eds.); "Quantitative geography: a British view" (Routledge, London)

Riley, K.A. and Nuttall, D.L. (1994); "Measuring performance – national contexts and local realities" in Riley, K.A. and Nuttall, D.L. (Eds.); "Measuring quality: education indicators – United Kingdom and international perspectives" (The Falmer Press, London)

Rogers, M. (1992); "Opting out: choice and the future of schools" (Lawrence and Wishart, London)

Rogers, R. (Ed.: 1986); "Education and social class" (Falmer Press, London)

SCAA (1994); "Value added performance indicators for schools: a report by the SCAA for the Secretary of State for Education" SCAA Ref.:COM/94/151 (SCAA/COI, London)

Schagen, I. (1994); "Multilevel analysis of the Key Stage 1 National Curriculum assessment data in 1991 and 1992" *Oxford Review of Education* vol.20 no.2, pp163-71

Scholten, H.J. and Stillwell, J.C.H.S. (Eds.: 1990); "Geographic information systems for urban and regional planning" (Kluwer, Dordrecht)

Schryock, H.C., Siegel, J.S. and Associates (1976); "The methods and materials of demography" (Condensed Edition (Ed. E.G. Stockwell): Academic Press, San Diego)

Sharratt, T. (1993); "Smiles and scorn at 'spurious' league tables" *The Guardian* 17th November, p4

Shaw, A. (1996); "Bending the school rules" *The Electronic Telegraph* 14th September (http://www.telegraph.co.uk/)

Simpson, S. and Lancaster, D. (1987); "Forecasting pupil numbers for educational planning" Report to Department of Education and Science, Sheffield City Polytechnic, Sheffield

Smedley, D.A. (1993); "Marketing schools to parents" Papers in education series, Department of Education, Loughborough University

Sofer, A. (1994); "Results need their context" *The Times Educational Supplement* 21st January, p23 [letter]

Statham, S. and Mackinnon, D. with Cathcart, H. and Hales, M. (1991); "The education factfile: a handbook of education information in the UK" (second edition: Hodder and Stoughton, London and Open University Press)

Stewart, J.Q. (1941); "An inverse distance variation for certain social influences" *Science* vol.93, pp89-90

Stewart, J.Q. (1950); "The development of social physics" *American Journal of Physics* vol.18, pp239-53

Stillwell, J.C.H. (1977); "Some historical tests of spatial interaction models for inter-area migration. Part I: inter-county migration" Working Paper 185, School of Geography, University of Leeds, Leeds, England

Stillwell, J.C.H. (1978); "Interzonal migration: some historical tests of spatial-interaction models" *Environment and Planning A* vol.10, pp1187-1200

Stillwell, J.C.H. (1994); "Monitoring intercensal migration in the United Kingdom" *Environment and Planning A* vol.26 no.11, pp1711-30

Strickland, S. (1994i); "Parents look beyond the figures" *The Independent* 24th November, p34

Sutcliffe, C.M. and Board, J.L. (1986); "Designing secondary school catchment areas using goal programming" *Environment and Planning A* vol.18, pp661-675

Swainston, R.A. (1993); "GIS in local Government ; GIS at the crossroads" Proceedings of the 'GIS 93' conference Birmingham, May, pp57-66

Tawney, R.H. (1922); "Secondary education for all: a policy for Labour" (George Allen and Unwin, London)

Taylor, D.R.F. (1991); "Geographic information systems: the microcomputer and modern technologies" **in** Taylor, D.R.F. (Ed.); "Geographic information systems: the microcomputer and modern technologies" (Pergamon Press, London)

Thomas, R.W. (1987); "Developments in mathematical programming models and their impact on the spatial allocation of educational resources" *Progress in Human Geography* vol.11, pp207-26

Thomas, R.W. and Huggett, R.J. (1980); "Modelling in geography: a mathematical approach" (Harper and Row, London)

Thomas, S., Goldstein, H. and Nuttall, D. (1993); "Number-crunching" *Guardian Education* 30th November, pp 3-4

Townsend, P., Phillimore, P. and Beattie, A. (1988); "Health and deprivation: inequality and the north" (Croom Helm, London)

Walsh, K. (1994); "Quality, surveillance and perfomance measurement" **in** Riley, K.A. and Nuttall, D.L. (Eds.); "Measuring quality: education indicators – United Kingdom and international perspectives" (The Falmer Press, London)

Ward, L. (1996); "GM schools top A-level cost league" *The Times Educational Supplement* 28th June, p3

Ward, L. (1997iii); "Parents urged to be wary of league tables" *The Independent* 7th March, p10

Ward, L. (1997vi); "How middle class families win the game" *The Independent* 17th April, p6

Waslander, S. and Thrupp, M. (1995); "Choice, competition and segregation: an empirical analysis of a New Zealand secondary school market" *Journal of Education Policy* vol.10 no.1, pp1-26

Webster, A., Owen, G. and Crowe, D. (1993); "School marketing: making it easy for parents to select your school: the lessons from a research project on parents' choice of state secondary education" (Avec Designs, Bristol)

Whitty, G. and Menter, I. (1991); "The progress of restructuring" **in** Coulby, D. and Bash, L. (Eds.: 1991); "Contradiction and conflict: the 1988 Education Act in action" (Cassell Educational Limited, New York)

Whitty, G., Edwards, T. and Gewirtz, S. (1993); "Specialisation and choice in urban education: the City Technology College experiment" (Routledge, London)

Willms, J. and Echols, F. (1992); "Alert and inert clients" *Economics of Education Review* vol.11 no.4, pp339-50

Wilson, A.G. (1970); "Entropy in urban and regional modelling" (Pion, London)

Wilson, A.G. (1971); "A family of spatial interaction models and associated developments" *Environment and Planning A* vol.3, pp1-32

Wilson, A.G. (1974); "Urban and regional models in geography and planning" (John Wiley, London)

Wilson, A.G. (1981); "Geography and the environment: systems analytical methods" (John Wiley, Chichester)

Wilson, A.G. and Bennett, R.J. (1985); "Mathematical methods in human geography and planning" (John Wiley, Chichester)

Wilson, P. (1961); "Views and prospects from Curzon Street: seven essays and addresses on the future of education" (Blackwell, Oxford)

Wintour, P. and Macleod, D. (1994); "U-turn by Labour on schools" *The Guardian* 21st November, p1

Woods, R. and Rees, P. (1986); "Population structures and models: developments in spatial demographics" (Allen and Unwin, London)

Worrall, L. (1990); "Information systems for urban and regional planning in the United Kingdom: a review" *Environment and Planning B* vol.17 no.4, pp451-62

Wright, J. (1988); "The plain fellow's guide to geographic information systems" *The Geographic Journal* vol.154 no.2, pp

Wrigley, N. (1988); "Store choice, store location and market analysis" (Routledge, London)

Zipf, G.K. (1949); "Human behaviour and the principle of least effort" (Addison Wesley Press, Cambridge, Mass.)

Appendix I

"Education after the war": a summary of the 'Green Book' of 1941

Foreword

1. Educational machinery must be adjusted to serve educational needs and not *vice versa*

Full-time schooling

2. The school leaving age to be raised to 15 without exemptions.
3. The area of elementary education to be redefined. Education will then fall into three stages;

   Primary: covering nursery schools and classes, infant schools and junior schools ending at the age of 11+,

   Secondary: covering secondary schools of all types – the modern school, the grammar school and the technical school, with leaving ages ranging from 15+ to 18,

   Further Education: covering day continuation schools, full-time education in senior, technical and commercial colleges, part-time technical and commercial education in the day or evening and adult education.
4. A single type of Local Education Authority to be established for both elementary and higher education.
5. Provision of secondary education to be a duty and not simply a power of LEAs.
6. All schools at the secondary stage to be on an equal footing.
7. All secondary schools provided, maintained or aided by LEAs to be free.
8. The special place examination at 11 to be abolished. Children to proceed to secondary schools of different types on the basis of their record in the primary school, supplemented by suitable intelligence tests.
9. A genuine review, with a re-sorting as may be necessary, to take place at the age of 13. To facilitate this interchange the content of the education for the age group 11-13 to be generally the same in all types of secondary school.

Day continuation schools

10. Day continuation schools to be established for young persons up to the age of 18.
11. The hours of attendance at day continuation schools to be 280 *per* year, preferably on two half days of 3.5 hours each *per* week.

[12 to 14 omitted]

The further education of the adolescent and the adult

[15 omitted]

16. There is an urgent need in the interests of industry and commerce to secure an improved system of technical and commercial training ...
17. Closer relations need to be established between education and industry and commerce ...
18. No development can be secured without extended and improved accommodation. The building programme planned before the war should be completed.

[19 to 22 omitted]

[23 to 26, *'The avenue to the universities'* omitted]

The health and physical well-being of the child

[27 to 32 omitted]

33. It should be made obligatory on LEAs to make or otherwise secure the provision of meals for all children for whom such provision is necessary in order that they may derive full benefit from their education.

[34 to 35, *'Recruitment and training of teachers'* omitted]

Units of local educational administration

36. A single type of LEA covering all types of education to be established ...

[37, *'The dual system'* omitted]

[38, *'Salaries of teachers'* omitted]

[39, *'The finance of education'* omitted]

Taken from* "Education after the war", *reprinted as an appendix to Middleton and Weitzman (1976)

Appendix II

The 1944 Education Act: a summary of its main points

The 1944 Education Act was published in 5 parts, 122 sections and was followed by 9 schedules. Its first paragraph stated that there would henceforth be a Minister for Education,

> "whose duty it shall be to promote the education of the people of England and Wales and the progressive development of the institutions devoted to that purpose, and to secure the effective execution by local authorities, under his control and direction, of the national policy for providing a varied and comprehensive educational service in every area" (p1).

The other main points of the Act were as follows;

1. The Board of Education was replaced by a Ministry of Education which was to have a creative rather than just a controlling brief.
2. No distinction was drawn between elementary and higher education – it introduced a unified system of free education for all based around the ideas of primary, secondary and further education. The LEAs based in County and Borough County Councils were to be in charge of all three levels of the system.
3. Education between the ages of 5 and 15 was made compulsory. The upper limit was to be increased to 16 "as soon as the Minister is satisfied that it has become practicable" (section 35). This education could be in LEA schools, other schools or "otherwise" (section 56 – essentially referring to education at home).
4. The powers of LEAs were increased beyond simply education in schools to cover such areas as nursery education, holiday classes, camps, swimming pools, recreation areas *etc.*
5. The LEAs' brief was thereby extended to both pre- and post-compulsory education. These new powers were to be the basis for the extension of education beyond 16, to ensure that all children received until age 18 at least one day a week in a county college. This was, of course, not a new idea, nor was this the last time it was mentioned. It was never implemented.

6. The provision of support services was included in the list of LEA statutory duties; home-school transport, free milk, free medical and dental treatment, school meals for all who wanted them were all offered.
7. Provision was made to clarify the relationship between the county and voluntary sectors in order to clear up decades-old arguments and provide a more unified system. Voluntary schools could become either 'aided' or 'controlled' by the LEA. The relationship set out in the 1944 Act still stands essentially unchanged today.
   - 'Aided' schools received grants from the LEA to cover teachers' salaries and maintenance charges, 50% of the cost of alterations to buildings, the entire cost of internal repairs and 50% of external repairs. If the school transferred to a new site, then 50% of the costs were received from the LEA (this was increased to 75% in 1959), the same if a new school were built to replace existing premises. The governing body had control of the appointment of staff and this governing body was largely appointed by the voluntary organisation itself rather than the LEA.
   - 'Controlled' schools were the financial responsibility of the LEA and the LEA also had a majority on the governing body; denominational instruction was the only real concession to the voluntary organisation in such a school.
8. The Minister for Education was to be the arbiter in disputes between LEAs and schools or voluntary bodies. He had to be consulted over any changes in provision in an area (openings, closures, changes of character *etc.*)
9. Two Central Advisory Committees for Education (CACE) were set up, one for England and one for Wales, with a remit to brief the Minister. They provided many reports but were gradually superseded by specific committees set up as and when they were needed.
10. Guidelines for in-school religious instruction were provided. Every school had to have a daily and corporate act of worship – exemptions were made for schools which had large numbers of pupils from differing religions. The Act also introduced the compulsory teaching of Religious Education, the only subject which <u>had</u> to be taught until the introduction of the national curriculum in 1988. This teaching had to be non-denominational except in voluntary schools, where the curriculum was set by the body founding the school. Parents had the option to exclude their children from this aspect of school life.
11. Parents also had increased rights over the education given in schools, under section 76 of the Act; "so far as is compatible with the provision of efficient instruction and training and the avoidance of unreasonable public expenditure, pupils are to be educated in accordance with the wishes of their parents."

12. Special Educational Needs had to be both ascertained and acted upon by LEAs. Ten categories were introduced to replace the previous designations of types of 'handicap', and it was a requirement that all children be educated in mainstream schools as far as was possible.
13. LEAs had to appoint Chief Education Officers to oversee and coordinate their activities. The Minister of Education had powers covering their remuneration, appointment and dismissal.
14. Restrictions on married women teachers were lifted, which meant that women were free to carry on teaching even if they chose to marry.
15. Her Majesty's Inspectorate of Schools (HMI)'s brief was expanded to ensure that there was a degree of national uniformity in educational standards. The number of inspectors was increased by approximately 200 to a new total of around 500.
16. LEAs were asked to provide development plans within a year of the Act being passed. "The Ministry had to be satisfied that sufficient primary and secondary schools ... were being provided" (Gosden 1976, p37)

Sources: *Education Act 1944, Gordon* et al. *1991, Gosden 1976, Maclure 1986, Statham* et al. *1991*

Appendix III

The education debate in the British press 1993-7: a bibliography of articles

A selection of the articles which have appeared in the British press between 1993 and 1996 regarding the education system. The articles are listed alphabetically by author.

Abrams, F. (1993i); "Schools 'are failing pupils in deprived urban areas'" *The Independent* 28th October, p6
Abrams, F. (1993ii); "Spending league plan for schools" *The Independent* 6th November, p8
Abrams, F. (1993iii); "Staff and pupils rise to challenge of urban life" *The Independent* 10th November, p8
Abrams, F. (1993iv); "Truancy league tables scorned" *The Independent* 12th November, p8
Abrams, F (1993v); "Patten announces A-level changes" *The Independent* 13th November, p4
Abrams, F. (1993vi); "Mistakes in school tables criticised" *The Independent* 18th November, p8
Abrams, F. (1993vii); "Schools could mortgage sites to get cash" *The Independent* 17th November, p6
Abrams, F. (1993viii); "Patten signals wider sixth-form choice" *The Independent* 26th November, p7
Abrams, F. (1993ix); "Adults must report truants, Patten says" *The Independent* 27th November, p1
Abrams, F. (1993x); "New head appointed for Eton" *The Independent* 1st December, p25
Abrams, F. (1993xi); "Teacher shortages predicted" *The Independent* 2nd December, p6
Abrams, F. (1993xii); "Damning reports expose two schools to take-over" *The Independent* 4th December, p5
Abrams, F. (1993xiii); "Teachers accept that criticism is 'fair'" *The Independent* 4th December, p5
Abrams, F. (1993xiv); "Britain still trailing in higher education stakes" *The Independent* 9th December, p7
Abrams, F. (1993xv); "Bobbing and dodging – but no shopping" *The Independent* 9th December, p31
Abrams, F. (1994i); "Committed (?) to testing at 'key stages'" *The Independent* 6th January, p4
Abrams, F. (1994ii); "Parents to help in rewriting curriculum" *The Independent* 7th January, p1
Abrams, F. (1994iii); [no title] *The Independent* 19th January, p2
Abrams, F. (1994iv); "Inner-city school fails to satisfy inspectors" *The Independent* 2nd February, p9
Abrams, F. (1994v); "Self-governing schools win £13.6m bonus for opting out" *The Independent* 3rd February, p10
Abrams, F. (1994vi); "Truants' school triumphs in exam results" *The Independent* 16th February, p4
Abrams, F. (1994vii); "Part-time schooling from age three urged" *The Independent* 18th March, p8
Abrams, F. (1994viii); "Parents say £3m charter misses real concerns" *The Independent* 15th June, p5
Abrams, F. (1994ix); "County cuts to hit over 60 schools" *The Independent* 7th October, p2
Abrams, F. (1994x); "Doubts cast over figures for surplus places" *The Independent* 7th October, p2
Abrams, F. (1994xi); "Class warfare" *The Independent* 26th October, p21
Abrams, F. (1994xii); "'We knew there was no pot of gold'" *The Independent* 3rd November, p30
Abrams, F. (1994xiii); "Shephard offers peace formula" *The Independent* 11th November, p3
Abrams, F. (1994xiv); "Publication of extra information leads to controversy" *The Independent* school league tables special, pl
Abrams, F. (1995i); "School considers legal challenge to inspectors' report" *The Independent* 16th January, p6
Abrams, F. (1995ii); "School governors threaten to resign over budget cuts" *The Independent* 30th January, p2
Abrams, F. (1995iii); "Outcry as opt-out schools hold back £74m" *The Independent* 14th February, p2
Abrams, F. (1995iv); "Parents rebel over schools shortage" *The Independent* 9th March, p4
Abrams, F. (1995v); "Shephard hints at more cash for education" *The Independent* 11th April, p1
Abrams, F. (1995vi); "Truants given 'study leave'" *The Independent* 12th April, p10
Abrams, F. (1995vii); "Borderline schools face return visits from inspectors" *The Independent* 26th May, p9
Abrams, F. (1995viii); "'Parents to blame' for record pupil exclusions" *The Independent* 31st May, p9
Abrams, F. (1995ix); "Blair 'happy to keep Tory schools policies'" *The Independent* 23rd June, p6
Abrams, F. (1995x); "Proposals 'are a confidence trick'" *The Independent* 23rd June, p6
Abrams, F. (1995xi); "Independent Catholic schools set to 'opt in'" *The Independent* 6th July, p8
Abrams, F. (1995xii); "Want to get rich quick? Play elsewhere" *The Independent* 7th July, p2
Abrams, F. (1995xiii); "Opted-out schools 'have much bigger classes'" *The Independent* 24th October, p4
Abrams, F. (1995xiv); "Research damns school league tables as 'meaningless' exercise" *The Independent* 20th November, p2
Abrams, F. (1995xv); "Criticism inspires comprehensive success" *The Independent* 21st November, p5
Abrams, F. (1995xvi); "Labour's tough line on schools 'is Tory echo'" *The Independent* 6th December, p5
Abrams, F. (1995xvii); "Shephard denies split over opt-out schools plan" *The Independent* 18th December, p2

