ECONOMIC ASPECTS OF SMOKING

Is there a case for government intervention in Finland?

Markku Johannes Pekurinen

Thesis submitted to the University of York for the degree of Doctor of Philosophy in the Department of Economics and Related Studies

January 1991

CONTENTS Page

ACKNOWLEDGEMENTS

Several individuals and bodies have made this study possible. Dr Matti Rimpelä suggested the topic initially, while Dr Ilkka Vohlonen and professor Seppo Aro provided facilities for carrying out the empirical stage at the National Public Health Institute. Dr Kimmo Leppo of the National Board of Health and professor Sirkka Sinkkonen of the University of Kuopio have had the patience and kindness to alleviate my other commitments during the study period. Professor Olli P Heinonen provided me with a splendid, classical researcher's 'chamber' at Salus research centre to write up the study.

My supervisory group in York, professor Alan Maynard, professor Peter Simmons and Dr Christine Godfrey, have applied valuable scrutinity to various drafts of the study. Professor Harri Sintonen made valuable comments on the second part of the study, while discussions with Jarmo Granfelt have benefited the third part. Collaboration with Dr Hannu Valtonen has influenced several stages of the study.

At the National Public Health Institute Satu Kerppilä has provided superb research assistance. Seija Puro, Timo Lehtinen, Pia Okamo and Tanja Hartikka gave me secretarial assistance and much other important help.

The Yrjö Jahnsson foundation and the National Board of Health have financially supported various phases of the study. Dick Burton has adjusted my 'Finglish'.

To all these individuals and institutions mentioned, I extend my deepest gratitude.

I direct particular gratitude to my wife Marja-Raita and to our daughters Miina-Liisa and Anna, who have had to bear all the externalities of this study. I dedicate this study to my wonderful wife Marja-Raita.

DECLARATION

Some material in this study has been published earlier in several articles.

Chapter 6.1 of the second part of the study has been published in Finnish in

> **Pekurinen M, Valtonen H, Heliövaara M, Klaukka T.** Tupakointi, lääkärissäkäynnit, lääkkeiden käyttö ja sairauspoissaolot. **Sosiaalilääketieteellinen Aikakauslehti,** 1989, 26, 309-322.

Brief summaries of the main results of the third part of the study have been published in two articles:

> **Pekurinen M.** The demand for tobacco products in Finland. **British Journal of Addiction,** 1989, 84, 1183-1192; and in Finnish in

> **Pekurinen M.** Voidaanko tupakkatuotteiden kysyntään vaikuttaa? **Sosiaalilääketieteellinen Aikakauslehti,** 1989, 26, 73-84.

Topics of the third part of the study have also been discussed earlier in

> **Pekurinen M, Valtonen H.** Price, policy and consumption of tobacco: the Finnish experience. **Social Science and Medicine,** 1987, 25, 875-881.

ABSTRACT

This study examines the case for government intervention on the tobacco markets in Finland. The research enquiry is split into three specific sub-questions: (1) Do demand-side market failures exist in the tobacco markets? (2) Are market failures quantitatively significant? (3) Are there effective tools available for government intervention? The study consists of three closely interconnected parts which aim to answer these questions.

The first part of the study analyses market failures most likely to occur in the tobacco markets, as well as outlining the principal policy responses for remedying them. Appropriate measures are also derived for evaluating the welfare implications of intervention separately for each of the policy tools.

The second part of the study evaluates the main health and economic consequences of smoking in Finland. Specifically, it develops a methodology for estimating the institutional and final external costs of smoking, with varying assumptions about tobacco addiction and consumer awareness of the health risks.

The third part of the study examines to what extent the demand for various tobacco products can be affected by policy measures; in particular, the possibility of asymmetric demand responses to changes in prices and income. Furthermore, the effects of anti-smoking publicity on demand are analysed explicitly.

The final part of the study summarizes the main findings and concludes that there may not be a case for government intervention on the tobacco markets in Finland to correct for financial externality, though there may be case for intervention to correct for the caring externality, imperfect information and tobacco addiction.

INTRODUCTION

The research question posed by this study is simple: is there a case for government intervention on the tobacco markets in Finland? The issue may be approached from the viewpoints of different disciplines: economics and medical sciences being most appropriate for designing policy.

The medical approach to smoking is straightforward. Smoking appears a major contributing factor to illness and premature death, and various health authorities claim smoking to be the most important single preventable cause of death (e.g. STM 1987). In the medical approach the key word is health and the aim of policy is to cut down tobacco consumption in order to diminish adverse health effects resulting from smoking. The economic question here is: what are most efficient methods for influencing the demand for tobacco?

One factor supporting the medical approach is the alleged diminishing marginal productivity of health care. The health of populations do not seem to improve at the same pace as resources devoted to health care increase. Consequently, health policy makers have started to look beyond health care for more effective health improvment factors. The economic question here is: is prevention more efficient than cure in creating health improvements?

Closely related to the health issue is how smoking affects the utilization of health care services? If smoking causes ill health it is likely to have an impact on health care resources. Rapid growth in health expenditure has forced decision makers to search for efficient cost-containment measures, prevention being one of the favorite candidates. As smoking is claimed to contribute to as much as 8-17 % of health expenditure (e.g. Thompson and Forbes 1983, Collishaw and Myers 1984) curtailing smoking would appear potentially effective in containing health care costs.

Government intervention on health grounds may attempt to reduce or prevent smoking in order to diminish morbidity and premature mortality, as well as to relieve pressures on health expenditure. A major problem with the medical approach is that it completely ignores the consumer orientation. Curtailing consumption is seen as means to ends other than consumer satisfaction, such as improved public health or slackening the rate of growth of health expenditure.

Health is not, however, the only thing consumers value. Although health is regarded an important part of the individual's welfare, other things, including smoking, contribute to this. Like the medical approach, the economic approach acknowledges that smoking may cause ill health and therefore decrease welfare, but it also recognizes that smokers derive satisfaction from their risky activity and thus improve their well-being. And there are no good reasons to ignore this consumption benefit when designing policy towards smoking.

While health promotion may provide a sufficient case for intervening on purely paternalistic grounds, welfare promotion is the main economic criterion for government intervention in the case of smoking. In the economic approach the key word is efficiency, with the aim of policy being to attain the optimum level of tobacco consumption in order to maximise social welfare.

In order to prove the case for government intervention, the economic approach would first need to indicate that there are market failures associated with tobacco consumption which lead to inefficient allocation of resources (e.g. Leu and Schaub 1984). This would demonstrate that there may be a case for intervention. Secondly, it would be required to show that market failures are quantitatively and economically significant, which would establish that there may be potential efficiency gains attainable. Thirdly, it would be vital to show that the demand for tobacco can be influenced by means at the government's disposal. This in turn, would indicate what possibilities there are for intervention. Finally, in the event of intervention, it needs to be ascertained that the welfare gains from intervention are likely to exceed the welfare losses.

Several studies in various countries have examined smoking-related health problems from the economic standpoint indicating the significant social costs which arise from tobacco smoking (e.g. Collishaw and Myers 1984, Hjalte 1984, Ellemann-Jensen 1986, Rice et al 1986). Demand for tobacco products has also been an extensive topic of econometric research (e.g. Fujii 1980, Lewit and Coate 1982, Leu 1984). Only a few studies have raised the more profound issue of whether a case for government intervention on the tobacco markets exists on any other than purely paternalistic grounds (e.g. Leu and Schaub 1984, Markandya and Pearce 1989).

Several studies have focused on one of the above preconditions, but none has covered them all. Costing studies have concentrated on aspects of the first question while demand studies have examined the second. Only a few studies have attempted a broader economic evaluation of the effects of market intervention (e.g. Godfrey and Maynard 1988).

This study points out the major demand-side market failures in the tobacco markets and outline specific policy responses individually for each of the failures to correct them. Further, measures to determine the welfare effect of government intervention are derived separately for the main policy instruments.

Specifically, the study examines the significance of one likely market failure, financial externality. The study applies the framework initially outlined by Atkinson (1974) and modified by Markandya and Pierce (1989), but extends it further to include varying assumptions about tobacco addiction and consumer awareness of the health risks of smoking. This study may be the first of its kind to examine economic consequences of smoking empirically from different economic perspectives. In particular, the study develops a methodology which allows estimation of the social costs of smoking falling on different institutions (institutional externality) and to examine how such costs are eventually distributed between smokers and non-smokers (final externality). The demand analysis tests several models suggested in the literature and outlines the relevant policy implications.

Purpose and structure of the study

The purpose of the study is to examine the case for government intervention on the tobacco markets in Finland. This research enquiry is split into three specific sub-questions:

(1) Do demand-side market failures exist in the tobacco markets?

(2) Are market failures quantitatively significant?

(3) Are there effective tools available for government intervention?

This study consists of three closely connected parts which aim to answer the three study questions. Part I analyses the likely market failures in the tobacco markets, as well as outlining the main policy responses to remedy these and derives appropriate measures for evaluating the welfare implications of intervention separately for each of the policy tools.

Part II evaluates the main health and economic consequences of smoking in Finland. Specifically it develops a methodology for estimating the institutional and final external costs of smoking, with varying assumptions about tobacco addiction and consumer awareness of the health risks.

Part III examines whether the demand for various tobacco products can be affected by policy measures. In particular, the study explores the possibility of asymmetric demand responses to changes in prices and incomes. Furthermore, it analyses explicitly the effects of anti-smoking publicity and tobacco advertising bans on demand.

Part IV summarizes the main findings of the study and concludes with several policy recommendations.

Although the study concentrates on tobacco, the approach outlined here for examining the case for government intervention is equally suitable, if appropriately modified, for analysing any activity which generates positive or negative health consequences, such as sports, nutrition and use of alcohol.

REFERENCES

Atkinson AB. Smoking and the economics of government intervention. In Perlman F (ed.). The economics of health care and medical care. Macmillan, London 1974.

Collishaw NE, Myers G. Dollar estimates of the consequences of tobacco use in Canada 1979. Canadian Journal of Public Health 1984, 75, 192-199.

Ellemann-Jensen P. Analyser af de samfundsokonomiske omkostninger ved tobaksrygning. Odense Universitet. Institut for Sundhedsokonomi og Sygdomsforebyggelse. Forskningrapport 1986, 1. Odense 1986.

Fujii ET. The demand for cigarettes: further empirical evidence and its implications for public policy. Applied Economics, 1980, 12, 479-489.

Godfrey C, Maynard A. Economic aspects of tobacco use and taxation policy. British Medical Journal 1988, 297, 339-343.

Hjalte K. Rökningens effekter och kostnader i Sverige 1980 en prevalensstudie. Institutet för hälso- och sjukvårdsekonomi. Meddelande 1984, 4. Lund 1984.

Leu RE. Anti-smoking publicity, taxation, and the demand for cigarettes. Journal of Health Economics, 1984, 3, 101-116.

Leu RE, Schaub T. Economic aspects of smoking. Effective Health Care 1984, 2, 111-122.

Lewit EM, Coate D. The potential for using excise tax to reduce smoking. Journal of Health Economics, 1982, 1, 121-145.

Markandya A, Pearce DW. The social costs of tobacco smoking. British Journal of Addiction 1989, 84, 1139-1150.

Rice DP, Hodgson TA, Sinsheimer P, Browner W, Kopstein AN, The economic costs of the health effects of smoking, 1984. Milbank Quarterly 1986, 64, 489,547.

STM (Ministry of Social Affairs and Health). Health for all by the year 2000. The Finnish national strategy. Helsinki 1987.

Thompson ME, Forbes WF. Estimating the health care costs of smokers. Canadian Journal of Public Health 1983, 74, 183-190.

PART I:

ANALYTICAL FRAMEWORK

OF THE STUDY

CONTENTS

1 INTRODUCTION

A normative starting point in economics is to respect the individual consumer's choices and assume that he knows what is best for himself. This is known as consumer sovereignty; the consumer is assumed to strive for maximum satisfaction of his needs and wants by consuming goods and services. Rational consumption behaviour means that a consumer chooses that mix of goods and services which maximizes his well-being or utility within the bounds of his preferences and income. The consumer's well-being is maximized when he consumes each commodity at such a level that his well-being is not improved by changing the overall structure of his consumption, for example by consuming more tobacco and less alcohol. With private consumption optimized thus, the marginal private benefits and the marginal private cost of consumption are regarder as equal. Consumption of a particular commodity implies that some other commodities are left unconsumed. Thus the very act of smoking reveals that smokers necessarily derive some benefit from smoking, otherwise they would not smoke.

It is further assumed that, under certain conditions, free competitive markets lead to the most efficient allocation of society's scarce resources. In explaining, efficient allocation, economists refer to the Pareto principle, which implies that the allocation of resources is efficient when it is not possible to improve the welfare of any single individual by reallocating resources without worsening the welfare of some other individual (e.g. Layard and Walters 1978). If such an improvement (called Pareto improvement) is feasible, resource allocation is inefficient. Inefficiency implies waste of resources in the sense that it would be possible to improve the welfare of society at large with the prevailing resources by reallocation and improved utilization.

Most economists agree that an economic system based on more or less free market competition is more efficient in maximizing social welfare than any form of government intervention. Competition between private firms for consumers' favour stimulates firms to provide commodities in quantities and qualities that are most preferred by consumers. Firms, striving for maximum profit, have an economic incentive to produce these commodities at minimum cost.

If, on the other hand, it can be shown that markets fail to produce an efficient allocation of resources, there may be a case for government intervention to improve efficiency. A case for government intervention, on efficiency grounds, can be made if the following three conditions are met: 1) there exists a market failure, 2) a market failure is quantitatively significant, and 3) government intervention can help to remedy market failure without generating further problems elsewhere.

There appear to be at least four potential market failures in the tobacco markets:

(1) Externalities in consumption.

(2) Imperfect information.

(3) Dependency.

(4) Inefficient level of prevention.

These potential market failures will be analysed more closely in chapter two. Significance of market failures is an empirical matter which will be analysed in part two.

In principle, the feasibility of government intervention could be evaluated by applying the Pareto principle. However, this is a strong criterion which is seldom attainable in practice. For example, Pareto improvement assumes that the prevailing income distribution persists. Many public projects affect the income distribution within society and hence decrease some individuals' welfare. Any government intervention on the tobacco markets would be unfeasible on this basis, since it would decrease the welfare of some smokers and owners of production factors in the tobacco industry.

For practical policy evaluation, the criterion for approval of an intervention has been changed to that of potential Pareto improvement. The intervention would satisfy the potential Pareto improvement criterion if it could make at least someone better off and no one worse off, if those who gain from the intervention could, at least in principle, compensate those who lose. Thus the criterion is satisfied if beneficiaries' gains exceed the amount losers lose.

Potential Pareto improvement is the cornerstone of cost-benefit analysis which aims to identify projects that satisfy this criterion. The aim is to maximise the total value of outputs produced in order to achieve social efficiency. This differs from the allocative efficiency in that the latter implies no losers, whereas the pursuit of social efficiency implies that there can be losers. If there is a potential Pareto improvement and compensation from beneficiaries to losers is actually undertaken then social and allocative efficiency coincide.

In chapter two we shall analyse potential market failures in the tobacco markets and outline some possible policy options to remedy them. We shall focus only on the demand side failures. Supply side failures, such as monopolistic market structure, are left unexplored. Chapter three introduces the benefit and cost concepts relevant for analysing smoking from the economic perspective and for deriving welfare measures of intervention. In chapter four we shall focus on the welfare implications of the market failures. Chapter five deals with the effects of the alternative tools of government intervention. In the final chapter we shall analyse the welfare implications of the intervention and derive measures of their welfare effects.

The analytical framework developed in this part of the study will be applied for an empirical analysis of the tobacco markets in parts two and three. In the second part we shall analyze the market failures for economic significance. In the third part we shall explore the availability of effective tools for the government to intervene with.

2 MARKET FAILURES IN THE TOBACCO MARKETS

2.1 Externalities

Externalities refer to harmful or beneficial side effects of consumption or production of commodities that are borne by parties not directly involved in the market exchange. Market demands and supplies of commodities reflect only the benefits and costs to the participants in the market (consumers, producers and distributors). Benefits and costs falling on third parties will not be taken into account when consumption and production decisions are made. Harmful side effects to third parties are called external costs and beneficial side effects external benefits.

Externalities lead to a divergence between private and social costs and benefits and hence to an inefficient allocation of resources. In the case of external costs (benefits) the marginal social costs exceed (fall short of) the marginal social benefits. As third parties do not pay for external benefits and they are not compensated for external costs, the market mechanism fails to produce an efficient allocation of resources. It leads to over or under consumption/provision of the commodity in question. Welfare of the society could be improved by curbing the demand for commodities producing external costs and stimulating the demand for commodities creating external benefits.

The market mechanism is unable to balance social costs and benefits since parties involved in the market exchange do not have any incentive to pay for the external costs, and third parties do not have any incentive to pay for the external benefits. The situation may be improved by government intervention, which may include measures, such as taxation, that feed the necessary cost/benefit information into the market mechanism.

The benefits of smoking seem to remain entirely with the consumer and, therefore, there are no significant external benefits associated with smoking. Thus the social and private benefits are equal. There are clearly external costs associated with smoking and, therefore, social and private costs will diverge. To the extent that the external costs are not included in the price of tobacco products, the price is too low and smokers will consume more tobacco than is socially desirable. Society as a whole would be better off if consumption were reduced. There appear to be two types of external costs related to smoking: direct and indirect externalities in consumption.

2.1.1 Indirect externalities

Indirect consumption externalities refer to all harmful side effects of smoking to third parties that arise as a result of smokers' ill health. These may include the additional health care costs and life insurance premiums non-smokers have to pay due to smoking, and the emotional distress due to smoker's ill health and premature death. These externalities do not affect non-smokers directly in the short-run, but only indirectly in the long-run through hazardous health effects to smokers. More formally, these effects can be classified into financial and caring externalities (Culyer 1976, Evans 1984, Mooney 1986).

Financial externality is simple to perceive. Smokers may impose monetary costs on non-smokers, who have to share the costs of e.g. health care generated by smoking-induced illness. Financial externalities may be interpreted as arising as a moral hazard in the market for life and health insurance. Since premiums paid by smokers may not fully reflect their higher probability of illness and death, but only average risks, smokers do not have financial incentives to take into account these risks on other insured and taxpaing individuals in their consumption decisions. In this case, non-smokers would be collectively justified in influencing smokers' smoking behaviour.

Since Pigou (1920), financial externality has been a common argument for warranting government intervention on efficiency grounds. In the health field, however, this type of externality may not be as significant as the caring externality, meaning that individuals care about each other, and, particularly, about each other's health. The extensive government provision and subsidy of health care services found in most of the developed countries can be interpreted to reflect people's willingness to pay to reduce distress caused by the ill health and suffering of others (e.g. Culyer 1976).

The caring externality argument is particularly relevant to preventive programmes directed at children. An individual's smoking and other lifestyle decisions are not taken in isolation. Each individual's lifestyle becomes part of the environment which affects the decisions of others. The tendency of smoking behaviour to begin among children in response to media and peer group pressure (e.g. Rimpelä 1981) and then to become addictive emphasizes the significance of caring externalities.

Caring externality applies to independent adults as well. If a non-smoker cares enough about a smoker, or a smoker's health, to subsidize his health care consumption, then presumably his interest is equally legitimately reflected in public programmes to influence smokers' behaviour or otherwise reduce the probability of smokers falling ill due to smoking. Few individuals are so isolated that their ill health or death, especially if premature, is not a cause of grief to others. To the extent that people are willing to pay to avoid this grief, prevention of ill health and deaths due to smoking is justifiable. However, although individuals may be willing to prevent ill health, they may not be willing to pay for preventive measures. So, there may be a case for the government to intervene to reduce caring externalities and force all taxpayers to share the costs of intervention.

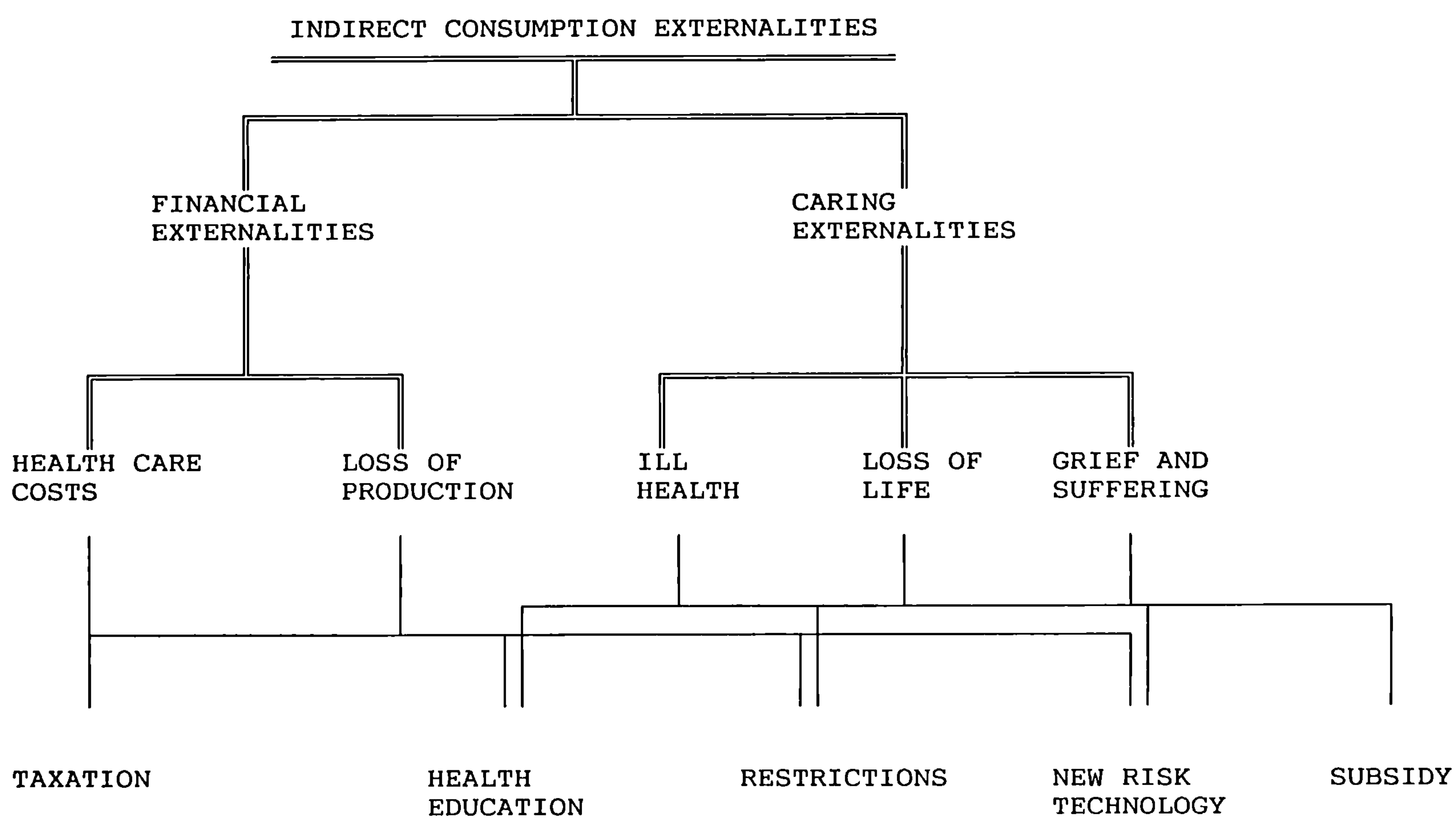
The conventional response to negative financial externalities is some form of tax to equate the marginal social costs with the marginal social benefits. In this case the government would rely on the markets' ability to deliver information about the risks of smoking to consumers and producers through the price mechanism. Besides taxation, all efficient measures that will reduce financial externalities will be appropriate, such as health education, restrictions and improved risk technology. The caring externality argument leads to the same policy recommendations, apart from taxation. Taxation would not be an appropriate tool to correct for caring externalities since smokers would have to pay for others' caring. A relevant financial response would be to subsidize smokers to give up smoking.

Figure 1 represents indirect consumption externalities and some possible remedies.

2.1.2 Direct externalities

Direct consumption externalities refer to harmful side effects of smoking to third parties that accrue directly as a result of smoking. These include health hazards to non-smokers due to passive smoking as well as other non-health related financial and non-financial nuisances. Such effects

Figure 1. Indirect consumption externalities and possible policy responses.



fall directly on third parties, unlike indirect consumption externalities which arise indirectly through smokers' ill health and premature death.

Passive or involuntary smoking appears to exert adverse health effects on those exposed. For example, maternal smoking during pregnancy and parental smoking in general are to some degree hazardous to the child. Smoking during pregnancy is related to low birth weight, early birth, stillbirths, and neonatal and perinatal deaths (McIntosh 1984). Several studies have reported a significant association between the prevalence of respiratory illnesses (bronchitis and pneumonia) in infants and children and parental smoking habits (e.g. Liard et al 1982, Ferguson et al 1981).

Among healthy adults, the most common symptoms arising from passive smoking are eye irritation, headaches, nasal symptoms and coughs (USDHEW 1979). There is also some evidence associating passive smoking with lung cancer (e.g. Hirayama 1981, Trichopoulos et al 1981, Humble et al 1987), but this link is still in dispute, particularly in men (Vandenbroucke 1988). Other nuisances include costs of firedamage and cleaning due to smoking.

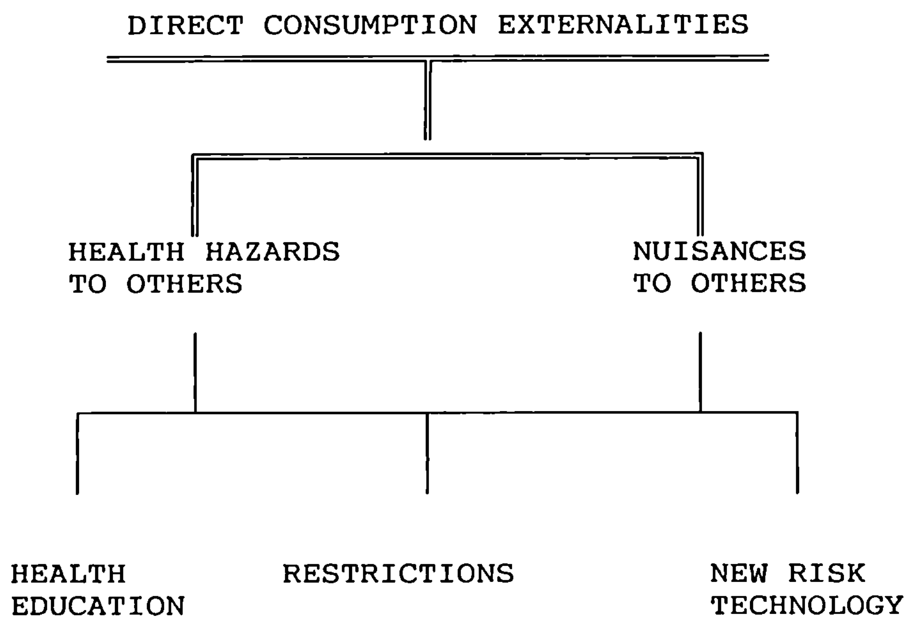
Appropriate measures to correct direct externalities include dissemination of information about the risk, restrictions on consumption and improvements in risk technology. Taxing tobacco may not be effective in this case. Risks of passive smoking may be reduced by informing mothers-to-be and parents about the risks and restricting smoking in public places and in public transportation. These measures require minimal interference with smokers' rights. Direct externalities do not, however, justify the current extensive intervention found in many countries.

Figure 2 represents direct consumption externalities and some possible remedies.

2.2 Imperfect information

The health hazards of smoking are widely publicized and most individuals know that smoking involves risks to health. It may be argued that smokers are aware of the risks and take a calculated risk when they decide to smoke. This may be interpreted to reveal that smokers consider the benefits they derive from smoking to exceed the risks involved. Smoking may be viewed as normal rational consumer behaviour comparable to other activities involving risks, like cycling or car-driving where risk is voluntarily assumed. It is clear, however, that an individual's behaviour can reflect his true preferences only if he is fully aware of the consequences of his actions. This means that individuals should have rather accurate knowledge of the nature and likelihood of the risks involved. If consumers are unaware of the risks, consumption will be greater than if they were fully informed.

Figure 2. Direct consumption externalities and possible policy responses.



At a general level people know and can identify the major risks of smoking (e.g. Valtonen and Rimpelä 1984). It is much more difficult, if not impossible, for a particular individual to perceive how hazardous smoking is for himself. For example, in a representative interview survey of the Finnish adult population, Valtonen and Rimpelä (1984) found that smokers regarded the general health risks of smoking more soundly proven than the specific risks closely related to the respondent's own smoking. Most of the smokers estimated smoking to have at most only a minor effect on their own health, and their perceived health risks were not related to the amount smoked, in contrast to the actual risk. Lack of risk awareness is mainly related to individuals ability to perceive small risks, the long latent period between exposure and ill health, and the gains of quitting.

Although it is not known how accurately individuals can judge smoking related risks, a study by Lichtenstein et al (1978) suggests that individuals may systematically under-estimate the risk of lung cancer, emphysema and heart disease and may not have accurate knowledge of the risk they face. Individuals also appear to have great difficulties in perceiving small risks. Compared to other every-day hazards such as being run over by a car, the risks of smoking may be seen as so small and distant that they can be ignored. Health risks of smoking emerge only after years of continuous smoking and the risk increases as a function of time smoked, and hence also as a function of age. Most smokers start smoking when young (Rimpelä 1981) and they may have great difficulties in understanding the ultimate consequences of their initial consumption decision.