Abrams, F. (1996i); "Parents will be asked to sign school contracts" *The Independent* 8th January, p2
Abrams, F. (1996ii); "An extremely select spot" *The Independent* Section II 27th June, p12
Abrams, F. (1996iii); "Parents appeal for choice of schools" *The Independent* 7th August, p5
Abrams, F. (1996iv); "Opt-out schools plan centres for problem pupils" *The Independent* 20th August, p6
Abrams, F. (1996v); "Pupils dumped in exam race" *The Independent* 21st August, p1
Abrams, F. (1996vi); "Weaker pupils sacrificed in grades chase" *The Independent* 22nd August, p2
Abrams, F. (1997i); "Tories scorn Major's nursery revolution" *The Independent* 13th March, p1
Abrams, F. (1997ii); "Tories at war over schools" *The Independent* 15th April, p1
Abrams, F. and Judd, J. (1993); "Heads say figures for truancy do not add up" *The Independent* 17th November, p6
Abrams, F. and Judd, J. (1995i); "Opt-out schools to gain £60m in 'unfair' scheme" *The Independent* 9th June, p9
Abrams, F. and Judd, J. (1995ii); "A school that fell from greatness" *The Independent* section II, 28th July, p2
Abrams, F. and Judd, J. (1995iii); "And now, a lesson from our sponsor" *The Independent* Section II, 16th November, pp12-13
Abrams, F. and Judd, J. (1997i); "'Go grammar' lure for schools" *The Independent* 14th April, p1
Abrams, F. and Judd, J. (1997ii); "Grammar schools plan in chaos" *The Independent* 21st April, p8
Adcock, C. and Hackett, G. (1995); "Opt-out head bids for 5-16s on one site" *The Times Educational Supplement* 20th January, p2
Airey, J. (1994); "School closures, but improvements too" *The Independent* 18th October, p17 [letter]
Allen, R. (1994); "Real GM dividend is in a better quality of service" *The Times Educational Supplement* 1st July, p21 [letter]
Anthony, V. (1993); "Case for league tables collapses" *The Times Educational Supplement* 3rd December, p16
Ashdown, P. (1995); "A vision for change, with price tag attached" *The Independent* 13th September, p17

Barber, M. (1994i); "The prime of R A Butler" *The Times Educational Supplement* Section II 14th January, pp1-2
Barber, M.(1994ii); "1944 and all that" *Guardian Education* 18th January, pp2-3
Barber, M. (1994iii); "Table manners" *Guardian Education* 3rd May, p4
Barber, M. (1995i); "Looking forward with hindsight" *The Times Educational Supplement* 24th February, p72
Barber, M. (1995ii); "New start for pupils sold short by council politics" *The Independent* 28th July, p4
Barber, M. (1996); "The eye of the storm" *Guardian Education* 30th January, pp2-3
Barker, B. (1995i); "Driven by fear into the results fray" *The Times Educational Supplement* Section II 10th February, p9
Barker, B. (1995ii); "Labour is locked into league tables" *The Times Educational Supplement* 5th May, p14
Barraud, J. (1994); "Class size is a vexed question worldwide" *The Independent* 8th September, p13 [letter]
Bates, S. (1995); "Shephard urged to resist vouchers" *The Guardian* 18th March, p4
Baxter, A. (1995); "Opting out is not the only answer" *The Times Educational Supplement* 13th October, p22
Beard, M. (1997); "Private investors pull out of Pimlico" *The Times Educational Supplement* 24th January, p7
Beck, K. (1995); "Shares in the classroom" *The Independent* 6th April, p27
Beckett, F. (1993); "The art of the state" *Guardian Education* 30th November, p10
Beckett, F. (1994); "No longer a vanishing species" *Guardian Education* 12th April, p3
Beischer, N. (1994); "A month-by-month admissions' plan" *Times Educational Supplement* 3rd June, Section II
Bell, M. (1996); "When choice is no choice at all" *The Times Educational Supplement* 12th April, p16
Bendelow, P. (1993); "Parents abandon the state sector" *The Times Educational Supplement* 10th September, p17
Benn, C. and Chitty, C. (1996); "Propelled by the weight of history" *The Times Educational Supplement* 10th May, p21
Bennett, G. (1994); "The truth behind the tables..." *The Times Educational Supplement* Section II 9th December, p2
Berliner, W. (1993); "A match made in Hertfordshire" *Guardian Education* 30th November, p9
Berliner, W. (1994i); "Too small to live, too good to die" and "United in everything but location" *The Independent* 3rd March, p30
Berliner, W. (1994ii); "How many prefabs fit in one garden" *The Independent* 14th July, p29
Berliner, W. (1994iii); "Proud record of school the league tables could not kill" *The Independent* school league tables special, pl
Berliner, W. (1995i); "Playgroups threaten to quit nursery voucher plan" *The Independent* 14th July, p7
Berliner, W. (1995ii); "'Hit squad' to run troubled school" *The Independent* 28th July, p1
Berliner, W. (1995iii); "Hackney Downs 'hit squad' has three options" *The Independent* 28th July, p4
Berliner, W. (1995iv); "Cabinet warned of lost battle that will cost votes" *The Independent* 15th September, p2
Berliner, W. (1995v); "Call for free hand to suspend pupils" *The Independent* 22nd September, p4
Bernadt, A. (1994); "Enforced cuts" *The Times Educational Supplement* 18th February, p21 [letter]
Bevins, A. (1993); "Scandal of £300m school rip-off by local councils" *The Observer* 14th November, p1
Blackburne, L. (1993i); "New hope in old buildings" *The Times Educational Supplement* 19th November, p4
Blackburne, L. (1993ii); "Call to divert cash into early years" *The Times Educational Supplement* 5th November, p7
Blackburne, L. (1994i); "Needy schools 'may have to opt out'" *The Times Educational Supplement* 14th January, p14
Blackburne, L. (1994ii); "Inquiry urged into 'wasted' £500m" *The Times Educational Supplement* 25th February, p3
Blackburne, L. (1994iii); "Shephard may tighten opt-out law" *The Times Educational Supplement* 28th October, p6
Blackburne, L. (1995i); "Work starts on league-table reform" *The Times Educational Supplement* 10th February, p3
Blackburne, L. (1995ii); "Lukewarm response to language selection" *The Times Educational Supplement* 30th June, p2
Blackburne, L. (1995iii); "GM schools split over opt-out ballots" *The Times Educational Supplement* 24th November, p4
Blackburne, L. and Rafferty, F. (1994); "GM sector wins most new sixth forms" *The Times Educational Supplement* 18th February, p3
Blackhurst, C. (1995); "Concern over role of governors" *The Independent* 23rd June, p6
Blair, T. (1995); "Dogmatic on goals, pragmatic on means" *The Times Educational Supplement* 23rd June, p19
Blair, T. (1996); "Far more carrot than stick" *The Times Educational Supplement* 19th January, p19
Blatchly, J. (1993); "12 heads are better than one" *The Times Educational Supplement* 24th December, 12
Blunkett, D. (1996); "Labour's Top Ten" *The Times Educational Supplement* 12th April, p14
Boggan, S. (1995); "Pride of community destroyed by inner-city tensions" *The Independent* 1st November, p3
Bolster, N. (1994); "Desperate for the right address" *The Times Educational Supplement* 23rd September, p6
Booth, C. and Hill, J. (1996); "Power without responsibility" *The Times Educational Supplement* Section II, 21st June, p20
Boseley, S. (1995); "Early learning" *Guardian Education* 23rd May, pp2-3
Bradnack, D. (1993); "Value-added survey" *Guardian Education* 7th December, p6 [letter]
Braid, M. (1994); "Pressure on governors to suspend headteacher" *The Independent* 27th January, p2
Brain, J. and Klein, R. (1994); "Like it or lump it" *The Times Educational Supplement* Section II 4th February, pp2-3

Brighouse, T. (1994); "Magicians of the inner city" *The Times Educational Supplement* Section II, 22nd April, pp2-3 [abridged text of 1994 *TES* Greenwich lecture]
Bright, M. (1996); "Bad schools 'to be run by good'" *The Observer* 29th September, p11
Brown, C. (1994); "Cash lure to increase opt-out schools" *The Independent* 28th December, p1
Brown, C. (1995i); "Major defies school governors' threats" *The Independent* 7th February, p1
Brown, C. (1995ii); "Draft report 'prepared by political advisor'" *The Independent* 15th September, p2
Brown, C. and Judd, J. (1995); "Schools that opt out may be awarded loan rights" *The Independent* 27th February, p6
Brown, C. and Rentoul, J. (1995); "Cabinet to rule on education budget" *The Independent* 1st November, p10
Budge, D. (1994i); "Study casts doubt on SATs' validity" *The Times Educational Supplement* 18th February, p14
Budge, D. (1994ii); "Small, but perfectly informed" *The Times Educational Supplement* 11th March, p12
Budge, D. (1994iii); "Happy to see snapshots of those bad old days" *The Times Educational Supplement* 7th October, p11
Budge, D. (1994iv); "Determined to grasp the value-added sword" *The Times Educational Supplement* 9th December, p10
Budge, D. (1995i); "Image moves to the top of the agenda" *The Times Educational Supplement* 13th January, p12
Budge, D. (1995ii); "Individual achievement is the selling point" *The Times Educational Supplement* 13th January, p12
Budge, D. (1995iii); "Reforms still fail to help the poorest" *The Times Educational Supplement* 3rd March, p4
Budge, D. (1995iv); "Cold shouldered in a polarised country" *The Times Educational Supplement* 3rd March, p12
Budge, D. (1995v); "A secretive partner who demands too much" *The Times Educational Supplement* 24th March, p14
Budge, D. (1996i); "Segregation still maintains a hold" *The Times Educational Supplement* 26th April, p14
Budge, D. (1996ii); "Primary tables go ahead despite protests" *The Times Educational Supplement* 3rd May, p6
Budge, D. (1996iii); "Baker sees lottery as lifeline for schools" *The Times Educational Supplement* 7th June, p1
Burstall, E. (1994); "A comeback for strict dress code" *The Times Educational Supplement* 20th May, p13
Burstall, E. (1995i); "Opt-outs seek to select 40 per cent" *The Times Educational Supplement* 31st March, p8
Burstall, E. (1995ii); "Two-tier fear over popularity pledge" *The Times Educational Supplement* 8th September, p6
Burstall, E. (1995iii); "Plea for value added in league tables" *The Times Educational Supplement* 10th November, p6
Burstall, E. (1995iv); "Exam results not key issue, says report" *The Times Educational Supplement* 17th November, p7
Burstall, E. (1996i); "Parent anger at 'bizarre' decision" *The Times Educational Supplement* 12th January, p4
Burstall, E. (1996ii); "Anger mounts over 'insulting' KS2 tables" *The Times Educational Supplement* 16th February, p14
Burstall, E. (1996iii); "Blunkett's new comprehensive ideal" *The Times Educational Supplement* 1st March, p4
Butler, C. (1995); "Why grammar schools are good for us" *The Times Educational Supplement* Section II 20th January, p2
Butler, C. (1996); "Natural case for selection" *The Times Educational Supplement* 7th June, p16

Caperon, J. (1993); "The market jungle of England" *The Times Educational Supplement* 15th October, p21
Carvel, J. (1995i); "Leaked papers reveal Tory plan to shake up teenage education" *The Guardian* 6th October, p1
Carvel, J. (1995ii); "Church schools face forced opt-out" *The Guardian* 28th October, p7
Carvel, J. (1995iii); "Bottom-of-class borough to try harder" *The Guardian* 21st November, p6
Carvel, J. and McHardy, A. (1995); "Making it all add up" *Guardian Education* 21st November, p2
Casson, D. (1993); "School dinners — for businessmen!" *The Leeds Weekly News* 25th November, p5
Castle, C. (1995); "Blair accepts opt-out schools" *Independent on Sunday* 18th June, p2
Catherall, S. (1995i); "Diocesan school to opt out after all" *The Times Educational Supplement* 1st September, p4
Catherall, S. (1995ii); "Ministers may look to New Zealand model" *The Times Educational Supplement* 1st September, p6
Chapman, C. (1993); "Value-added performance tables give students the best value" *The Times Educational Supplement* 31st December, p7 [letter]
Chitty, C. and Benn, C. (1994); "Fully comp?" *Times Educational Supplement* 3rd June, p18
Chote, R. (1993); "Repair the roof or pay the teacher?" *The Independent* 29th October, p35
Clanchy, J. (1995); "The price of independents" *The Independent* 9th March, p27
Clare, J. (1993); "Inner city schools are top of the truancy league" *The Daily Telegraph* 17th November, p1
Clare, J. (1994); "Catholic schools shine in exam league tables" *The Daily Telegraph* 22nd November, p1
Clare, J. (1994i); "Poor children do poorly" *The Daily Telegraph* 22nd November, p16
Clare, J. (1994ii); "Absence makes the marks drop lower" *The Daily Telegraph* 22nd November, p17
Clare, J. (1994iii); "Catholic ethos aids learning" *The Daily Telegraph* 22nd November, p17
Clare, J. (1994iv); "Catholic schools shine in exam league tables" *The Electronic Telegraph* 22nd November (http://www.telegraph.co.uk/)
Clare, J. (1994v); "School test results 'are not helpful to parents'" *The Electronic Telegraph* 13th December (http://www.telegraph.co.uk/)
Clare, J. (1995i); "Labour education plans: opt-out schools targeted in Blair shake-up" *The Electronic Telegraph* 23rd June (http://www.telegraph.co.uk/)
Clare, J. (1995ii); "School GCSE tables show the performance gap is widening" *The Electronic Telegraph* 21st November (http://www.telegraph.co.uk/)
Clare, J. (1996i); "Education: Labour pledge not to destroy the grammar schools' role" *The Electronic Telegraph* 1st January (http://www.telegraph.co.uk/)
Clare, J. (1996ii); "State schools give [*sic*] power to select at 11" *The Electronic Telegraph* 9th January (http://www.telegraph.co.uk/)
Clare, J. (1996iii); "Everyone is doing it, so why the fuss?" *The Electronic Telegraph* 26th January (http://www.telegraph.co.uk/)
Clare, J. (1996iv); "Choice goes to the top of the agenda" *The Electronic Telegraph* 26th June (http://www.telegraph.co.uk/)
Clare, J. (1996v); "Schools fail Parent's Charter test" *The Electronic Telegraph* 3rd September (http://www.telegraph.co.uk/)
Clare, J. and Jones, G. (1996); "A grammar stream in all schools" *The Electronic Telegraph* 25th June (http://www.telegraph.co.uk/)
Clayton, R. (1994); "A bad example" *The Times Educational Supplement* 18th February, p21 [letter]
Clement, B. (1993); "'Apprentice' system comes in a year early" *The Independent* 1st December, p8
Cooper, G. (1995); "Broad approval is tempered by scepticism" *The Independent* 7th July, p2
Corbett, A. (1994); "A measurement of how the *lycées* fare" *The Times Educational Supplement* 9th December, p11
Coryton, D. (1995); "Parents, not politicians, must rule" *The Times Educational Supplement* 8th September, p25
Coryton, D. (1996i); "Selection limits fairness and choice" *The Times Educational Supplement* 2nd February, p18
Coryton, D. (1996ii); "Polls show voters do not back selection" *The Times Educational Supplement* 29th March, p4
Coward, R. (1996); "Why the Tories have won over education" *The Guardian* 2nd September, p11