Unlike the situation with most other commodities, it is very difficult to learn from one's own or another's smoking experiences, and to experiment with the beneficial and harmful effects of smoking as is possible for example with medicines. Benefits and side effects of medicine usually appear after a relatively short usage. If side effects emerge, it is possible to try another medicine. The benefits of smoking are experienced instantly, whereas the possible health hazards appear only after years of continuous smoking when it may already be too late to give up.

Hazards due to other common risks, like cycling and car-driving, fall on identifiable individuals and are commonly reported in the mass media. Smoking hazards also fall on individuals, but apart from smoking-related fires, it is usually impossible to identify the individuals affected. The hazards of smoking fall on 'statistical' individuals who do exist, but cannot be identified with certainty. Therefore, many of the hazardous consequences of smoking may be completely invisible to the public at large.

It is not clear how significant the lack of risk awareness is. A case can be made, however, that markets do not provide sufficient information about the risks of smoking. Due to externalities, the price of tobacco may not fully reflect all the costs of consumption. On the other hand, markets do not provide enough information about the hazards of smoking. The tobacco industry and trade do not have any economic incentive to inform consumers about the risks of smoking, but every reason to suppress, belittle and contradict such information. Since tobacco does not have close substitutes, competing industries do not have any incentive to provide information about the risks of smoking. Therefore, a case can be made for government intervention to supply such information. This can take various forms, including tobacco taxation.

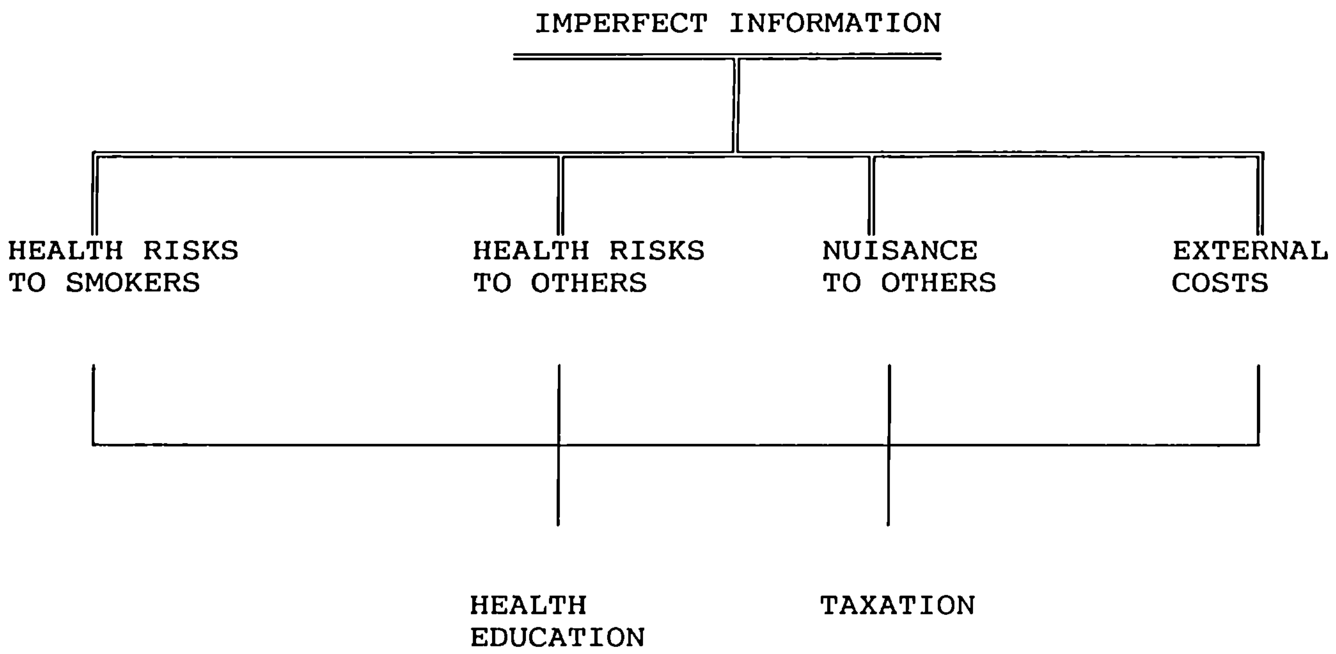
Although an individual smoker's risk of contracting a smoking-induced illness is fairly small, it may be significant from the point of view of society. Individuals may have difficulty in assessing how smoking affectst heir own health. When the government has superior information about the risks, there is a legitimate basis for intervention. Government agencies have greater possibilities to pool information from different sources, to increase the precision of their risk judgements and to interpret the implications of the available scientific evidence more accurately to individuals and society at large. Thus government should provide more information and diminish consumers' unawareness of the health risks of smoking, thus enabling consumers to make more informed judgements about the consequences of their choices.

It may not be sufficient, however, to restrict intervention only to the provision of information. Kahneman and Tversky (1979) suggest that most individuals prefer certain to uncertain gains, but prefer uncertainty to certainty with respect to losses. Such asymmetry in risk aversion may have important consequences for smoking prevention. Consider a smoker contemplating giving up smoking, and hence some pleasure. The immediate action involves a certain loss, but his future gain is quite uncertain even though it may be highly predictable, on a large population level. Thus, the stronger the individual's asymmetry with respect to uncertainty, the less likely he will be to give up smoking. The uncertainty element is probably large in the case of giving up smoking. Even the best information available indicates only the average expected benefits from such health investment. The return to any individual is highly uncertain. For example, only a minority of smokers will contract lung cancer or coronary heart disease, while giving up smoking does not provide a guarantee against these diseases.

Since provision of information may be costly and not very effective, one way to inform smokers about the risks is to tax tobacco to the extent that social costs and social benefits of smoking will be equal.

Figure 3 represents imperfect information and some possible remedies.

Figure 3. Imperfect information and possible policy responses.



2.3 Dependency

Two types of dependency are associated with smoking: the smoking habit and tobacco addiction. The borderline between habit and addiction may be difficult to draw, but in practice, addiction can be assumed when individuals wanting to abandon the habit cannot do so. Therefore, the distinction between habit and addiction may be defined as follows. If an individual wanting to change a habit, e.g. give up smoking,is able to do so then the dependency may be termed a habit. If, on the other hand, the individual is unable to give up the habit then the dependency may be called an addiction.

Extensive behavioural and psychological research demonstrates that smoking, once established as a habit, is extremely persistent and resistant to change (USDHEW 1979). This may not, however, be typical only to smoking. Some economists argue that habit formation is a rather universal phenomenon (e.g. Scitovsky 1976) and in this respect smoking does not differ from other everyday activities like drinking coffee or watching television. Habit formation, as such, is not the problem. Littlechild and Wiseman (1984) illustrate this with an example taken from classical music. One may acquire a taste for classical music as a result of repeated listening to it. Such changes are often deliberately cultivated, and there is no reason to believe that the individual's ability to choose is at all impaired. It is just that different choices are made as a result of experience. No government intervention is called for in such cases.

Another case arises when the use of a substance results in addiction. Insofar as the psychological or physiological dependency on tobacco products prevents the smoker from choosing freely whether and how much he wants to smoke, addiction interferes with the basic rationality postulate of consumer theory and hence constitutes a market failure.
A crucial issue is how severe a problem addiction is and hence how important a source of market failure. In a recent Finnish health survey 20 per cent of current smokers claimed to have attempted to stop smoking during the previous six months without success (Vohlonen 1989), severe withdrawal symptoms being one of the major reasons for failure. Thus, tobacco addiction may be a source of a significant market failure. If that is the case, two questions arise: what society should do in order to help the addicted to abandon the habit, and how far society should attempt to prevent individuals from becoming addicted in the first place.

Helping addicts to give up smoking may include public provision or subsidy of smoking cessation programmes and subsidies to the tobacco industry to remove addicted substances from tobacco. In order to prevent addiction, government may launch health education programmes, set restrictions on advertising of tobacco products and restrict sale of tobacco to minors. The government may also use tax measures to deter minors from taking up smoking and thus prevent them becoming addicted. Taxation would, however, reduce the welfare of those who continue to smoke. The changing risk technology would involve creation of incentives to the tobacco industry to remove addictive substances from tobacco products.

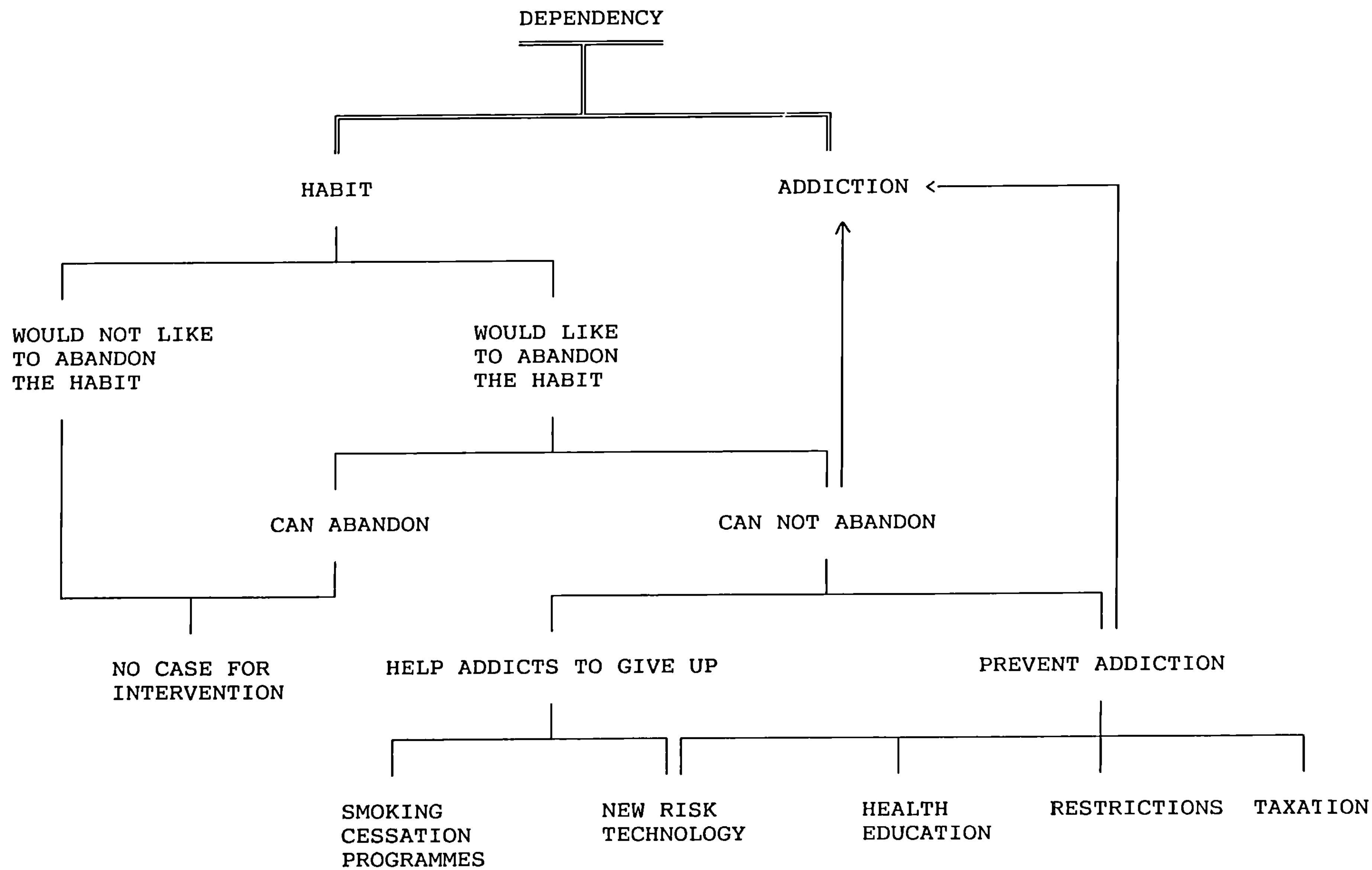
Figure 4 represents smoking dependency and some possible remedies.

2.4 Inefficient level of prevention

Prevention of smoking refers to a whole range of activities that may help individuals and society avoid the harmful effects of smoking (e.g. health education, restrictions and taxation). Preventive measures may be effective in reducing the social costs of smoking, but the public good aspect of prevention and related externalities may lead to a situation where markets may provide too little prevention even if it would be socially efficient to prevent smoking.

Public (or social) goods refers to commodities which are not provided, or not in sufficient quantities, by the market because of two characteristics: non-exclusion and non-rival consumption (e.g. Atkinson and Stiglitz 1980). Non-exclusion means that once the good is provided for some individuals, it is impossible or at least very costly to exclude others from benefiting from it. Non-rival consumption means that many

Figure 4. Dependency and possible policy responses.



individuals may simultaneously consume the same good without diminishing its availability to others.

Smoking prevention, particularly the provision of information about the health risks of smoking, clearly has characteristics of a public good. If risk information is provided for one individual, there is no way in which others can be prevented from consuming it as well. Nevertheless, consumption of risk information by one individual does not reduce the amount available for consumption by others. The marginal cost of supplying a fixed quantity of information about the health risks of smoking to another individual is also likely to be small.

On the other hand, it may be impossible or extremely costly to charge those who would benefit from private preventive programmes. Effective preventive measures may discourage some smokers from smoking, thus reducing the social costs of smoking and hence benefiting each taxpayer. However, no single taxpayer would be willing, on purely economic grounds, to finance such campaigns voluntarily since he would have to bear the full implementation costs while the benefits would be spread over all taxpayers (free rider problem). For this reason there will be no extensive private demand for such programmes, and the market does not provide them. Therefore, it may be necessary for the government to intervene and less costly to force every taxpayer to contribute to the implementation costs.

2.5 Conclusions

The preceding discussion indicates that due to market failures free competitive tobacco markets may lead to an inefficient allocation of resources. Consumption externalities, imperfect information about the health risks, smoking dependency and inefficient levels of prevention may lead to a situation where free competitive tobacco markets may create external costs to third parties and may not maximize smokers' and nonsmokers' welfare. Therefore, if left alone, the competitive markets may fail to produce an efficient allocation of resources and thus there may also be a case for the government to intervene in tobacco markets on other than purely paternalistic grounds.

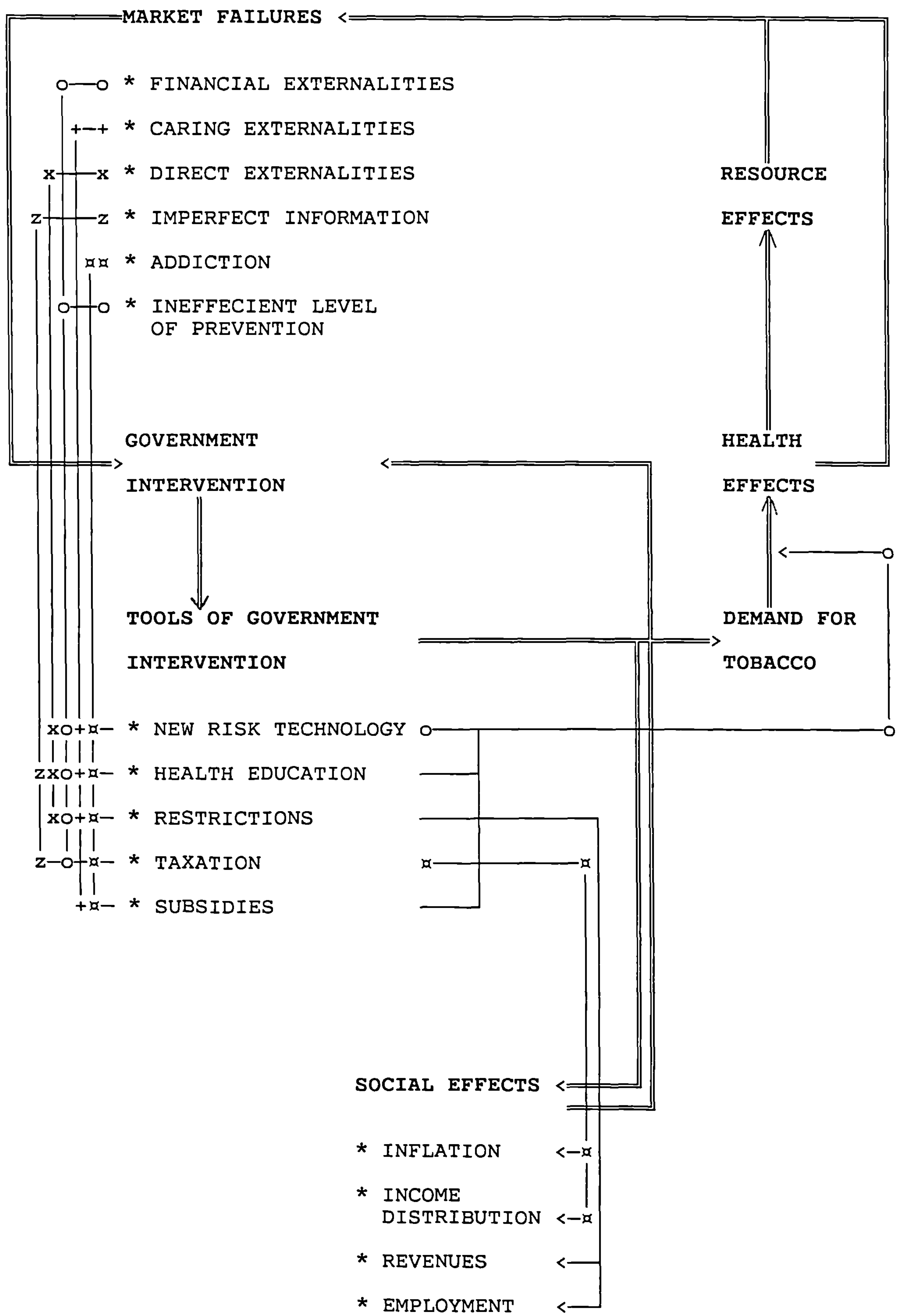
Existence of a market failure is a necessary but not a sufficient condition for government intervention. A further condition is that market failure is quantitatively significant. This can be assessed by analysing the social benefits and social costs of smoking. Another condition is that the government has effective tools to intervene.

The most commmonly used intervention tools include taxing tobacco, health education campaigns, restrictions on availability, provision and advertising of tobacco, improvements in risk technology and financial subsidies to smokers and firms.

It is important to recognize that the choice of an appropriate tool depends on the market failure government wants to remedy (Figure 5). If the main concern is financial externality, prevention of addiction or an inefficient level of prevention, then taxation, health education, restrictions and improvements in risk technology will be appropriate. If the government attempts to diminish caring externality then health education, restrictions, improvements in risk technology and subsidies will be suitable. The same measures, excluding subsidies, are appropriate for correcting direct consumption externalities. Market failure due to imperfect information may be corrected by health education and taxation. If the government attempts to help addicts free themselves of dependency, then improvements in risk technology, subsidies to smokers wanting to give up and firms helping smokers in their endeavour will all be suitable measures to take.

The relative efficiency of intervention measures in remedying each of the market failures can be evaluated by cost-effectiveness analysis, where effectiveness is defined in relation to the objectives of the intervention (e.g. Sintonen 1981). If the government is concerned how best to help addicts to give up smoking, then the relative efficiency of reimbursing smokers to give up compared with subsidizing smoking cessation clinics to supply their services free of charge or at reduced price, or subsidizing the tobacco industry to produce a non-addictive tobacco, can be evaluated

Figure 5. Market failures and government intervention in the tobacco markets



by comparing the costs of each option by relative success rates. Options can then be compared and ranked according to their cost-effectiveness. An option will be technically efficient and preferable to other options if it maximises the benefit obtainable from the given budget or minimises the cost of attaining the given objective.

Most of the intervention measures also influence other market failures and may have desirable or undesirable effects on other parts of the economy if they affect employment, inflation and income distribution (Figure 5). For example, improved risk technology may, apart from relieving dependency, reduce financial, caring and direct consumption externalities. In order to assess the relative merits of intervention it may, therefore, be preferable to evaluate the social efficiency of intervention which involves estimating the costs and benefits of each option in monetary terms (e.g. Sintonen 1981). If the net welfare gain is positive, e.g. benefits exceed costs, the option will be socially efficient. If a choice must be made between several mutually exclusive options, the one with the largest net welfare gain will be preferred.

In chapter three we shall derive the cost and benefit concepts relevant to an economic analysis of smoking. In chapters four to six we shall derive the appropriate welfare measures for each of the intervention measures.

3 COST AND BENEFIT CONCEPTS RELEVANT TO SMOKING

3.1 Introduction

Conceptually it is simple to define the social costs of smoking as the total costs of smoking to the whole of society. In practice, however, the term social costs is used inconsistently. Some researchers speak of social costs when they mean external costs (e.g. Markandya and Pearce 1989), and some use the terms the other way round. Confusion is compounded by the yet unestablished use of concepts such as resource costs, economic costs (e.g. Rice et al 1986) or simply costs (e.g. Thompson and Forbes 1982, Hjalte 1984) of smoking to indicate a subset of social costs that arise as a result of smoking. Usually no attempt is made to relate these or other related concepts to external costs. In this chapter we shall define the cost and benefit concepts that will be used throughout this study.

3.2 Private costs

Private costs of consumption (PC) per unit consumed are made up of three components: price of tobacco (P), and perceived (CR_p) and unperceived (CR_{up}) costs of health risks of smoking, which depend on the amount of tobacco smoked. The perceived cost CR_p is the psychological cost a smoker attaches to each amount of tobacco consumed, knowing that smoking can be hazardous to his health in the long-run. CR_p includes all other costs of smoking besides the price of tobacco that the smoker believes to fall on him as a result of smoking, e.g. health care costs, lost earnings and risk of ill health and premature death. The unperceived cost CR_{up} represents all costs of smoking falling on a smoker that he is not aware of. The sum of CR_p and CR_{up} represents the private costs of health risk of smoking (CR) to a smoker per unit consumed. Hence the private cost of smoking equals

$$PC = P + CR_p + CR_{up}$$
$$= P + CR.$$

The price of tobacco (P) is made up of taxes (T), production costs (PRC) and costs of distribution (DC):

$$P = T + PRC + DC.$$

The private costs per unit consumed can now be redefined as

$$PC = T + PRC + DC + CR.$$

Taxes and other components of the unit price are assumed to be constant over the relevant range of consumption. Epidemilogic evidence suggests (e.g. USDHEW 1979) and it is also commonly perceived (e.g. Valtonen and Rimpelä 1984) that the more one smokes the more likely he is to experience smoking related health problems. Therefore, marginal private costs of health risks of smoking (MCR) are assumed to increase as a function of the amount consumed.

3.3 Social costs and external costs

Social costs of smoking (SC) can be defined as the total costs of smoking to the whole society. Since Pigou (1920) the divergence between the social and private costs have been called external costs (EXC):

$$SC - PC = EXC.$$

External costs arise whenever consumption or production activity creates adverse effects on third parties which are not compensated for. In the absence of external costs, social costs equal private costs. Negative external costs are called external benefits. As most of the external costs of smoking are due to smoking related health risks, it is likely that the marginal external costs (MEXC) will increase as the amount of tobacco consumed increases.

In the absence of costs other than price to consumers, the difference between social costs and price gives the external costs per unit consumed

$$SC - P = EXC.$$

If consumers have to incur other costs besides the price this identity does not hold. In the case of smoking

$$SC - P = EXC + CR.$$

As the CR is assumed to be positive over the relevant range of consumption it is likely that

$$SC - P > EXC.$$

The external costs and private costs of health risks of smoking can be decomposed into monetary (m) and intangible (i) costs:

$$CR = CR^{m} + CR^{i}$$

$$EXC = EXC^{m} + EXC^{i}.$$

Monetary costs are measured in monetary terms. Intangibles are costs that cannot be measured or are not favoured to be expressed in monetary terms. The distinction between monetary and intangible costs largely depends on the state of the art in measuring and valuing cost components which do not have market price.

The monetary costs can further be sub-divided into direct (md) and indirect costs (mi)

$$CR^{m} = CR^{md} + CR^{mi}$$

$$EXC^{m} = EXC^{md} + EXC^{mi}.$$

Direct costs mainly comprise costs of prevention, treatment and rehabilitation for smoking related illnesses. Indirect costs consist mainly of the value of lost health resulting from smoking related morbidity and mortality. Direct cost reflect the true financial burden of treating illnesses falling on society. Indirect costs are based on imputed values.

The social costs can now be redefined as

$$SC = P + CR^{md} + CR^{mi} + CR^{i} + EXC^{md} + EXC^{mi} + EXC^{i}$$

and rearranging terms

$$SC - P = CR^{md} + CR^{mi} + EXC^{md} + EXC^{mi} + CR^{i} + EXC^{i}.$$

3.4 Economic costs and adverse costs

The commonly estimated economic costs (EC), resource costs or simply costs of smoking (e.g. Shillington 1977, Luce and Schweitzer 1978, Thompson and Forbes 1982, Collishaw and Myers 1984, Hjalte 1984, Ellemann-Jensen 1986, Rice et al 1986) are the sum of monetary external costs and monetary private costs of health risks of smoking

$$
\begin{aligned}
EC &= CR^{m} + EXC^{m} \\
&= CR^{md} + CR^{mi} + EXC^{md} + EXC^{mi}.
\end{aligned}
$$

It is clear that economic costs do not measure social costs nor external costs. As economic costs also include costs that fall on smokers themselves it is obvious that external costs are only a sub-set of economic costs. Social costs and external costs can be defined with the help of economic costs as follows

$$
\begin{aligned}
SC &= EC + P + CR^{i} + EXC^{i} \\
EXC &= EC + EXC^{i} - CR^{md} - CR^{mi}.
\end{aligned}
$$

By redefining the divergence between the social costs and price in terms of economic costs

$$
\begin{aligned}
SC - P &= EC + CR^{i} + EXC^{i} \\
&= CR^{m} + EXC^{m} + CR^{i} + EXC^{i}
\end{aligned}
$$

it seems obvious that earlier cost of smoking studies have used a cost concept that is not strictly related to external costs. The estimates exclude intangibles and include monetary costs of smoking falling both on smokers and third parties. Even the estimated monetary costs are only partially external since some of them are borne by smokers.

Because, in the case of tobacco, we cannot refer to the divergence between the social cost and the price as external cost, and as the concept of economic cost only partially covers the difference, we use the concept adverse costs (ADC) to indicate the value of the adverse effects of smoking to both third parties (EXC) and to smokers (CR)

$$\begin{aligned} ADC &= SC - P \\ &= CR + EXC \\ &= CR^m + CR^i + EXC^m + EXC^i. \end{aligned}$$

Figure 6 indicates the relationship of the different cost concepts developed above. An attempt to estimate the various components of the adverse costs is made in part two.

3.5 Institutional and final external costs

Having estimated either the adverse costs or economic costs of smoking the next question is how to isolate the external costs from the rest, i.e. how to estimate the $EXC^m + EXC^i$ in

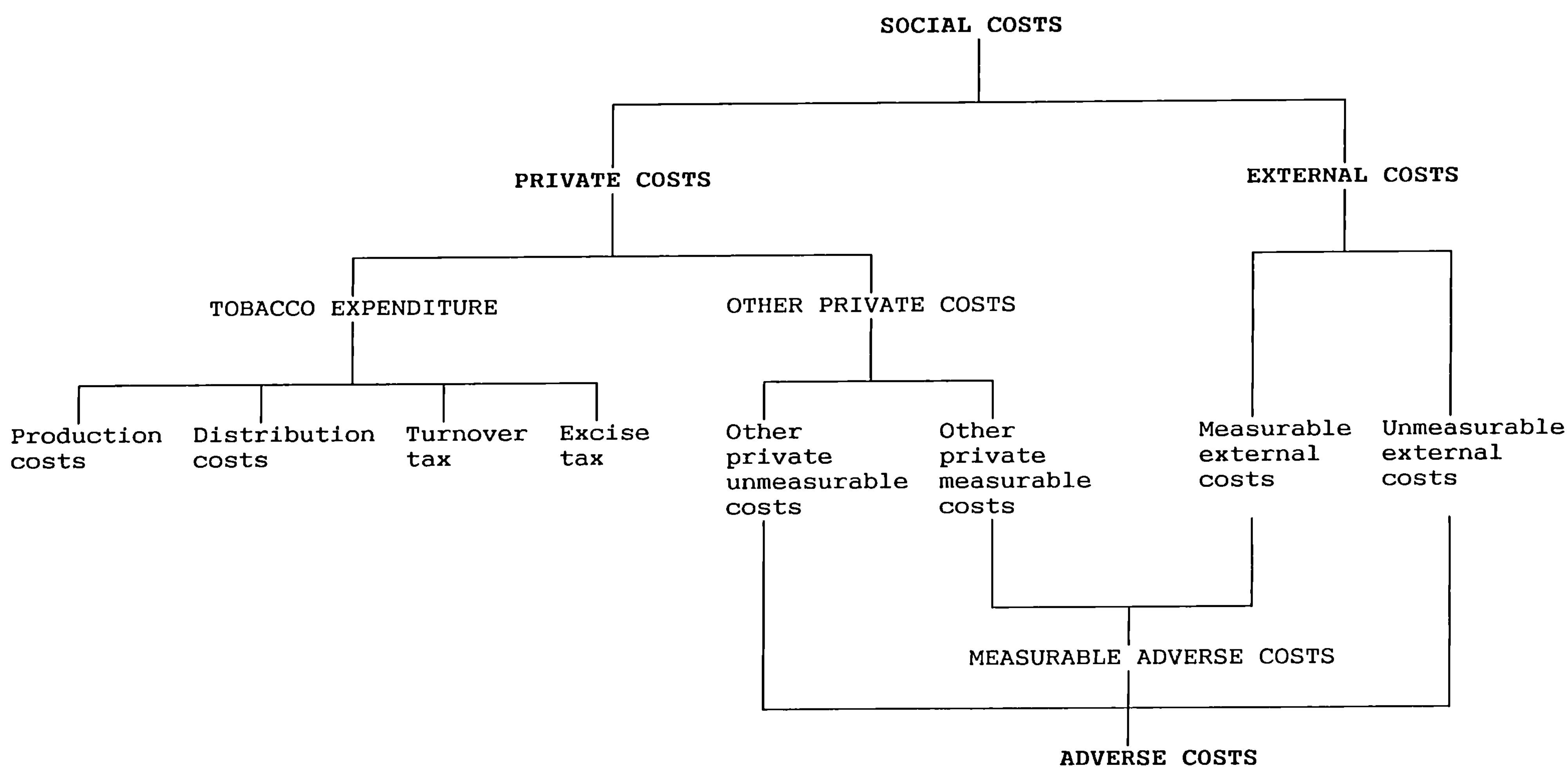
$$ADC = CR^m + CR^i + EXC^m + EXC^i$$

or EXC^m in

$$EC = CR^m + EXC^m.$$

The extent to which the ADC or EC reflects true external costs depends on institutional arrangements. For example, if patients have to pay all the medical treatment costs in full

Figure 6. Cost concepts relevant to smoking.



without being reimbursed then all the health care costs of smoking would be borne by smokers and third parties would be unaffected. All costs would be private and there would be no external costs. If compensation is paid and funded by payments from third parties, then there will be external costs.