Cox, J. and Nash, I. (1995); "Cash carrots cause new split" *The Times Educational Supplement* 8th September, p14
Craig, T. (1994); "Voting for local democracy" and "For council read quango" *Guardian Education* 3rd May, pp10-11
Crequer, N. (1993); "Councils must cut jobs and axe services to keep within 2.3% limit" *The Independent* 1st December, p8
Crequer, N. (1994i); "Education official in row over size of school classes" *The Independent* 5th September, p5
Crequer, N. (1994ii); "Education changes 'fail to satisfy most parents'" *The Independent* 19th September, p5
Crook, F. (1993); "We can free the funds" *The Independent* 29th November, p14
Cunningham, S. (1995); "Class of 46 is record crowding" *The Independent* 15th September, p2

Daily Telegraph (1993); "Closer links with education urged" *The Daily Telegraph* 17th November, p33
Daily Telegraph (1994); "Moving up a league" *The Daily Telegraph* 22nd November, p26 [leading article]
Davies, H. (1994); "Private recession" *Guardian Education* 3rd May, pp6-7
Davies, R.T. (1995); "Further blessings of a religious schooling" *The Electronic Telegraph* 5th January (http://www.telegraph.co.uk/)
Davis, G. (1993); "Around the world in 80 ways" *The Times Educational Supplement* 10th September, Section II, p19
Dean, C. (1993i); "Academics attack market madness" *The Times Educational Supplement* 10th September, p2
Dean, C. (1993ii); "Kent chief condemns 'corrosive' opting out" *The Times Educational Supplement* 1st October, p1
Dean, C. (1993iii); "Christians blaze a GM trail" *The Times Educational Supplement* 1st October, p5
Dean, C. (1993iv); "Patten revels in the spotlight" *The Times Educational Supplement* 8th October, p3
Dean, C. (1993v); "Delighted to fly a kitemark" *The Times Educational Supplement* 8th October, p7
Dean, C. (1993vi); "Bullish Patten intends to 'mix it' with LEAs" *The Times Educational Supplement* 15th October, 4
Dean, C. (1993vii); "Shires pour millions into anti-cuts drive" *The Times Educational Supplement* 22nd October, p1
Dean, C. (1993viii); "Patten strives to revive opting out" *The Times Educational Supplement* 22nd October, p4
Dean, C. (1993ix); "Cashback plan for opt-out ballots" *The Times Educational Supplement* 29th October, p1
Dean, C. (1993x); "Opt-out formula remains unclear" *The Times Educational Supplement* 29th October, p6
Dean, C. (1993xi); "More delegation ordered" *The Times Educational Supplement* 29th October, p6
Dean, C. (1993xii); "GM schools rake in £26m bonus" *The Times Educational Supplement* 3rd December, p9
Dean, C. (1993xiii); "Opt-out sector to build on £120m" *The Times Educational Supplement* 24th December, p2
Dean, C. (1993xiv); "'Biased' GM leaflet revised" *The Times Educational Supplement* 31st December, p3
Dean, C. (1994i); "Judge blocks New Year opt-out" *The Times Educational Supplement* 7th January, p1
Dean, C. (1994ii); "Ministers plan new GM cash injection" *The Times Educational Supplement* 14th January, p1
Dean, C. (1994iii); "GM funding favouritism phased out" *The Times Educational Supplement* 21st January, p3
Dean, C. (1994iv); "Patten may force all secondaries to opt out" *The Times Educational Supplement* 28th January, p1
Dean, C. (1994v); "PM raises hopes of threatened counties" *The Times Educational Supplement* 28th January, p3
Dean, C. (1994vi); "Councils pull out of GM funding pilot" *The Times Educational Supplement* 4th February, p1
Dean, C. (1994vii); "New chief 'has much to learn about education'" *The Times Educational Supplement* 4th February, p4
Dean, C. (1994viii); "Class divide deepens in poll" *The Times Educational Supplement* 11th February, p3
Dean, C. (1994ix); "Watchdog to rule on DfE opt-out ads" *The Times Educational Supplement* 11th February, p4
Dean, C. (1994x); "Morality of money weighs heavy on governors" *The Times Educational Supplement* 11th February, p4
Dean, C. (1994xi); "Councils turn to law in GM cash row" *The Times Educational Supplement* 18th February, p1
Dean, C. (1994xii); "£500,000 blow to truancy battle" *The Times Educational Supplement* 18th February, p1
Dean, C. (1994xiii); "Ministers 'scared of own policy'" *The Times Educational Supplement* 15th April, p6
Dean, C. (1994xiv); "Final piece in Whitehall's jigsaw" *The Times Educational Supplement* 15th April, p6
Dean, C. (1994xv); "Staff quit as school goes GM" *The Times Educational Supplement* 22nd April, p2
Dean, C. (1994xvi); "Patten hints at end of opt-out vote" *The Times Educational Supplement* 22nd April, p6
Dean, C. (1994xvii); "No money in opting out" *The Times Educational Supplement* 29th April, p2
Dean, C. (1994xviii); "New LEA technology school set to opt out" *The Times Educational Supplement* 4th March, p9
Dean, C. (1994xix); "GM bid accused of 'dirty tricks'" *The Times Educational Supplement* 6th May, p2
Dean, C. (1994xx); "CTC recovers from early bad report" *The Times Educational Supplement* 6th May, p2
Dean, C. (1994xxi); "Reward expected for loyalty" *The Times Educational Supplement* 6th May, p11
Dean, C. (1994xxii); "'Parents misled' dossier goes to MP" *Times Educational Supplement* 3rd June, p11
Dean, C. (1994xxiii); "GM schools receive £4.7m from firms" *The Times Educational Supplement* 1st July, p2
Dean, C. (1994xxiv); "Grammar go-ahead for school in ban row" *The Times Educational Supplement* 26th August, p1
Dean, C. (1994xxv); "Moser urges action in the inner city" *The Times Educational Supplement* 9th September, p4
Dean, C. (1994xxvi); "Shephard rules out national formula" *The Times Educational Supplement* 7th October, p1
Dean, C. (1994xxvii); "GM heads fight for moral high-ground" *The Times Educational Supplement* 7th October, p5
Dean, C. (1994xxviii); "Opt-out heads just wanted to be free" *The Times Educational Supplement* 7th October, p8
Dean, C. (1994xxix); "Old values come on stream : admissions" *The Times Educational Supplement* 7th October, p8
Dean, C. (1994xxx); "Funding formula splits sector : finance" *The Times Educational Supplement* 7th October, p9
Dean, C. (1994xxxi); "A rosy picture after years of frustration : secondary" *The Times Educational Supplement* 7th October, p11
Dean, C. (1994xxxii); "GM rolls in spotlight as county calls foul" *The Times Educational Supplement* 21st October, pp1-2
Dean, C. (1994xxxiii); "Shephard defends LMS" *The Times Educational Supplement* 28th October, p2
Dean, C. (1994xxxiv); "Funding agency rattles council over places" *The Times Educational Supplement* 28th October, p3
Dean, C. (1994xxxv); "'Democratic deficit' fear" *The Times Educational Supplement* 28th October, p6
Dean, C. (1994xxxvi); "Shephard urged to chew over GM claims" *The Times Educational Supplement* 4th November, p5
Dean, C. (1994xxxvii); "High-cost CTCs fall short of excellence" *The Times Educational Supplement* 25th November, p1
Dean, C. (1995i); "Funding chief to be grilled on GM riches" *The Times Educational Supplement* 10th February, p1
Dean, C. (1995ii); "Deficit row secondary allowed to opt out" *The Times Educational Supplement* 17th March, p1
Dean, C. (1995iii); "Whitehall's secret plan to reform funding" *The Times Educational Supplement* 24th March, p1
Dean, C. (1995iv); "GM applicants change their minds" *The Times Educational Supplement* 14th April, p2
Dean, C. (1995v); "Heads dig in over future of opt-outs" *The Times Educational Supplement* 28th April, p1
Dean, C. (1995vi); "Swing to selection continues in Barnet" *The Times Educational Supplement* 28th April, p2
Dean, C. (1995vii); "Opt-out heads plan breakaway 11-plus" *The Times Educational Supplement* 12th May, p7
Dean. C. (1995viii); "Parents back Blair over opting out" *The Times Educational Supplement* 19th May, p2
Dean, C. (1995ix); "MPs defied over £40m bonus for GM schools" *The Times Educational Supplement* 9th June, p1
Dean, C. (1995x); "'No votes' in Patten's passion" *The Times Educational Supplement* 8th September, p6

Dean, C. (1995xi); "Shephard buzzes to Major's beat" *The Times Educational Supplement* 15th September, p2
Dean, C. (1995xii); "Kiss and sell mission" *The Times Educational Supplement* 15th September, p3
Dean, C. (1995xiii); "Law tightens up on lying parents" *The Times Educational Supplement* 22nd September, p10
Dean, C. (1995xiv); "Opting out cost us dear, claims head" *The Times Educational Supplement* 13th October, p2
Dean, C. (1995xv); "Parents' opt-out vote at risk" *The Times Educational Supplement* 27th October, p1
Dean, C. (1995xvi); "GM pupils excel despite larger classes" *The Times Educational Supplement* 27th October, p6
Dean, C. (1995xvii); "Latest skirmish in spending power battle" *The Times Educational Supplement* 27th October, p11
Dean, C. (1995xviii); "Opt-out fast track comes under fire" *The Times Educational Supplement* 1st December, p2
Dean, C. (1995xix); "Parents record three no votes in a row" *The Times Educational Supplement* 1st December, p2
Dean, C. (1995xx); "GM quango eager to build schools" *The Times Educational Supplement* 1st December, p9
Dean, C. (1996i); "Tories fail to lure opt-outs into the red" *The Times Educational Supplement* 19th January, p1
Dean, C. (1996ii); "GM heads say no to bank borrowing" *The Times Educational Supplement* 19th January, p3
Dean, C. (1996iii); "Agency warns of lack of GM capital" *The Times Educational Supplement* 9th February, p9
Dean, C. (1996iv); "Patten backs plan for new GM school" *The Times Educational Supplement* 23rd February, p4
Dean, C. (1996v); "Major to challenge councils on LMS" *The Times Educational Supplement* 15th March, p3
Dean, C. (1996vi); "Top comprehensive gets selection go-ahead" *The Times Educational Supplement* 24th May, p2
Dean, C. (1996vii); "Formula losers would 'squeal like pigs'" *The Times Educational Supplement* 24th May, p11
Dean, C. (1996viii); "GM advisors reject cash formula" *The Times Educational Supplement* 31st May, p7
Dean, C. (1996ix); "Favourites offered greater autonomy" *The Times Educational Supplement* 28th June, p6
Dean, C. (1996x); "Opt-out sector fears budget axe" *The Times Educational Supplement* 27th September, p5
Dean, C. (1996xi); "Proposals put decade's gains at risk, say directors" *The Times Educational Supplement* 11th October, p3
Dean, C. (1996xii); "Competition helps boost GCSE grades" *The Times Educational Supplement* 29th November, p5
Dean, C. (1996xiii); "The gulf between 'too many' and 'too few'" *The Times Educational Supplement* 20th December, p6
Dean, C. (1996xiv); "The choice conundrum" *The Times Educational Supplement* 20th December, p6
Dean, C. (1996xv); "Review GM escape route, ministers advised" *The Times Educational Supplement* 20th December, p7
Dean, C. (1996xvi); "Parents hang on to their fistful of offers" *The Times Educational Supplement* 20th December, p7
Dean, C. (1996xvii); "Alternative to letting the market reign" *The Times Educational Supplement* 20th December, p7
Dean, C. and Burstall, E. (1995); "Major pressed to cut out councils" *The Times Educational Supplement* 27th October. p3
Dean, C. and Hackett, G. (1993); "Intemperate Patten savages CEOs" *The Times Educational Supplement* 8th October. p1
Dean, C. and Hackett, G. (1995); "Major's GM dreams face election hurdle" *The Times Educational Supplement* 15th September. p1
Dean, C. and Maxwell, E. (1993i); "Schools stash away millions" *The Times Educational Supplement* 29th October, p3
Dean, C. and Maxwell, E. (1993ii); "Fee-payers face up to exam scrutiny" *The Times Educational Supplement* 19th November, p4
Dean, C., Maxwell, E. and Holdsworth, N. (1994); "GM heads to resist Labour" *The Times Educational Supplement* 7th October, p1
Dean, C. and Rafferty, F. (1996); "Ministers may drop selection to save Bill" *The Times Educational Supplement* 8th November. p1
Dean, C. with Rafferty, F. (1995); "Independent cash 'lifeline' under fire" *The Times Educational Supplement* 13th January, p3
Dettmer, J. (1993); "Business to take over city schools" *The Times Educational Supplement* 26th November, p15
Doe, B. (1995i); "Benchmark of intelligence" *The Times Educational Supplement* Section II 24th February, p7
Doe, B. (1995ii); "They also can achieve who live in the lower ranks" *The Times Educational Supplement* Section II, 27th October, p6
Dore, A. (1994i); "One third of biggest schools seek GMS" *The Times Educational Supplement* 11th February, p1
Dore, A. (1994ii); "New quango's first clash over admissions" *The Times Educational Supplement* 23rd September, p4
Dore, A. (1994iii); "Queasy about the quangocracy" *The Times Educational Supplement* 4th November, p4
Dore, A. (1994iv); "Blaydon races ahead of the rest" *The Times Educational Supplement* 2nd December, p10
Douglas, B. (1995); "Don't let a little middle tier bring you down" *The Times Educational Supplement* 20th January, p15
Downes, P. (1994); "Fair funding will need more money all round" *The Times Educational Supplement* 28th January, p17
Dunkin, G.F. (1993); "Missed point" *The Times Educational Supplement* 10th December, p16 [letter]
Dyer, R. (1994); "A quango too far" *Guardian Education* 26th April, p8 [letter]

Eaton, L. (1993); "How to build Big Brother" *The Times Educational Supplement* 15th October, Further Education supplement, pVII
Education (1994); "OFSTED backs input-output exam study" *Education* 23rd September, p228
Elkin, S. (1994); "Still learning, and a good thing too" *The Independent* 19th January, p16
Evans, R. (1994); "A key man behind the 1944 Act" *The Times Educational Supplement* 28th January, p22 [letter]

Fielding, M. (1993); "Exceptions to a silly rule" *The Times Educational Supplement* 22nd October, Section II, p5
Fisher, P. (1996); "How to get ahead without advertising" *The Times Educational Supplement* 14th June, p13
Fisher, R. (1994); "Parents 'duped' on school opt-out polls" *The Observer* 8th May, p11
Fitz-Gibbon, C. (1994); "Three routes to the wrong answer" *The Times Educational Supplement* 9th December, p11
Flint, C. (1994); "Little pleasures, crude figures" *The Times Educational Supplement* 2nd December, p18
Freed, H. (1994); "Curriculum choice" *Guardian Education* 8th February, p7 [letter]
Frisby, C. (1995); "Time to privatise state schools" *The Times Educational Supplement* 17th February, p19 [letter]

Gardiner, J. (1995i); "Opponents find the devil in the detail" *The Times Educational Supplement* 30th June, p7
Gardiner, J. (1995ii); "Individual staff to face reports" *The Times Educational Supplement* 15th September, p2
Gardiner, J. (1995iii); "An average rating in the gush-and-flush stakes" *The Times Educational Supplement* 22nd September, p4
Gardiner, J. (1995iv); "What price stability in the East End?" *The Times Educational Supplement* 29th September, p5
Gardiner, J. (1995v); "Chimera of choice frustrates parents" *The Times Educational Supplement* 6th October, p10
Gardiner, J. (1996); "Tories shoot from the lip on choice" *The Times Educational Supplement* 5th April, p5
Gardiner, J. and Rafferty, F. (1995); "Heads welcome changed stance" *The Times Educational Supplement* 23rd June, p5
Gardner, S. (1993); "When approval means truancy" *The Independent* 19th November, p17 [letter]
Gardner, S. (1994); "Give the contrary view to GM propaganda" *The Times Educational Supplement* Section II, 6th May, p6 [letter]

Garner, R. (1994); "'Failures' top of the class" *The Daily Mirror* 16th March, p6
Gerard, L. (1995i); "Education shortfall equal to 20,000 jobs" *The Independent* 22nd February, p7
Gerard, L. (1995ii); "Dilapidated schools 'make children ill'" *The Independent* 17th March, p12
Gerard, L. (1995iii); "Everyone's happy with the A-team" *The Independent* 6th April, p27
Gerard, L. (1995iv); "Labour plans to break up staff of 'failing' schools" *The Independent* 12th April, p10
Gold, K. (1993); "How they put a price on a pupil's head" *The Independent* 11th November, p33
Gold, K. (1994); "Think big, start small, and hey presto" *The Independent* 3rd February, p31
Goodwin, S. (1994); "Government 'wasted £1bn on refining curriculum'" *The Independent* 6th October, p4
Goodwin, S. (1995); "Party rejects call to abolish grant-maintained schools" *The Independent* 5th October, p10
Gordon, H. (1995); "State schools benefit from business" *Electronic Telegraph* 24th February (http://www.telegraph.co.uk/)
Gray, J. (1994i); "Iterating the not necessarily obvious" *The Times Educational Supplement* 9th December, p10
Gray, J. (1994ii); "Relative values" *The Times Educational Supplement* 16th December, p15
Green, D. (1995); "How vouchers gave hope to Harlem" *The Independent* 7th July, p19
Guardian (1993i); "Now add the value" *The Guardian* 17th November, p27 [leading article]
Guardian (1993ii); "Primary classes bigger" *The Guardian* 11th December, p5
Guardian (1994i); "New school song from Blunkett" *The Guardian* 21st November, p21 [leading article]
Guardian (1994ii); "Method in their madness" *Guardian Education* 22nd November, p4
Guardian (1995); "A school is not a business" *The Guardian* 18th March, p24 [leading article]
Guiness, J. (1994); "Sandwich short of a picnic" *The Guardian* 5th February, p26 [letter]
Gurdon, H. (1995); "State schools benefit from business" *The Electronic Telegraph* 24th February

Hackett, G. (1993i); "Cash drought may frustrate tech plan" *The Times Educational Supplement* 8th October, p3
Hackett, G. (1993ii); "Troubled opt-out centre rescued" *The Times Educational Supplement* 15th October, p1
Hackett, G. (1993iii); "Deprived children 'poorly served'" *The Times Educational Supplement* 29th October, p3
Hackett, G. (1993iv); "GM flagship foundering" *The Times Educational Supplement* 10th December, p3
Hackett, G. (1993v); "Weightings weigh down poor areas" *The Times Educational Supplement* 10th December, p5
Hackett, G. (1993vi); "Special school may follow opt-out path" *The Times Educational Supplement* 17th December, p3
Hackett, G. (1994i); "Patten looks for bridges up North" *The Times Educational Supplement* 14th January, p2
Hackett, G. (1994ii); "Comprehensives move to select" *The Times Educational Supplement* 14th January, p3
Hackett, G. (1994iii); "£13m overpaid on opt-outs" *The Times Educational Supplement* 4th February, p3
Hackett, G. (1994iv); "A healthy option for finances?" *The Times Educational Supplement* 4th February, p4
Hackett, G. (1994v); "Tables of teaching hours to go ahead" *The Times Educational Supplement* 11th February, p3
Hackett, G. (1994vi); "Failure blamed on high turnover" *The Times Educational Supplement* 11th February, p4
Hackett, G. (1994vii); "Wandsworth CTC fails inspection" *The Times Educational Supplement* 18th February, p2
Hackett, G. (1994viii); "Patten in dark over ex-gratia £25,000" *The Times Educational Supplement* 18th February, p3
Hackett, G. (1994ix); "Selective Ulster's results no better" *The Times Educational Supplement* 18th February, p4
Hackett, G. (1994x); "GM lobby reshuffle after charity probe" *The Times Educational Supplement* 4th March, p2
Hackett, G. (1994xi); "Sikhs lead the way into the GM fold" *The Times Educational Supplement* 4th March, p5
Hackett, G. (1994xii); "Go for grammar Patten advises" *The Times Educational Supplement* 4th March, p6
Hackett, G. (1994xiii); "Opt-out push freezes new places" *The Times Educational Supplement* 11th March, p3
Hackett, G. (1994xiv); "Funding agency may lose support" *The Times Educational Supplement* 11th March, p3
Hackett, G. (1994xv); "Techno-cash curb set to spark row" *The Times Educational Supplement* 25th March, p5
Hackett, G. (1994xvi); "Tories aim for private funding in GM sector" *The Times Educational Supplement* 15th April, p1
Hackett, G. (1994xvii); "Key Tory heads opt-out quango" *The Times Educational Supplement* 22nd April, p2
Hackett, G. (1994xviii); "Too much blue in the colour scheme" *The Times Educational Supplement* 22nd April, p12
Hackett, G. (1994xix); "MPs want radical funding overhaul" *The Times Educational Supplement* 29th April, p2
Hackett, G. (1994xx); "Small schools stay put" *The Times Educational Supplement* 20th May, p11
Hackett, G. (1994xxi); "College faces 'hit squad'" *The Times Educational Supplement* 3rd June, p2
Hackett, G. (1994xxii); "Tables set to measure progress" *The Times Educational Supplement* 10th June, p3
Hackett, G. (1994xxiii); "'Failed' schools set their targets" *The Times Educational Supplement* 10th June, p10
Hackett, G. (1994xxiv); "Opt-out lobby cries for help" *The Times Educational Supplement* 17th June, p3
Hackett, G. (1994xxv); "Go-ahead for GM privateers to open" *The Times Educational Supplement* 24th June, p2
Hackett, G. (1994xxvi); "A maverick's blueprint" *The Times Educational Supplement* 24th June, pp4-5
Hackett, G. (1994xxvii); "Success to mean more pupils – and problems" *The Times Educational Supplement* 1st July, p4
Hackett, G. (1994xxviii); "Council to resist extra grammars" *The Times Educational Supplement* 1st July, p5
Hackett, G. (1994xxix); "Shephard softens budget policy" *The Times Educational Supplement* 9th September, p3
Hackett, G. (1994xxx); "'Failed' school facing closure" *The Times Educational Supplement* 16th September, p4
Hackett, G. (1994xxxi); "Review chief insists no push on opt-outs" *The Times Educational Supplement* 23rd September, p5
Hackett, G. (1994xxxii); "Blair facing revolt on opt-out schools" *The Times Educational Supplement* 30th September, p2
Hackett, G. (1994xxxiii); "Catholics lead GM opt-in bids" *The Times Educational Supplement* 21st October, p3
Hackett, G. (1994xxxiv); "Tories in dilemma on small schools" *The Times Educational Supplement* 21st October, p6
Hackett, G. (1994xxxv); "Labour sends out feelers to GM sector" *The Times Educational Supplement* 4th November, p1
Hackett, G. (1994xxxvi); "Building on a £2m foundation" *The Times Educational Supplement* 4th November, p5
Hackett, G. (1994xxxvii); "What a difference some days make" *The Times Educational Supplement* 4th November, p6
Hackett, G. (1994xxxviii); "Previous years' trends confirmed" *The Times Educational Supplement* 25th November, p4
Hackett, G. (1994xxxix); "Pattern of success now established" *The Times Educational Supplement* performance tables supplement, 25th November, pi
Hackett, G. (1994xl); "Shephard invites CEOs in from cold" *The Times Educational Supplement* 2nd December, p2
Hackett, G. (1994xli); "Church turns on Blair school" *The Times Educational Supplement* 9th December, p1
Hackett, G. (1994xlii); "DfE acts on 'covert selection'" *The Times Educational Supplement* 16th December, p1
Hackett, G. (1995i); "Tories put hit squads on hold" *The Times Educational Supplement* 10th February, p14
Hackett, G. (1995ii); "Tories may let opt-out schools borrow" *The Times Educational Supplement* 17th February, p2
Hackett, G. (1995iii); "Parents say yes to tests but no to opting out" *The Times Educational Supplement* 24th February, p1
Hackett, G. (1995iv); "Return to the state unlikely" *The Times Educational Supplement* 31st March, p6
Hackett, G. (1995v); "Shephard stands firm against vouchers" *The Times Educational Supplement* 7th April, p1

Hackett, G. (1995vi); "Blair school in admissions row" *The Times Educational Supplement* 28th April, p1
Hackett, G. (1995vii); "Plea for anti-élite admissions system" *The Times Educational Supplement* 2nd June, p7
Hackett, G. (1995viii); "Vouchers are 'the key to diversity'" *The Times Educational Supplement* 9th June, p2
Hackett, G. (1995ix); "Labour's new deal to tackle selection" *The Times Educational Supplement* 9th June, p7
Hackett, G. (1995x); "Cabinet split on opt-out policy" *The Times Educational Supplement* 1st September, p3
Hackett, G. (1995xi); "Move to put fresh spark into opt-outs" *The Times Educational Supplement* 8th September, p6
Hackett, G. (1995xii); "GM selections on hold" *The Times Educational Supplement* 15th September, p3
Hackett, G. (1995xiii); "Selection approved at Blair boy's school" *The Times Educational Supplement* 22nd September, p2
Hackett, G. (1995xiv); "Blair's local loyalties in doubt" *The Times Educational Supplement* 29th September, p2
Hackett, G. (1995xv); "Labour set to shift opt-out stance" *The Times Educational Supplement* 29th September, p6
Hackett, G. (1995xvi); "GM selection with strings" *The Times Educational Supplement* 13th October, p7
Hackett, G. (1995xvii); "Less able lose out on places" *The Times Educational Supplement* 27th October, p4
Hackett, G. (1995xviii); "Churches oppose speedier opt-out" *The Times Educational Supplement* 3rd November, p3
Hackett, G. (1995xix); "Table talk centres in fears of deep divide" *The Times Educational Supplement* 24th November, p6
Hackett, G. (1995xx); "Inner-city pupils fall behind" *The Times Educational Supplement* 15th December, p1
Hackett, G. (1995xxi); "A flawed spur to improve" *The Times Educational Supplement* 15th December, p12
Hackett, G. (1995xxii); "Brakes on opt-out fast track" *The Times Educational Supplement* 22nd December, p5
Hackett, G. (1996i); "Election muddies selection change" *The Times Educational Supplement* 12th January, p4
Hackett, G. (1996ii); "The battle for the middle class" *The Times Educational Supplement* 1st March, p4
Hackett, G. (1996iii); "Labour fails to win trust of grammars" *The Times Educational Supplement* 15th March, p5
Hackett, G. (1996iv); "Tories see selection as a winner" *The Times Educational Supplement* 22nd March, p3
Hackett, G. (1996v); "White Paper to pave way to more selection" *The Times Educational Supplement* 29th March, p2
Hackett, G. (1996vi); "Tories see selection as the key" *The Times Educational Supplement* 26th April, p10
Hackett, G. (1996vii); "All aboard the selection bus" *The Times Educational Supplement* 28th June, p6
Hackett, G. (1996viii); "Heads bruised in selection scramble" *The Times Educational Supplement* 20th September, p8
Hackett, G. (1996ix); "Shephard sets results targets" *The Times Educational Supplement* 27th September, p5
Hackett, G. (1996x); "Bill would extend selection" *The Times Educational Supplement* 1st November, p3
Hackett, G. (1996xi); "Results show rise in standards is slowing" *The Times Educational Supplement* 22nd November, p4
Hackett, G. and Burstall, E. (1996); "Tories seek grammar votes" *The Times Educational Supplement* 28th June, p1
Hackett, G. and Dean, C. (1995i); "Opt-outs gather on failure list" *The Times Educational Supplement* 26th May, p2
Hackett, G. and Dean, C. (1995ii); "'Failures' turn the tables" *The Times Educational Supplement* 24th November, p1
Hackett, G. and Rafferty, F. (1995); "Bishops threaten GM push" *The Times Educational Supplement* 13th October, p1
Hagedorn, J. (1993); "A matter of choice...or is it?" *The Independent* 17th November, p2 of league tables supplement
Haigh, G. (1993i); "Message in a module" *The Times Educational Supplement* 29th October, Section II, p6
Haigh, G. (1993ii); "Torn up by the grassroots" *The Times Educational Supplement* 5th November, pp16-17
Haigh, G. (1994i); "Absorbing the shock of the new" *The Times Educational Supplement* 21st January, p6
Haigh, G. (1994ii); "Flying in the face of expectation" *The Times Educational Supplement* Primary Update section, 25th February, p5
Haigh, G. (1995); "Getting rid of the layered look" *The Times Educational Supplement* section II, 23rd June, p7
Hall, D. (1994); "We bribe, you decide" *Guardian Education* 8th February, p7 [letter]
Halpin, D., Campbell, J. and Neill, S. (1995); "Insecure amid the trappings of wealth" *The Times Educational Supplement* 9th June, p11
Hamilton, A. (1993); "When approval means truancy" *The Independent* 19th November, p17 [letter]
Hampson, C.J. (1994); "Positively pro" *The Times Educational Supplement* 1st July, p21 [letter]
Harney, E. (1993); "Teacher training" *Guardian Education* 7th December, p7 [letter]
Harries, J. (1994); "'Accountability coming out of our ears'" *The Times Educational Supplement* Section II, 29th April, p4
Hattersley, R. (1995); "Labour's big, bad idea" *The Independent* 22nd June, p19
Haylock, D. (1994); "The fruits of multiplying value" *The Times Educational Supplement* Section II 2nd December, p2
Head Teacher's Briefing (1994i); "Proposals for a new system of funding" *The Head Teacher's Briefing* Issue 62, pp4-7
Head Teacher's Briefing (1994ii); "Delegated budgets" *The Head Teacher's Briefing* Issue 62, p8
Heath, T. (1994i); "Welsh Office steps up opt-out campaign" *The Times Educational Supplement* 16th September, p13
Heath, T. (1994ii); "Minister orders re-run of anti-opt-out vote" *The Times Educational Supplement* 30th September, p15
Heath, T. (1995); "Selection plan courts controversy" *The Times Educational Supplement* 23rd June, p10
Hedley, K. (1995); "We will not bite at 'immoral' cash bait" *The Daily Telegraph* 20th September, p15
Henderson, D. (1994); "Co-op pays big dividends" *The Times Educational Supplement* 11th March, pp12-13
Herald and Post (1994); "Education today :you can afford to go private" *(Market Harborough) Herald and Post* 7th January, pp9-11 (multiple advert feature)
Heron, E. (1994); "£950,000 GM 'bribe' angers council" *The Times Educational Supplement* 21st January, p4
Hetherington, P. (1993i); "Two schools given 40-day standards deadline" *The Guardian* 4th December, p6
Hetherington, P. (1993ii); "Failures blamed on Whitehall cash squeeze" *The Guardian* 4th December, p6
Hibbs, J. (1995i); "Major cool on grammar school plan" *The Daily Telegraph* 29th March, p8
Hibbs, J. (1995ii); "Tory split over pressure to make schools opt out" *Electronic Telegraph* 25th August (http://www.telegraph.co.uk/)
Hill, D. (1994); "Choice in a cul-de-sac" *The Guardian* 22nd November, p24
Hillmore, P. and McKay, R. (1996); "Of class and classes" *The Observer* 28th January, p15
Hinds, D. (1993i); "Governors are in business" *The Independent* 14th October, p31
Hinds, D. (1993ii); "'Losers' claim justifiable pride at progress" *The Independent* 17th November, p6
Hinds, D. (1994i); "Teachers give welcome tinged with scepticism" *The Independent* 6th January, p4
Hinds, D. (1994ii); "The annual bout of out or in" *The Independent* 6th January, p28
Hinds, D. (1995); "Choice spells homework for parents" *The Independent* 23rd February, p31
Hodges, L. (1994); "Profiting from decline" *The Times Educational Supplement* 4th March, p18
Hodges, L. and Young, S. (1995); "Privatised schools on Tory itinerary" *The Times Educational Supplement* 26th May, p1
Hofkins, D. (1994i); "More say Minister has the power" *The Times Educational Supplement* 18th February, p14
Hofkins, D. (1994ii); "'Failing' school switches to ability banding" *The Times Educational Supplement* 17th June, p3
Hofkins, D. (1994iii); "Parents disgruntled at growing classes" *The Times Educational Supplement* 14th October, p13