Assuming we have estimated the economic costs, then the external costs are the difference between the total economic costs and the economic costs borne by smokers

$$EXC^m = EC - CR^m.$$

It is obvious that both the magnitude of external costs and the ratio between external and economic costs depends on how the cost component CR is defined. We have two options here. We can either assume that

(i) the CR includes only the direct monetary losses suffered by smokers (e.g. out-of-pocket payments for medical treatment), or that

(ii) the CR also includes smokers' contributions to the financing of the health care services, social security and other relevant institutions affected.

The external costs are clearly greater in the former case. The latter, however, is the more appropriate approach, since it recognizes the fact that smokers also contribute to the financing of the institutions concerned. Smokers use e.g. health care services and finance them together with non-smokers. The first option implicitly assumes that the only cost to smokers is out-of-pocket-payments, while the remainder is financed by non-smokers. The first option (i) characterizes externalities from the viewpoint of various institutions and these can therefore be called **institutional externalities**. The second option (ii) demonstrates how costs are distributed between smokers and non-smokers and can therefore be termed **final externalities**.

It is not clear which of these two options researchers into the costs of smoking have had in mind. A cautious interpretation would suggest writers to be in favour of the institutional externalities approach. We shall adopt here the second option, however, since there are no good reasons for ignoring smokers' contributions to the financing of the institutions concerned.

3.6 Private and social benefits

The jobs created in the tobacco industry and trade, as well as the tax revenues received by the state, are often interpeted as social benefits of smoking. In economics, however, benefits can only be assessed in relation to consumers' satisfaction or utility. In an efficient economic system, allocation of resources eventually adapts to consumer preferences rather than the other way round. The change in consumer preferences manifests in the change of demand and thereby in the demand for labour and income within different production sectors. When the demand for a product decreases, it is likely that consumers spend their money thus released on other commodities, thus increasing the demand for labour and income in respective production sectors.

Tax revenues derived from tobacco by the state represent a transfer of income from smokers to the state. Taxes are used to redistribute income between the private and the public sector and, as such, do not increase the consumption potential of society as a whole. Tobacco excise can, however, be interpreted to offset the external costs of smoking.

The real benefits of smoking are the satisfaction of needs or the utility which consumers derive from smoking. The minimum of these benefits can be crudely estimated by consumer expenditure on tobacco, which reflects consumers' aggregate willingness to pay for obtaining the benefits associated with smoking. In practice, this approach is not completely satisfactory, since it ignores any effects of possible imperfect information and the existence of dependency, and does not account for consumer surplus.

The benefits of smoking seem to rest entirely with smokers. Therefore, it is likely that there are no significant external benefits, and thus the social benefits of smoking will be equal to the private benefits.

3.7 Private consumption equilibrium

In economics, consumers are assumed to consume each product in the quantity that equates the marginal private benefits (MPB) with the perceived marginal private costs (MPC^*). Hence, at optimum consumption, MPB = MPC^*. The perceived marginal private costs reflect the costs of consumption to the consumer that he is aware of. As was noted earlier, however, these may not, represent the full cost of consumption to the consumer, since he may incur some costs that he is unaware of. The true marginal private cost (MPC) is made up of three components: the money price of tobacco (P) and the marginal private costs of health risks of smoking, which may be perceived (MCR_p) or not perceived (MCR_{up}) by the smoker

$$\begin{aligned} MPC &= P + MCR_p + MCR_{up} \\ &= MPC^* + MCR_{up}. \end{aligned}$$

This distinction between the perceived and unperceived costs is important since it is the perceived marginal cost that determines an individual's actions (cf. Markandya and Pearce 1989). For the sake of analysis we assume that smokers perceive the private costs fully, e.g. we assume that MPC = MPC^* and MCR_{up} = 0. Hence the private consumption optimum will be where MPB = MPC^*.

4 IMPLICATIONS OF MARKET FAILURES IN THE TOBACCO MARKETS

4.1 Introduction

In chapter two we introduced four potential market failures in the tobacco markets which may lead to inefficient allocation of resources. Market failures lead to a situation where the market demand for tobacco is greater than is socially optimal. As the demand effects of all potential market failures are similar it is sufficient to outline their welfare effects by illustrating one of them. For the sake of analysis we shall focus on the welfare effects of external costs. These generalized conclusions are equally appicable to other market failures, since this analysis will highlight the effects both on external costs and perceived costs of smoking which are affected by all such failures.

4.2 Welfare implications of market failures

In the absence of external costs of smoking the marginal social costs (MSC) will be equal to the marginal private costs

$$MSC = MPC = P + MCR_p.$$

Also, the marginal private benefits and marginal social benefits (MSB) will be equal

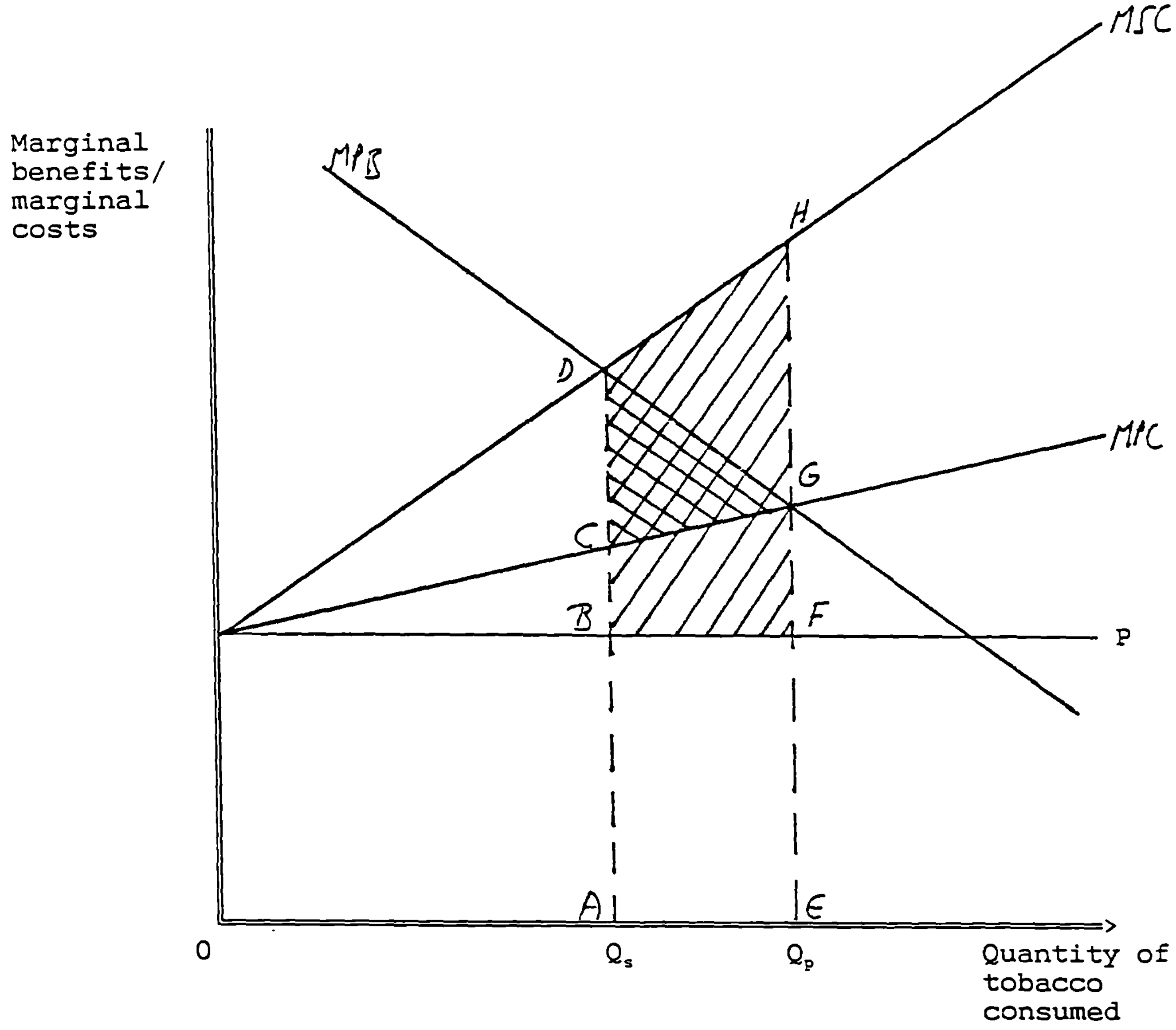
$$MSB = MPB = P + MCR_p = MSC.$$

When consumption creates external costs (MEXC > 0), marginal social costs will exceed the marginal private costs. This can be shown by a simple diagram (Figure 7). The vertical axis measures marginal costs and marginal benefits of smoking, and the horizontal axis the quantity of tobacco consumed.

It is natural to assume that the marginal private benefits will fall as the quantity of tobacco consumed increases. This reflects the decreasing marginal utility of consumption: individuals can increase their well-being by consuming more, but the marginal increase in well-being derived by an increase in consumption is decreasing. Therefore the marginal benefit curve in figure 7 slopes downwards. The area under the MPB curve represents the total value consumers attach to each level of consumption. It indicates consumers' willingness to pay for each quantity of tobacco consumed.

The marginal private costs will be equal to the marginal private benefits only for the last unit consumed. For the last and all previous units consumed, the total private costs of consumption are less than the total private benefits from that consumption. The area between the MPB and the MPC curves represents the total consumers' surplus associated with each consumption level.

Figure 7.



MSC
Marginal benefits/ marginal costs
MPB
H
D
MPC
G
C
B
F
P
A
E
0
Q_s
Q_p
Quantity of tobacco consumed

The money price of tobacco is assumed to be constant over the relevant range of consumption. The perceived marginal costs of health risks of smoking, and hence the marginal private costs, are assumed to be an increasing function of consumption. The marginal external costs are also assumed to rise as a function of consumption. The marginal social costs are the sum of marginal private costs and external costs

$$MSC = MPC + MEXC.$$

In the absence of government intervention, smokers will consume an amount Q_p of tobacco, which equates the marginal private benefits and costs (EG in Figure 7). At Q_p the marginal social costs (EH) exceed the marginal private costs because of the external costs of consumption (GH). Society as a whole would be better off if consumption were reduced. The socially optimal level of consumption is where the marginal social benefits equal the marginal social costs. Assuming that smoking does not create marginal external benefits to third parties, marginal social benefits are equal to marginal private benefits. Then the socially optimal level of consumption is Q_s, where marginal private benefits equal marginal social costs (AD).

By reducing their consumption, from the current level Q_p to the socially optimal level Q_s, smokers will lose part of the consumer surplus (ΔCS) equal to

$$\Delta CS = \int_{Q_s}^{Q_p} \{MPB(Q) - MPC(Q)\}dQ$$

which equals the area CDG in figure 7. This represents the loss of smokers' welfare resulting from reduced consumption.

On the other hand, smokers benefit from reduced smoking by an amount of the decreased perceived costs of health risks of smoking (ΔCR_p) equal to

$$\Delta CR_p = \int_{Q_s}^{Q_p} MCR_p(Q)dQ$$

$$= \int_{Q_s}^{Q_p} \{MPC(Q) - P\}dQ.$$

This is equal to the area BCGF in figure 7.

The net welfare effect to smokers (ΔW_s) from reduced smoking is the difference between smokers' gains and losses, i.e.

(1) $\Delta W_s = \Delta CR_p - \Delta CS.$

Third parties gain an amount equal to the reduction in external costs associated with a fall in consumption (area

CDHG). More formally the reduction in external costs (ΔEXC) is

$$(2) \quad \Delta EXC = \int_{Q_s}^{Q_p} MEXC(Q)dQ$$

$$= \int_{Q_s}^{Q_p} \{MSC(Q) - MPC(Q)\}dQ.$$

This represents the original welfare loss to third parties resulting from market failures. The net welfare gain to society is the sum of the gains to smokers and to third parties minus the loss in smokers' welfare. The sum of (1) and (2) indicates the net welfare gain to society (ΔW) resulting from reduction in consumption from Q_p to Q_s, i.e.

$$(3) \quad \Delta W = \Delta EXC + \Delta CR_p - \Delta CS$$

$$= \int_{Q_s}^{Q_p} \{MSC(Q) - MPC(Q)\}dQ + \int_{Q_s}^{Q_p} \{MPC(Q) - P\}dQ$$

$$- \int_{Q_s}^{Q_p} \{MPB(Q) - MPC(Q)\}dQ$$

$$= \int_{Q_s}^{Q_p} \{MSC(Q) + MPC(Q) - MPB(Q) - P\}dQ$$

which is equal to area DHG + BCGF in figure 7. This represents the total original welfare loss due to market failures that could potentially be eliminated by government intervention.

4.3 Welfare effects of reduced smoking

It is worth noting that the socially optimal level of consumption is not zero, but the level where marginal private benefits equal marginal social costs, i.e. Q_s in figure 7. The failure to recognize this and to call for outright eradication of smoking is obviously based on notion that smoking causes external costs to third parties but no benefits to smokers, i.e. MEXC > 0 and MPB = 0 for all Q. The latter assumption is clearly not justified, since smokers presumably derive some benefit from smoking, otherwise they would not smoke. An alternative justification for eradication is if the benefits of smoking are constant over the relevant range of consumption, i.e. if the marginal benefit curve is horizontal. In either case (MPB = 0 or MPB = constant) the socially optimal level of consumption is zero. The welfare gains resulting from eradication differ, however.

If smokers derive no benefit from smoking, but are forced to smoke, then, besides the external costs, smokers' expenditure on tobacco as well as other costs born by smokers also represent a welfare loss to society (cf. Atkinson and Meade 1974). Society would be better off by the amount spent on tobacco plus the external and perceived costs of health risks of smoking if smoking was eradicated. In this case the welfare gains of eradication are

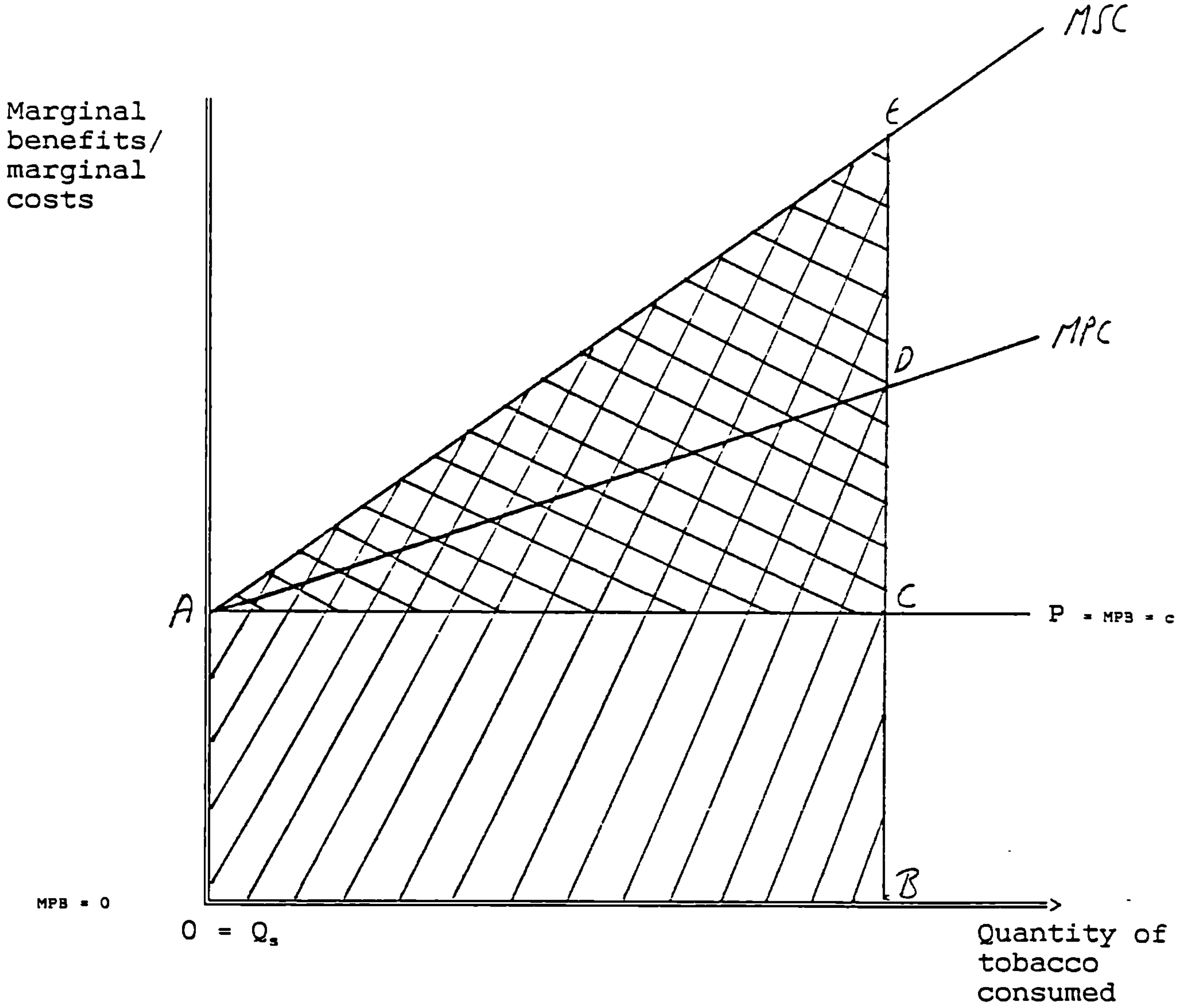
$$(4) \quad \Delta W^{*} = \int_{O}^{Q_p} \{MPC(Q) + MEXC(Q)\}dQ$$

$$= \int_{O}^{Q_p} \{MCR_p(Q) + MEXC(Q) + P\}dQ.$$

In figure 8 this equals the area OAEB.

If, on the other hand, smokers do derive benefit from smoking, but the size of the benefit does not depend on the amount consumed, the socially optimal level of consumption is again zero. That is the only level of consumption where the marginal social costs equal marginal private (social) benefits. In this case, it is reasonable to assume that the marginal private benefits equal the price of tobacco. The welfare gains of eradication will be smaller than in the case of zero consumption benefits. Gains to third parties equal the reduction in the external costs (area AED). As there is no consumer surplus, there will be no loss in smokers' welfare due to this reason. Smokers welfare will improve by the amount equal to the reduction in the perceived costs of health risks of smoking (area ADC). Welfare gains to society resulting from eradication of smoking will be the sum of the gains to third parties and to smokers, i.e.

Figure 8.



MSC
Marginal benefits/ marginal costs
E
MPC
D
A
C
P = MPB = c
B
MPB = 0
0 = Q$_s$
Quantity of tobacco consumed

$$(5) \qquad \Delta W^{**} = \int_{O}^{Q_p} \{MEXC(Q) + MCR_p(Q)\}dQ$$

$$= \int_{O}^{Q_p} \{MSC(Q) - P\}dQ.$$

In figure 8 this equals the area AEC.

It is clear from (3)-(5) that, even if applied to estimate the welfare gains of a less dramatic reduction in smoking than complete eradication, such as movement from Q_p to Q_s in figure 7, the three welfare criteria will produce different estimates. In general the magnitude of the estimated welfare gains are likely to be in the following order

$$\Delta W < \Delta W^{**} < \Delta W^{*}.$$

Economists tend to follow criteria more in line with ΔW (e.g. Leu and Schaub 1984), whereas the medical profession tends to be more in favour of ΔW^{*} (e.g. Thompson and Forbes 1982).

4.4 Conclusions

Information requirements arising from the above discussion fall into three categories depending on the question under consideration:

(1) In order to evaluate the socially optimal level of consumption, information on the marginal external costs and on the marginal private costs and benefits is required.

(2) To justify government intervention on efficiency grounds information on external costs is needed.

(3) To determine the optimal extent of government intervention information on the welfare gains and costs of intervention is essential. This includes data on the likely changes in external and perceived costs of health risks of smoking and in consumer surplus, and information on the costs of intervention itself.

Part two will attempt to provide some of the information required.

5 METHODS OF GOVERNMENT INTERVENTION

5.1 Introduction

The government can take a variety of steps to remedy market failures and to bring the level of consumption of tobacco down to its socially optimal level. It has four main options available:

(1) taxation on tobacco,
(2) health education,
(3) restrictions on consumption, and
(4) improvements in risk technology.

This chapter will focus on the effects of these options. Each option will be examined in turn.

5.2 Taxation

In this case the social optimum can be achieved by setting tobacco tax at a level where the marginal social benefits equal the marginal social costs. In figure 7, the optimal tobacco tax would be set at CD per unit of tobacco. The tax would raise the marginal private costs from EG to AD and reduce the private consumption optimum from Q_p down to the social optimum Q_s.

It is important to note that ideally the optimal tax rate should be set in relation to the marginal external cost at the social consumption optimum Q_s and not in relation to the marginal external cost at the current consumption level Q_p. The optimal tax per unit equals the marginal external cost per unit at Q_p only if MEXC is constant over the relevant range of consumption. Otherwise, the optimal tax per unit is less than the marginal external cost at Q_p. Only if the marginal external costs are decreasing over the relevant range of consumption is the optimal tax greater at Q_s than at Q_p. In the case of tobacco the assumption of falling marginal external costs can be safely ruled out.

It is also worth noting that there will be costs to third parties even when the optimal tax is levied at the social consumption optimum Q_s. The costs to third parties will be equal to CD in figure 7. Interpretation of these costs is not always unambiguous. In welfare economics these costs would not be called external costs since smokers compensate for them to third parties, at least in principle, by paying a tax per unit that equals precisely the cost CD. However, only if the tax is earmarked and used to compensate third parties fully do no problems arise. Taxes that are not earmarked raise a distributive dilemma. If the government does not compensate the third parties they still have to bear the costs despite the tax. Government receives the tax revenue, while the third parties have to bear the costs. Here we shall call the costs to third parties as the optimal external cost per unit of consumption. The total amount of the optimal external costs (EXC^{α}) to third parties at the social optimum is given by

$$EXC^{\alpha} = \int_{0}^{Q_s} MEXC(Q)dQ.$$

5.3 Health education

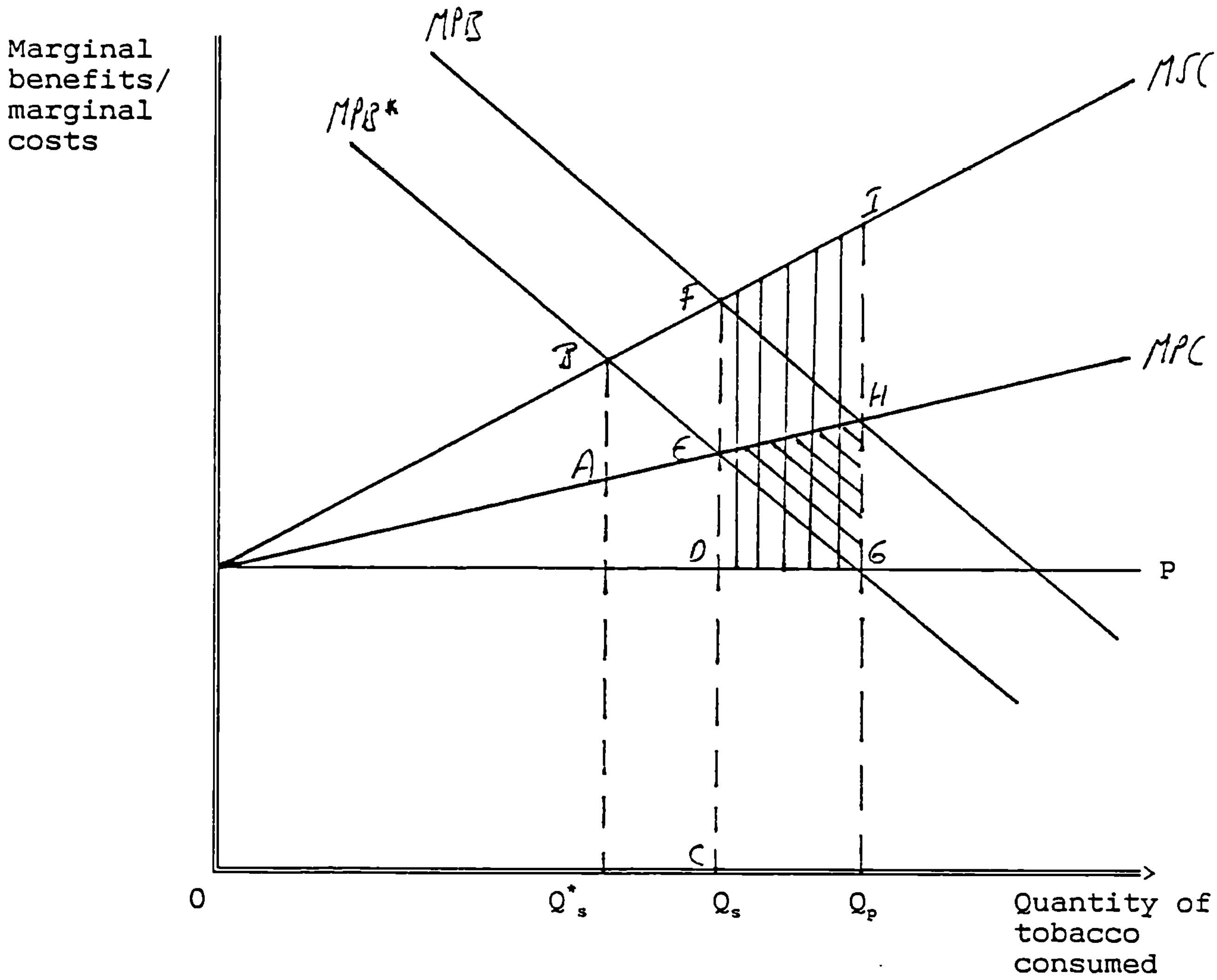
Health education attempts to alter consumers' perception of the benefits attached to consumption of hazardous or beneficial goods. Technically, smoking related health education aims to shift the marginal private benefit schedule MPB so that the new MPB schedule cuts the marginal private cost schedule MPC at point C in figure 7. When consumption falls from Q_p to Q_s the marginal external costs are reduced from GH to CD.

Now three points are worth noting. First, it is indeed possible to reduce external costs via health education by altering smokers' perception of the marginal private benefits of smoking. Second, it is never possible to internalize external costs by health education. Third parties are better off by the amount equal to the reduction in external costs, but even at the new level of consumption Q_s the divergence between the marginal social and private costs remains (CD in figure 7). This is because smokers do not compensate for the loss they cause to third parties. Third, the socially optimal level of consumption can never be secured by health education alone. Due to health education the social optimum is continously shifting. In fact, the social opimum is reached only when consumption is zero. That is the only level of consumption where there is no divergence between the marginal social and private costs. This can be seen from figure 9.

Assume that health education has shifted the marginal private benefit schedule from MPB to MPB^* so that the MPB^* schedule cuts the MPC schedule at point E. With their new preference, smokers voluntarily choose to consume the socially optimal amount Q_s of tobacco. When consumption is reduced from Q_p to Q_s via health education, losses to third parties will fall from HI to EF per unit of tobacco consumed. Moreover, the marginal private costs at Q_s are CE which fall short of the marginal social costs CF by the amount EF. The latter therefore represents the welfare loss to third parties at the new consumption level Q_s. Therefore Q_s clearly cannot be the socially optimal level of consumption. The optimal level of consumption with consumers' new preferences is Q_s^* ($< Q_s$) in figure 9, where the marginal private benefits equal the marginal social costs.

The government can attempt to reach the new optimum by launching a new health education programme, but then again if the programme is effective the social optimum will shift to a lower level of consumption than Q_s^*. Thus it is not possible

Figure 9.