Hofkins, D. (1994iv); "Expulsions rocket to double 1991 total" *The Times Educational Supplement* 28th October, p2
Hofkins, D. (1995i); "Deprivation is the common factor" *The Times Educational Supplement* 10th February, p14
Hofkins, D. (1995ii); "Girls outperform boys at school-entry stage" *The Times Educational Supplement* 24th March, p3
Hofkins, D. (1995iii); "Tests provoke fear of return to 11-plus ethos" *The Times Educational Supplement* 31st March, p8
Hofkins, D. (1995iv); "A shining example of inner-city success" *The Times Educational Supplement* 30th June, p5
Holderness, M. (1994); "Station to station" *The Times Educational Supplement* 14th January, p16
Holdsworth, N. (1993i); "Omnibus of choice a bus ride away" *The Times Educational Supplement* 15th October, p14
Holdsworth, N. (1993ii); "Battle for heart and minds" *The Times Educational Supplement* 15th October, p14
Holdsworth, N. (1993iii); "No double checking for exam tables" *The Times Educational Supplement* 5th November, p11
Holdsworth, N. (1994i); "Surplus wishes hard to grant" *The Times Educational Supplement* 25th March, p8
Holdsworth, N. (1994ii); "Catalyst to fire towns' imagination" *The Times Educational Supplement* 3rd June, p10
Holdsworth, N. (1994iii); "When bigger is not better" *The Times Educational Supplement* 1st July, p5
Holdsworth, N. (1994iv); "How to fight back against deprivation" *The Times Educational Supplement* 16th September, p15
Holdsworth, N. (1994v); "Promise of extra funding largely realised : church" *The Times Educational Supplement* 7th October, p10
Holdsworth, N. (1994vi); "County to test minister's zest for opting out" *The Times Educational Supplement* 14th October, p8
Holdsworth, N. (1995); "Parents see victory soon on closures" *The Times Educational Supplement* 1st September, p7
Hollbrook, C. (1994); "How many surpluses in a bandwagon?" *The Times Educational Supplement* 25th March, p20 [letter]
Holliday, J (1994); "Class concerns in Warwickshire : why should rural communities lose out?" *The Independent* 11th October, p15 [letter]
Hugill, B. (1993); "School inspections in crisis" *The Observer* 19th December, p2
Hugill, B. (1994i); "Backbench challenge to Patten on school funds" *The Observer* 24th April, p2
Hugill, B. (1994ii); "School to start at age of four" *The Observer* 4th September, p1
Hugill, B. (1994iii); "Top comprehensive plans 11-plus exam" *The Observer* 18th December, p2
Hugill, B. and McSmith, A. (1996); "Blair wants best teachers for failing schools" *The Observer* 28th January, p1
Hugill, B. and Narayan, N. (1996); "A lesson in hypocrisy" *The Observer* 28th January, pp14-15
Humphries, E. (1996); "More mark cards for share of lottery cash" *The Times Educational Supplement* 19th January, p3

Independent (1993i); "Nurseries: we can afford them" *The Independent* 16th November, p17 [leading article]
Independent (1993ii); "Get into business of education, says Patten" *The Independent* 17th November, p33
Independent (1993iii); "Minister 'sneaking in' selective schools plan" *The Independent* 30th December, p2
Independent (1994i); "Truancy tables" *The Independent* 1st February, p4
Independent (1994ii); "Poverty measure" *The Independent* 1st February, p4
Independent. (1994iii); "Q.A. written replies: assisted places" *The Independent* 16th February, p8
Independent (1994iv); "Spare places will mean schools close" *The Independent* 7th March, p3
Independent (1994v); "School history review was a 'botched job'" *The Independent* 16th March, p9
Independent (1994vi); "'Random selection at schools fair'" *The Independent* 28th July, p3
Independent (1994vii); "Size isn't everything in the classroom" *The Independent* 6th September, p11 [leading article]
Independent (1994viii); "Counting the cost of parental choice" *The Independent* 7th October, p17 [leading article]
Independent (1994ix); "Ideology leaves the classroom" *The Independent* 19th October, p17 [leading article]
Independent (1994x); "Study reveals league table problems" *The Independent* 10th November, p28
Independent (1995i); "A farewell to arm-wrestling" *The Independent* 2nd March, p16 [leading article]
Independent (1995ii); "Vouchers for the kids" *The Independent* 7th July, p20
Independent (1995iii); "Last chance for Hackney Downs" *The Independent* 28th July, p14 [leading article]
Independent (1995iv); "Opening up the school cabinet" *The Independent* 15th September, p20 [leading article]
Independent (1996); "Luring parents past the school gates" *The Independent* 9th January, p14 [leading article]
Independent on Sunday (1995); "A slip on the nursery slope" *Independent on Sunday* 9th July, p24
Independent on Sunday (1996); "Four lies to tell parents" *Independent on Sunday* 30th June, p20 [leading article]

Jarvis, F., O'Connor, M. and Vickers, J. (1994); "Brighouse fund" *The Times Educational Supplement* 7th January, p20 [letter]
Jarvis, J. (1993); "Government tables" *Guardian Education* 7th December, p6 [letter]
Jenkins, S. (1993); "Unwillingly to school" *The Times* 17th November, p16
Jepson, J.S. (1993); "When approval means truancy" *The Independent* 19th November, p17 [letter]
Jones, G. (1993); "Ashdown urges penny tax for investment in schools" *The Daily Telegraph* 17th November, p11
Jones, G. (1995i); "Opt-out schools to be given greater freedom to choose pupils" *The Electronic Telegraph* 12th September (http://www.telegraph.co.uk/)
Jones, G. (1995ii); "Labour bans school selection" *The Electronic Telegraph* 5th October (http://www.telegraph.co.uk/)
Jones, N. (1995); "Choosing an inner-city school is harder than winning the lottery" *The Independent* Section II, 16th November, p13
Joseph, C. (1994); "Showpiece city college 'is failing its pupils'" *The Independent* 15th February, p5
Judd, J. (1993i); "Patten calls schools chief a nutter" *The Independent* 7th October, p1
Judd, J. (1993ii); "City's underspend on schools put at £250m" *The Independent* 10th November, p8
Judd, J. (1993iii); "Success at GCSE 'can hide weaknesses in basic skills'" *The Independent* 30th November, p2
Judd, J. (1993iv); "Short school hours 'equal to a year's lost teaching'" *The Independent* 8th December, p6
Judd, J. (1993v); "Most schools break law on religious education" *The Independent* 10th December, p3
Judd, J. (1993vi); "Patten is criticised over school dismissal" *The Independent* 22nd December, p3
Judd, J. (1993vii); "Children in primary classes of more than 30 increase" *The Independent* 22nd December, p6
Judd, J. (1994i); "National curriculum is torn up" *The Independent* 6th January, p1
Judd, J. (1994ii); "Unions divided over Dearing proposals" *The Independent* 6th January, p4
Judd, J. (1994iii); "Gravy train slows down" *The Independent* 6th January, p28
Judd, J. (1994iv); "Selling out on ideals to attract a better class" *The Independent* 29th January, p33
Judd, J. (1994v); "Patten warns schools not to shun act of worship" *The Independent* 1st February, p9
Judd, J. (1994vi); [no title] *The Independent* 15th February, p5
Judd, J. (1994vii); "Twelve new specialist schools to get £3m" *The Independent* 1st March, p5
Judd, J. (1994viii); "Nursery plan seen by Major as vote-winner" *The Independent* 15th March, p3
Judd, J. (1994ix); "Minister admits flaws in vocational qualifications" *The Independent* 2nd March, p8

Judd, J. (1994x); "Patten 'hedges' on compulsory opting out call" *The Independent* 20th April, p6
Judd, J. (1994xi); "How red tape tied the hands of teachers" *The Independent* 12th May, p31
Judd, J. (1994xii); "Error 'robs schools of £69m in grants'" *The Independent* 9th June, p3
Judd, J. (1994xiii); "When big does not mean beautiful" *The Independent* 14th July, p29
Judd, J. (1994xix); "Shephard bids for centre ground on schools" *The Independent* 19th October, p1
Judd, J. (1994xx); "Shephard prepares for a period of calm pragmatism" *The Independent* 19th October, p10
Judd, J. (1994xxi); "How hard lessons led to better marks" *The Independent* 3rd November, p30
Judd, J. (1994xxii); "Dearing cure of curriculum ills calms teachers" *The Independent* 11th November, p3
Judd, J. (1994xxiii); "'Value-added' issue taxes politicians" *The Independent* school league tables special, pl
Judd, J. (1994xxiv); "Schools 'hoarding thousands of pounds'" *The Independent* 1st December, p12
Judd, J. (1994xxv); "Raise the standard higher" *The Independent* 1st December, p34
Judd, J. (1994xxvi); "Value-added school tables agreed" *The Independent* 6th December, p3
Judd, J. (1994xxvii); "Think-tank backs £700 nursery vouchers" *The Independent* 8th December, p10
Judd, J. (1994xxviii); "Schools' bar on reporting test results is waning" *The Independent* 13th December, p7
Judd, J. (1995i); "School governors *vs.* the Government" *The Independent* 7th February, p13
Judd, J. (1995ii); "Schools 'should go into the red'" *The Independent* 22nd February, p7
Judd, J. (1995iii); "Parents challenge school place 'lottery'" *The Independent* 24th February, p3
Judd, J. (1995iv); "Gummer dashes hopes of a school cuts reprieve" *The Independent* 28th February, p6
Judd, J. (1995v); "Parents seek reform of school funding" *The Independent* 2nd March, p9
Judd, J. (1995vi); "School fees aid 'misses target'" *The Independent* 9th March, p10
Judd, J. (1995vii); "Clarke in favour of nursery vouchers" *The Independent* 17th March, p3
Judd, J. (1995viii); "Pupils put up with fleas and leaking huts" *The Independent* 17th March, p12
Judd, J. (1995ix); "A battle for the brighter pupil" *The Independent* 6th April, p27
Judd, J. (1995x); "Redwood targets school standards" *The Independent* 7th April, p6
Judd, J. (1995xi); "Opted-out schools teach fewer poor pupils" *The Independent* 25th May, p10
Judd, J. (1995xii); "Is opting out more than cashing in?" *Independent on Sunday* 18th June, p10
Judd, J. (1995xiii); "Pupils' poor performance blamed on parents" *The Independent* 6th July, p8
Judd, J. (1995xiv); "Nursery vouchers cost councils £70m" *The Independent* 31st July, p4
Judd, J. (1995xv); "State schools 'falling behind'" *The Independent* 31st July, p4
Judd, J. (1995xvi); "Popular schools in Wales to get £20m" *The Independent* 6th September, p7
Judd, J. (1995xvii); "Middle classes get wise over schools" *The Independent* 18th September, p7
Judd, J. (1995xviii); "Call for compulsory nurseries" *The Independent* 21st September, p2
Judd, J. (1995xix); "Curriculum 'stifles schools'" *The Independent* 25th September, p7
Judd, J. (1995xx); "Public school heads seek funding for more places" *The Independent* 11th October, p7
Judd, J. (1995xxi); "Schools to be marked on pupil performance" *The Independent* 17th October, p7
Judd, J. (1995xxii); "Failed school to be shut down" *The Independent* 1st November, p1
Judd, J. (1995xxiii); "Inner-city schools find elusive key to success" *The Independent* 9th November, p6
Judd, J. (1995xxiv); "Church protest delays opt-out plans" *The Independent* 16th November, p6
Judd, J. (1995xxv); "Teacher fury as Blair hits at schools" *The Independent* 6th December, p1
Judd, J. (1995xxvi); "Parties match each other with policies : analysis" *The Independent* 6th December, p5
Judd, J. (1995xxvii); "Church schools want ballots, too" *The Independent* 19th December, p17
Judd, J. (1996i); "Selection unlikely for majority of schools" *The Independent* 4th January, p6
Judd, J. (1996ii); "Choice on merit keeps comprehensive spirit" *The Independent* 4th January, p6
Judd, J. (1996iii); "Schools plan attacked by critics as 'social selection'" *The Independent* 9th January, p5
Judd, J. (1996iv); "Half nation's schools fail to make grade" *The Independent* 6th February, p1
Judd, J. (1996v); "Major fails his 11-plus test" *The Independent* 26th June, p1
Judd, J. (1996vi); "Schools 'cull A-level hopefuls to keep league table position'" *The Independent* 30th September, p5
Judd, J. (1996vii); "Nightmare for parents over school choice" *The Independent* 10th October, p10
Judd, J. (1997i); "Bad results to cost jobs of teachers" *The Independent* 12th February, p1
Judd, J. (1997ii); "League tables lost on half of parents" *The Independent* 13th February, p9
Judd, J. (1997iii); "Poor marking flaws primary tests, says study" *The Independent* 6th March, p4
Judd, J. (1997iv); "Test tables are trickery, say teachers" *The Independent* 11th March, p5
Judd, J. (1997v); "The parents who cheat for their children" *The Independent* 17th April, p6
Judd, J. and Abrams, F. (1993); "Commission urges radical changes in education" *The Independent* 16th November, p3
Judd, J. and Abrams, F. (1994i); "Teachers welcome curriculum" *The Independent* 11th November, p1
Judd, J. and Abrams, F. (1994ii); "Schools improve GCSE results" *The Independent* 22nd November, p1
Judd, J. and Abrams, F. (1995i); "Shows improvement, but could do better" *The Independent* 1st February, p17
Judd, J. and Abrams, F. (1995ii); "Labour emasculates opted-out schools" *The Independent* 22nd June, p2
Judd, J. and Abrams, F. (1995iii); "Parents to be given nursery vouchers" *The Independent* 7th July, p2
Judd, J. and Abrams, F. (1995iv); "A child of four could see the problems" *The Independent* 7th July, p19
Judd, J. and Abrams, F. (1995v); "Best and worst schools grow further apart" *The Independent* 21st November, p5
Judd, J. and Brown, C. (1995); "Schools plan short-time working" *The Independent* 8th February, p1
Judd, J. and Crequer, N. (1994); "Major drops nursery places pledge" *The Independent* 15th March, p1
Judd, J. and Rentoul, J. (1995); "Major allows opted-out schools to select pupils" *The Independent* 13th September, p2
Judd, J. and Ward, L. (1997); "A-levels remain on the gold standard" *The Independent* 12th February, p7
Jury, L. (1995); "How to achieve against the odds" *The Independent* 9th November, p6

Kelly, A. (1994); "Table talk ought to mention free dinners" *The Independent* 24th November, p34
Kendell, R.I. (1993); "Lies, damned lies and league tables" *Guardian Education* 14th December, p8 [letter]
Kingston, P. (1993); "Cultivating green shoots" *Guardian Education* 7th December, pp2-3
Kingston, P. (1994i); "1944 and all that" *Guardian Education* 16th January, p3
Kingston, P. (1994ii); "Comprehensive challenge" *Guardian Education* 16th January, p4
Kingston, P. (1994iii); "The ballot of Britain" *Guardian Education* 24th May, pp2-3
Kirkman, S. (1994); "Families trapped by catchment 22" *The Times Educational Supplement* 7th January, p18
Kirkman, S. (1996); "A really good school is well worth cheating for" *The Times Educational Supplement* 29th November, p12

Klein, R. (1996); "Race inequality 'as bad as ever'" *The Times Educational Supplement* 6th September, p13
Knight, C. (1993); "Grant-maintained and just loving it" *The Times Educational Supplement* 8th October, p18
Knight, C. (1994); "No turning back for this quiet revolution" *The Times Educational Supplement* 3rd June, p21 [letter]
Küchemann, D.E. (1993); "Value-added survey" *Guardian Education* 7th December, p6 [letter]
Kuyser, S. (1994); "Howard's gang of eight" *The Times Educational Supplement* 25th February, p6

Lane, A. (1994); "Who will step into the breach?" *The Times Educational Supplement* 14th January, p6
Lane, G. (1994); "Half-baked ideas will destroy state education" *The Times Educational Supplement* Section II, 6th May, p6 [letter]
Lang, T. (1993); "A free lunch now will save cash later" *The Independent* 29th November, p15
Lawson, D. (1993); "Housebuyers drawn into schools' magnetic field" *The Independent* 27th November, p48
Leary, M. (1993); "Teacher trauma" *Guardian Education* 9th November, p3
Lepkowska, D. (1995i); "Opt-outs led into finance 'grey area'" *The Times Educational Supplement* 3rd March, p2
Lepkowska, D. (1995ii); "Councils clash on selection" *The Times Educational Supplement* 26th May, p4
Lepkowska, D. (1995iii); "The right direction, says opted out head" *The Times Educational Supplement* 23rd June, p4
Lepkowska, D. (1995iv); "Shephard approves massive overhaul" *The Times Educational Supplement* 30th June, p3
Lepkowska, D. (1995v); "Opt-out 'trickle' continues" *The Times Educational Supplement* 30th June, p6
Luke, H.B. (1994); "Formula that won't add up" *The Times Educational Supplement* 18th March, p23 [letter]
LWN (1993i); "New unit for under eights" *The Leeds Weekly News* 25th November, p7
LWN (1993ii); "Sponsor a pupil scheme" *The Leeds Weekly News* 25th November, p9