Marginal benefits/ marginal costs
MPB
MPB*
MSC
MPC
I
F
B
H
A
E
D
G
P
C
O
Q^*_s
Q_s
Q_p
Quantity of tobacco consumed

to attain the social optimum by health education alone. Only if accompanied by taxation or restrictions can the social optimum be reached. The new optimum Q_s^* can be attained by setting a tax per unit equal to the marginal external costs at Q_s^*, i.e. equal to AB. Thus, health education needs to be supported by taxation or restrictions in order to achieve the socially optimal level of consumption.

5.4 Restrictions

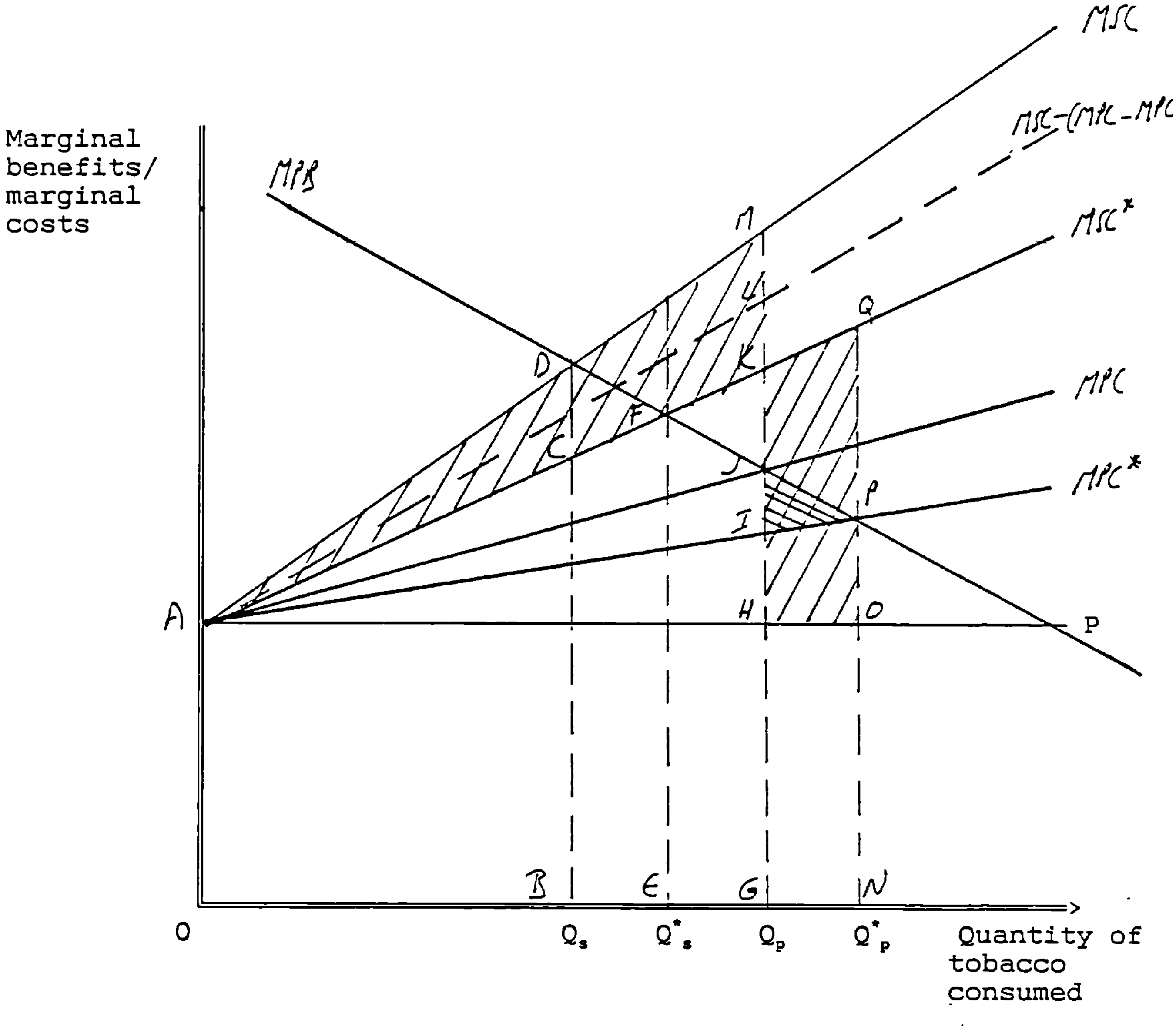
The government can try to achieve the socially optimal level of consumption by restricting consumption directly to the optimal level, e.g. by rationing the maximum number of cigarettes sold to X packs per time unit per consumer. If the government succeeds in its attempt, the welfare implications are the same as in the health education option. The social consumption optimum does not shift continuously in this case, however. In the social consumption optimum Q_s, in figure 7, the marginal social costs and benefits are equal to AD. There will still be divergence between the marginal social and private costs at the optimal consumption level Q_s equal to CD. This can be interpreted to represent indirect subsidy to smokers from third parties since they are willing or forced to accept that amount of external cost.

5.5 Improvements in risk technology

In this case the government would either attempt to set maximum legal limits on harmful substances allowed in tobacco, or subsidize the tobacco industry or other parties to develop and produce a safer cigarette. An improvement in risk technology will have three effects: (1) while it will reduce both the marginal private and external costs (2) it will encourage smokers to increase their consumption and (3) it will increase both the private and socially optimal level of consumption. Figure 10 illustrates the consequences of improved risk technology.

At the current level of consumption Q_p, introduction of a new risk technology, e.g. launching a safe cigarette into the markets, will shift the marginal private cost schedule from MPC to MPC^* and the marginal social cost schedule from MSC to MSC^*. The marginal private costs will be reduced from GJ to GI, marginal external costs from JM to IK, and marginal social costs from GM to GK. The fall in the marginal private costs will induce smokers to increase their consumption of tobacco from Q_p to Q_p^*, where the marginal private benefits will be equal to the marginal private costs (NP) under the new risk technology. The private consumption optimum will therefore be higher under the new risk technology than under the old one. The social optimal level of consumption will also increase. As the marginal social cost schedule will then shift from MSC to MSC^*, Q_s will no longer be socially optimal.

Figure 10.


Marginal benefits/ marginal costs
MSC
MSC-(MPC-MPC
MSC*
MPC
MPC*
MPB
A
P
O
Qs
Q*s
Qp
Q*p
Quantity of tobacco consumed

The marginal private benefits BD at Q_s exceed the marginal social costs BC by the amount CD. Consequently the social optimum will move from Q_s to Q_s^*, where the marginal social costs equal the marginal private (social) benefits (EF) under the new risk technology.

We can distinguish between two types of improvements in the risk technology: complete and partial. **Complete** here refers to changes in risk technology that will entirely remove the hazardous components from tobacco and thus eliminate all the external and private costs of health risks of smoking. **Partial** refers to less succesful attempts. As we have already covered the partial case we shall discuss here only the complete case.

If the new risk technology is complete there will be no adverse costs at any level of consumption. Therefore, there will be no divergence between private and social costs and the private and social consumption optima will merge. The marginal social costs will be equal to the price of tobacco in this case. The new private optimal level of consumption Q_p^{**} will be greater than the old optimum Q_p, since the only cost to smokers will now be the price of tobacco.

Figure 11 illustrates the effects of a complete change in risk technology on consumption and social costs. As the marginal private costs will fall from BD to BC, consumption will increase from Q_p to Q_p^{**}. Also the socially optimal level of consumption will rise to Q_p^{**} (= Q_s^{**}) from Q_s, since there will be no adverse costs of smoking anymore. It is clear that both the private and social optimum levels of consumption will be greater under the complete risk technology than under the partial one. It is not possible, however, to attain the social optimal level of consumption by changing risk technology unless the resulting technology is complete. In all other cases, the private optimum will always be greater than the social optimum.

5.6 Conclusions

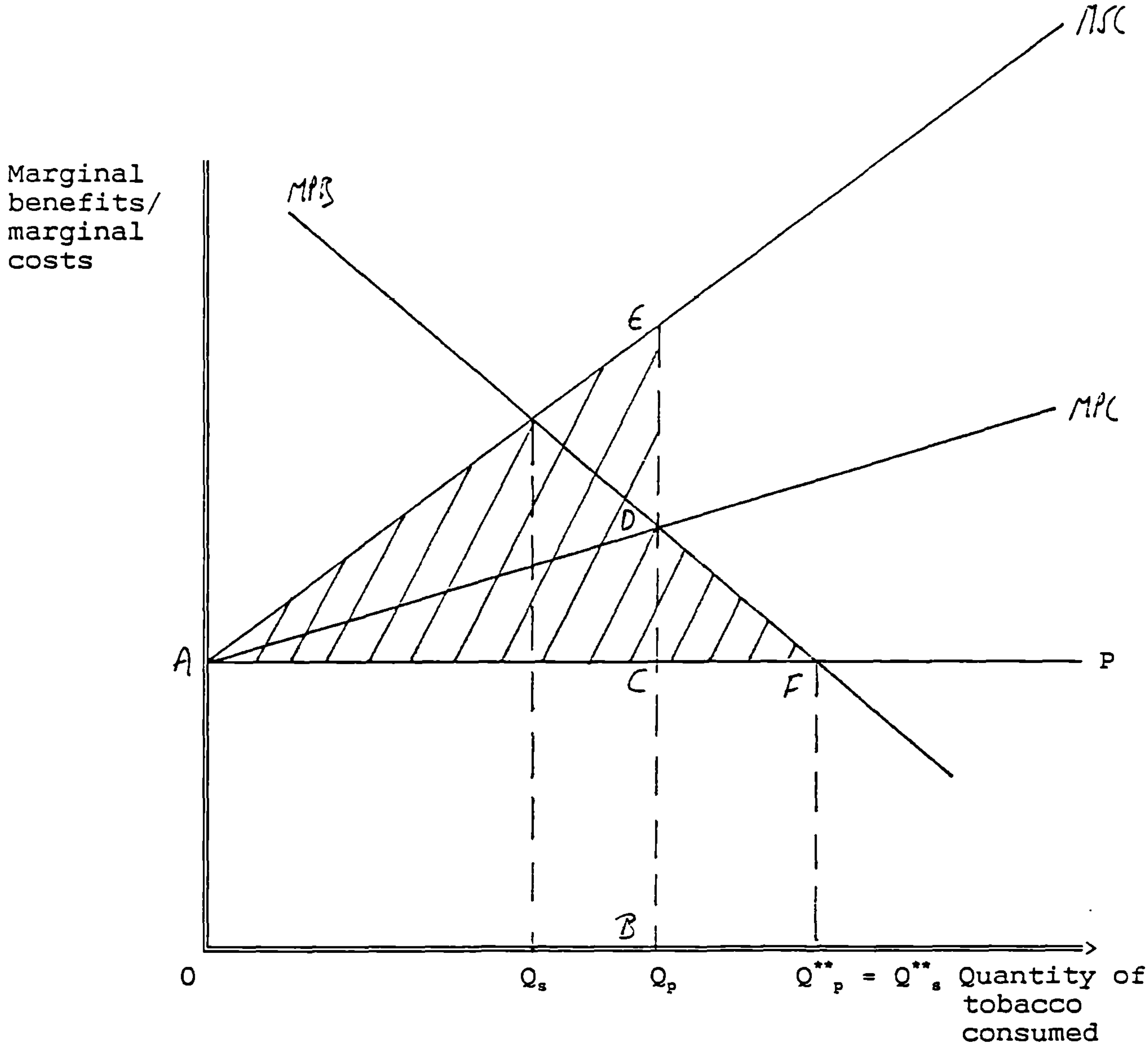
What has been said above can be summarized as follows:

(1) It is indeed possible, in principle, to reduce the external costs of smoking by taxation, health education, restrictions and by changing risk technology.

(2) The social optimum can be acheived by taxation and, in principle, by restricting consumption, but in the latter option there will still be external costs.

(3) The socially optimal level of consumption cannot be attained by health education, unless the optimum is zero, nor by changing risk technology, unless the new risk technology is complete.

Figure 11.


MSC
Marginal benefits/ marginal costs
MPB
E
MPC
D
A
P
C
F
B
0
Qs
Qp
Q**p = Q**s
Quantity of tobacco consumed

(4) If, in addition to reducing the external costs, the aim of the intervention is to reach the social optimal level of consumption then health education and changes in risk technology ought to be combined with taxation or restriction measures.

(5) Taxation is the only measure that will internalize externalities, other measures will reduce external costs, but there will always be some costs to third parties.

6 WELFARE IMPLICATIONS OF GOVERNMENT INTERVENTION IN THE TOBACCO MARKETS

6.1 Introduction

The mere existence of market failures does not automatically imply that government intervention on efficiency grounds is desirable. Two further conditions must be met. The government must have efficient tools available to remedy market failures, and the welfare gains achieved by intervention must outweigh its costs. The former condition is trivial, but in practice not much is known about the effectiveness of measures other than taxation. The latter condition is important but mostly overlooked in practice. In this chapter we shall derive measures for the net welfare gains of intervention for the four major policy options: (1) taxation, (2) health education, (3) restrictions, and (4) improvements in risk technology.

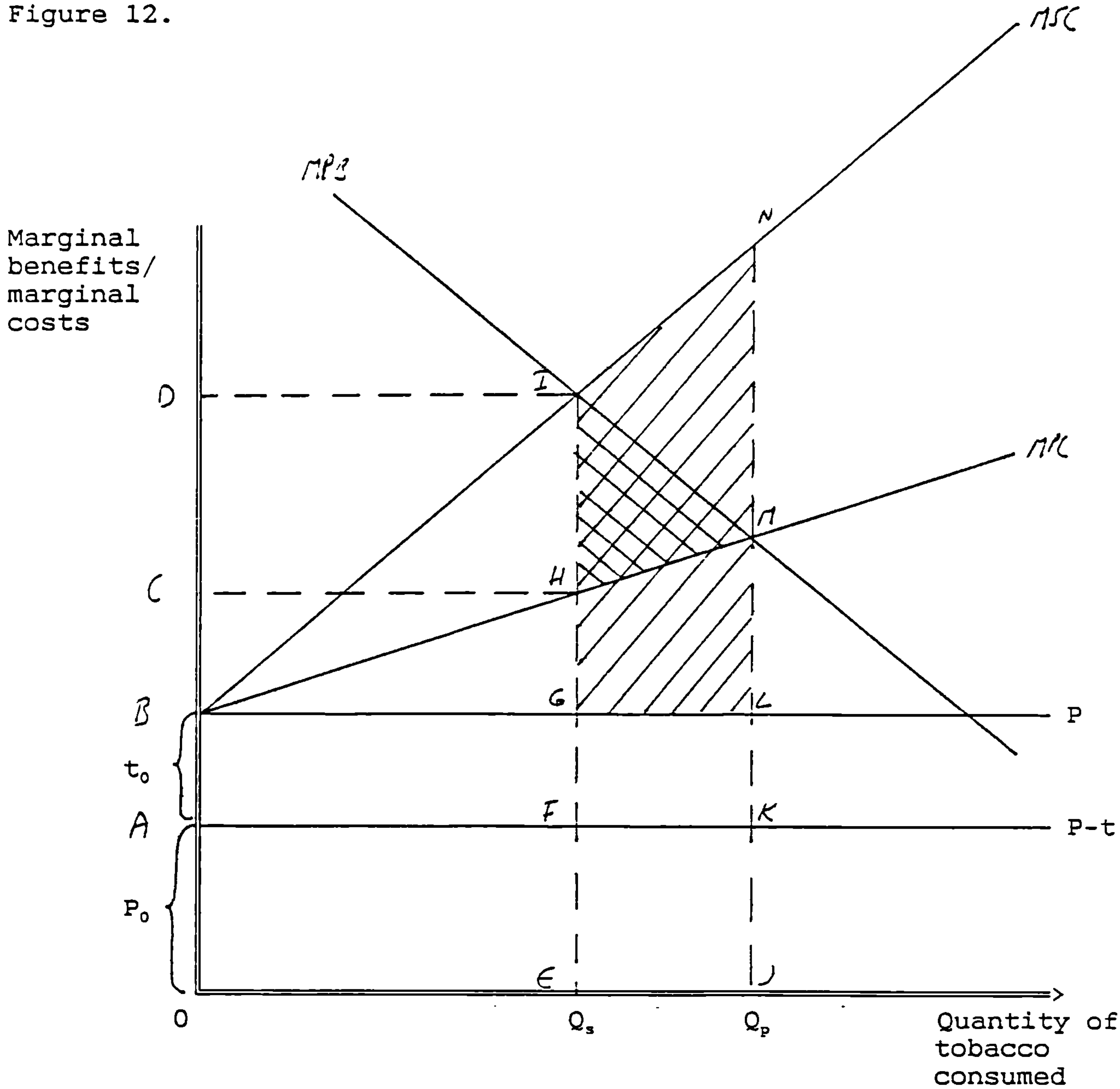
It is often argued that since determination of the socially optimal level of consumption requires so much information it may be more practical to direct public policy towards the attainment of some predetermined target level of consumption rather than the social optimum (Baumol and Oates 1979, Burrows 1979). This is the approach adopted by the Finnish government in its tobacco policy. In a recent health policy document 'Health for all by the year 2000' the government set a target of reducing the total consumption of tobacco by three per cent annually (STM 1987).

To simplify matters, it is assumed in the following analysis that the government has set the social optimum as the target level of consumption and that the relevant demand, cost and other functions are known. This is illustrated in figure 12. In the initial situation a tax is included in the price of tobacco. The tax per unit consumed (t_0) is equal to t_0 = KL so that the cost to consumers per unit is $P = t_0 + P_0$, which equals KL + JK = JL in figure 12 and, where P_0 is the pre tax price. Consumers' expenditure on tobacco is the retail price multiplied by the quantity consumed, i.e. PQ_p or the area OBLJ. The government's tax revenue equals the tax per unit multiplied by the quantity consumed, i.e. t_0Q_p or the area ABLK. Revenue to producers and distributors is equal to the pre tax price multiplied by the quantity consumed, i.e. P_0Q_p or the area OAKJ. This allows us to examine the effects of alternative public policies on tax revenues and producers' and distributors' revenues. In the initial situation, the private optimum Q_p is greater than the social optimum Q_s which is set by the government as the target level of consumption.

6.2 Taxation

In this option the government would raise the tax on tobacco from t_0 (FG in figure 12) to t_1 (or FG + HI) per unit. This would raise the total costs to smokers from JM to EI per unit

Figure 12.


MSC
MPB
Marginal benefits/ marginal costs
N
D
I
MC
M
C
H
G
L
B
P
t_0
A
F
K
P-t
P_0
E
J
0
Q_s
Q_p
Quantity of tobacco consumed

and reduce consumption from Q_p to Q_s, which would become also the private optimum. As a result of tax increase, smokers would suffer a loss in welfare equal to the loss of consumer surplus (ΔCS) which equals the area CDIH + HIM. The former (area CDIH) represents the welfare loss to consumers resulting from the fact that amount $(t_1 - t_0)Q_s$ is now paid in taxes (ΔT_1). The latter (area HIM) represents the welfare loss to consumers resulting from the reduction in quantity consumed. On the other hand, the fall in perceived costs of health risks of smoking from LM to GH creates a welfare gain to smokers (ΔCR_p) which is equal to the area GHML. This gain is analogous to the loss of consumer surplus. While consumers pay only the price of tobacco, they attach to each unit of tobacco consumed a perceived marginal cost of health risks of smoking.

Thus the net welfare loss to smokers (ΔW_s) is

$$\Delta W_s = \Delta T_1 + \Delta CS - \Delta CR_p.$$

In the tax option, third parties gain from the reduction in smoking in two ways. First, the external costs imposed on third parties (ΔEXC) will fall by the amount depicted by the area HINM. Second, a rise in tax rate from t_0 to t_1 increases tax revenue by the amount (ΔT_1) equal to the area CDIH. Thus the total welfare gain to third parties (ΔW_{tp}) is

$$\Delta W_{tp} = \Delta EXC + \Delta T_1.$$

The net welfare gain to society (ΔW_1) is the difference between gainers' gains and losers' losses, i.e.

$$\begin{aligned} \Delta W_1 &= \Delta W_{tp} - \Delta W_s \\ &= \Delta EXC + \Delta T_1 - \Delta T_1 - \Delta CS + \Delta CR_p \\ &= \Delta EXC + \Delta CR_p - \Delta CS. \end{aligned}$$

In figure 12, this is equal to the area HINM + GHML - HIM = INM + GHML. More formally the net welfare gain to society can be expressed as

$$\begin{aligned} \Delta W_1 &= \int_{Q_s}^{Q_p} \{MEXC(Q) + MCR_p(Q)\}dQ - \int_{Q_s}^{Q_p} \{MPB(Q) - MPC(Q)\}dQ \\ &= \int_{Q_s}^{Q_p} \{MSC(Q) - P\}dQ - \int_{Q_s}^{Q_p} \{MPB(Q) - MPC(Q)\}dQ \\ &= \int_{Q_s}^{Q_p} \{MADC(Q) + MPC(Q) - MPB(Q)\}dQ. \end{aligned}$$

The reduction in tax revenue (ΔT_L) associated with the reduction in consumption, the area FGLK, is loss to third parties, but it is not a loss to society as a whole. Consumers will gain exactly the same amount since they do not have to pay that in taxes anymore. ΔT_L represents a transfer of income from third parties to smokers and the net welfare effect will therefore be zero. The same conclusion applies to the other tax component (ΔT_1). In political decision making, however, income transfers often play a crucial role. Typically the loss of tax revenue is an argument often used to fend off demands for future government intervention in the tobacco markets (e.g. Pekurinen 1985).

The gain in tax revenue (ΔT_G) is equal to the increase in tax rate ($t_1 - t_0$) multiplied by the new quantity consumed (Q_s). The loss in tax revenue is equal to the old tax rate (t_0) multiplied by the reduction in consumption ($Q_p - Q_s$). The net effect of the increase in tax rate on tax revenue (ΔT_1) is thus

$$\Delta T_1 = \Delta T_G - \Delta T_L$$

$$= (t_1 - t_0)Q_s - t_0(Q_p - Q_s).$$

The reduction in smokers' tobacco expenditure, area EFKJ, does not represent a loss to society, but a transfer of income from producers and distributors of tobacco to producers and distributors of other commodities. However, the loss of revenue and jobs in the tobacco industry and trade are the main arguments used by producers and distributors to oppose any actions aimed at curbing consumption. The revenue loss to producers and distributors (ΔR_1) is equal to the pre tax price multiplied by the fall in consumption, i.e.

$$\Delta R_1 = P_0(Q_p - Q_s).$$

6.3 Health education

In this case government aims to shift the marginal private benefit schedule MPB to the left, so that the new schedule MPB^* cuts the marginal private cost schedule MPC at the point E in figure 9. As a result of health education, consumers will attach a smaller marginal benefit to each unit of tobacco consumed. With their new preferences smokers will choose to consume Q_s voluntarily. Welfare gains to third parties will be equal to the reduction in the external costs (ΔEXC), area EFIH. Smokers gain the amount equal to the reduction in the perceived costs of health risks (ΔCR_p), area DEHG. In this case there will be no loss of consumer surplus, since smokers reduce their consumption voluntarily. In fact there will be an increase in consumer surplus (ΔCS^*) to smokers, as shown by Fujii (1975), equal to area EHG. This welfare gain results from smokers' ability to avoid a welfare loss, equal to EHG, caused by imperfect information. The net welfare gain to society is equal to smokers' and third parties' gains, i.e.

$$\Delta W_2 = \Delta W_{tp} + \Delta W_s$$

$$= \Delta EXC + \Delta CR_p + \Delta CS^*.$$

In figure 9, this is equal to the area DFIG + EHG. More formally, the net welfare gain to society from health education is

$$\Delta W_2 = \int_{Q_s}^{Q_p} MEXC(Q)dQ + \int_{Q_s}^{Q_p} MCR_p(Q)dQ + \int_{Q_s}^{Q_p} \{MPC(Q) - MPB(Q)\}dQ$$

$$= \int_{Q_s}^{Q_p} \{MSC(Q) - P\}dQ + \int_{Q_s}^{Q_p} \{MPC(Q) - MPB(Q)\}dQ$$

$$= \int_{Q_s}^{Q_p} \{MADC(Q) + MPC(Q) - MPB(Q)\}dQ.$$

Government, producers and distributors will lose revenue if the health education is effective and the target level of consumption is reached. The loss in tax revenue is equal to the fall in consumption multiplied by the tax rate, i.e.

$$\Delta T_2 = t_0(Q_p - Q_s).$$

The fall in producers' and distributors' revenues is equal to the pre tax price multiplied by the fall in consumption, i.e.

$$\Delta R_2 = \Delta R_1 = P_0(Q_p - Q_s).$$

6.4 Restrictions

In the restrictions option the net welfare gain to society will be the same as in the tax option, but the impact on tax revenue will be the same as in the health education option. Effects on producers' and distributors' revenues will be the same as in the tax and health education options. In the restrictions option therefore, the net welfare gain to society is

$$\Delta W_3 = \Delta W_1 = \int_{Q_s}^{Q_p} \{MADC(Q) + MPC(Q) - MPB(Q)\}dQ.$$

The loss in tax revenue is

$$\Delta T_3 = \Delta T_2 = t_0(Q_p - Q_s)$$

and the fall in producers' and distributors' revenue is

$$\Delta R_3 = \Delta R_2 = \Delta R_1 = P_0(Q_p - Q_s).$$

6.5 Improvements in risk technology

In this option the government would either set maximum legal limits on harmful constituents in tobacco, or subsidize the tobacco industry or other parties to develop and produce a safe cigarette. The resulting improvements in risk technology would be either complete or partial. In the complete case the new risk technology would eliminate all the hazardous substances and thus most of the adverse costs of smoking. In the partial case the new risk technology would be less successful and some adverse costs would still remain at all levels of consumption.

Consider first the case of **complete risk technology improvement** illustrated in figure 11. The complete risk technology would eliminate all the hazardous components from tobacco and thus the adverse health consequences of smoking. While indirect consumption externalities would disappear some direct consumption externalities would probably remain.

If there are no direct consumption externalities, third parties' gain from complete risk technology improvement will be equal to the reduction in the external costs. Since all external costs will be eliminated, the gains to third parties will be equal to the total external costs of consumption (EXC) at Q_p, i.e.

$$\Delta W_{tp} = EXC.$$

In figure 11, this is equal to the area AED.

The gain in smokers' welfare is made up of two components: reduction in the perceived costs of the health risks of smoking (CR_p), area ADC, and the increase in consumer surplus (ΔCS), area CDF, i.e.

$$\Delta W_s = CR_p + \Delta CS.$$

CR_p represents welfare gains to smokers arising from elimination of the adverse health effects of smoking. The increase in consumer surplus represents the welfare gain to smokers resulting from the increased quantity of tobacco consumed.

The total welfare gain to society from the complete risk technology improvement is equal to

$$\Delta W_4 = EXC + CR_p + \Delta CS.$$

In figure 11, this is equal to the area AEDF. The welfare measure ΔW_4 provides an estimate of the maximum potential welfare gains that can be achieved by producing a completely safe cigarette. ΔW_4 can thus be compared with the costs of developing and producing such a product. More formally, the welfare gain to society is

$$\Delta W_4 = \int_{O}^{Q_p}\{MSC(Q) - MPC(Q)\}dQ + \int_{O}^{Q_p}\{MPC(Q) - P\}dQ + \int_{Q_p}^{Q_p^{**}}\{MPB(Q)-P\}dQ$$

$$= \int_{O}^{Q_p}\{MSC(Q) - P\}dQ + \int_{Q_p}^{Q_p^{**}}\{MPB(Q) - P\}pQ$$

$$= \int_{O}^{Q_p}MADC(Q)dQ + \int_{Q_p}^{Q_p^{**}}\{MPB(Q) - P\}dQ.$$

There will be an increase in the government's tax revenue equal to the increase in consumption multiplied by the tax rate, i.e.

$$\Delta T_4 = t_0(Q_p^{**} - Q_p).$$

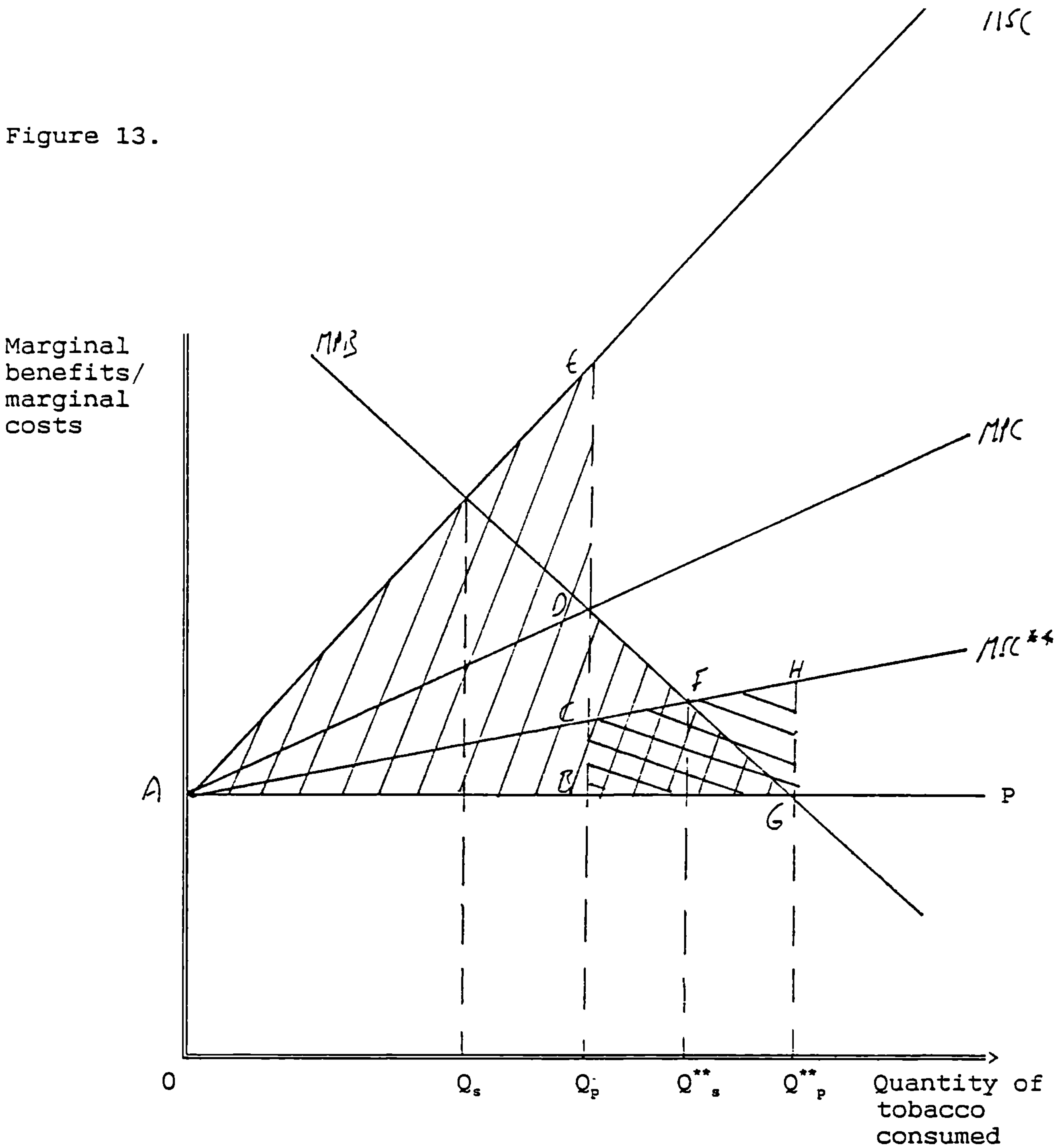
There will also be an increase in producers' and distributors' revenues equal to the increase in consumption multiplied by the pre tax price, i.e.

$$\Delta R_4 = P_0(Q_p^{**} - Q_p).$$

If, on the other hand, there are <u>direct consumption externalities,</u> smokers' gain from complete risk technology will be the same as in the previous case, but gains to third parties will be smaller. Figure 13 illustrates this case. Smokers' gain equals

$$\Delta W_s = CR_p + \Delta CS$$

Figure 13.