McAdam, N. (1994); "Province to increase integrated schooling" *The Times Educational Supplement* 21st October, p8
McAdam, N. (1996); "Ulster board considers abolishing 11-plus" *The Times Educational Supplement* 12th January, p4
McAleese, K. (1994); "The loneliness of the axe-wielding head" *The Times Educational Supplement* School Management Supplement 4th November, pp4-5
MacBride, A. (1996); "Labour voters want the best for their children, too" *The Times Internet Edition* 26th January (http://www.the-times.co.uk/)
McGavin, H. (1995); "Head to challenge 'flawed' report" *The Times Educational Supplement* 10th February, p14
McGill, P. (1993); "Centres of excellence" *Guardian Education* 30th November, p9
McGill, P. (1994); "Turning the tables" *Guardian Education* 22nd November, pp2-3
McGill, P. and Dean, C. (1995); "GM reserves top £74m" *The Times Educational Supplement* 3rd February, p1
McSmith, A. (1994); "£20m bill for empty desks in opt-out schools" *The Observer* 17th April, p6
Macintyre, D. (1994); "The Tories are still in trouble at school" *The Independent* 7th January, p17
Macintyre, D. (1995i); "Shephard paper admits schools are short of cash" *The Independent* 15th September, p1
Macintyre, D. (1995ii); "Blair backed over opt-out schools" *The Independent* 5th October, p1
Macintyre, D. (1995iii); "Blair to take 'education crusade' to the country" *The Independent* 7th December, p8
Macintyre, D. and Abrams, F. (1995); "Major orders blueprint for all schools to opt out" *The Independent* 4th September, p1
Macintyre, D. and Judd, J. (1995); "Blair makes U-turn on education" *The Independent* 22nd June, p1
MacLeod, D. (1991); "A truer way to chart progress" *The Independent* 10th October, p17
MacLeod, D. (1993i); "Review puts Patten to test" *The Guardian* 13th November, p1
MacLeod, D. (1993ii); "Commission's call for more education cash embarrasses Government" *The Guardian* 13th November, p5
MacLeod, D. (1993iii); "Spending static for 10 years says blueprint for change" *The Guardian* 16th November, p4
MacLeod, D. (1993iv); "Teaching hours to be put in league tables" *The Guardian* 8th December, p5
MacLeod, D. (1993v); "Bullying blamed on poor teaching" *The Guardian* 8th December, p5
MacLeod, D. (1993vi); "Britain lagging on student numbers" *The Guardian* 8th December, p5
MacLeod, D. (1993vii); "Slings and arrows" *Guardian Education* 14th December, p2
MacLeod, D. (1994i); "Inspectors censure flagship grant school" *The Guardian* 5th February, p50
MacLeod, D. (1994ii); "Think-tank calls for vouchers to fund nursery education" *The Guardian* 19th March, p5
MacLeod, D. (1994iii); "Across the divide" *Guardian Education* 22nd March, p4
MacLeod, D. (1994iv); "Censured opt-out school sets 3-year goal for GCSE results" *The Guardian* 26th March, p10
MacLeod, D. (1994v); "Quango man" *Guardian Education* 12th April, p2
MacLeod, D. (1994vi); "CTCs aim to do better" *The Guardian* 22nd November, p5
MacLeod, D. (1995i); "Anger at education cuts alarms Tories" *The Guardian* 28th January, p7
MacLeod, D. (1995ii); "Exam attack on opt-out pioneer" *The Guardian* 6th May, p6
MacLeod, D. (1995iii); "Blair advisor finds 3,000 'bad' schools" *The Guardian* 13th May, p10
MacLeod, D. (1996); "'Harman factor' fear as schools seek selection" *The Guardian* 2nd September, p2
MacLeod, D. and Meikle, J. (1993); "Patten aims to cut costs by FE boost" *The Guardian* 6th November, p10
MacShane, D. (1996); "Enough to try the patience of St. Olave" *The Times Internet Edition* 26th January (http://www.the-times.co.uk/)
Macwhirter, I. (1996); "In knots over old school ties" *The Observer (Review section)* 28th January, p3
Mace, J.R. (1993); "It's just not fair" *The Times Educational Supplement* 29th October, p16 [letter]
Maden, M. (1995); "Welcome for more fairness" *The Times Educational Supplement* 30th June, p20
Maden, M. (1996); "A tale of two tribes" *The Times Educational Supplement* Section II, 10th May, pp3-4
Marr, A. (1994); "Every school should be fit for a Blair" *The Independent* 20th December, p15
Marr, A. (1995); "Egalitarians versus angry parents" *The Independent* 5th October, p21
Marston, P. (1994); "School tables may add progress points" *The Electronic Telegraph* 6th December (http://www.telegraph.co.uk/)
Marston, P. (1995i); "Must try harder" *The Electronic Telegraph* 10th March (http://www.telegraph.co.uk/)
Marston, P. (1995ii); "How the best schools cash in on success" *The Daily Telegraph* 29th March, p17
Marston, P. (1995iii); "Must do better, can do better" *The Electronic Telegraph* 4th August (http://www.telegraph.co.uk/)
Marston, P. (1995iv); "One school right the way through" *The Electronic Telegraph* 14th August (http://www.telegraph.co.uk/)
Marston, P. (1995v); "Breaking out of 'status zero'" *The Electronic Telegraph* 10th November (http://www.telegraph.co.uk/)
Marston, P. (1995vi); "Freedom to help the needy" *The Electronic Telegraph* 1st December (http://www.telegraph.co.uk/)
Marston, P. (1996); "Dual approach offers a model for the future" *The Electronic Telegraph* 26th June (http://www.telegraph.co.uk/)

Martinson, J. (1994); "Opt-out trickle is still long way from a flood" *The Times Educational Supplement* 4th March, p17
Maslen, G. (1996); "League tables provoke uproar" *The Times Educational Supplement* 27th September, p18
Maxwell, E. (1993); "Solidarity with the underdogs" *The Times Educational Supplement* 19th November, p4
Maxwell, E. (1994i); "'Bribes' claim may be tested in court" *The Times Educational Supplement* 4th March, p9
Maxwell, E. (1994ii); "Marked by a major lack of interest" *The Times Educational Supplement* 18th March, p12
Maxwell, E. (1994iii); "Unions condemn Patten plan as unworkable" *The Times Educational Supplement* 1st July, p4
Maxwell, E. (1994iv); "Delighted to escape" *The Times Educational Supplement* 7th October, p8
Maxwell, E. (1995); "State high-flyers are selecting now" *The Times Educational Supplement* 24th November, p7
Maxwell, E. and Rafferty, F. (1995); "Governors seek cash as class sizes swell" *The Times Educational Supplement* 6th January, p1
Meikle, J. (1993i); "Cradle-to-grave learning goals" *The Guardian* 16th November, p4
Meikle, J. (1993ii); "Inner cities falter in £2m school tables" *The Guardian* 17th November, p1
Meikle, J. (1993iii); "Patten call to arms on checking truancy" *The Guardian* 27th November, p3
Meikle, J. (1993iv); "From the raw to the refined" *Guardian Education* 30th November, p2
Meikle, J. (1994i); "Not voting with their feet" *Guardian Education* 18th January, p5
Meikle, J. (1994ii); "Patten faces new row over parent power" *The Guardian* 29th January, p6
Meikle, J. (1994iii); "Arrests drop by half in truancy-free zone" *The Guardian* 29th January, p8
Meikle, J. (1994iv); "Tories 'pack' schools quango" *The Guardian* 23rd February, p4
Meikle, J. (1994v); "Patten urges heads to push through tests" *The Guardian* 19th March, p5
Meikle, J. (1994vi); "Teachers face bigger classes" *The Guardian* 21st May, p8
Meikle, J. (1994vii); "Two in three schools boycott tests at 14" *The Guardian* 28th May, p10
Meikle, J. (1994viii); "Patten scraps exclusion list" *The Guardian* 28th May, p10
Meikle, J. (1994ix); "League tables 'a boost to exam results'" *The Guardian* 22nd November, p5
Meikle, J. (1995); "Shephard prompts new school cash row" *The Guardian* 25th February, p3
Merrick, N. (1994); "Sharp practice in good faith" *The Times Educational Supplement* Update Section 21st January, p16
Merrick, N. (1996); "Nothing so common as luck" *The Times Educational Supplement* Section II, 28th June, p21
Middleton, A. (1994); "Better way of funding exists" *The Times Educational Supplement* 25th February, p25 [letter]
Millar, G. (1994); "Till we can clear these ambiguities..." *Guardian Education* 15th February, p7
Miller, P. (1995); "Listen to the people actually doing the job" *The Times Educational Supplement* 30th June, p20
Mitchell, L. (1993); "Focusing on results hurts the weakest" *The Times Educational Supplement* 31st December, p7 [letter]
Montgomery, J. (1996); "Grammar school idea 'forced through'" *The Times Educational Supplement* 3rd May, p9
Mortimore, Professor P. (1994); "Class size is a vexed question worldwide" *The Independent* 6th September, p13 [letter]
Moyes, J. (1995); "School closure greeted with boos by pupils" *The Independent* 1st November, p3
Munro, N. (1995); "Robertson seeks way out of self-rule jam" *The Times Educational Supplement* 1st September, p6
Murphy, R. (1995i); "Social class and the birth rate influence exam grades" *The Independent* section II, 31st August, pp14-15
Murphy, R. (1995ii); "You can't sum it up in a soundbite" *The Independent* section II, 5th October, p15
Myers, K. (1994); "Admiring glances" *The Times Educational Supplement* Section II 24th June, p7

Nash, I. (1994i); "Postcode poverty incentive for FE" *The Times Educational Supplement* 4th February, p4
Nash, I. (1994ii); "Colleges suspect dirty tricks" *The Times Educational Supplement* 16th September, p1
Nash, I. (1995i); "Crowded school loses out to developer" *The Times Educational Supplement* 30th June, p1
Nash, I. (1995ii); "Will Blair take it further?" *The Times Educational Supplement* 30th June, p7
Nash, I. and Prestage, M. (1994); "Labour challenges funding appointment" *The Times Educational Supplement* 4th February, p3
Newsam, P. (1995i); "How to replace the noose and the garland" *The Times Educational Supplement* 27th January, p17
Newsam, P. (1995ii); "A skewed arithmetic of choice" *The Times Educational Supplement* 1st December, p18
Newsam, P. (1996i); "Take the terminology to task" *The Times Educational Supplement* 22nd March, p13
Newsam, P. (1996ii); "What now for inner London?" *The Times Educational Supplement* 26th April, p22
Newsam, P. (1996iii); "Capital idea" *The Times Educational Supplement* 7th June, p16
Nicholson-Lord, D. (1994); "Wealth gap 'will widen over next five years'" *The Independent* 1st February, p6
Norman, M. (1994); "How Blunkett got lost in the blackboard jungle" *The Times* 22nd November, p18
Norris, B. (1993); "Firm proves pupils and profits do mix" *The Times Educational Supplement* 15th October, p17

O'Connor, M. (1994i); "Listen to the Mamas and the Papas" *The Times Educational Supplement* 25th February, p13
O'Connor, M. (1994ii); "Governors too big for their boots?" *The Observer/OPUS Technology* schools special, 13th March, p12
O'Connor, M. (1994iii); "Rising to a city challenge" *The Independent* 1st December, p34
O'Connor, M. (1996i); "Look to the needs of the individual" *The Times Educational Supplement* 16th February, p17
O'Connor, M. (1996ii); "Fully comp but losing out to third parties" *The Times Educational Supplement* 22nd March, p12
O'Connor, M. (1996iii); "Appalled by some unnatural selection" *The Times Educational Supplement* 22nd March, pp12-13
O'Leary, J. (1993i); "Protests dog school league tables" *The Times* 17th November, p1-2
O'Leary, J. (1993ii); "All together in the league tables" *The Times* 17th November school league tables supplement, p1
O'Leary, J. (1994i); "Head teachers say league tables are crude and flawed" *The Times* 22nd November, p5
O'Leary, J. (1994ii); "League tables are passing the test" *The Times* school league tables special 22nd November, p1
O'Leary, J. and Preston, B. (1994); "Britain's most improved school" *The Times* 22nd November, p1
O'Shea, P. (1995); "Still waiting for the revolution" *The Times Educational Supplement* 1st September, p17
Observer (1996); "The need for comprehensive change" *The Observer (Review section)* 28th January, p3
Ogle, R. (1994); "Not in the same league" *The Independent* 24th November, p34

Parker, A. (1995); "Striking at the heart of local democracy" *The Times Educational Supplement* 27th January, p18
Passmore, B. (1993i); "Putting the Boots man in" *The Times Educational Supplement* 22nd October, p5
Passmore, B. (1993ii); "Survival of the slickest" *The Times Educational Supplement* 12th November, p11
Passmore, B. (1994i); "Continental drift" *The Times Educational Supplement* Section II 21st January, pp1-2
Passmore, B. (1994ii); "Seven deadly questions to heads" *The Times Educational Supplement* 6th May, p11
Passmore, B. (1994iii); "Researchers let loose on value added" *The Times Educational Supplement* 13th May, p8
Passmore, B. (1994iv); "Indexing improvement" *The Times Educational Supplement* 2nd December, p10
Passmore, B. (1995i); "Welsh set to bid for minister's £20m" *The Times Educational Supplement* 10th February, p9

Passmore, B. (1995ii); "London searches for improvement" *The Times Educational Supplement* 10th March, p8
Passmore, B. (1995iii); "Will they call the whole thing off?" *The Times Educational Supplement* 22nd September, p4
Passmore, B. (1996i); "Escape route sought from private sector" *The Times Educational Supplement* 1st March, p6
Passmore, B. (1996ii); "Admissions draft comes under fire" *The Times Educational Supplement* 8th March, p9
Passmore, B. (1996iii); "Thatcher legacy is 'more parental choice'" *The Times Educational Supplement* 11th October, p6
Patten, J. (1993); "A learning-by-choice revolution" *The Independent* 5th April, p?
Penn, H. (1993); "Careless society" *Guardian Education* 7th December, p4
Perri 6 (1995); "Voucher system would be fair for all" *The Independent* 9th January, p14
Pick, M. (1996); "Face up to the class divide" *The Times Educational Supplement* 26th April, p22
Pithers, M. (1993); "Parents bemused by verdict on primary school" *The Independent* 4th December, p5
Pointon, B. (1994); "Class concerns in Warwickshire : why should rural communities lose out?" *The Independent* 11th October, p15 [letter]
Poole, T. (1993); "Chinese scramble for private school places" *The Independent* 13th November, p12
Prestage, M. (1993); "Pupil poaching angers head" *The Times Educational Supplement* 17th December, p3
Prestage, M. (1994i); "Funding hope for self-help pioneers" *The Times Educational Supplement* 18th February, p14
Prestage, M. (1994ii); "Cutting up rough over 'glib' proposal" *The Times Educational Supplement* 1st July, pp4-5
Prestage, M. (1995i); "Shephard backs city grammars" *The Times Educational Supplement* 10th February, p5
Prestage, M. (1995ii); "GM head fears 'halfway house'" *The Times Educational Supplement* 30th June, p7
Prestage, M. (1996i); "Catholic independent opts into state system" *The Times Educational Supplement* 31st May, p2
Prestage, M. (1996ii); "Closure plans top of unitary council's list" *The Times Educational Supplement* 14th June, p8
Prestage, M. (1996iii); "New authority plans to close 58 schools" *The Times Educational Supplement* 20th November, p8
Prestage, M and Nash, I. (1993); "Scandal of 'ghost' payments" *The Times Educational Supplement* 3rd December, p1
Preston, B. (1993); "Pupils lay down the law on discipline" *The Times* 9th December, p8
Preston, B. (1994i); "More parents denied choice" *The Times* 2nd May, p4
Preston, B. (1994ii); "Private schools ready to defend charity status" *The Times* 22nd November, p5
Preston, B. (1994iii); "Manchester worst but truancy in cities is falling" *The Times* 22nd November, p5
Preston, B. (1994iv); "Real progress is still hard to monitor" *The Times* school league tables special 22nd November, p1
Preston, B. (1994v); "After the exams, a gulf opens up" *The Times* school league tables special 22nd November, p18
Preston, M. (1993); "Secondary thoughts" *Guardian Education* 9th November, pp2-3
Price, C. (1995); "Charity should begin at school" *The Times Educational Supplement* 13th January, p19
Price, C. (1996); "Stick to the idea" *The Times Educational Supplement* 15th March, p20
Price, T. (1994); "Class concerns in Warwickshire : why should rural communities lose out?" *The Independent* 11th October, p15 [letter]
Pritchard, B. (1996); "Some minuses of the 11-plus" *The Times Educational Supplement* Section II, 7th June, p4
Pryke, R. (1993); "Opting into irrelevance" *The Times Educational Supplement* 1st October, pp12-13
Pyke, N. (1993i); "Thornton lambasts policy" *The Times Educational Supplement* 8th October, p3
Pyke, N. (1993ii); "Unable to get in on the Act" *The Times Educational Supplement* 31st December, p3
Pyke, N. (1994i); "'Partisan' funding body condemned" *The Times Educational Supplement* 25th February, p2
Pyke, N. (1994ii); "Tories seek easier opting-in route" *The Times Educational Supplement* 4th March, p5
Pyke, N. (1994iii); "Christians shy of opting into state" *The Times Educational Supplement* 18th March, p2
Pyke, N. (1994iv); "Secrets of the quango tango" *The Times Educational Supplement* 22nd April, p13
Pyke, N. (1994v); "Patten is forced to apologise" *The Times Educational Supplement* 24th June, p1
Pyke, N. (1994vi); "Muslims condemn 'unfair' GM policy" *The Times Educational Supplement* 1st July, p1
Pyke, N. (1994vii); "Opting out fails to improve choice, says think-tank" *The Times Educational Supplement* 18th November, p8
Pyke, N. (1995i); "Ethnic monitoring scaled down" *The Times Educational Supplement* 24th March, p2
Pyke, N. (1995ii); "Churches fear cuts in free transport" *The Times Educational Supplement* 24th March, p10
Pyke, N. (1995iii); "Super-Bill aimed to streamline laws" *The Times Educational Supplement* 19th May, p2
Pyke, N. (1995iv); "Yes, Prime Minister, but how can we do it?" *The Times Educational Supplement* 1st September, p6
Pyke, N. (1995v); "Christian GM bid stalled" *The Times Educational Supplement* 22nd September, p3
Pyke, N. (1995vi); " Churches condemn fast track" *The Times Educational Supplement* 24th November, p5
Pyke, N. (1995vii); "Parents appeal for real choice" *The Times Educational Supplement* 29th December, p1
Pyke, N. (1996i); "Tory Right rejects high-speed opt-outs" *The Times Educational Supplement* 19th January, p12
Pyke, N. (1996ii); "Americans warned off UK reforms" *The Times Educational Supplement* 26th April, p4
Pyke, N. (1996iii); "Heads set to wreck tables" *The Times Educational Supplement* 10th May, p1
Pyke, N. (1996iv); "Specialists join push for selection" *The Times Educational Supplement* 24th May, p6
Pyke, N. (1996v); "Schools focus on 'D-graders' to boost ranking" *The Times Educational Supplement* 22nd November, p4
Pyke, N. and Hackett, G. (1994); "Church furious at Patten's choice" *The Times Educational Supplement* 25th March, p4
Pyke, N. and Rafferty, F. (1995); "GM schools get secret first aid" *The Times Educational Supplement* 17th November, p1

Rafferty, F. (1993i); "'Lenient' inspectors under attack" *The Times Educational Supplement* 10th December, p3
Rafferty, F. (1993ii); Patten's GM goal 'now unreachable'" *The Times Educational Supplement* 17th December, p3
Rafferty, F. (1994i); "Report finds LMS fails to deliver" *The Times Educational Supplement* 20th May, p9
Rafferty, F. (1994ii); "Blair provokes opt-out row" *The Times Educational Supplement* 1st July, p7
Rafferty, F. (1994iii); "Stratford embroiled in a new crisis" *The Times Educational Supplement* 9th September, p3
Rafferty, F. (1995i); "Eight out of 10 Gillicks prefer it" *The Times Educational Supplement* 13th January, p3
Rafferty, F. (1995ii); "Anguished affair of GM and the party" *The Times Educational Supplement* 23rd June, p5
Rafferty, F. (1995iii); "Clever stuff verdict on Labour policy" *The Times Educational Supplement* 30th June, p6
Rafferty, F. (1996i); "Bank says no to opt-out booklet" *The Times Educational Supplement* 9th February, p3
Rafferty, F. (1996ii); "Inspectors to take account of deprivation" *The Times Educational Supplement* 23rd February, p1
Rafferty, F. (1996iii); "Value added on hold for primaries" *The Times Educational Supplement* 23rd February, p3
Rafferty, F. (1996iv); "Heads choose to reject selection" *The Times Educational Supplement* 3rd May, p4
Rafferty, F. (1996v); "Dream on, Mr. Major..." *The Times Educational Supplement* 28th June, p7
Rafferty, F. (1996vi); "Barber rounds on political playground" *The Times Educational Supplement* 13th December, p4
Rafferty, F. and Dean, C. (1995); "Surpluses under scrutiny" *The Times Educational Supplement* 27th January, p1
Rafferty, F. and Maxwell, E. (1994); "Right hits out at 'DIY school' plan" *The Times Educational Supplement* 7th January, p3

Rafferty, F., Dean, C. and Whitehead, M. (1996); "Opt-outs fear Labour victory" *The Times Educational Supplement* 11th October, p2
Rayment, T. and Scott-Clark, C. (1995); "Can anyone save one of Britain's worst schools?" *The Sunday Times* section I, 30th July, p11
Redwood, F. (1995); "Time to tackle pupil power" *The Daily Telegraph* 4th October, p15
Rees, J. (1993i); "Where the uniform is worn with pride : 'The best'" *The Daily Telegraph* 17th November, p16
Rees, J. (1993ii); "Bleak future at the bottom of the pile : 'The worst'" *The Daily Telegraph* 17th November, p16
Rentoul, J. (1995); "Shephard rejects nursery vouchers" *The Independent* 7th April, p2
Rentoul, J. (1996i); "Blair 'fast track' scheme for schools" *The Independent* 29th January, p2
Rentoul, J. (1996ii); "Blair under fire over 'fast-tracking'" *The Independent* 30th January, p2
Rentoul, J. and Abrams, F. (1995); "Tories' school claim backfires" *The Independent* 7th December, p2
Rentoul, J. and Judd, J. (1995); "Blair set to accept Tory nursery vouchers" *The Independent* 5th December, p2
Rogers, M. (1993); "The opting out challenge" *??????* date, pp91-2
Rogers, M. (1994i); "The rush to opt out is much overstated" *The Times Educational Supplement* 25th February, p25 [letter]
Rogers, M. (1994ii); "Why 'quiet GM revolution' is practically silent" *The Times Educational Supplement* 17th June, p26 [letter]
Rogers, M. (1994iii); "From battleground to common ground" *The Times Educational Supplement* 28th October, p18
Rogers, M. (1996); "Wake up to the selection nightmare" *The Times Educational Supplement* 26th January, p18
Rogers, R. (1994); "Wholesale changes" *The Times Educational Supplement* Section II, 13th May, pp1-2
Rosenthal, D. (1996); "Top schools condemn selection" *The Times Educational Supplement* 5th April, p5
Ryan, D.J.P. (1994); "When Essex wisdom fell on deaf ears" *Guardian Education* 26th April, p8

St. John-Brooks, C. (1993); "No more knocking stories" *The Times Educational Supplement* date and page number
St. John-Brooks, C. (1994); "A renewed air of authority" *The Times Educational Supplement* 28th January, p10
Sallis, J. (1993); reply in 'Agenda' column *The Times Educational Supplement* 17th September, Section II, p8
Sammons, P. (1993); "First weigh your ingredients" *The Independent* 18th November, p20
Schagen, I. (1995); "In the premier league" *Guardian Education* 23rd May, p3
Seager, J. (1995); "GM entry test fuels debate on selection" *The Times Educational Supplement* 10th February, p5
Shakespeare, S. (1995); "Bad schools should be killed off quickly" *The Sunday Times* section I, 30th July, p11
Sharratt, T. (1993i); "Smiles and scorn at 'spurious' league tables" *The Guardian* 17th November, p4
Sharratt, T. (1993ii); "Carrot, stick, and uniform create winning ambience" *The Guardian* 9th December, p5
Shaw, A. (1996); "Bending the school rules" *The Electronic Telegraph* 14th September (http://www.telegraph.co.uk/)
Shephard, G. (1994); [no title, introduction] *The Times* school league tables special 22nd November, p1
Sherman, J. (1993); "Ashdown supports a boost for education" *The Times* 17th November, p9
Sherratt, B. (1995); "Dangerous dependency" *The Times Educational Supplement* 13th October, p22
Shrimsley, R. (1996); "Selection is not needed, says Blunkett" *The Electronic Telegraph* 26th June (http://www.telegraph.co.uk/)
Smith, G.J. (1994); "Tabling a goodbye to fairness and justice" *The Times Educational Supplement* 16th September, p16
Slater, A. (1993); "The case for a bigger carrot" *The Times Educational Supplement* 8th October, School Management supplement, p24
Sofer, A. (1993); "Problems don't end at the city boundary" *The Times Educational Supplement* 10th December, p56
Sofer, A. (1994); "Results need their context" *The Times Educational Supplement* 21st January, p23 [letter]
Spackman, A. (1995); "For good schools, move now" *The Independent* weekend section 15th July, p11
Spencer, D. (1996i); "Independent school wants to opt in" *The Times Educational Supplement* 1st March, p12
Spencer, D. (1996ii); "Catholic independent opts in" *The Times Educational Supplement* 18th October, p9
Spencer, D. (1997); "Store may get site in return for school" *The Times Educational Supplement* 24th January, p14
Strickland, S. (1994i); "Parents look beyond the figures" *The Independent* 24th November, p34
Strickland, S. (1994ii); "The great catchment cons" *The Independent* 15th December, p27
Strickland, S. (1995); "Is your child's school as good as you think it is?" *The Independent* Section II, 23rd November, pp14-15
Sutcliffe, J. (1993); "Technology schools may get £25m cash carrot" *The Times Educational Supplement* 24th September, p3
Sutcliffe, J. (1995); "Labour tries to reconcile its opposites" *The Times Educational Supplement* 13th January, p4
Sutcliffe, J. (1996); "Selection 'will mean secondary moderns'" *The Times Educational Supplement* 30th August, p5
Sutcliffe, J., Maxwell, E. and Burstall, E. (1995); "Tories prepare to kill the sacred cow" *The Times Educational Supplement* 6th October, p6
Sweetman, J. (1993); "Children with special needs suffer for lack of cash" *Guardian Education* 30th November, p11
Sweetman, J. (1994); "Hard times ahead for the juggernaut jugglers" *Guardian Education* 16th January, p9
Sylvester, R. (1996i); "Shephard hints at grammar school in every town" *The Electronic Telegraph* 10th June (http://www.telegraph.co.uk/)
Sylvester, R. (1996ii); "Shephard is accused of school U-turn" *The Electronic Telegraph* 24th June (http://www.telegraph.co.uk/)
Symonds, M. (1993); "John Patten's school days grow happier" *The Independent* 3rd November, p18

Taylor, C. (1996); "Just feel the width" *The Times Educational Supplement* 12th April, p16
Terry, S. (1993); "Parents' feet vote against selection" *The Independent* 5th November, p17 [letter]
TES (1993i); "More equal than others" *The Times Educational Supplement* 8th October, p18 [leading article]
TES (1993ii); "How small schools can cope with LMS" *The Times Educational Supplement* 8th October, section II, p6
TES (1993iii); "Funding changes worry councils" *The Times Educational Supplement* 15th October, p4-5
TES (1993iv); "Rotten fruit targeted at dissident CEOs" *The Times Educational Supplement* 15th October, p5
TES (1993v); "Tories laud Brighouse" *The Times Educational Supplement* 15th October, p5
TES (1993vi); "Autumn offensive" *The Times Educational Supplement* 15th October, p20 [leading article]
TES (1994i); "County melt-down" *The Times Educational Supplement* 28th January, p18 [leading article]
TES (1994ii); "Time to slim the tables" *The Times Educational Supplement* 25th February, p20 [leading article]
TES (1994iii); "Choice on the map" *The Times Educational Supplement* 4th March, p20 [leading article]
TES (1994vi); "Closing time again?" *The Times Educational Supplement* 11th March, p18 [leading article]
TES (1994v); "GM cash shortage" *The Times Educational Supplement* 18th March, p2
TES (1994vi); "Vote for vouchers" *The Times Educational Supplement* 18th March, p2
TES (1994vii); "DfE ads face top-level probe" *The Times Educational Supplement* 25th March, p2
TES (1994viii); "GMS bids slump" *The Times Educational Supplement* 8th April, p2

TES (1994ix); "Publicity probe" *The Times Educational Supplement* 8th April, p2
TES (1994x); "End of the GM rainbow" *The Times Educational Supplement* 22nd April, p16 [leading article]
TES (1994xi); "Finding a formula" *The Times Educational Supplement* 29th April, p14 [leading article]
TES (1994xii); "Chimera of choice" *The Times Educational Supplement* 6th May, p16 [leading article]
TES (1994xiii); "Sports bid for 'failing' school" *The Times Educational Supplement* 17th June, p15
TES (1994xix); "Chartered accountability" *The Times Educational Supplement* 17th June, p20 leading article)
TES (1994xx); "Euro-role model for city schools" *The Times Educational Supplement* 24th June, p2
TES (1994xxi); "Threat of closure for small schools in Ulster" *The Times Educational Supplement* 24th June, p13
TES (1994xxii); "Diversity or division?" *The Times Educational Supplement* 1st July, p16
TES (1994xxiii); "Wall-to-wall freedom" *The Times Educational Supplement* 7th October, p14 [leading article]
TES (1994xxiv); "Surplus sacrifice" 14th October, p18 [leading article]
TES (1994xxv); "The vision game" *The Times Educational Supplement* 28th October, p18 [leading article]
TES (1994xxvi); "Thinking backwards" *The Times Educational Supplement* 4th November, p20 [leading article]
TES (1994xxvii); "GM vote setback" *The Times Educational Supplement* 25th November, p2
TES (1994xxviii); "Tables are not enough" *The Times Educational Supplement* 25th November, p14 [leading article]
TES (1994xxix); "Confronting choice" *The Times Educational Supplement* 9th December, p14 [leading article]
TES (1994xxx); "Aspects of value" *The Times Educational Supplement* 9th December, p14 [leading article]
TES (1995i); "Ma and Pa not sold on power" *The Times Educational Supplement* 24th February, p8
TES (1995ii); "Cash for technology" *The Times Educational Supplement* 27th January, p2
TES (1995iii); "What parents want" *The Times Educational Supplement* 24th February, p14 [leading article]
TES (1995iv); "Opt-out inquiry" *The Times Educational Supplement* 24th March, p2
TES (1995v); "Weighing the facts" *The Times Educational Supplement* 31st March, p18 [leading article]
TES (1995vi); "Value-added trouble" *The Times Educational Supplement* 26th May, p2
TES (1995vii); "Adding value" *The Times Educational Supplement* 26th May, p18 [leading article]
TES (1995viii); "Stuck in the traffic" *The Times Educational Supplement* 9th June, p18 [leading article]
TES (1995ix); "Labour's relaunch" *The Times Educational Supplement* 23rd June, p18 [leading article]
TES (1995x); "After the gamble" *The Times Educational Supplement* 30th June, p18 [leading article]
TES (1995xi); "Whose agenda?" *The Times Educational Supplement* 1st September, p16 [leading article]
TES (1995xii); "Magnet for Hackney?" *The Times Educational Supplement* 1st September, p4
TES (1995xiii); "Opted-out opt out of scrutiny" *The Times Educational Supplement* 22nd September, p3
TES (1995xiv); "Opt in to the state" *The Times Educational Supplement* 27th October, p16 [leading article]
TES (1995xv); "Fuller picture needed" *The Times Educational Supplement* 24th November, p13 [leading article]
TES (1995xvi); "Fast track to bitterness" *The Times Educational Supplement* 24th November, p13 [leading article]
TES (1995xvii); "Gaps in the tables" *The Times Educational Supplement* 15th December, p15 [leading article]
TES (1996i); "Selective debate" *The Times Educational Supplement* 22nd March, p18 [leading article]
TES (1996ii); "Laissez-faire selection" *The Times Educational Supplement* 5th April, p16 [leading article]
TES (1996iii); "Selective thinking" *The Times Educational Supplement* 28th June, p21 [leading article]
TES (1996iv); "Markets at work" *The Times Educational Supplement* 1st November, p18 [leading article]
TES (1996v); "Market gridlock" *The Times Educational Supplement* 20th December, p12 [leading article]
Thomas, S., Goldstein, H. and Nuttall, D. (1993); "Number-crunching" *Guardian Education* 30th November, pp 3-4
Thornton, Sir M. (1994); "A donation to clarity" *The Times Educational Supplement* 29th April, p15
Thornton, Sir M. (1995); "There is still a role for local authorities" *The Times Educational Supplement* 6th October, p20
Tileman, R. (1993); "'Open up schools to private sector'" *The Times* 17th November, p28
Times (1993); "Down with school" *The Times* 17th November, p21 [leading article]
Times (1994); "New ballot confirms opt-out vote" *The Times* 22nd November, p5
Timmins, N. (1993); "Market forces in NHS 'not working'" *The Independent* 29th October, p10
Timmins, N. (1995); "Education vouchers put back on Tory agenda" *The Independent* 16th March, p5
Timmins, N. and Judd, J. (1995); "Tories renege on cash for schools" *The Independent* 1st December, p1
Todd, M. (1993); "Kelly twins prepare for life in the 21st century" *The Times Educational Supplement* 24th September, p3
Todd, M. (1994i); "Hardy annual flares again" *The Times Educational Supplement* 9th September, p12
Todd, M. (1994ii); "Classes at home may be an answer" *The Times Educational Supplement* 9th September, p12
Tonge, J. (1993); "When approval means truancy" *The Independent* 19th November, p17 [letter]
Torday, P. (1993); "Education and health escape as spending axe falls" *The Independent* 1st December, p8
Travers, T. (1993); "Winners and losers in forest of figures" *The Times Educational Supplement* 10th December, p4
Travers, T. (1994); "Number by the numbers" *The Times Educational Supplement* 14th January, p8
Travers, T. (1995i); "The Government's pet begins to bite back" *The Times Educational Supplement* 17th February, p8
Travers, T. (1995ii); "The end of the world as we know it" *The Times Educational Supplement* 27th October, p11
Travis, A. (1993); "Howard drops police tables" *The Guardian* 4th December, p3
Turner, A. (1995); "Benefits of GM status" *The Times Educational Supplement* 31st March, p20 [letter]
Turner, G. (1994); "More for opt outs means less for the rest" *The Times Educational Supplement* 21st October, p18 [letter]
Tyler, W (1994); "Class concerns in Warwickshire : why should rural communities lose out?" *The Independent* 11th October, p15 [letter]