Marginal benefits/ marginal costs
MPB
MSC
MPC
MSC**
E
D
F
H
C
B
A
G
P
0
Q_s
Q_p
Q^{**}_s
Q^{**}_p
Quantity of tobacco consumed

86

or the area ADB + BDG = ADG. Welfare gains to third parties equal the reduction in external costs of consumption (ΔEXC^*), i.e. area AED - ACB. In this case, however, third parties still have to bear the costs of direct consumption externalities. This loss of welfare is equal to the increase in costs of direct consumption externalities resulting from increased consumption, (ΔEXC^{**}) which is equal to the area BCHG. Thus the net welfare gain to third parties is

$$\Delta W_{tp} = \Delta EXC^* - \Delta EXC^{**}.$$

The net welfare gain to society as a whole equals

$$\Delta W_5 = \Delta EXC^* - \Delta EXC^{**} + CR_p + \Delta CS.$$

In figure 13, this is equal to the area AED - ACB - BCHG + ADB + BDG = AEC - BCHG + BDG = AEDF - FHG. More formally, the net gain to society is equal to

$$\Delta W_5 = \int_0^{Q_p} \{MSC(Q) - MSC^{**}(Q)\}dQ + \int_{Q_p}^{Q_p^{**}} \{MPB(Q)-P\}dQ - \int_{Q_p}^{Q_p^{**}} \{MSC^{**}(Q)-P\}dQ$$

$$= \int_0^{Q_p} \{MSC(Q) - MSC^{**}(Q)\}dQ + \int_{Q_p}^{Q_p^{**}} \{MPB(Q) - MSC^{**}(Q)\}dQ.$$

Government, producers and distributors will increase their revenues by the same amount as in the previous case, i.e.

$$\Delta T_5 = \Delta T_4 = t_0(Q_p^{**} - Q_p)$$

and $$\Delta R_5 = \Delta R_4 = P_0(Q_p^{**} - Q_p).$$

Consider finally the **partial risk technology improvement** option. In this case there will be welfare gains and losses both to smokers and third parties. Welfare gains are generated in two ways. First, the marginal external and private costs will fall at private consumption optimum Q_p under the old technology. Second, there will be an increase in consumer surplus resulting from an increase in consumption from Q_p to Q_p^*, the private optimum under the new risk technology. Losses of welfare are associated with the rise in the marginal external and private costs resulting from increased consumption under the new risk technology. Which of the compensating effects dominates is an empirical question. It is clear, however, that creation of a less hazardous tobacco does not automatically improve social welfare, unless the new risk technolocy is complete. Welfare effects are illustrated in figure 10.

The welfare gains to third parties resulting from improved risk technology are equal to the reduction in the external costs (ΔEXC^+) at the old private optimum Q_p. This is the area AML, which is equal to the reduction in social costs (ΔMSC), area AMK, minus the reduction in the private costs (ΔCR_p), area AJI. Third parties will suffer a loss (ΔEXC^{++}) resulting from increased consumption of tobacco which is equal to area IKQP. Thus the net welfare gain to third parties from the introduction of a partial risk technology is

$$\Delta W_{tp} = \Delta EXC^{+} - \Delta EXC^{++}.$$

Welfare gain to smokers equals the fall in the perceived costs of health risks of smoking (ΔCR_p^{+}) at the old level of consumption plus the gain in consumer surplus (ΔCS^{+}) resulting from increased consumption. In figure 10, the former is the area AJI and the latter the area IJP. There will also be a loss to consumers resulting from increased consumption which is equal to the increase in the perceived costs (ΔCR_p^{++}), the area HIPO. Thus the net welfare gain to consumers is

$$\Delta W_s = \Delta CS^{+} + \Delta CR_p^{+} - \Delta CR_p^{++}.$$

The net welfare gain to society is the sum of the gains and losses to third parties and consumers, i.e.

$$\begin{aligned}\Delta W_6 &= \Delta EXC^{+} - \Delta EXC^{++} + \Delta CS^{+} + \Delta CR_p^{+} - \Delta CR_p^{++} \\ &= \Delta EXC^{+} + \Delta CR_p^{+} + \Delta CS^{+} - \Delta EXC^{++} - \Delta CR_p^{++} \\ &= \Delta ADC^{+} + \Delta CS^{+} - \Delta ADC^{++}.\end{aligned}$$

In figure 10, this is equal to the area AMK - AJI + AJI + IJP - HKQO = AMK + JKQP + HIPO. More formally, the net welfare gain to society from the partial improvement in risk technology is

$$\Delta W_6 = \int_{O}^{Q_p} \{MSC(Q) - MSC^*(Q)\}dQ + \int_{Q_p}^{Q_p^*} \{MPB(Q) - MPC^*(Q)\}dQ$$

$$- \int_{Qp}^{Q_p^*} \{MSC^*(Q) - P\}dQ$$

$$= \int_{O}^{Q_p} \{MSC(Q) - MSC^*(Q)\}dQ$$

$$+ \int_{Q_p}^{Q_p^*} \{MPB(Q) + MSC^*(Q) + P - MPC^*(Q)\}dQ.$$

There will be an increase in the government's tax revenue equal to the increase in consumption multiplied by the tax rate, i.e.

$$\Delta T_6 = t_0(Q_p^* - Q_p).$$

There will also be an increase in producers' and distributors' revenues equal to the increase in consumption multiplied by the pre tax price, i.e.

$$\Delta R_6 = P_0(Q_p^* - Q_p).$$

6.6 Comparison of the welfare and revenue effects of the alternative policy options

Measures derived for the welfare and revenue effects of the examined options are summarized in table 1.

Compare first the tax, health education and restrictions options. Overlooking the costs of intervention, it is obvious that the net welfare gains to society from achieving the target level of consumption will be greater with the health education option than with either of the other two, i.e.

$$\Delta W_2 \;>\; \Delta W_1 \;=\; \Delta W_3.$$

The net welfare gain with the health education option outweighs the gains of tax and restriction options by the amount

$$\Delta W_2 - \Delta W_1 \;=\; \Delta CS^* + \Delta CS.$$

It is clear that $\Delta W_2 - \Delta W_1 > 0$, since $\Delta CS^* > 0$ and $\Delta CS > 0$.

The tax option is preferable for governments, however, since it may result in a net increase in tax revenue, whereas the health education and restriction options will inevitably result in a fall in tax revenue, i.e.

$$\Delta T_1 \;>\; \Delta T_2 \;=\; \Delta T_3.$$

Table 1. Summary of the welfare and revenue implications of the main policy options to remedy market failures in the tobacco markets.

OPTION	WELFARE EFFECT[1]	TAX EFFECT	EFFECT ON PRODUCERS' AND DISTRIBUTORS' REVENUES
TAXATION	$\Delta W_1 = \Delta EXC + \Delta CR_p - \Delta CS$	$\Delta T_1 = (t_1 - t_0)Q_s - t_0(Q_p - Q_s)$	$\Delta R_1 = P_0(Q_p - Q_s)$
HEALTH EDUCATION	$\Delta W_2 = \Delta EXC + \Delta CR_p + \Delta CS^{*}$	$\Delta T_2 = t_0(Q_p - Q_s)$	$\Delta R_2 = \Delta R_1$
RESTRICTIONS	$\Delta W_3 = \Delta W_1$	$\Delta T_3 = \Delta T_2$	$\Delta R_3 = \Delta R_1$
COMPLETE RISK TECHNOLOGY No direct consumption externalities	$\Delta W_4 = EXC + CR_p + \Delta CS$	$\Delta T_4 = t_0(Q_p^{**} - Q_p)$	$\Delta R_4 = P_0(Q_p^{**} - Q_p)$
COMPLETE RISK TECHNOLOGY Direct consumption externalities	$\Delta W_5 = \Delta EXC^{*} - \Delta EXC^{**} + CR_p + \Delta CS$	$\Delta T_5 = \Delta T_4$	$\Delta R_5 = \Delta R_4$
PARTIAL RISK TECHNOLOGY	$\Delta W_6 = \Delta ADC^{+} + \Delta CS^{+} - \Delta ADC^{++}$	$\Delta T_6 = t_0(Q_p^{*} - Q_p)$	$\Delta R_6 = P_0(Q_p^{*} - Q_p)$

[1] Excluding the costs of intervention.

Tax revenue generated by the tax option will exceed the revenue from the two other options by the amount

$$\Delta T_1 - \Delta T_3 = (t_1 - t_0)Q_s.$$

All the options will reduce producers' and distributors' revenues by the same amount, i.e.

$$\Delta R_1 = \Delta R_2 = \Delta R_3.$$

Compare next the alternative risk technology options. The net welfare gain to society is greatest when the new risk technology is complete and there are no direct consumption externalities, i.e. .

$$\Delta W_4 > \Delta W_5 \quad \text{and} \quad \Delta W_4 > \Delta W_6.$$

The net social welfare gains arising from the complete risk technology in the absence of direct consumption externalities exceed the gains from the technology with production externalities by the amount

$$\Delta W_4 - \Delta W_5 = EXC + \Delta EXC^{**} - \Delta EXC^{*}$$

and those of partial risk technology by the amount

$$\Delta W_4 - \Delta W_6 = EXC + CR_p + \Delta CS - \Delta EXC^+ - \Delta CR_p^+$$
$$- \Delta CS^+ + \Delta EXC^{++} + \Delta CR_p^{++}.$$

The difference $\Delta W_4 - \Delta W_5 > 0$, since $EXC > \Delta EXC^*$, and $\Delta EXC^* > 0$. Also $\Delta W_4 - \Delta W_6 > 0$, since $EXC + CR_p > \Delta EXC^+ + \Delta CR_p^+$, $\Delta CS > \Delta CS^+$, $\Delta EXC^{++} > 0$ and $\Delta CR_p^{++} > 0$. It is not a priori clear, however, whether ΔW_5 is greater, equal or smaller than ΔW_6. As the direct consumption externalities tend to be only a fraction of the indirect consumption externalities it is highly probable that ΔW_5 is greater than ΔW_6.

Since the private consumption optimum will be higher under the complete risk technology, so will be the increase in the government's tax revenue and producers' and distributors' revenues resulting from increased consumption, i.e.

$$\Delta T_4 = \Delta T_5 > \Delta T_6, \text{ and}$$
$$\Delta R_4 = \Delta R_5 > \Delta R_6.$$

The total tax revenue produced by the introduction of the complete risk technology will exceed the revenue generated by the partial risk technology by the amount

$$\Delta T_4 - \Delta T_6 = t_0(Q_p^{**} - Q_p^*).$$

The net revenue gain to producers and distributors from the complete risk technology as compared with the partial technology will be

$$\Delta R_4 - \Delta R_6 = P_0(Q_p^{**} - Q_p^{*}).$$

6.7 Efficiency of the government intervention

In the above analysis the costs of government intervention were overlooked. In reality there are clearly costs associated with intervention. Only when these costs are taken into account can rational judgements be made about the desirability and optimal extent of intervention, and meaningful comparisons be made between options. Defining the net benefits of intervention (ΔNB) as a difference between the net welfare gains and costs of intervention (C)

$$\Delta NB = \Delta W - C$$

then option i is preferrable to option j if

$$\Delta NB_i > \Delta NB_j.$$

REFERENCES

Atkinson AB, Meade TW. Methods and preliminary findings in assessing the economic and health services consequences of smoking, with particular reference to lung cancer. Journal of the Royal Statistical Society, Series A, 1974, 137, 297-312.

Atkinson AB, Stiglitz JE, Lectures on public economics. McGraw-Hill, Maidenhead 1980.

Baumol WJ, Oates WE. Economics, Environmental Policy and the Quality of Life. Prentice Hall, Englewood Cliffs 1979.

Burrows P. The Economic Theory of Pollution Control. Martin Robertson, Oxford 1979.

Collishaw NE, Myers G. Dollar estimates of the consequences of tobacco use in Canada 1979. Canadian Journal of Public Health 1984, 75, 192-199.

Culyer AJ, Need and the National Health Service. Martin Robertson, London 1976.

Ellemann-Jensen P. Analyser af de samfundsokonomiske omkostninger ved tobaksrygning. Odense Universitet. Institut for Sundhedsokonomi og Sygdomsforebyggelse. Forskningrapport 1986, 1. Odense 1986.

Evans RG, Strained/Mercy: The Economics of Canadian Health Care, Butterworths, Toronto 1984.

Ferguson DM, Horwood LJ, Shannon FT, Taylor B. Parental smoking and lower respiratory illness in the first three years of life. Journal of Epidemiology and Community Health 1981, 35, 180-184.

Fujii ET. On the value of information on product safety: an application to health warnings on the long run medical implications of cigarette smoking. Public Finance 1975, 30, 323-332.

Hirayama T. Non-smoking wives of heavy smokers have a higher risk of lung cancer: a study from Japan. British Medical Journal 1981, 282, 183-185.

Hjalte K. Rökningens effekter och kostnader i Sverige 1980 en prevalensstudie. Institutet för hälso- och sjukvårdsekonomi. Meddelande 1984, 4. Lund 1984.

Humble CG, Samet JM, Pathak DR, Marriage to smoker and lung cancer risk. American Journal of Public Health 1987, 77, 598-602.

Kahneman D, Tversky A, Prospect theory: an analysis of decision under risk. Econometrica 1979, 47, 263-291.

Layard PRG, Walters AA. Microeconomic Theory. McGraw-Hill, London 1978.

Leu RE, Schaub T. Economic aspects of smoking. Effective Health Care 1984, 2,111-122.

Liard R, Perdrizet S, Reinert P. Wheezy bronchitis in infants and parents' smoking habits. Lancet 1982, 1, 334-335.

Lichtenstein S, Slovic P, Fischhoff B, Layman M, Combs B, Judged frequency of lethal events. Journal of Experimental Psychology: Human Learning and Memory 1978, 4, 551-578.

Littlechild SC, Wiseman J, Principles of public policy relevant to smoking. Policy Studies 1984, 4, 54-67.

Luce BR, Schweitzer SO. Smoking and alcohol abuse: a comparison of their economic consequences. New England Journal of Medicine 1978, 17, 52-74.

Markandya A, Pierce DW. The social costs of tobacco smoking. British Journal of Addiction 1989, 84, 1139-1150.

McIntosh ID. Smoking and pregnancy: I. Maternal and placental smoking. Public Health Reviews 1984, 12, 1-28.

McIntosh ID. Smoking and pregnancy: II. Offspring risks. Public Health Review 1984, 12, 29-63.

Mooney GH. Economics, Medicine and Health Care, Wheatsheaf Books, Brighton 1986.

Pekurinen M. An evaluation of the effects of an increase in the price of tobacco and a proposal for the tobacco price policy in Finland in 1985-87. Publications of the National Board of Health. Health Education, Series Statistics and Reviews 7/1985, Helsinki 1985.

Pigou AC, The Economics of Welfare. Macmillan, London 1920.

Rice DP, Hodgson TA, Sinsheimer P, Browner W, Kopstein AN. The economic costs of the health effects of smoking, 1984. The Milbank Quarterly 1986, 64, 489-547.

Rimpelä M. Incidence of smoking among Finnish youth - a follow up study (in Finnish with English summary). Kansanterveystieteen julkaisuja M65/81. Tampere 1981.

Scitovsky T, The Joyless Economy. Oxford University Press, Oxford 1976.

Shillington ER, Selected economic consequences of cigarette smoking. Department of National Health and Welfare, Ottawa 1977.

Sintonen H. An Approach to Economic Evaluation of Actions for Health. Official Statistics of Finland, Special Social Studies, SVT XXXII:74. Government Printing Centre, Helsinki 1981.

STM (Ministry of Social Affairs and Health). Health for all by the year 2000. The Finnish national strategy. Helsinki 1987.

Thompson ME, Forbes WF. Costs and 'benefits' of cigarette smoking in Canada. Canadian Medicl Association Journal 1982, 127, 831-832.

Trichopoulos D, Kalandidi A, Sparros L, MacMahon B. Lung cancer and passive smoking. Internationl Journal of Cancer 1981, 27, 1-4.

U.S. Department of Health, Education and Welfare. Public Health Service. Smoking and Health. A report to the Surgeon General. U.S. Government Printing Office. Washington 1979.

Valtonen H, Rimpelä M, Smoking habits of the adult Finnish population 1978-1982 (in Finnish with English summary). Publications of the National Board of Health, Health Education, Original Reports 3/1984. Helsinki 1984.

Vandenbroucke JP, Passive smoking and lung cancer: a publication bias? British Medical Journal 1988, 296, 391-392.

Vohlonen I (ed.), Personal Doctor Program: Data, results and conclusions of the Finnish study (in Finnish with English summary). Health Services Research by the National Board of Health in Finland No. 50. Helsinki 1989.

PART II:

ECONOMIC CONSEQUENCES OF SMOKING

IN FINLAND IN 1987

CONTENTS Page

Page

1 INTRODUCTION

1.1 Background and purpose of the study

In the previous part of the study it was argued that there are several market failures associated with consumption of tobacco products. It was also noted that the existence of market failures is not in itself a sufficient condition for government intervention. The second criterion set here was that market failures should be quantitatively significant. In order to establish their magnitude, it is necessary to consider health, as well as the cost and beneficial consequences of smoking.

The health risks of smoking have been extensively researched over the past 30 years. Mounting epidemiologic evidence suggests smoking to be associated with the onset of numerous diseases (USDHEW 1979). Prevention of smoking and a sustained fall in consumption are thought to be effective measures in improving public health. For example, the Finnish national health strategy "Health for all by the year 2000" (STM 1987) maintains that stopping smoking would reduce premature mortality and morbidity more than any other preventive measure.

During the last 20 years, economists, epidemiologists, medical researchers and public organizations in various countries have sought to estimate the economic costs of the health consequences of smoking. This has made decision-makers more aware of the smoking and health issue than when described simply in terms of rates of death and disability.

As a result, the arguments used to support preventive actions have changed slightly. It has long been the tradition to support active measures to restrict smoking by health arguments. During the last 10 years, economic arguments have become more popular: since smoking appears to create a significant economic burden on society, it is vital to reduce this burden by taking active measures to cut consumption. In Finland, however, such economic evidence has not yet been published.

Does smoking create an economic burden on society? Empirically the question may be divided into at least three sub-questions depending on the point of view:

(1) Do smokers, as a group, burden non-smokers economically?

(2) Does smoking cause a financial burden on the public sector and other parties?

(3) Is smoking more beneficial than harmful on the society at large?

More technically, these questions can be reformulated as follows:

(1) Does smoking cause external costs?

(2) Does smoking cause institutional externalities?

(3) What are the social costs and benefits of smoking?

In this study we seek to answer these questions in the Finnish context. Some answers will be tentative, since current epidemiologic and economic knowledge does not permit us to measure and evaluate all economic consequences of smoking. We hope, however, to give some impression of the order of magnitude of the costs and benefits involved and point out the need for further research.

The purpose of this study is:

(1) To outline an analytical framework for analysing the economic consequences of smoking from the point of view of different parties.

(2) To analyse empirically the social costs and benefits of smoking and their incidence in Finland in 1987.

(3) To estimate the institutional and final external costs of smoking in Finland in 1987.

1.2 Structure of the study

This study is divided into ten chapters. After this introductory chapter, the second chapter, will briefly describe the economic approaches and analytical methods applied in several previous studies dealing with the economic consequencies of smoking-related health risks.

Chapter three outlines a framework allowing us to analyse the economic consequences of smoking from the point of view of different parties. Chapter four summarizes the facts about the Finnish tobacco markets. In chapter five we shall describe the main health effects of smoking, define the diseases analysed in this study and estimate the fraction of cases attributed to smoking.

In chapters six and seven we shall analyse in detail the economic consequences of smoking arising from morbidity and mortality. Economic, financial and distributive effects will be analysed separately. Chapter eight focuses on other economic consequences of smoking.

Chapter nine gives a detailed summary of the health and economic effects of smoking. In particular, it focuses on two questions: does smoking cause external costs, and is there a case for government intervention on the tobacco markets? The main cpnclusions of the study are presented in chapter ten.

2 SOME PREVIOUS STUDIES

2.1 Introduction

During the past two decades, several studies have explored economic aspects of smoking in various countries like Sweden (Lindholm 1973, Johnsson 1980, Hjalte 1984a, 1984b), Denmark (Ellemann-Jensen 1986), Switzerland (Leu and Schaub 1984), England (Peston 1972, DHSS 1972, Atkinson and Townsend 1977, Cohen 1984), the United States (Luce and Schweitzer 1978, Rice et al 1986) and Canada (Shillington 1977, Thompson and Forbes 1982, Collishaw and Myers 1984). In most cases, studies have primarily sought to discover the magnitude of the social costs of smoking-related health problems in the country.

Studies differ in how they view smoking in terms of consumer theory, and hence how costs and benefits are defined, what diseases are to be included in the analysis, and how various health consequences are quantified and valued. In this chapter we shall briefly outline the methods used in some of the major previous studies.

2.2 Viewpoints

The economic consequences of smoking can be analysed from many different perspectives. The viewpoint may be, for example, that of smokers, households, firms, the public sector or the whole of society. The analysis can be made more complex and effective by examining how costs and benefits are distributed between smokers, firms, local government, central government, and other parties who commonly finance the costs of diverse activities. It is also possible to examine who eventually pays the costs: smokers or non-smokers. Revenue effects may be analysed from firms' or the public sector's viewpoint.

Previous studies have primarily adopted the societal viewpoint. This is well-founded, since a narrower perspective would leave part of the effects unexamined and thus make the analysis incomplete. Only a few studies have looked at the distribution of costs between smokers and other parties (e.g. Leu and Schaub 1984). External costs have not been analysed empirically. Some studies have shown, however, that smoking may not cause external costs in health care (Leu and Schaub 1983b, Stoddart et al 1986).

Several studies have examined various revenue effects of smoking, such as tobacco excise (DHSS 1972, Atkinson and Townsend 1977, Thompson and Forbes 1982, Cohen 1984, Collishaw and Myers 1984, Ellemann-Jensen 1986), other tax revenues (Ellemann-Jensen 1986), disability pensions (DHSS 1972, Atkinson and Townsend 1977, Thompson and Forbes 1982, Ellemann-Jensen 1986), sickness benefits (DHSS 1972, Atkinson and Townsend 1977, Ellemann-Jensen 1986), widows' pensions

(DHSS 1972, Atkinson and Townsend 1977), and revenues of the tobacco industry (Thompson and Forbes 1982).

Since the primary aim of the studies has been to estimate the costs of smoking, little attention has been paid to benefits. It is not completely clear, however, whether the studies have tried to estimate the social costs or external costs. While social costs also include those falling on smokers, external costs exclude them. External costs are the relevant costs for guiding policy.

2.3 Economic frameworks

The economic frameworks have varied somewhat but one of the following three options has generally been used: (1) a prevalence-based disease costing approach, (2) an incidence-based disease costing approach, or (3) a traditional or modified economic model. Some studies do not permit us to determine which economic framework has been applied (e.g. Thompson and Forbes 1982, Cohen 1984). In the following we shall briefly outline these options.

The prevalence-based disease costing approach

Most studies have used the so-called disease costing model (Hodgson and Meiners 1982) as their economic framework, and applied the corresponding methods (Table 1). In this approach the attemp is to evaluate the value of resources used (direct

Table 1. Stylized facts about the previous studies.

STUDY	Diseases analysed[1]	Age-groups	Economic framework[2]	Method used to evaluate health effects[2]
SWEDEN				
1 Lindholm (1973)	All/ 4 main	35-89	COI	Human capital
2 Johnsson (1980)	4 main	40-69	COI	Human capital
3 Hjalte (1984a)	12 main	35-84	COI	Human capital
4 Hjalte (1984b)	4 main	35-84	COI/i	Human capital
ENGLAND				
5 Peston (1972)	All	Not known	COI	Human capital
6 DHSS (1972)	4 main	35-74	TradE	TradE
7 Atkinson and Townsend (1977)	Not known	Not known	TradE	Not valued
8 Cohen (1984)	4 main + 4 minor	15+	Ad hoc	Not valued
UNITED STATES				
9 Luce and Schweitzer (1978)	Several mdg[3]	Not known	COI	Human capital
10 Rice et al (1986)	Several mdg[3] 19 main (mortality)	17+ 20+ (mortality)	COI	Human capital
CANADA				
11 Shillington (1977)	4 main	15+	COI	Human capital
12 Thompson and Forbes (1982)	All	All	Ad hoc	Human capital
13 Collishaw and Myers (1984)	All	15+	COI	Human capital
DENMARK				
14 Ellemann-Jensen (1986)	12 main	35-84	COI & A&M[4]	Human capital
SWITZERLAND				
15 Leu and Schaub (1984)	Not known	Not known	COI TradE	Human capital & TradE

[1] Will be defined in chapter 5.2.

[2] COI = Cost of illness (prevalence approach),
COI/i = Cost of illness (incidence approach),
TradE = Traditional economic model,
Ad hoc = Theoretical economic model not clearly specified.

[3] Main disease groups.

[4] Analysis suggested by Atkinson and Meade (1974)

costs) and lost (indirect costs) due to a disease in a given year, regardless of the time of onset of the disease. Direct costs mainly include the costs of treatment. Indirect costs describe the value of lost health. In principle, this approach also attempts to estimate the intangible costs (e.g. grief and suffering to others), but in most cases they are merely mentioned.

This approach describes the impact of past smoking on the costs in a given year. The analysis is based on the prevalence of diseases caused by smoking which manifest in the total morbidity or mortality of that year. For this reason, this type of approach is sometimes called the prevalence approach.

The incidence-based disease costing approach

In contrast to the prevalence approach, which embodies the costs manifested during a given year, the incidence approach seeks to estimate the life-time costs expected to occur as a result of smoking-related disease. In the incidence approach all present and future costs are determined for a single person affected by the disease in present or future periods (Hartunian et al 1981). The costs attributable to smoking are derived by multiplying the anticipated costs by the increased probability of incurring the disease in each of the periods in question for a smoker versus a non-smoker (Oster et al

1984). The costs thus calculated are discounted and summed in order to get the present value of the costs per smoker.

This approach describes the impact of current smoking on the future costs. The results can be used to approximate the economic benefits for an individual giving up smoking.

The traditional and modified economic model

Prevalence- and incidence-based disease costing models aim primarily to estimate the social costs of smoking. They do not, however, allow one to identify the external costs. Only a few studies have sought to outline the magnitude of the institutional externalities but none has assessed the final external costs.

Several studies have employed the traditional economic framework (DHSS 1972, Atkinson and Townsend 1977, Leu and Schaub 1984) to identify the financial external costs, while some (e.g. Ellemann-Jensen 1986) have applied the modified economic model suggested by Atkinson and Meade (1974) which allows for consumption benefits, addiction and inadequate information. Interpretation of the empirical results has proved difficult, since it appears impossible to carry out an unambiguous cost-benefit analysis of smoking. The end-result depends crucially on how addiction and inadequate information are interpreted and allowed for in the study[1].

2.4 Methods and results

In principle, there are two main methods available for evaluating the health effects of smoking[2]: the human capital approach and the willingness to pay approach (Hodgson and Meiners 1982). The human capital approach values an individual's health in terms of his production capacity and seeks to answer the question: what is the individual's economic contribution to production (e.g. Cooper and Rice 1976)? In the willingness to pay approach, health evaluation is based on the individuals' willingness to pay for a reduction in the risk of illness or death (e.g. Mishan 1971, Jones-Lee 1976).

Previous studies have applied mainly the human capital approach (Table 1). Consequently, they have attempted to estimate the value of resources devoted to prevention, cure and rehabilitation of illness resulting from smoking (direct costs) and the value of potential production lost due to smoking-related illness and premature deaths (indirect costs). Studies have not, however, analysed how the cost-burden falls on different parties (institutional

---

[1] This topic will be discussed more thoroughly in chapter 3.

[2] These approaches will be discussed more thoroughly in chapter 5.4.

externalities) and how it is eventually distributed between smokers and non-smokers (final externalities). Only a few studies have considered the benefits of smoking simultaneously with the costs (e.g. Collishaw and Myers 1986).

Empirical results have varied substantially, even within a country. For example, the difference between various Canadian cost-estimates is over five-fold (Shillington 1977, Thompson and Forbes 1982, Collishaw and Myers 1984). In the USA, Rice et al (1986) estimated the costs of smoking to amount to 8.5 % of the total costs of all illnesses while the Luce and Schweitzer (1978) estimate is over 11 % of the costs. Internationally, the total costs per smoker, as reported in Markandya and Pearce (1989), range from FIM 1070 (Shillington 1977) to FIM 4130 (Luce and Schweitzer 1978) at 1987 prices. These discrepancies are mainly due to the different diseases chosen for analysis, the different age-groups included, and the different empirical estimation methods employed.

Most studies have covered either all diseases or focused on those for which there exists a broad consensus of their highly probable causal relationship with smoking (Table 1). Costs have been estimated either for all age groups, for people aged 15 and over or for people aged 35-84. It is evident that the fewer diseases and the narrower age-band analysed, the smaller will be the costs of smoking.

The number of cases (e.g. lung cancer deaths) and the related costs due to smoking have been estimated by applying so-called attributable fractions[1], which indicate what proportion of the cases observed in the population may be interpreted to result from smoking. Attributable fractions have commonly been derived by using national tobacco consumption data and smokers' mortality risk as compared to non-smokers', obtained from the most well known epidemiologic studies (e.g. Hammond 1966, Cederlöf et al 1975, Doll and Peto 1976).

Besides mortality, the same attributable fractions have been applied for other health consequences of smoking (health care utilization, sickness absence and disability) (e.g. Lindholm 1973, Shillington 1977, Luce and Schweitzer 1978, Cohen 1984, Hjalte 1984a, Thompson and Forbes 1982, Ellemann-Jensen 1986). In some studies, estimates of the attributable fractions have been derived on the basis of smokers' and non-smokers' different utilization rates (e.g. hospital inpatient care, outpatient visits) and differences in case prevalence (e.g. disability) (e.g. DHSS 1972, Atkinson and Townsend 1978, Collishaw and Myers 1984, Rice et al 1986).

A general feature of the studies is that the indirect costs constitute the bulk of the estimated costs of smoking,

---

[1] Attributable fractions will be discussed more thoroughly in chapter 5.3.

ranging from 56 % (Rice et al 1986) to 90 % (Leu and Schaub 1984).

Two studies (Hjalte 1984b, Oster et al 1984) have applied the incidence approach to estimate the cost of smoking. In the preface to Hjalte (1984b), Lindgren points out that the total costs per individual smoker thus calculated can be converted into national figures by summing all smokers' anticipated costs. The results of the incidence approach (Hjalte 1984b) are remarkably higher (fourteen times for the direct costs and six times for the indirect costs) than those of the prevalence approach (Hjalte 1984a). It is not possible, however, to determine the reason for this dicrepancy.

2.5 Conclusions

Generally, the previous studies suggest that it is not feasible to carry out a rigorous cost-benefit analysis of smoking for several reasons. It is difficult to include, even in a semi-quantitative manner, all the costs associated with smoking. Moreover, there are many consequences, particularly those related to disability and death, which are not readily quantifiable in economic terms, such as the pain and suffering that must be borne by smokers and by their families in cases of smoking-related illness and death.

Perhaps the most important item in any comprehensive analysis of the costs of smoking is the value placed on an individual's life. However, very different values can be placed on an individual's life depending on the valuation method used.

Even if the analysis is confined to entities which can be expressed fairly readily in economic terms, the estimated costs of smoking will vary considerably depending on which economic framework[1] is used. A theoretically correct economic analysis of the costs of smoking depends to a large extent on unknown quantities - what should be included and what should not - and depends on the assumptions made with regard to dependence and information among consumers.

---

[1] Alternative options for analysing the cost and benefits of smoking will be discussed in the next chapter.

3 ALTERNATIVE OPTIONS FOR ANALYSING THE COSTS OF SMOKING

3.1 What is the problem?

It is of some interest in itself to know the magnitude of the social costs of smoking. These may not, however, be particularly meaningful for policy purposes since some of the social costs are paid by smokers themselves. Traditionally economists have argued that it is only the costs falling on parties other than smokers which justify public intervention in the tobacco markets. A further condition is that such external costs should exceed the proceeds from tobacco excise.

It is important to note that it is not necessary to analyse the benefits of smoking in order to assess conditions for public intervention on efficiency grounds. It is sufficient to clarify whether the relevant costs exceed proceeds from tobacco excise. However, in order to decide the optimal scale of intervention, information on benefits is also required.

Since consumers may have limited information and may be addicted to tobacco, the traditional economic model may be an inadequate framework for distinguishing policy-relevant costs. Several authors (e.g. Atkinson 1974, Atkinson and Meade 1974, Leu and Schaub 1984, Markandya and Pearce 1989) have sought to outline policy-relevant costing models with varying assumptions about addiction and smokers' awareness about the smoking-related health risks: i.e. the costs that may be used to assess justification for public intervention. At one extreme is the traditional, fully-informed, rational consumer who is not addicted to tobacco. At the other end lies the addicted smoker who is unaware of the health risks and does not even derive any benefits from smoking. As the models are based on different assumptions about smoking behaviour, the cost items to be included and the intervention criteria also vary from model to model.

In this chapter we shall first derive the alternative costing models and list the items to be analysed. Then we shall indicate *how the social costs of smoking may be decomposed* into institutional and final externalities. The analysis will focus on financial externalities.

3.2 Alternative economic models: part 1

3.2.1 Traditional economic model

The traditional economic model assumes consumers to be fully informed about the health risks of smoking, but not to be addicted to it. Consumers are assumed to act rationally and to take into account the health risks of smoking in their private decision making. In this model, smoking is comparable to any other activity involving risk. Smokers' consumption decisions reflect their individual valuations of the private benefits and costs of smoking. There is no need to value, for example, premature deaths. If smokers are fully informed about the health risks, one may assume that they consider themselves better off despite the risk (e.g. Mishan 1971). In this model only the external costs may justify government intervention. Relevant costs to the analysis (C_0) are defined as (see Table 2[1] for definition of the cost items)

$$C_0 = EXC.$$

Government intervention is justified if external costs exceed the revenue obtained from tobacco excise (T), i.e. if $C_0 - T > 0$. The change in social welfare[2] as a result of a public intervention is the change in external costs minus the change in consumer surplus

$$\Delta W_0 = \Delta C_0 - \Delta CS.$$

The assumption of the fully informed non-addicted consumer may not, however, be a proper description of smoking behaviour, as noted in part I of this study. If a smoker is not fully aware of the health risks of smoking, he presumably does not take into account the likely private costs of

---

[1] Table 2 indicates which cost items Atkinson and Meade (1974) considered relevant in different models. We shall not, however, appply their classification in the empirical part of this study, since the methodology developed here permits estimation of policy-relevant costs directly.

[2] The costs of intervention are overlooked in deriving the welfare measures on pages 121-131.

Table 2. Cost-items included in alternative costing models as defined in Atkinson and Meade (1974)[1].

Item	Traditional economic model IF & NAD	Modified economic model 1 NIF & NAD	Modified economic model 2 NIF & AD
Health care costs (HC)	+	+	+
Lost production as a result of a sickness (LP_S)		+	+
Social security benefits paid in case of sickness (SB_S)	+		
Cost of premature death (LP_D)[2]		+	+
Net financial costs of premature death (NC_D)[3]	+		
Resources employed in the production of tobacco (PDC)			+
Losses of well being, pain and suffering to others (PS)	+		
Nuisance and other externalities to non-smokers (NE)	+	+	+

1 IF = consumers aware of the health risks of smoking.
NIF = consumers unaware of the health risks of smoking.
AD = consumers addicted to smoking.
NAD = consumers not addicted to smoking.

2 Includes pain and suffering to others (PS).

3 Taxes not received - social security benefits not paid.

smoking-related illness and premature death when he decides to smoke. If this is the case, then the unperceived costs should also be included in the analysis.

3.2.2 Modified economic models

Atkinson has modified the traditional economic model to allow for aspects of addiction and lack of awareness about the health risks of smoking (Atkinson 1974, Atkinson and Meade 1974). He specified two models, which will be termed modified economic models 1 and 2.

Modified economic model 1 differs from the traditonal economic model in that consumers are assumed to be unaware of the health risks of smoking. Because of this they are not able to take into account these risks in their private decision making. The decision to smoke will not reflect the private costs associated with the risk of increased illness and premature death. Otherwise they are assumed to act rationally. In this model the external costs and the unperceived private costs to smokers are basis for government intervention. Relevant costs are defined as (see Table 2)

$$C_1 \;=\; EXC + CR.$$

Government intervention is justified if the sum of the external and unperceived private costs exceeds the revenue from tobacco excise, i.e. if $C_1 - T > 0$. The change in social welfare as a result of a public intervention is the change in external costs and private unperceived costs to smokers minus the change in consumer surplus

$$\Delta W_1 = \Delta C_1 - \Delta CS.$$

In **modified economic model 2** consumers are assumed to be both unaware of the health risks of smoking and addicted. In this case consumers' ability to make rational choices is distorted. They do not derive any utility from smoking, but are forced to do so only because of addiction. Consumers overvalue their tobacco consumption by the amount they spend on it. If they could be freed from addiction, they could spend that amount on other commodities instead of tobacco and thus increase their well-being without giving up anything.

Expenditure on tobacco equals production and distribution costs plus profits and taxes. Profits represent a transfer of income from smokers to the owners of the tobacco industry and trade and taxes represent a transfer from smokers to non-smokers. Neither of these income transfers should be included in the real cost. In this model the external costs and the unperceived private costs to smokers (CR), as well as the cost of production and distribution (PDC) are basis for government intervention. Relevant costs are defined as (see Table 2)

$$C_2 = EXC + CR + PDC.$$

Government intervention is justified if the sum of the costs exceeds proceeds from tobacco excise, i.e. if $C_2 - T > 0$. As there will be no loss in consumer surplus in this case, the change in social welfare as a result of a public intervention is the change in the costs

$$\Delta W_2 = \Delta C_2.$$

3.2.3 Medical model

Most of the previous studies referred to in chapter 2 have estimated the costs of smoking by applying the cost of illness methodology (see Table 1). In this **medical model** smoking is comparable to a disease which causes costs to consumers and to society at large without providing any benefits, not even to smokers. In this model the external costs and the perceived private costs to smokers are basis for the government intervention. Relevant costs are defined as

$$C_4 = EXC + CR.$$

Costs defined by the medical model and the intervention criteria are the same as in modified economic model 1, but the welfare implications of intervention differ. Unlike modified economic model 1, the medical model does not identify any consumption benefits. Therefore, there will be no welfare loss in terms of forgone benefits. The change in social welfare resulting from public intervention is the change in the costs as there will be no loss in consumer surplus in this case

$$\Delta W_4 = \Delta C_4.$$

3.3 Alternative economic models: part 2

One aspect that differentiates the above defined models is addiction. In order to highlight the polar cases it was assumed that addiction is either perfect or non-existent. In reality, however, it is highly unlikely that all smokers would be addicted to tobacco, or would be willing to give up smoking. Even if smokers were addicted, it is apparent that those who would prefer to carry on with the habit would derive some benefit from smoking. There are no good reasons to ignore these consumption benefits.

Even if all smokers were addicted to tobacco, part of the resources devoted to production and distribution of tobacco would be used in ways that would improve consumers well-being. Therefore, it may not be appropriate to include the entire value of these resources in social cost estimates, as was done in modified economic model 2.

For analytical purposes, addiction can be defined as in part I of this study: i.e. addiction can be assumed when individuals wanting to abandon a habit, e.g. smoking, cannot do so. The strength of smoking-dependency is difficult to measure. For the purpose of economic analysis it may be depicted by smokers' willingness to pay for means which may help free them from dependency. In this case, the willingness-to-pay estimate represents the value of the smoking-caused disbenefit (DBA), which smokers would prefer to live without.

Economic model 2 can now be modified by allowing for consumption benefits for those who would like to continue to smoke, despite dependency, and for disbenefits for those who would like to give up. This is achieved by substituting production and distribution costs for the value of smoking-caused disbenefit to those who would prefer to give up. The relevant costs may be redefined as

$$C^{*}_{2} = EXC + CR + DBA.$$

Government intervention is justified if the sum of the costs exceeds the revenue from tobacco excise, i.e. if $C^{*}_{2} - T > 0$. As revised model 2 allows for consumption benefits, the change in social welfare as a result of public intervention is the sum of change in external costs, private unperceived costs to all smokers and smoking-caused disbenefit to those smokers who would like to give up moking, but cannot do so because of addiction, minus the change in consumer surplus

$$\Delta W^{*}_{2} = \Delta C^{*}_{2} - \Delta CS.$$

Analogically, we can now define the fifth model, **modified economic model 3**, which assumes consumers to be aware of the health risks and addicted to tobacco. In this model, the relevant costs for considering grounds for government intervention are the external costs, smoking-caused disbenefit and the perceived private costs (CR^{A}) to those who would be willing to give up smoking. Relevant costs are defined as

$$C_{3} = EXC + CR^{A} + DBA.$$

In this case also, government intervention is justified if $C_{3} - T > 0$. The change in social welfare as a result of public intervention is the sum of change in external costs, private perceived costs and smoking-caused disbenefit to those smokers who would be willing to give up smoking minus the change in consumer surplus

$$\Delta W_{3} = \Delta C_{3} - \Delta CS.$$

The alternative costing models derived in this chapter are summarized in Table 3. Table 4 gives the intervention criteria and net gain in social welfare due to intervention implied by alternative models.

In all the models derived above, government intervention may be justified if the estimated costs exceed the revenue derived from tobacco excise. However, very different interpretations can be placed on the tobacco excise. Tobacco excise can be regarded as an attempt to correct for the consequences of the private decision to smoke with regard partly to the externalities and partly to the consequences of inadequate information and dependency. The original purpose for levying an excise on tobacco may have had little to do with these motives, however. Tobacco has traditionally been one of the governments' favorite taxable items because of its low price elasticity. In Finland, the fiscal motive has clearly dominated tobacco taxation in the past (Pekurinen and Valtonen 1987).

Markandya and Pearce (1989) argue that since the purpose of tobacco excise is not solely to compensate for the external costs but also to raise money for the government, only a proportion of tobacco excise should be deducted from the gross social costs to obtain a policy-relevant net cost figure. They do not indicate, however, how this proportion should be derived.

Table 3. Alternative costing models used in this study.

	Traditional economic model	Modified economic model 1	Modified economic model 2	Modified economic model 3	Medical model[a]
CONSUMERS[b]					
Fully informed	+	-	-	+	-
Addicted	-	-	+	+	-
RELEVANT COST COMPONENTS[c]					
External costs (EXC)	+	+	+	+	+
Unperceived costs (CR)	-	+	+	+[1]	+
Disbenefits due to addiction (DBA)	-	-	+	+	-

[1] Perceived private costs for those who would like to give up smoking, but cannot due to addiction.

[a] Note that, while the cost side of the medical model and economic model 1 are equal, they view consumption benefits differently. The medical model does not acknowledge any consumption benefits while economic model 1 does.

[b] Yes (+), No (-).

[c] Relevant (+), Not relevant (-).

Table 4. Intervention criteria and net gain in social welfare due to intervention implied by alternative costing models.

Model	Consumers[a]		Intervention criteria	Net gain in social welfare due to intervention[b]
	Fully informed	Addicted		
Traditional economic model	+	-	EXC > T	ΔEXC - ΔCS
Modified economic model 1	-	-	EXC + CR > T	ΔEXC + ΔCR - ΔCS
Modified economic model 2	-	+	EXC + CR + DBA > T	ΔEXC + ΔCR + ΔDBA - ΔCS
Modified economic model 3	+	+	EXC + CR^A + DBA > T	ΔEXC + ΔCR^A + ΔDBA - ΔCS
Medical model	-	-	EXC + CR > T	ΔEXC + ΔCR

[a] Yes (+), No (-).

[b] Excluding the costs of intervention.

3.4 Effects to be analyzed

Smoking-related harm to individuals arises mainly as a result of illness and premature death caused by smoking. The direct costs are mainly due to smokers' excess utilization of health care services as compared with non-smokers. Direct costs are commonly broken down into costs of hospital inpatient care and non-institutional care, pharmaceutical expenditure and other costs. Costs of inpatient care fall primarily on general hospitals. Costs of non-institutional care ensue from the use of outpatient services provided by general hospitals, health centres, occupational health care and private physicians. Pharmaceutical expenditure can be broken down into expenditure on prescribed medicines and over-the-counter-medicines. Most previous studies have also estimated the costs of fires caused by (e.g. Shillington 1977, Luce and Schweitzer 1978, Collishaw and Myers 1984, Ellemann-Jensen 1986). Some have also estimated the costs of rehabilitation (e.g. Leu and Schaub 1984).

Indirect costs reflect mainly the value of health lost due to smoking. A lower limit for this is usually derived by estimating the value of production lost due to smoking related morbidity and mortality. Production lost due to morbidity arises as a result of sickness absence and short-term and permanent disability. Production lost due to premature death depicts the value of production which the person could have generated by the end of his working life had he not died prematurely. Previous studies have not sought to estimate the value of lives lost due to smoking.

Smoking also generates several other disadvantages that are difficult to measure in monetary terms. Illness lowers smokers' quality of life and this may also cause distress to others. Passive smoking may cause health and other problems to non-smokers. Employers may have to hire auxiliary employees to offset smokers increased sickness absence. Smoking also creates additional ventilation and cleaning costs at home and in public premises. Investment in creating special areas or sections for smokers is required, for example, at workplaces and on public transport. Research into smoking and health education also consume resources.[1]

Smoking also generates various transfers of income. Tobacco excise is one such transfer of income from smokers to non-smokers. Loss of earnings due to sickness absence and disability are partly compensated by sickness allowance and disability pensions and rehabilitation costs may also be compensated. When death results, widow's and orphan's pensions are paid. Illness and premature death result in less taxes being collected. Due to premature deaths, pension payments are 'saved', as are health care costs.

---

[1] Strictly speaking the costs of research into the effects of smoking and health education should not be included as costs in the social cost calculations, since they represent the costs of actions to correct for externalities. Instead, they should be viewed as costs in economic appraisals of anti-smoking policies (e.g. Markandya and Pearce 1989).

In order to avoid double-counting, income transfers have not usually been analyzed in previous studies. This is justified, since transfers of income do not increase or decrease society's available resources. Income transfers are used to redistribute income between the private and public sector or between smokers and non-smokers. Income transfers play a significant role in political decision-making and should therefore not be overlooked.

Table 5 details the direct consequences, and table 6 the indirect consequences relevant to analysing grounds for government intervention in the tobacco markets. The items have been grouped under two headings, i.e. economic and financial effects, and classified into costs and benefits. Economic effects include items that reflect use of resources. Financial effects contain items that indicate transfers of income. For each of the items listed, some proportion constitutes a component of policy-relevant cost, but they cannot simply be added to produce a total. A summary of the cost items analysed in previous studies is presented in Appendix 1.

Table 5. **Direct** economic effects of smoking analysed in this study [Benefit (+), Cost (-)].

EFFECT	ECONOMIC EFFECT	FINANCIAL EFFECT
PRODUCTION, DISTRIBUTION AND DEMAND		
Benefits to smokers	+	
- Resources devoted to production and distribution	(-)	
- Proceeds from excise duty	(+)	+
Disbenefits due to addiction	-	
MORBIDITY		
Cost of hospital care	-	-
Costs of outpatient care	-	-
- General hospitals		
- Health centres		
- Occupational health care		
- Private physicians		
Cost of medicines	-	-
- Prescribed medicines		
- Over-the-counter medicines		
Sickness benefits		-
Costs of rehabilitation	-	-
Disability benefits		-
MORTALITY		
Widow's and orphan's pensions		-
OTHER DIRECT EFFECTS		
Fire damage	-	
Costs of health education and research	-	-
Costs of extra cleaning and ventilation	-[1]	
Investments in facilities for smokers	-[1]	-[1]

[1] Not analysed empirically in this study.

135

Table 6. **Indirect** economic effects of smoking analysed in this study [Benefit (+), Cost (-)].

EFFECT	ECONOMIC EFFECT	FINANCIAL EFFECT
MORBIDITY		
Lost production due to - Sickness absence - Disability	-	
Extra costs to employers	-[1]	
Lost tax-revenues due to - Sickness absence - Disability		-
MORTALITY		
Lost production	-	
Avoided health care expenditure		+
Lost tax-revenues		-
Avoided pension payments		+
Other avoided social security benefits		+
OTHER INDIRECT EFFECTS		
Psychosocial costs	-[1]	
Quality of life	-[1]	
Grief and suffering to others	-[1]	
Nuisance to non-smokers	-[1]	
Health risks of passive smoking	-[1]	
Costs and benefits at work-place	-/+[1]	

[1] Not analysed empirically in this study.

136

3.5 Estimation of the final external costs

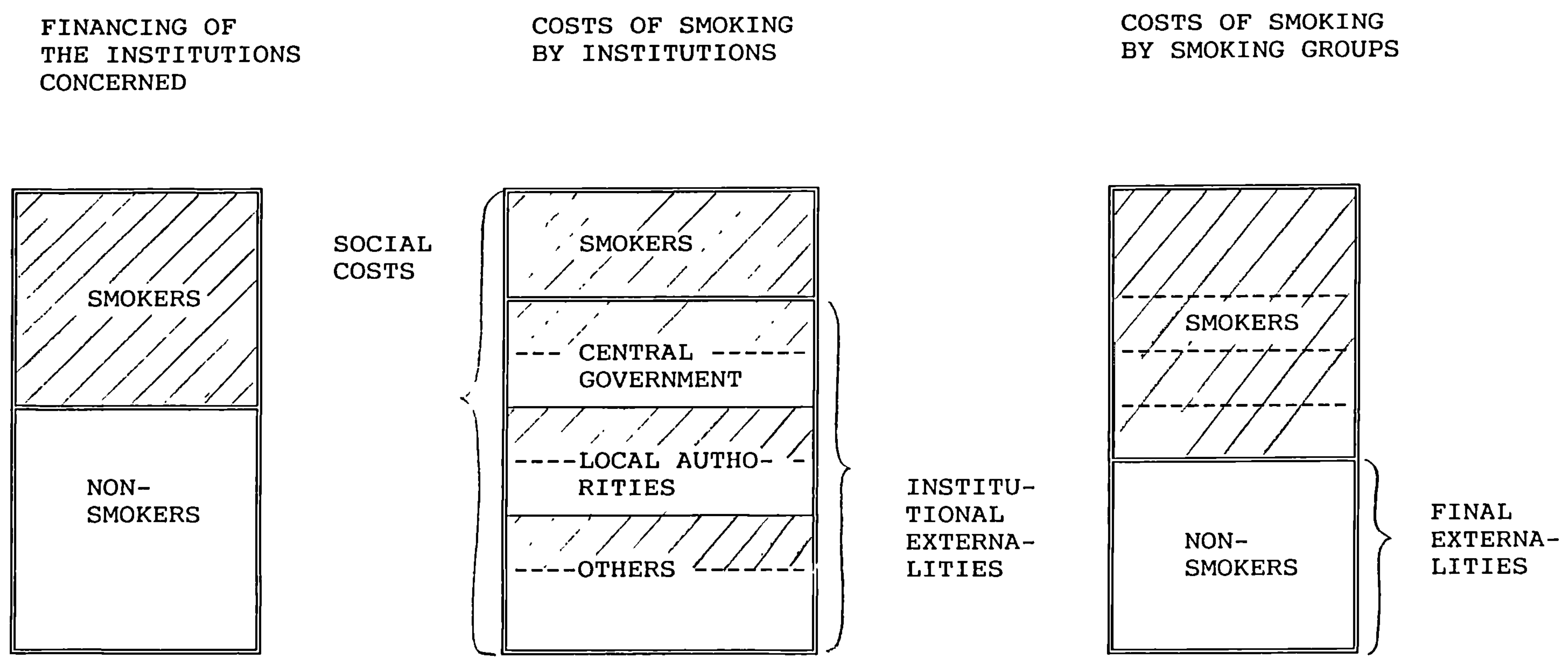
After estimating the social costs by components the next task is to decompose the costs between financing parties in order to arrive at institutional externalities. Depending on the origin of the cost the financing bodies vary, but in general the following parties are involved: central government, local authorities, public and private insurance institutions and companies, firms and patients/employees. Besides knowing which bodies bear the costs of smoking it is also essential to know how they themselves finance their expenditure. Only then can we distinguish the final external costs borne by non-smokers from the costs borne by smokers. Figure 1 illustrates the case.

Take the health care costs of smoking as an example. The cost imposed on health care by smoking (HC) is the sum of the costs borne by smokers (HC^S) and by third parties (HC^{EX}). The final cost burden is determined by smokers' and non-smokers' relative contributions to the financing of health care services. Let us denote smokers' share by p^S and non-smokers' share by p^{EX}. Thus

$$(1) \quad HC = HC^{EX} + HC^S$$

$$= \sum_i (p_i^{EX} + p_i^S) HC_i,$$

Figure 1. The relationship between total costs, institutional externalities and final externalities of smoking.



where $0 \leq p_i^{EX}$, $p_i^{S} \leq 1$; $p_i^{EX} + p_i^{S} = 1$, and where subscript i refers to the health care service i. If patients pay their treatment in full, there will be no external costs. Thus, if $p_i^{S} = 1$ then $p_i^{EX} = 0$ and hence $HC_i^{EX} = 0$.

In practice, there are only few services for which patients have to pay the full fee. Utilization of services is typically heavily subsidized through taxation (public provision) or insurance. In this case there may be external costs. Thus, if $p_i^{S} < 1$ then p_i^{EX} and $HC_i^{EX} \geq 0$.

The magnitude of the final external costs depends on the way health care is financed. In Finland, health care is financed by the central government, local authorities, public health insurance, state churches, employers, patients, and other parties (private health insurance, sickness funds, etc.). The financing of the health care service i can thus be decomposed into seven components

$$(2)\quad p_i^{EX} + p_i^{S} = p_i^{CG} + p_i^{LG} + p_i^{SI} + p_i^{C} + p_i^{EM} + p_i^{P} + p_i^{X};\quad \sum_j p_i^{j} = 1,$$

where p_i^{CG} = proportion of the total costs of service i financed by the central government,

p_i^{LG} = proportion of the total costs of service i financed by local authorities,

p_i^{SI} = proportion of the total costs of service i financed by public health insurance,

p_i^{C} = proportion of the total costs of service i financed by the state churches,

p_i^{EM} = proportion of the total costs of service i financed by employers,

p_i^{P} = proportion of the total costs of service i financed by patients,

p_i^{X} = proportion of the total costs of service i financed by other parties.

Denoting smokers' proportional contribution to financing services by β and non-smokers' contribution by (1 - β), each of the components in (2) can be broken down to smokers' and non-smokers' contributions. Thus

$$
\begin{aligned}
p_i^{EX} + p_i^{S} = \; & [\beta_{CG} + (1 - \beta_{CG})]p_i^{CG} \\
& + [\beta_{LG} + (1 - \beta_{LG})]p_i^{LG} \\
& + [\beta_{SI} + (1 - \beta_{SI})]p_i^{SI} \\
& + [\beta_{C} + (1 - \beta_{C})]p_i^{C} \\
& + p_i^{EM} + p_i^{P} + p_i^{X}
\end{aligned}
$$

and rearranging terms (2) becomes

$$
\begin{aligned}
(3)\quad p_i^{EX} + p_i^{S} = \; & [(1 - \beta_{CG})p_i^{CG} + (1 - \beta_{LG})p_i^{LG} \\
& + (1 - \beta_{SI})p_i^{SI} + (1 - \beta_{C})p_i^{C} + p_i^{EM} + p_i^{X}] \\
& + [\beta_{CG}p_i^{CG} + \beta_{LG}p_i^{LG} + \beta_{SI}p_i^{SI} + \beta_{C}p_i^{C} + p_i^{P}].
\end{aligned}
$$

The terms in the first brackets in (3) give the proportion of the smoking-related costs of service i paid by non-smokers (final external costs), i.e.

$$(4) \quad p_i^{EX} = (1 - \beta_{CG})p_i^{CG} + (1 - \beta_{LG})p_i^{LG} + (1 - \beta_{SI})p_i^{SI} + (1 - \beta_C)p_i^{C} + p_i^{EM} + p_i^{X}$$

and the terms in the second brackets give the proportion paid by smokers, i.e.

$$(5) \quad p_i^{S} = \beta_{CG}p_i^{CG} + \beta_{LG}p_i^{LG} + \beta_{SI}p_i^{SI} + \beta_C p_i^{C} + p_i^{P}.$$

Thus, when the smoking related costs have been estimated, formula (4) enables one to evaluate the final external costs. The final external health care costs due to smoking in the case of service i are

$$\begin{aligned} HC_i^{EX} &= p_i^{EX}HC_i \\ &= [(1 - \beta_{CG})p_i^{CG} + (1 - \beta_{LG})p_i^{LG} + (1 - \beta_{SI})p_i^{SI} \\ &\quad + (1 - \beta_C)p_i^{C} + p_i^{EM} + p_i^{X}]HC_i \end{aligned}$$

or in more general form

$$(6) \quad HC_i^{EX} = \sum_j (1 - \beta_j)p_i^{j}HC_i$$

where HC_i = the costs of health care service i associated with smoking,

p^j = the proportion of costs of the service i financed by party j,

$1 - \beta_j$ = the proportion of party j's revenue paid by non-smokers.