Uhlig, R. (1995); "Education: pupils wise up to the joys of smart cards" *The Electronic Telegraph* 1st November (http://www.telegraph.co.uk/)
Underwood, V. [pseudonym] (1994); "Places at the Ritz for the favoured few" *The Independent* 20th October, p27

Vickers, J. (1994); "Beware extremists with orders to opt out" *The Times Educational Supplement* Section II, 6th May, p6 [letter]

Wainwright, M. (1993); "Three wise men deliver 'a kick up the backside'" *The Guardian* 4th December, p6
Walden, G. (1995i); "Schooled in hypocrisy" *The Independent* 9th January, p14
Walden, G. (1995ii); "The school wall won't fall down" *The Independent* 31st July, p13
Wallace, G. (1993); "Across the great divide" *The Times Educational Supplement* 22nd October, Section II, p6
Ward, D. (1994i); "The last quango in Powys" *Guardian Education* 8th February, p6
Ward, D. (1994ii); "GCSE successes made from 11-plus failures" *The Guardian* 22nd November, p5

Ward, D. and Jury, L. (1993); "Teachers and students welcome review" *The Guardian* 13th November, p5
Ward, L. (1996); "GM schools top A-level cost league" *The Times Educational Supplement* 28th June, p3
Ward, L. (1997i); "Girls on top again, as inspectors say failing schools are full of boys" *The Independent* 6th March, p4
Ward, L. (1997ii); "Labour threat to super-grammar" *The Independent* 6th March, p4
Ward, L. (1997iii); "Parents urged to be wary of league tables" *The Independent* 7th March, p10
Ward, L. (1997iv); "Shephard sends in her education hit squad" *The Independent* 11th March, p5
Ward, L. (1997v); "Nursery sweetener for opt-out schools" *The Independent* 20th March, p10
Ward, L. (1997vi); "How middle class families win the game" *The Independent* 17th April, p6
Ward, L. (1997vii); "Parents launch fight to claim school places" *The Independent* 22nd April, p5
West, R. (1995); "Small but surviving" *The Daily Telegraph* 20th September, p15
Weston, C. (1993); "Smiles and scorn at 'spurious' league tables" *The Guardian* 17th November, p4
Whatford, C. (1996); "Interviews with comprehensive pupils are the sting in the tail" *The Times Educational Supplement* 2nd February, p18
White, M. (1995i); "Leader picks education row to rally Lib Dems" *The Guardian* 10th March, p6
White, M. (1995ii); "Blair camp may avert schools defeat" *The Guardian* 30th September, p6
Whitehead, M. (1993); "Classics in a new class of its own" *The Times Educational Supplement* 29th October, p8
Whitehead, M. (1996i); "Anxiety at new ruling on special schools" *The Times Educational Supplement* 12th January, p4
Whitehead, M. (1996ii); "Selection could hinge on a question of sex" *The Times Educational Supplement* 19th January, p3
Whitehead, M. (1996iii); "Hard to keep the customers satisfied" *The Times Educational Supplement* 5th April, p4
Whitehead, M. (1996iv); "Selection may force new split" *The Times Educational Supplement* 11th October, p6
Whitehead, M. (1996v); "City technology colleges boast 54 per cent averages" *The Times Educational Supplement* 22nd November, p4
Whitehead, M. and Dean, C. (1996); "Selection bid rejected by minister" *The Times Educational Supplement* 5th January, p4
Whitehead, P. (1995); "School that hit bottom of tables to be closed" *The Times Educational Supplement* 1st December, p6
Whitty, G. and Edwards, T. (1993); "And now, a word from our sponsors" *The Times Educational Supplement* 22nd October, Technology Supplement, pV
Wilkins, J. (1994); "Time for reason on opting out" *The Times Educational Supplement* 1st July, p18
Wilkinson, T. (1993); "Claws" cartoon strip *The Guardian* 11th December, p28
Williams, E. (1993); "Occupational hazards" *The Independent* 2nd December, p31
Wintour, P. (1993); "Private welfare backed by PM" *The Guardian* 27th November, p1
Wintour, P. (1995); "Labour to set new test for schools" *The Guardian* 25th November, p1
Wintour, P. and Carvel, J. (1996); "Blair plan for school fast track" *The Guardian* 29th January, p1
Wintour, P. and MacLeod, D. (1994); "U-turn by Labour on schools" *The Guardian* 21st November, p1
Woodford, S. and de Zoysa, A. (1993); "Modern parents need nurseries" *The Independent* 19th November, p17 [letter]
Wragg, T. (1993i); "Humanity loses out in competition" *The Times Educational Supplement* 10th September, p18
Wragg, T. (1993ii); "Here comes yet another bundle of joy" *The Times Educational Supplement* 8th October, p64
Wragg, T. (1993iii); "Hold the Kwality, give us some calibre" *The Times Educational Supplement* 22nd October, p48
Wragg, T. (1993iv); "Answer the questionnaire, it's pay-risible" *The Times Educational Supplement* 31st December, p24
Wragg, T. (1994i); "The number is up for flying yoghurt pots" *The Times Educational Supplement* 17th June, p104
Wragg, T. (1994ii); "Your right to be duped in your own home" *The Times Educational Supplement* 1st July, p72
Wynn Davies, P. (1993i); "Major to stress 'core value' of education to nation's well-being" *The Independent* 15th November, p3
Wynn Davies, P. (1993ii); "Labour warns of £61 cut for each local authority school place" *The Independent* 2nd December, p11
Wynn Davies, P. (1994); "Tories back down again on police Bill" *The Independent* 1st March, p6
Wynn Davies, P. (1995i); "Tories seize initiative in school fees row" *The Independent* 3rd January, p2
Wynn Davies, P. (1995ii); "Ashdown slams Tories' school 'vandalism'" *The Independent* 13th March, p2
Wynn Davies, P. (1995iii); "Showpiece school looks at opting in" *The Independent* 28th March, p3
Wynn Davies, P. (1995iv); "A-level pupils could get £8,000 vouchers" *The Independent* 4th April, p4
Wynn Davies, P. (1995v); "Major's push for schools to opt out" *The Independent* 24th August, pp1-2

Young, S. (1993i); "Mission impossible for enfeebled LEAs" *The Times Educational Supplement* 5th November, p8
Young, S. (1993ii); "Learning to succeed; report of the National Commission on Education" introduction *The Times Educational Supplement* special report 19th November, p1
Young, S. (1994i); "Urban renewal the next task" *The Times Educational Supplement* 7th January, p12
Young, S. (1994ii); "League table revamp on cards" *The Times Educational Supplement* 25th March, p2
Young, S. (1994iii); "Heads reject pioneer performance payments" *The Times Educational Supplement* 22nd April, p1
Young, S. (1994iv); "Beware the perils of parental power" *The Times Educational Supplement* 6th May, p7
Young, S. (1994v); "£3m charter is greeted with scorn" *The Times Educational Supplement* 17th June, p14
Young, S. (1994vi); "GM opt-out rejected by 99 per cent" *The Times Educational Supplement* 24th June, p8
Young, S. (1994vii); "CEOs call for fairness in opt-out campaigns" *The Times Educational Supplement* 1st July, p3
Young, S. (1994viii); "A mirage of choice frustrates parents" *The Times Educational Supplement* 9th September, p12
Young, S. (1994ix); "Support role is crucial, says Labour" *The Times Educational Supplement* 25th November, p5
Young, S. (1994x); "Specialist language schools on the way" *The Times Educational Supplement* 2nd December, p1
Young, S. (1994xi); "Three-way contest for value-added pilot" *The Times Educational Supplement* 9th December, p6
Young, S. (1995i); "Blair majors on standards" *The Times Educational Supplement* 23rd June, p1
Young, S. (1995ii); "Paper beats a path through minefields" *The Times Educational Supplement* 23rd June, p4
Young, S. (1996); "Heads' 'nightmare' vision of selection" *The Times Educational Supplement* 11th October, p3

where;

O_i = origin totals (total flows originating at i)

D_j = destination totals (total flows ending at j)

Flexible constraints

$$O_i^L \le \sum_j T_{ij} \le O_i^U \qquad \text{[A4.5]}$$

and/or;

$$D_j^L \le \sum_i T_{ij} \le D_j^U \qquad \text{[A4.6]}$$

where the lower and upper limits on O_i and D_j (L and U) are specified *a priori* by the user.

Singly-constrained model

Production-constrained

$$T_{ij} = A_i . O_i . W_j . e^{-\beta . c_{ij}} \qquad \text{[A4.7]}$$

where;

$$A_i = \frac{1}{\sum_j W_j . e^{-\beta . c_{ij}}} \qquad \text{[A4.8]}$$

and;

A_i = balancing factor to ensure [A4.3] is satisfied

β = parameter to reproduce the effects of distance decay

It is also possible to add an α parameter to the W_j variable in order to reproduce the varying importance of attractiveness in different datasets

Other factors are as previously defined

Destination-constrained

$$T_{ij} = B_j . W_i . D_j . e^{-\beta . c_{ij}} \qquad \text{[A4.9]}$$

where;

$$B_j = \frac{1}{\sum_i W_i . e^{-\beta . c_{ij}}} \qquad \text{[A4.10]}$$

and;

B_j = Balancing factor to ensure that [A4.4] is satisfied

All other variables are as previously defined

Doubly-constrained model

$$T_{ij} = A_i.B_j.O_i.D_j.e^{-\beta.c_{ij}} \quad [A4.11]$$

where;

$$A_i = \frac{1}{\sum_j B_j.D_j.e^{-\beta.c_{ij}}} \quad [A4.12]$$

and;

$$B_j = \frac{1}{\sum_i A_i.O_i.e^{-\beta.c_{ij}}} \quad [A4.13]$$

All variables and parameters are as previously defined

Entropy maximising model

Entropy maximisation replaces the standard power distance function, c_{ij}^{-2}, or $c_{ij}^{-\beta}$ with the exponential function used in the model equations displayed here.

Intervening opportunities model

$$T_{ij} = A_i.O_i.D_j.e^{(-\lambda Z_{ij}.-\beta c_{ij})} \quad [A4.14]$$

where;

$$A_i = \frac{1}{\sum_j B_j.D_j.e^{(-\sigma W_{ij}-\beta C_{ij})}} \quad [A4.15]$$

$$B_j = \frac{1}{\sum_i A_i.O_i.e^{(-\sigma.W_{ij}-\beta.C_{ij})}} \quad [A4.16]$$

and;

W_{ij} = the cumulative number of intervening opportunities between i and j

σ = the probability of a destination opportunity being chosen if it is considered

Competing destinations model

$$T_{ij} = A_i.O_i.D_j^{\alpha}.Z_{ij}^{\delta}.e^{-\beta.c_{ij}} \quad [A4.17]$$

where;

$$A_i = \frac{1}{\sum_j B_j.D_j.Z_{ij}^{\delta i}.e^{-\beta.c_{ij}}} \quad [A4.18]$$

$$B_j = \frac{1}{\sum_i A_i . O_i . Z_{ij}^{\delta i} . e^{-\beta . c_{ij}}}$$ [A4.19]

$$Z_{ij} = \sum_k W_k . e^{\sigma_i . C_{jk}}$$ [A4.20]

and;

Z_{ij}	=	accessibility of destination j to other destinations (k) available from origin i as perceived by the residents of i
W_k	=	attractiveness of alternate destination choice k
C_{jk}	=	distance between destination j and alternate destination k

Error functions for calibration

Minimise sum of squares error function

$$f = \sum_i^m \sum_j^n \left(S_{ij} - T_{ij}\right)^2 \Big/ m * n$$ [A4.21]

where

S_{ij}	=	predicted flow
T_{ij}	=	actual flow
m	=	number of origins
n	=	number of destinations

Mean trip length error function

$$f = \left(dt_{obs} - dt_{pred}\right)^2$$ [A4.22]

where;

$$dt_{obs} = \left[\left(\sum_i^m \sum_j^n S_{ij} . C_{ij} \right) \Big/ \left(\sum_i^m \sum_j^n S_{ij} \right) \right]$$ [A4.23]

and;

$$dt_{pred} = \left[\left(\sum_i^m \sum_j^n T_{ij} . C_{ij} \right) \Big/ \left(\sum_i^m \sum_j^n T_{ij} \right) \right]$$ [A4.24]

Where C_{ij} is taken to be the distance from origin to destination and the other elements are as previously defined.

Harris/Wilson dynamic model

The model first used is based on Harris and Wilson (1978) and programming of Clarke and Clarke (1984). This solves a simple production constrained model (as at [A4.7] and [A4.8] above) and then applies the following rules;

Let $D_j = \sum_i S_{ij}$.

If $D_j = kW_j$ for all j then equilibrium is acheived.

Otherwise set $W_j = D_j / k$ and re-solve the production-constrained model.

where all elements are as previously defined, except k, which is the unit cost of providing W_j. The rules are repeated in chapters five and eight.

In the later section the model used is taken from Michell (forthcoming), which is based on the model described by Wilson (1985) although it has been modified by the addition of a fixed-cost parameter c

$$W_{j_{n+1}} = W_{j_n} + \varepsilon\left(D_{j_n} - kW_{j_n} - c\right. \qquad [A4.25]$$

where c is the measure of a school's fixed costs. D_j is as usual the result of solving the production constrained spatial interaction model, although the exact form varies depending on the attractiveness measure used. If school capacity is used the function is as [A4.26], if attractiveness is examination results then [A4.27] must be applied because the schools' attractiveness does not change as school size changes.

$$D_j = \sum_i O_i . \frac{W_j^{\alpha} . e^{-\beta_i c_{ij}}}{\sum_k W_k^{\alpha} . e^{-\beta_i c_{ik}}} \qquad [A4.26]$$

$$D_j = \sum_i O_i . \frac{G_j^{\alpha} . e^{-\beta_i c_{ij}}}{\sum_k G_k^{\alpha} . e^{-\beta_i c_{ik}}} \qquad [A4.27]$$

where all elements are as previously defined, with G referring to examination results.

Business potential dynamic model

$$P_j = (F * D_j) - \left((C + CC) * \left(W_j / Av\right)\right) - V \qquad [A4.28]$$

where;

P_j	=	business potential function
F	=	funding *per* head of school roll
D_j	=	total potential demand for school (from spatial interaction model)
C	=	average teacher salary
CC	=	cost *per* classroom
W_j	=	school size (capacity) or other attractiveness measure
Av	=	average class size
V	=	overhead costs *per* school

In simpler terms, this equation can be written as;

Business potential = potential revenue – current costs

or;

P_j = (revenue) – (roll factored costs) – (fixed overheads)

where;

revenue	=	potential demand (pupils) * funding *per* head
roll factored costs	=	(cost of classroom and teacher)*(no. of classes)
fixed overheads	=	costs immaterial of school size (*e.g.* assembly hall, gym *etc.*)