The total final external health care costs of smoking are the sum of the final external costs by service or

$$(7) \qquad HC^{EX} = \sum_i HC_i^{EX} = \sum_i \sum_j (1 - \beta_j) p_i^j HC_i.$$

The smoking related costs of health care service i paid by smokers are

$$(8) \qquad HC_i^S = p_i^S HC_i = [\beta_{CG} p_i^{CG} + \beta_{LG} p_i^{LG} + \beta_{SI} p_i^{SI} + \beta_C p_i^C + p_i^P] HC_i.$$

or in more general form

$$(9) \qquad HC_i^S = \sum_j \beta_j p_i^j HC_i.$$

The total health care costs of smoking eventually paid by smokers as a group are the sum of the respective costs by service, i.e.

$$(10) \qquad HC^S = \sum_i HC_i^S = \sum_i \sum_j \beta_j p_i^j HC_i.$$

From (8)-(10) it is clear that the out-of-pocket payment is only part of the medical treatment costs smokers have to bear as a result of smoking. The rest may be quantitatively more significant though less obvious to smokers. Other cost items can be decomposed in the same way.

The advantage of decomposing the costs by formulae (6)-(10) is that while identifying the parties affected, one can directly estimate the magnitude of the external costs by parties. Thus it is possible to sort out how the economic costs of smoking are distributed between the parties concerned (central government, local authorities, public health insurance, employers, smokers and others) (institutional externalities) and how they are eventually distributed between smokers and non-smokers (final externalities).

To summarize, the magnitude of the external costs of smoking depends on

(i) the estimated economic costs, the HC_i:s,

(ii) the way these costs are institutionally financed, the p_i^j:s, and

(iii) smokers' contribution to financing the institutions concerned, the β_j:s.

The estimation of the HC_i:s is complicated and requires specific research effort, but it can be done by applying appropriately revised methods suggested by various authors. The p_i^j:s can be obtained from the relevant financial statistics, though in some cases published figures need to be revised (Vainiomäki et al 1987).

The estimation of the β_j:s is clearly the most difficult and demanding task. Financial statistics do not discriminate between smokers' and non-smokers' contributions. As we cannot observe the β_j:s directly we have applied the approach suggested in Appendix 2 to derive estimates for them in the empirical part of the study.

4 CONSUMPTION, PRODUCTION AND DISTRIBUTION OF TOBACCO

4.1 Consumption of tobacco products

In Finland the prevalence of smoking in the adult population has changed in a manner similar to other developed countries: the proportion of smoking men has decreased since the 1960s but has remained steady during the last ten years at about 35 per cent. Smoking among women has become more popular, and the proportion of smoking women has gradually increased to about 20 per cent (STM 1987). Smoking among adolescents decreased between 1973 and 1981 but subsequently appeared to rise once again. During the past few years a great number of smokers have switched to tobacco products containing less of harmful substances.

In 1987 the total consumption of tobacco amounted to 8.2 billion units (a unit being equal to one cigarette, cigar or one gramme of pipe tobacco) which is equal to 2072 units for every Finn aged 15 or over. The total consumption of tobacco products is divided between four product groups: manufactured cigarettes (89.6 % of total consumption in 1987), pipe tobacco (9.2 %), cigars (0.9 %) and snuff and chewing tobacco (0.3 %) (Tilastokeskus 1988). Light cigarettes (containing less than 10 mg tar) now account for one third of cigarette consumption (Tilastokeskus 1988). Most of the tobacco products consumed are manufactured in Finland, with foreign products accounting for only about 2 per cent of the total consumption (Tilastokeskus 1988). Consumption expenditure on tobacco was about FIM 1077 for every Finn aged 15 and over in 1987. Tobacco expenditure amounts to 2.2 per cent of households' total consumption expenditure (Lehtinen and Koskenkylä 1988).

4.2 Production and distribution

The retail price of tobacco is made up of excise duty, turnover tax, percentages for the wholesale and retail trades, and industry's share. The price structure of tobacco products and the breakdown of the total retail sales value among the sectors is shown in Table 7.

The tobacco industry is heavily concentrated. Tobacco markets are dominated by three Finnish companies which are affiliated to the major American and British tobacco companies.

The tobacco industry is capital-intensive. Labour costs accounted for 41 per cent of the industry's total production costs in 1987 (Tilastokeskus 1989). The tobacco industry employed 1230 persons in 1987. The employement impact of the tobacco trade is difficult to assess.

About 45 per cent of retail tobacco sales take place from retail stores, 17 per cent from kiosks, 12 per cent from cafés and bars and the rest from other sales outlets (LTT

Table 7. Price structure of tobacco products and distribution of total retail sale value in 1987.

	Cigarettes (%)	Pipe tobacco (%)	Cigars (%)	TOTAL (FIM million)
Tobacco excise	51.42	36.00	30.02	2161.6
Turnover tax	16.00	16.00	16.00	685.3
Wholesale and retail trade	16.15	16.15	16.15	691.7
Tobacco industy	16.43	31.84	37.83	744.5
Total	100.00	100.00	100.00	4283.0

1986). Tobacco products are a major sales item for retail stores, and in particular for kiosks. They account for about 6 % of sales of retails stores and about 30 % of kiosk sales (LTT 1982).

The balance of the tobacco trade in 1987 was FIM 132 million negative. The value of tobacco exports was FIM 77 million, and imports 209 million. Exports are comprised mainly of tobacco products, while about 83 per cent of imports are raw and other materials (Tilastokeskus 1988).

5. SMOKING AND HEALTH

5.1 Introduction

The health risks associated with tobacco smoking have been widely documented (e.g. USDHEW 1979). Smoking has been shown to be associated with a number of illnesses, both serious and minor. Smoking increases the smoker's likelihood of contracting many chronic, widespread illnesses and it is commonly regarded as the single most important cause of premature death (e.g. USDHEW 1979). Smoking-related illnesses are often influenced by other factors, but smoking is often considered an important, and in some cases the most important, single cause. A central problem in analysing the economic consequences of smoking is to identify the health risks that arise as a result of smoking and what is the likely magnitude of these risks.

This chapter is mainly devoted to the epidemiologic aspects of smoking and health which, although technical from the perspective of economics, do, in fact, largely determine the magnitude of the final cost estimates. The second sub-section reviews findings from the major prospective epidemiologic follow-up studies on the link between smoking and health, in order to generate estimates of relative risks of smokers compared to non-smokers that can be used in the cost analysis. In the third sub-section the appropriate parameters for estimating costs are derived. The fourth sub-section deals with the problem of how to value the health consequences of smoking.

5.2 Smoking and mortality

5.2.1 General findings

The relationship between smoking and health is one of the most extensively researched areas in epidemiology. Several prospective surveys on the health consequences of smoking began in the 1950's. Groups of initially healthy persons were observed for a number of years and several important factors were registered, including diseases, causes of death, occupation, age, smoking habits, etc. Perhaps the most well known prospective studies are that on the British doctors (Doll and Peto 1976), the Dorn study on US war-veterans (Kahn 1966, Rogot and Murray 1980), the study by the American Cancer Society (Hammond 1966) and the Swedish population study (Cederlöf et al 1975).

These studies generally described the impact of smoking on mortality in terms of relative risk (mortality ratio), which measures the importance of smoking in the etiology of a disease relative to other possible causes of the disease. The relative risks are obtained by dividing the death rate of smokers by the death rate of non-smokers of the same age and sex. The relative risk equals one if smoking is not related to the disease, it is greater than one if the disease is either related to or associated with smoking, and it is less than one if smoking is preventive factor in the etiology of the disease.

Prospective studies have indicated that smokers experience a higher mortality relative to non-smokers overall and with respect to specific diseases. The relative risk of male smokers compared to life long non-smokers is about 1.7 for all causes of death, which implies 70 % excess mortality. For women, the relative risks have generally appeared to be smaller than for men, which the most recent studies attribute to less hazardous smoking habits among women. Women tend to start smoking later in life, to smoke less and to inhale less than men (Rogot and Murray 1980).

Smoking habits have a crucial impact on relative risks. The most important factors associated with the increased risk of smokers compared to non-smokers are the type of smoking, daily consumption, degree of inhalation, age at start and years smoked (e.g. USDHEW 1979).

Cigarette smoking is the main cause of smoking-related mortality. The relative risks of cigar and pipe tobacco smokers are generally found to be only slightly above non-smokers' risk. This is probably related to the fact that inhalation is less common among pipe and cigar smokers than among cigarette smokers (e.g. Hammond 1966).

The amount of cigarettes smoked daily is found to be linearly related to the relative risk. The relative risk depends also on the degree of inhalation, but compared to the quantity smoked effect the inhalation effect is relatively small (e.g. Hammond 1966).

The health risks are also related to the tar, nicotine and carbon monoxide content of the cigarette, but research into these aspects has not yet been extensive, as 'low-tar' cigarettes have only recently been launched onto the markets (e.g. Rimpelä 1986). The question of whether filter tipped cigarettes are less hazardous than others is somewhat controversial. Though filter cigarettes have a smaller tar content than non-filter cigarettes, they cause a greater exposure to carbon monoxide which is one of the risk factors for coronary heart disease (e.g. Rimpelä 1978).

Age at the start of smoking is inversely related to the relative risk; the younger the new smoker, the greater the risk (e.g. Cederlöf et al 1975). Because most diseases associated with smoking require a long period to develop, it has been found that smoking even 5-15 years does not increase the risk considerably (USDHEW 1979).

The relative risk decreases as a function of time passed since smoking ceased. Sometimes the relative risk of ex-smokers has been greater than that of current smokers, for example, in the case of lung cancer, chronic bronchitis and emphysema (e.g. Hammond 1966, Kahn 1966, Doll and Peto 1976, Rogot and Murray 1980). This finding has been interpreted to arise from the fact that ex-smokers are likely to differ from those who continue to smoke. Smokers do not stop smoking randomly. Some stop because of ill health or on doctor's orders. The survival of those with an advanced condition cannot be expected to improve considerably after stopping smoking, because much of the damage, particularly lung damage, is already irreparable. In general, ex-smokers' relative risk seems to decline over the course of time and to approach non-smokers' risk in 10-20 years.

5.2.2 Smoking and disease specific mortality

Coronary heart disease

Coronary heart disease (CHD) is the leading cause of death in Finland and in many other developed countries. Several studies show cigarette smoking to be one of the most important risk factors, together with raised blood-cholesterol level and high blood pressure. Lack of exercise, mental stress and diabetes may also have a role in CHD etiology (e.g. USDWEH 1979).

The number of cigarettes smoked per day, years smoked and degree of inhalation are found to be associated with the development of coronary heart disease (e.g. Cederlöf et al

1975, Doll and Peto 1976, USDWEH 1979). The relative risks appear to depend on age. The association is the strongest among young men (35-44 years). After that the ageing effect is so dominant that the contribution of smoking to risk is rather modest at older ages (Townsend and Meade 1979). The relative risk of cigar and pipe tobacco smokers is found to be somewhat smaller than that of cigarette smokers.

Several studies show a reduction in the risk of heart attack and of death from coronary heart disease among ex-smokers compared to those who continue to smoke (e.g. Kahn 1966, Doll and Peto 1976, Rogot and Murray 1980) although it may take over 5 or more years for ex-smokers to approach non-smokers' risk levels. In general, it is estimated that within ten years after smoking has stopped ex-smokers risk will approach that of life long non-smokers. It has also been found that, smokers who stop after a heart attack are less likely to have further attack than those who go on smoking (e.g. USDWEH 1979).

Cancers

The most well known of the health risks of smoking is the increasing lung cancer risk which has been repeatedly found in epidemiologic studies since the 1920's. Smokers' relative risk is found to be about ten times higher than that of life long non-smokers, though the results vary considerably (e.g. Hammond 1966, Cederlöf et al 1975, Doll and Peto 1976). This discrepancy is due to the fact that lung cancer is very rare among non-smokers, which makes the estimation of relative risk unstable.

An unanimous finding of the epidemiologic studies is that the risk of death from lung cancer is closely related to cigarette smoking and to a smaller extent to other forms of smoking (e.g. Hammond 1966, Kahn 1966, Cederlöf et al 1975, Doll and Peto 1976, Rogot and Murray 1980). Amongst light and moderate smokers those who inhale have a higher risk of getting lung cancer than those who do not. The risk of lung cancer is also greater among smokers who start early in life.

All prospective studies show a marked reduction in lung cancer risk in those who have stopped smoking cigarettes compared with those who continue (e.g. Hammond 1966, Kahn 1966, Doll and Peto 1976, Rogot and Murray 1980). This reduction in relative risk is apparent within a few years of stopping but it is still twice as high as that of life long non-smokers after 15 years. The risk of those who continue to smoke increases rapidly with age, but the ex-smoker's risk stays almost constant (Doll and Peto 1976) and thus falls relative to the increasing risk experienced by a person had he continued smoking. About ten years after stopping, the ex-smokers risk is only about one quarter that of the continuing smoker of the same age.

Air pollution and certain occupational factors such as asbestos dust appear to raise the risk of lung cancer, but this effect is small compared with that of cigarette smoking. Strong occupational exposure may be the sole cause of lung cancer for those exposed, but their number is small compared to the whole population. For example, Hakama (1976) reports that 80 % of lung cancers could be eliminated if no-one smoked, while only 0.1 % of lung cancers could be elimated if no-one was exposed to occupational risks. For its part, air pollution is estimated to account for 8 % of all lung cancer cases.

In addition to lung cancer, smoking has been found to increase the risk of many other cancers, such as cancer of the oral cavity, esophagus, pancreas, larynx and urinary bladder (e.g. Doll and Peto 1976, USDHEW 1979). Being so common, however, lung cancer is by far the most important cancer in public health terms. Smokers' risk with respect to all cancers combined is roughly twice the risk of non-smokers (USDHEW 1979).

Chronic bronchitis and emphysema

Chronic bronchitis and emphysema are the two other important causes of death attributable to smoking. They are invariably found to be associated with smoking. Because of the small number of deaths from these causes among non-smokers and the strong relation between the smoking habit and risk, reliable estimation of the relative risk is difficult. Death rates from chronic bronchitis and emphysema appear to be related to the number of cigarettes smoked and the way of smoking (e.g. Doll and Peto 1976, Rogot and Murray 1980).

Pollution and occupational exposure to certain dusts may cause chronic bronchitis, but predominantly among smokers (e.g. USDHEW 1979). The same holds for emphysema. Post-mortem studies show that the pathological changes of bronchitis and emphysema are related to smoking: severe emphysema is almost never found in non-smokers.

The lower relative risks from chronic bronchitis and emphysema in ex-smokers compared with those who go on smoking have been reported in several studies (e.g. Doll and Peto 1976, Rogot and Murray 1980). A considerable reduction of death rates in ex-smokers can be expected only after 10 years since smoking has stopped. Before that, giving up smoking appears to increase the risk of death (e.g. Doll and Peto 1976, Rogot and Murray 1980), although this is likely to be due to the selection bias mentioned earlier in relation to cancer.

Passive smoking

Over the recent years, the effect of smoking on non-smokers health has been extensively researched. The terms passive smoking and involuntary smoking have been used synonymously throughout the scientific literature when describing this relationship. A recent report by the U.S. Surgeon General (USDHHS 1986) reviews in detail the scientific evidence on passive smoking as potential cause of disease in non-smokers. The report concludes that, while the risks of passive smoking are smaller than the risks of active smoking, passive smoking is indeed a cause of diseases, including lung cancer, in healthy non-smokers.

In particular, the report indicates that cigarette smoking during pregnancy may have an adverse effect on the baby. Mothers who smoke have, on average, smaller babies than those who do not smoke, and have nearly twice the likelihood of a baby weighing less than 2 500 g at birth. Still birth and death in the first week of life are nearly 30 % more common in mothers who smoke regularly after the fourth month of pregnancy, and this relationship remains when the effects of other factors known to be associated with increased death rates have been controlled. Further, the children of parents who smoke compared with the children of non-smoking parents have an increased risk of respiratory infections and respiratory symptoms.

5.2.3 On causality between smoking and mortality

Although the excess mortality of smokers compared to non-smokers is undisputable, there is not complete unanimity over the causal nature of the relationship. The dispute is mainly localised over coronary heart disease, whereas the causality between smoking and lung cancer, chronic bronchitis and emphysema is generally considered proven. In order to regard the association between assumed cause and effect as causal, a dose-response relationship must first be observed (e.g. Saxen and Hakama 1970). Secondly, the association must be biologically sensible, and thirdly there must be confidence that some third factor has not caused the association. Despite the mounting evidence, all these criteria are still being debated, particularly in regard to coronary heart disease.

The dose-response relationship has been examined both on the individual and aggregate levels. Prospective follow-up studies have consistently shown mortality risks to increase as a function of the daily intake. In itself, that is not sufficient proof of causality, because a third factor which increases in the same proportion as smoking may have caused the association.

The fact that ex-smokers' risk is lower than that of continuing smokers', and that the risk seems to decrease as a function of time passed since smoking stopped is often regarded as evidence of causality. The main problem with this evidence is that ex-smokers are likely to differ from those who continue to smoke (e.g. Selzer 1980). Unfortunately, the studies involved have not generally controlled for the selection effect. Friedman et al (1979) found that ex-smokers had smoked less and far shorter periods than those who continued. Moreover, ex-smokers consumed less alcohol and were better educated.

Rose and Hamilton (1978) tried to overcome this problem by designing an intervention study. In the study group smokers were strongly encouraged to give up smoking, while no advice was given to the control group. After eight years follow-up the symptoms of chronic bronchitis had become more rare in the study group than in the control group, while no difference was found in overall mortality; nor had sickness absences from work decreased. On the other hand, the causality hypothesis is supported by findings that smokers who stop after a coronary attack are less likely to relapse than those who continue. A Swedish study reported that stopping halved both the number of non-fatal recurrences and the cardiovascular deaths (Wilhelmsson et al 1981).

At the population level the dose-response relationship has been studied by comparing the changes in the smoking habit. However, the results are conflicting even in the case of lung cancer (e.g. Townsend 1978, Burch 1980). The discrepancy is mainly caused by different opinions as to how smoking affects mortality on the individual level and hence the choice of different measures of exposure. On the other hand, mortality, particularly coronary heart disease mortality, is affected by so many simultaneous factors that it is doubtful whether the causality hypothesis can ever be proved at the population level.

The main problem in proving causality is that the observed excess mortality of smokers over non-smokers may be due to compounding factors. Many studies do not adequately account for socio-economic factors, other health behaviours such as alcohol consumption, and other life style factors, occupational and environmental risks which are known to be related to health status and also to smoking habits (USDHEW 1979). Studies that have controlled for the compounding factors have shown smoking to have an independent effect on mortality, although alcohol consumption and low income (Cederlöf et al 1975) and occupational status (Marmot et al 1978) are found to be related to coronary heart disease risk.

Twin studies suggest that chronic bronchitis and lung cancer are causally related to smoking, whereas in the case of coronary heart disease causality is still open to debate. The twin studies, however, do suggest that the relationship between smoking and coronary heart disease may largely be that of cause and effect (Cederlöf et al 1977, Lundman 1981).

Causality between smoking and mortality can never be proved conclusively by empirical methods, whatever the evidence, because the influence of all compounding factors cannot be controlled. For example, smoking is neither a necessary nor a sufficient condition for lung cancer; all smokers do not get lung cancer and a small proportion of lung cancer patients have never smoked. Because the causality hypothesis cannot be proved directly, conclusions must be based on the results that support the correlation, on the strength of the correlation, on the temporal dose-response relationship and on the consistency of the findings from different studies.

For preventive purposes it is safe to adopt the pragmatic concept of causality: causality exists if there is evidence that the possible etiological factor, such as smoking, forms a part of the circumstances under which the probability of getting the disease increases and if the prevalence of the disease declines when the influence of the factor decreases or ceases (e.g. Saxen and Hakama 1970). In addition to this, those responsible for prevention have to consider the harm which may occur while waiting for conclusive evidence.

Findings from the epidemiologic studies imply that if we adopt the pragmatic definition of causality, smoking can be interpreted to be causally related to lung cancer, chronic bronchitis and emphysema and strongly associated with coronary heart disease and several other diseases. On the basis of the results from Doll and Peto (1976) and the USDHEW (1979) report, Leu and Schaub (1983) have isolated the diseases listed in Table 8 as having a 'convincing' or 'highly probable' causal relation to smoking.

Some of the most recent studies on the economic costs of smoking have analysed various cost components with respect to the eleven diseases or disease groups listed in Table 8 (Hjalte 1984a, Ellemann-Jensen 1986). Some studies have estimated the costs for all diseases (Peston 1972, Lindholm 1973, Thompson and Forbes 1982, Collishaw and Myers 1984) or for broad disease groups (Luce and Schweitzer 1978, Rice et al 1986), while most have considered only the four main diseases associated with smoking (DHSS 1972, Lindholm 1973, Shillington 1977, Cohen 1984, Hjalte 1984b). Some studies do not explicitly specify the diseases analysed (Atkinson and Townsend 1977, Leu and Schaub 1984).

5.3 Estimates of attributability

5.3.1 Attributable risk

At the population level the quantitative relationship between smoking and health risks is commonly expressed in terms of attributable risk. Attributable risk is defined as the maximum proportion of a disease that can be attributed to a characteristic or etiologic factor (e.g. Lilienfeld and Lilienfeld 1980) assuming that other factors influencing the occurence of smoking-related diseases are equally distributed among smokers and non-smokers. The attributable risk depends on the relative risk of smokers as compared to non-smokers and on the prevalence of smoking among the population. In

Table 8. Diseases strongly related to smoking[a]

Disease	ICD-9 code
Cancer of	
Oral cavity	140-149[1]
Esophagus	150[1]
Pancreas	157
Larynx	161[1]
Lung	162
Urinary bladder	188
Coronary heart disease	410-412, 414
Aortic aneurysm	441
Other peripheral vascular diseases	443
Chronic bronchitis	491
Emphysema	492

Source: Leu and Schaub (1983), based on Doll and Peto (1976) and USDHEW (1979).

[a] The precise names of the diseases are given in Appendix 3.

[1] 50 % of the excess deaths of smokers attributed to other factors.

this section we derive the relevant parameters for estimating the attributable risks and hence the proportion of cases and costs that can be attributed to smoking.

5.3.2 Relative risks for the chosen diseases

The cases and costs estimated in the following sections are confined to the diseases shown in Table 8, although they may represent conservative estimates and thus underestimate the health consequences of smoking. The chosen diseases are the same as analysed in Leu and Schaub (1983b), Hjalte (1984a) and Ellemann-Jensen (1986).

In the case of diseases that are caused by several factors it is always difficult to isolate the true impact of a single factor. Therefore it is very difficult, if not impossible, to give a precise estimate of how smoking contributes to the development of a particular disease. However, the uncertainties surrounding the estimates can be minimized by applying alternative relative risks for a given disease. As disease, age and sex specific relative risks in relation to smoking are not available for Finland, we used figures commonly applied in comparable studies.

The approach here is to use the disease specific relative risks derived in three well-known prospective epidemiologic follow-up studies based on British doctors (Doll and Peto 1976), males and females in 25 U.S. states (Hammond 1966) and a probability sample of the Swedish population (Cederlöf et al 1975). Most of the previous studies on economic costs of smoking have derived the relative risks either from Doll and Peto (1976) or Hammond (1966). The Swedish study (Cederlöf et al 1975) controlled for several confounding socioeconomic factors and was therefore included. Table 9 outlines some basic information about the three studies. The age-and sex specific relative risks used in this study for smokers and former smokers are given in Appendix 4.

Application of the relative risks implies several assumptions. First, the estimated excess mortality of smokers compared to non-smokers is assumed to be mainly caused by smoking. That is, if current smokers stopped smoking, their mortality rate is then assumed to approximate that of non-smokers. In reality this may happen only after a long period of time, even if smokers were assumed to be similar to non-smokers in all other respects. Secondly, it is assumed that smoking has an independent effect on mortality. That is, a combination of other risk factors, such as alcohol and hypertension, will operate additively upon mortality. Thirdly, the relationship between smoking and mortality in Finland is assumed to be similar to the country of the original study. That is, the prevalence of other risk factors known to increase mortality, such as high blood pressure in case of coronary heart disease, should be about equal. This is not necessarily the case. Therefore, the results to be reported in later sections should be interpreted cautiously.

Table 9. Outline of the prospective epidemiologic studies of smoking and mortality used to derive the relative risks applied in this study

	STUDY		
	Doll and Peto (1976)	Hammond (1966)	Cederlöf et al (1975)
Subjects	British doctors	Citizens of U.S. states	Probability sample of the Swedish population
Population size	40 000	1 000 000	55 000
- females	6 000	563 000	27 700
Age range	20+	35-84	18-69
Years of follow-up reported	20	12	10
Number of deaths	10 072	150 000	4 500
Person years of experience	600 000	8 000 000	550 000

5.3.3 Prevalence of smoking

The quantitative impact of smoking-related health risks depends crucially on the prevalence of smoking in a population. The proportion of smokers among the Finnish population over 15 years old has remained more or less constant since the latter half of the 1970's. A third of Finnish males and about one fifth of women smoke daily (STM 1987). Smoking depends on age and sex. There are relatively more former smokers in the oldest age groups than in any other.

The prevalence of smoking is, however, very difficult to establish precisely, since consumers tend to under-report their consumption. Interview studies usually appear to reveal only about 70 per cent of the total consumption suggested by sales statistics (e.g. Valtonen and Rimpelä 1982, Warner 1977). Accurate information on the prevalence of smoking is essential for assessing its impact on the population and for empirical cost estimates.

The relative sizes of various smoking groups were estimated from a representative sample of the non-institutionalised Finnish population. The original interview survey was carried out by the Social Insurance Institution in 1976 (Kalimo et al 1982). For the purpose of this study the original sample was limited to persons aged 25 and over (N=11 677). Interviewees were divided into three smoking groups: non-smokers, former smokers and regular smokers (persons who had smoked regularly during the year preceding the interview). Occasional smokers were classified as non-smokers. Smokers were not divided into sub-groups according to type of tobacco smoked, number of cigarettes smoked per day or duration of smoking. Thus the following results relate to an average smoker.

Enactment of the Tobacco Act in 1976 sparked a lively public discussion about the health risks of smoking. As the interview survey was carried out at about the same time, it is unlikely that the interviewees exaggerated their smoking. Thus it is possible that the attributable risks estimated in this study are too low. Classification of occasional smokers as non-smokers may have a similar effect. The figures were not, however, adapted for possible underreporting. The relative sizes of the smoking groups by age and sex are given in Appendix 4.

5.3.4 Estimation of the attributable risks

The disease specific attributable risks were estimated separately for smokers and jointly for smokers and former smokers by age and sex. The attributable risks for smokers were estimated for all diseases listed in Table 8. The joint attributable risks were estimated only for the four main smoking-related illnesses: lung cancer, coronary heart disease, chronic bronchitis and emphysema.

The **total** number of cases and costs attributed to smoking were estimated using the joint attributable risks for the four diseases and the smokers' attributable risks for the other seven diseases. The **maximum** of potentially **avoidable** cases and costs were approximated using the attributable risks for smokers. These can be interpreted to reflect the maximum number of cases that can be avoided or the maximum value of resources that can be freed to cure other illnesses or freed for other uses in society in the long run if all current smokers stopped smoking and would never start again.

In order to estimate the range of the likely cases and costs, three sets of age and sex specific attributable risks were estimated for each diagnosis, applying the relative risks obtained in the three chosen studies (Doll and Peto 1976, Hammond 1966, Cederlöf et al 1975).

Doll and Peto (1976) suggest that 50 % of the excess mortality of smokers for cancers of the oral cavity (140-149), esophagus (150) and larynx (161) can be attributed to other factors than smoking. The estimated attributable risks were adjusted accordingly.

In estimating the attributable risks for smokers, former smokers and non-smokers were grouped together, assuming that both groups were similar. This procedure is likely to underestimate the potentially avoidable cases and costs.

The results reported in the empirical part of this study were detailed separately for each disease, age and sex group. However, only the range of the empirical estimates is given in each section. The attributable risks reported for males and females in various sections indicate the total proportion of cases and costs attributed to smoking in this study. The detailed data and the method for calculating the attibutable risks are given in Appendix 4.

5.3.5 Application of the attributable risks

The major economic consequences of smoking were listed in chapter 3. The magnitude of the health consequences and the subsequent costs are determined by the attributable risks. The number of premature deaths due to smoking can be estimated directly by applying the attributable risks defined in the previous section. Other cost items are more difficult to attribute.

Methodologically, the costs arising from health services utilization, sickness absence, disability and rehabilitation should be estimated by applying the respective attributable risks derived from the different rates of utilization, sickness absence, disability and rehabilitation between smokers to non-smokers. This is the approach adopted in some studies to attribute health care costs (DHSS 1972, Atkinson and Townsend 1977, Collishaw and Myers 1984, Rice et al 1986) and costs due to sickness absence (Atkinson and Townsend

1977, Shillington 1977). Given that the data used have not been controlled for other factors, such as social class and use of alcohol, which are known to be related to smoking, the studies tend to overestimate the costs.

The second best approach, adopted in most studies, is to attribute health care costs and other health related costs by applying attributable risks derived for mortality (Lindholm 1973, Shillington 1977, Luce and Schweitzer 1978, Thompson and Forbes 1982, Hjalte 1984b, Cohen 1984, Ellemann-Jensen 1986). Use of attributable risks based on overall mortality would implicitely assume all diseases to be terminal, which obviously is not the case. However, this approach can be employed for analysing costs arising from the major smoking-related diseases, such as listed in Table 8, which are frequently fatal, because it is reasonable to assume that the observed differences in mortality also apply in morbidity, otherwise two sets of causal relations would be called for.

In this study, the disease specific attributable risks are used for estimating the cases and costs arising from health services utilization, sickness absence, disability, rehabilitation and premature deaths. The link between smoking and all health risks is thus assumed to be the same as between smoking and mortality by age, sex and diagnosis. Estimated costs of smoking reflect the true costs as far as this assumption is justified.

5.4 Valuation of health effects

The most complex and controversial task in any study attempting to evaluate the economic consequences of risky activities is to assign a monetary value to the health effects produced by the activity or avoided by prevention. In economic literature, the problem of valuing health is most commonly addressed under the heading of 'valuation of life'. There is no single universally accepted approach for valuing health. In empirical research either of the two main methods is commonly applied: the human capital approach or the willingness to pay approach. The human capital approach derives the value of life from the discounted stream of future earnings. The willingness to pay approach studies how much individuals or society would be prepared to pay for a reduction in the risk of death. The methods are used to value changes in both morbidity and mortality.

The social costs of smoking depend crucially on the value assigned to smoking related deaths. Therefore, in this section we give a rather lengthy review of the pros and cons of the alternative methods for valuing health and finally assess their applicability for valuing the health effects of smoking. In what follows, the terms value of life and value of health are used synonymously.

5.4.1 The human capital approach

According to the human capital school of thought the value of health is determined by an individual's contribution to production. Basically, this method attempts to assess a value for an individual's productive output. The basic idea is simple. When the individual falls ill, he is not taking part in production and therefore part of society's human capital rests idle. When the individual dies, the society loses part of its human capital entirely. From this perspective, the premature death of an individual of working age implies that society loses his potential productive output, which is reflected in commodities left unproduced and in lost economic welfare (Cooper and Rice 1976, Mooney 1977, Hodgson and Meiners 1982).

In the human capital approach the economic impact of a premature death is evaluated by estimating what would have been the value of individual's expected production during the rest of his life-time had he not died prematurely. The value of expected life-time production is usually estimated on the basis of expected working-years and expected earnings (Cooper and Rice 1976, Hodgson and Meiners 1982). An allowance is made for the individual's life-expectancy and often for his/her probability of being employed at various ages. The earnings are often adjusted for indirect labour costs, such as employers contributions to social security schemes, and other components reflecting the value of production (Hodgson and Meiners 1982). The value of expected life-time production is estimated by age and sex and discounted to the present value.

Several reasons have been put forward for discounting the future costs and benefits. Individuals may have positive time preference rates and may thus weigh future benefits less highly than present benefits. This may be due to pure myopia, to uncertainty associated with the future, or to diminishing marginal utility of consumption. The other reason is that benefits available in the present may be invested to produce greater benefits in the future, and thus there may be an opportunity cost of receiving benefits in the future instead of in the present. In either case, the undiscounted sum of the life-time benefits would overstate the present value of the benefits to the individual. Discounting converts a stream of future benefits into its present value.

Human capital estimates generally account for the anticipated average annual rate of growth in productivity, and sometimes for unemployment. The proponents of this approach, however, suggest that the work-experience rates during a year of full employment should be used, otherwise losses due to illness cannot be isolated from losses due to unemployment (e.g. Rice and Hodgson 1981). If, however, the figures are used to illustrate only the economic losses to society, not the value of life, then they should be adjusted for unemployment.

Sometimes a component is added to the human capital estimate to allow for pain, suffering and other psychosocial costs (e.g. Weisbrod 1961, Dawson 1973). Non-labour income is excluded from the calcluations, since the value and earnings of a decendent's assets are transferred to other members of society.

As the purpose is to describe the value of an individual's production from the societal point of view, taxes and fiscal charges are not deducted from the earnings. From the individual's point of view the relevant perspective is naturally the expected life-time net earnings (earnings minus direct taxes and fiscal charges).

Some have proposed that the value of an individual's expected life-time consumption should be deducted from the value of expected life-time production (e.g. Weisbrod 1961, Dawson 1973). If the individual had not died prematurely he would have increased society's material well-being by his productive output, but would have consumed part of it himself. It is therefore argued that when the individual dies the rest of society loses the difference between his expected life-time production and consumption. Economists applying the human capital approach nowadays generally agree that consumption should not be deducted from production, since that would imply an individual's life to have value only to other members of society, not to the individual himself (e.g. Hodgson and Meiners 1982). The net approach is not commonly encountered in practice because of its obvious policy implications: the death of anyone whose expected life-time consumption would exceed expected production would imply a net gain to society. In Finland, those would be men aged 55 and women aged 50. The net approach can, however, be applied if the aim is to assess the economic externalities arising from premature deaths.

Human capital estimates are relatively simple to derive and intuitively easy to understand. This approach emphasises the individual's value as a factor of production, but ignores other dimensions of illness and death such as pain and suffering, aversion to risk and loss of leisure. The estimated human capital values reflect livelihood rather than the value of life; what matters is the productive potential of an individual, not his life itself. The method implies that the life of the young is more valuable than the life of the elderly and the life of a man worth more than a woman's. Standard human capital estimates have a zero value for persons living on non-labour income, such as pensioners, and for persons doing unpaid work, like house-wives. However, imputed values can be derived for these groups.

In this approach it is assumed that employees are paid by their marginal product and the future will be like the present. With centrally negotiated wages, it is clear that wages and salaries paid do not necessarily reflect the individual's marginal product. Ideally, the analysis should be based on expected future survival probabilities, the probabilities of having an occupation and the expected earnings provided one is alive and in an occupation. While studies on the rational expectations provide some grounds for assuming that the actual market prices reflect expectations for the future, the same cannot be assumed of structural factors such as female labour force participation rates, which are influenced by cohort effects, among other things.

An important practical problem in applying the human capital approach is the choice of the discount rate, as there is no single correct discount rate applicable in all circumstances. According to the time preference school of thought, the discount rate should reflect the social time preference, while the opportunity cost school of thought maintains that the rate should reflect the social opportunity cost of resources employed in the next best alternative. If all markets were perfectly competitive these two rates would be equal. However, since the markets are imperfect there is not a single rate of discount which would combine both these aspects. The discount rate should be the result of a balance between opportunity cost and time preference. How to arrive at this balance is not specified, however, and the usual approach is to present a number of alternative rates.

The human capital approach also has some more profound theoretical shortcomings (Mishan 1971, Jones-Lee 1976, Mooney 1977). It is not consistent with the traditional economic approach which is based on the consumer's own preferences; i.e his/her willingness to pay for receiving benefits and avoiding risks. The human capital approach does not measure the individual's own assessment of the value of his life, nor does it reflect society's valuation of an individual's life. In the human capital approach life is seen to have only instrumental value. The approach is based on the social welfare function which aims to maximize the gross national product (Mishan 1971, Jones-Lee 1976, Mooney 1977), which is not necessarily the same as maxmizing social welfare.

When applied to the health sector, the method implies that the primary objective of preventive or any other health care activities is to improve the productive potential of the labour force. That clearly is one of the objectives, but it is not generally regarded as the most important (Sintonen 1981, STM 1987). Allocation of health care resources to the care of the elderly, for example, indicates that the human capital approach is not the leading principle for decision-making within the health sector. The human capital approach can, however, be applied to assess the economic burden to society arising from illness and death.

5.4.2 The willingness to pay approach

Individuals' willingness to pay

The lack of consumer orientation in the human capital approach has led to attempts to value life in accordance with mainstream economic theory. Mishan (1971) argued that valuation of life should be based on the same principles that are generally followed in welfare economics, and to derive the value of life from individuals' preferences, and their willingness to avoid or accept a health risk. The basic idea is that the individual himself is the best person to make value judgements concerning his welfare and health and therefore that values should be derived from individuals' willingness to pay.

In the willingness to pay approach it is crucial to make some assessment of how individuals value small changes in risks. In most decisions that lead to changes in health risks it is not possible to idenfity in advance the individuals that will be affected by the decision. In most cases it is possible, however, to estimate, for example, how many deaths can be avoided statistically by the decision. Thus, the willingness to pay approach does not attempt to value life directly, but to examine how much people are individually or collectively prepared to pay for a small reduction in the risk of injury or death (Schelling 1968, Mishan 1971, Jones-Lee 1976). If an individual prefers a low probability of death to a high probability, he can be assumed to be willing to give up some of his present wealth in order to achieve a reduction in the probability of injury or death. Aggregating these valuations among individuals a social valuation can be derived. This approach is based on the social welfare function which aims to maximize welfare of society, not only the gross national product (Mishan 1971, Jones-Lee 1976, Mooney 1977).

The empirical willingness to pay estimates have been derived either by examining the choices made by individuals or by survey methods. Examination of choices is based on the idea that in many real-life situations individuals choose between alternative risky perspectives (e.g. travelling to work by car or bus) and in making these choices reveal their preferences towards various risks. Thus, it is possible to infer from these choices indirectly how individuals value changes in risks in practice. In this revealed preference approach, the willingness to pay estimates are derived by examining individuals actual choices in situations were they voluntarily assume risks.

The revealed preference estimates have been derived on the basis of the compensated wage differentials associated with risky jobs and consumption decisions. By comparing the wages paid in risky occupations with the general wage level, various studies have attempted to estimate the size of the risk-premium, i.e. the extra compensation necessary to induce workers to take risky jobs (e.g. Thaler and Rosen 1973, Viscusi 1978, Veljanovski 1978, Needleman 1980, Marin and Psacharopoulos 1982). Willingness to pay estimates inherent in consumption activities have been derived by analysing for example choices associated with the purchase of smoke detectors (Dardis 1980) and traffic safety, such as the use of pedestrian subways (Melinek 1974), car seat belts (Blomquist 1979) and time, fuel and risk trade-offs in motorway driving (Ghosh et al 1975). The labour market studies have produced a wider range of estimates for the value of statistical life than studies based on consumption activities (Table 10).

The advantage of the revealed preference approach is that the values are based on individuals' actual choices. In practice, however, there are only rare situations where individuals are genuinly free to choose between risk and compensation.

Studies using survey methods (interview- or postal surveys) have attempted to estimate individuals willingness to pay directly, by asking the respondents how much they would be prepared to pay for a small reduction in risk of injury or death in various hypothetical situations. The general approach is to assume that, for example, two people out of 10 000 will die as a result of an action or activity, but it is not known in advance who those two will be. Each of the 10 000 has an equal chance of becoming a victim. Individuals are asked to assess how much they would be prepared to pay

Table 10. Estimates of the value of statistical life from some revealed preference studies (FIM 1987)[1]

AUTHORS	DATA SOURCE	ESTIMATED VALUE OF STATISTICAL LIFE (FIM million)
	Time/safety/etc trade-off	
Dardis (1980)	Purchase of domestic smoke detectors (USA)	2.112
Ghosh, Lees and Seal (1975)	Motorway speed/time/fuel trade-off (UK)	2.565
Melinek (1974)	Time/safety trade-off in use of pedestrian subways (UK)	2.615
Blomquist (1979)	Time/safety trade-off in use of car seat belts (USA)	2.816
	Compensating wage differentials	
Needleman (1980)	for construction workers (UK)	0.855
Thaler and Rosen (1973)	for workers in risky occupations (USA)	3.017
Marin and Psacharopoulos (1982)	for manual and non-manual workers (UK)	12.370
Viscusi (1978)	for manual workers (USA)	17.147
Veljanovski (1978)	in industry (UK)	30.120

Source: Jones-Lee (1985).

[1] The original 1983 figures reported by Jones-Lee have been converted to 1987 Finn marks using relevant price indices and exchange rates.

for a reduction in the risk of death from 2/10 000 to 1/10 000 (e.g. Acton 1973, Jones-Lee 1976, Jones-Lee et al 1985, Persson 1988). The studies based on survey methods have produced a wide range of estimates for the value of statistical life (Table 11).

The willingness to pay approach produces substantially higher estimates for the value of life than the human capital approach and the range of willingness to pay estimates appears to be wider (Blomquist 1981). Value of life estimates reported in Jones-Lee's (1985) survey range from FIM 0.4 million to FIM 30 million, expressed in 1987 Finn marks. Most of the studies surveyed reported the value of statistical life to be over FIM 2.5 million.

Conceptually, the willingness to pay estimate is broader than the human capital estimate and includes, in principle, all factors affecting an individuals welfare, including factors that are difficult to measure, such as pain and suffering, risk aversion and the value of leisure. With the willingness to pay approach it is also possible to derive a value of life for persons living on non-labour income, such as pensioners, and for persons doing unpaid work like house-wives, whose life would be given a zero value in a standard human capital approach.

Table 11. Estimates of the value of statistical life from some questionnaire studies (FIM 1987)[1]

AUTHORS	DATA SOURCE	ESTIMATED VALUE OF STATISTICAL LIFE (FIM million)
Acton (1973)	Small non-random sample survey (N = 93) of willingness to pay for public provision of prevention of death from heart attack (USA)	0.362
Melinek (1974)	Non-random sample survey (N = 873) of willingness to pay for hypothetical safe cigarettes (UK)	0.855
Melinek, Woolley and Baldwin (1973)	Non-random sample survey (N = 873) of willingness to pay for domestic fire safety (UK)	1.659
Persson (1988)	Random-sample survey (N = 506) of willingness to pay for transport safety (Sweden)	7.161
Jones-Lee, Hammerton and Philips (1985)	Random-sample survey (N = 1 150) of willingness to pay for transport safety (UK)	11.918

Source: Jones-Lee (1985) except Persson (1988).

1 The original 1983 figures reported by Jones-Lee and Persson have been converted to 1987 Finn marks using relevant price indices and exchange rates.

Empirical results suggest that the willingness to pay estimates mainly reflect the non-economic side of life. In the Jones-Lee et al (1985) study only a small proportion of the respondents took into account direct economic effects, such as lost working hours or medical costs, in answering the valuation questions.

Theoretical studies, based on the expected utility theory, have shown that individuals' willingness to pay for a similar size change in risk increases with the level of the initial risk (e.g. Weinstein et al 1980, Rosen 1981); individuals are prepared to pay more for a reduction in risk from 10/10 000 to 9/10 000 than from 5/10 000 to 4/10 000, though the actual reduction in risk is equal in both cases. This implies that there is not a single value for a statistical life that could be applied in all circumstances, but that it is likely to vary depending on the decision context.

If applied in health care, the willingness to pay principle would imply that priority in resource allocation would be given to reduce the risks of those groups with high risk of death, though the number of lives saved would be smaller than had the resources been allocated to reduce the risks of low risk groups.

The willingness to pay approach provides, at least in theory, a simple solution to the discounting problem. The willingness to pay estimate incorporates an implicit rate of time preference, which reflects how the individual weighs future benefits as compared with the present. Therefore, no further disounting is needed in this case.

In theory, the willingness to pay approach makes it possible to derive a value for statistical life which is based on an individuals' own valuations to be used in economic evaluation of life-saving programmes. In practice, many difficulties are encountered in deriving the willingness to pay estimates.

The reliability of the methods used for deriving willingness to pay estimates is not yet very good. For example, the wage premiums may not necessarily reflect accurately the risks involved in jobs. Individuals' opportunities to choose freely their occupation and place of work according to their preferences are often limited. The situation in the labour market may have a greater impact on job-seeking from risky occupations than the compensation received, at least occasionally and in certain regions. The wage-level is determined mainly by other factors than the riskiness of the occupation.

Individuals may not perceive risks correctly. For example, wage premiums may not accurately reflect workers preferences if they have incomplete information regarding the risks to which they are exposed. Consumers' knowledge and ability to understand the risks involved in consumption choices may be limited. It is also difficult to separate risk premiums from other confounding factors. Apart from risks, consumption decisions depend on consumers' ability to pay and hence on the prevailing distribution of income. For the same reason, it is likely that the sum individuals would be willing to pay for reduced risk of death differs from the sum they would be willing to accept as compensation for increased risk of death.

Individuals have great difficulties in perceiving marginal changes in small probabilities. In interview and postal surveys, individuals may have difficulties in answering rationally and consistently to abstract and complicated questions dealing with marginal changes in risks in hypothetical situations (e.g. Tversky and Kahneman 1974, Muller and Reutzel 1984). In the Jones-Lee et al (1985) study the great proportion of the respondents appeared to have difficulties in this respect.

Answers to hypothetical valuation questions may also depend on the respondents ability to pay. To allow and control for this, the respondents may be asked to bear in mind what they can afford (e.g. Jones-Lee et al 1985). Expressed willingness to pay may differ from what individuals are actually prepared to pay when faced with the real choice. Respondents may conceal their true willingness to pay if they believe they will eventually have to pay. On the other hand, they may exaggerate their willingness to pay if they believe they will not be actually required to do so.

The willingness to pay approach is consistent with the traditional economic approach which emphasizes consumer sovereignity and is regarded a theoretically sound approach to health valuation. Among economists, the willingness to pay approach is clearly displacing the traditional human capital approach. Due to uncertainties connected with the empirical willingness to pay estimates, however, the method is not yet commonly applied in economic evaluation and decision making.

Society's willingness to pay

The willingness to pay approach has been criticized in that, among other things, the individual willingness to pay may have little relevance in the decision-making of a public sector body whose budget constraints need bear little relation to the wealth of individuals affected by its decisions (e.g. Keeney 1982). Therefore, it has been suggested that the valuation problem should be approached directly from the decision-makers point of view and to derive the value of life indirectly from the values implicit in previous resource allocation decisions (e.g Mooney 1977).

It is fairly straightforward to show that every decision affecting health positively or negatively carries a value for life implicit in the decision. When a new health care programme is adopted, or the existing programme expanded, the decision makers are valuing life indirectly. Investments improving traffic safety or tighter fire safety regulations may prevent deaths. By examining the costs of the programmes and deaths prevented/caused by them it is possible to derive the value of life implicit in the decisions.

A simple example illustrates this approach. If y deaths caused by collisions with elks can be prevented by installing an elk-fence, costing x marks, along a highway, but the fence is not installed, it can be inferred that the value of life implicit in the decision is at most x/y marks. If on the other hand, the fence is installed, the value of life implied in the decision is at least x/y marks. In both cases the decision made reveals the decision-makers' willingness to pay to prevent deaths. The similarity with the revealed preference approach is obvious.

The social willingness to pay estimates derived on the basis of past decisions vary greatly from one situation and programme to another (Mooney 1977) (Table 12). For example, fewer resources are allocated to preventive measures aimed at the healthy population than to treatment of the seriously ill, though the expected number of lives saved would be the same. The great variation in the implicit values applied in different decisions may not, however, necessarily indicate inconsistent decision-making.

As noted in the previous section, it is natural and consistent with the expected utility theory that individuals

Table 12. Estimates of the value of statistical life implicit in some past decisions made in Finland (FIM 1987)

AUTHORS	DATA SOURCE	ESTIMATED VALUE OF STATISTICAL LIFE
TVH (1979)[1]	Rescue operations at sea	478 000
TVH (1979)[2]	Care of the mentally retarded	3 283 000
LTT (1990)	Care of the permanently disabled	3 788 000
Konttinen (1987)[2]	Coronary artery bypass surgery	28 000[a] 36 000[b]

1 The original figures have been converted to 1987 marks using the consumer price index.

2 The original figures have been converted to 1987 marks using the hospital cost index.

a Cost per life-year gained.

b Cost per working-year gained.

value statistical life differently in cases of high and low risk (e.g. Weinstein et al 1980, Rosen 1981). Preference for ineffective, expensive, crisis-oriented medical procedures rather than cheap, cost-effective preventive measures affecting smaller risks can be perfectly rational, and thus variation in society's willingness to pay natural.

The advantage of this approach is that the figures derived reflect decision-makers' views on the value of life. However, it ignores the valuations of the individuals affected by the decisions, and thus it is not consistent with the traditional economic approach which gives priority to individuals' valuations. It is not generally possible to work out how the implicit values have been arrived at. Despite its similarities with the revealed preference approach, the society's willingness to pay approach has not been commonly applied in practice to valuation of health or life.

5.4.3 The relationship between the human capital approach and the willingness to pay approach

These days, economists generally acknowledge that the human capital estimates reflect only part of the value of life and therefore recommend willingness to pay as a theoretically sound approach to value life (e.g. Mishan 1971, Mooney 1977, Jones-Lee 1985). In practice, however, the human capital approach is the most commonly applied, despite its theoretical shortcomings.

From the point of view of decision-making, it is naturally interesting to know whether the estimates derived by the two methods are theoretically related, and hence if it is possible to derive willingness to pay estimates from human capital estimates. Theoretical studies that have addressed the problem have usually examined individuals' willingness to pay to avoid economic losses associated with small changes in risks (e.g. Usher 1973, Conley 1976, Goddeeris 1983). Willingness to pay estimates thus derived are conceptually not as broad as the estimates derived by the revealed preference approach or survey methods, which, at least in principle, also include all non-economic factors affecting individuals' welfare.

Usher (1973) and Conley (1976) examined how much well-informed rational individuals would be prepared to pay to avoid economic losses associated with a small risk of death. In accordance with the willingness to pay principle, they assumed that individuals weigh economic risks and benefits when they make decisions concerning safety, such as whether to purchase a cyclist's helmet. Individuals are assumed to maximize their expected life-time income, to be risk-averse and to treat economic losses associated with the risk of death symmetrically to other economic risks. It is shown that, by these assumptions, the lower limit of the value of statistical life is equal to the individual's expected life-time income.

Theoretical studies have not been able to show that the willingness to pay estimates can be derived from the human capital estimates. They do, however, strongly suggest that human capital estimates can be interpreted to serve as a lower limit for the willingness to pay estimates (e.g. Usher 1973, Conley 1976, Linnerooth 1979, Blomquist 1981, Rosen 1981, Goddeeris 1983, Jones-Lee 1985) and hence a lower limit for the value of life. Blomquist (1981) therefore suggests that decisions concerning projects which improve health by small amounts should be based on a value of life greater than the human capital estimate in order to avoid underinvestment.

Landefeld and Seskin (1982) have attempted to operationalize the results obtained by Usher (1973) and Conley (1976) and to seek for the likely lower limit of what the individuals would be prepared to pay in practice from the human capital perspective. They call their approach an adjusted willingness to pay/human capital approach. In accordance with the willingness to pay approach, they try to gauge how much a risk-averse individual would be prepared to pay to avoid economic risks associated with the risk of death. Following the human capital approach, they examine only economic losses associated with death and exclude all non-material losses. They seek to discover how much potential income is lost by the individual when he dies prematurely.

The income concept applied in the analysis covers all an individual's expected life-time income such as earnings, interest, rents, royalties, pensions and other transfer payments. As in the willingness to pay approach, the discount rate used represents the individual's opportunity cost of investing in risk-reducing activities, rather than society's opportunity costs as in the human capital approach. From the individual's perspective, the relevant income measure is net-income (income after taxes) and the relevant discount rate is after-tax rate of return. Finally, in accordance with the willingness to pay approach, a risk-aversion factor is applied to take account of the fact that individuals are likely to be at least as risk-averse with regard to loss of life as they are with respect to financial loss.

The empirical adjusted willingness to pay/human capital estimates derived by Landefeld and Seskin (1982) were two to four times higher than the human capital estimates for people aged 35. The relative differences in the value of life estimates between males and females and between young and old persons remained virtually the same as in the human capital approach. For those under 15 years of age, the proposed method produced clearly higher estimates for the value of life than the human capital approach, mainly because of the lower discount rate used in calculating the adjusted willingness to pay/human capital estimates.

In the author's opinion, the major advantage of the proposed approach is that the changes in health risks are valued from the individual's point of view, as in the willingness to pay approach. This method attempts to cover, at least in principle, all economic consequences to the individual resulting from changes in health risk. However, the method is only loosely linked with the welfare theory and excludes all non-economic losses from the analysis.

The adjusted willingness to pay/human capital approach can be regarded as an extension of the human capital approach with a mild willingness to pay flavour in it. The method allows one to estimate the magnitude by which the human capital estimates should be upgraded if the economic effects of illness and death are to be analysed from the point of view of the individuals affected. Basically, the method provides an answer to the question of how much individuals would, in principle, be able to pay, if they eventually had to, for programmes that improve health. This method has not been commonly applied in practice to value health.

5.4.4 Smoking and the value of health

Assigning a monetary value to the health effects of smoking is an essential part of social cost calculations in each of the models defined above. The preceding discussion does not offer, however, any obvious solution for estimating the value of smoking-related health effects. The willingness to pay approach is theoretically sound and should therefore be preferred. However, the reliability of the methods used for deriving the respective estimates remains unsatisfactory. The human capital approach has the merit of being relatively easy to apply and it is the most commonly encountered. However, it, undermines consumers' valuations. So does the societal variant of the willingness to pay approach. The adjusted willingness to pay/human capital approach looks at individuals ability, not willingness, to pay and ignores non-economic aspects of life, which the willingness to pay approach, at least in principle, includes.

To what extent the estimated value of health or life is relevant for assessing the policy relevant costs varies between models. In the traditional economic model the value of health is not a relevant cost item for designing policy. Since, in this model, consumers voluntarily assume risk, and smoking reveals that consumption benefits surpass the risks. Therefore, no value should be assigned to life, in order to avoid double counting (e.g. Mishan 1971, Littlechild and Wiseman 1984). In accordance with this approach some studies have estimated the number of deaths only without assigning any value to the lives lost (e.g DHSS 1972, Atkinson and Townsend 1977). This would be a valid approach as long as it is plausible to assume that smokers are fully aware of the risk they take, they are not addicted and no caring externalities exists.

In all other models, one or more of these asumptions does not hold, and whole or part of the value of health is relevant to policy. Most of the previous studies have applied the human capital approach to estimate this item (e.g. Peston 1971, Shillington 1977, Luce and Schweitzer 1978, Collishaw and Myers 1984, Hjalte 1984a, Ellemann-Jense 1986, Rice et al 1986), but have not usually noted that only part of this estimate is relevant for guiding policy.

The approach here is to assume that the human capital estimates serve as a lower limit for the willingness to pay estimates and hence a lower limit for the value of life. Accordingly, we shall evaluate the health effects by the human capital approach, identify the proportion of these estimates that is relevant for policy in each of the models and indicate the implicit lower limit of the caring externality in order to justify public intervention in each case.

6 ECONOMIC CONSEQUENCES OF SMOKING RELATED MORBIDITY

6.1 Direct consequences

Smoking imposes a large cost burden on the health service through its negative effect on health. In Canada smoking is estimated to account for 11.5 % of health care expenditure (Thompson and Forbes 1983) and in the United States for 7.8 % (Luce and Schweitzer 1978).

This chapter examines the relationship between smoking and the use of health services in Finland. It aims at answering the following questions: does smoking increase the utilization of health services, is any such utilization quantitatively and economically important, and which services are likely to be affected by smoking.

6.1.1 Costs of hospital inpatient care

Smoking appears to impose a considerable strain on the hospital system. According to studies carried out in the United States smokers account for about 20 % more bed-days annually than non-smokers (Oakes et al 1974, Vogt and Schweitzer 1985). Former smokers also need slightly more bed-days than non-smokers (Vogt and Schweitzer 1985). Results obtained in the UK and Switzerland support these findings (Ashford 1973, Leu and Schaub 1983b).

Estimates of the cost burden of smoking on the hospital system vary from 2-5 % of hospital expenditure in Sweden, Denmark and Switzerland (Leu and Schaub 1983b, Hjalte 1984a, Ellemann-Jensen 1986) to 8-17 % in the United States and Canada (Thompson and Forbes 1983, Collishaw and Myers 1984, Hinds 1986). The great discrepancy between such estimates is explained by differences in treatment practices, smoking habits and the estimation methods applied.

The number of bed-days attributed to smoking is usually estimated by interview surveys or by applying the disease specific-attributable fractions. Studies based on interview surveys usually examine utilization of health services by smokers and non-smokers at highly aggregated levels without analyzing by disease (Collinshaw and Myers 1984). Smokers' and non-smokers' bed-days are calculated per capita and the difference is interpreted to result from smoking. Multiplying the difference by the number of smokers gives an estimate of the number of bed-days attributed to smoking. Since studies based on interview surveys have not generally examined the utilization of hospital services by disease, and bed-days have not been standardized for factors other than age and sex, a very high estimate is often obtained for the number of bed-days attributed to smoking.

The number of smoking-related bed-days by disease is usually estimated applying the attributable fractions derived for smoking-related deaths (Leu and Schaub 1983b, Thompson and

Forbes 1983, Hjalte 1984a, Ellemann-Jansen 1986, Stoddart et al 1986), in which case the link between smoking and hospitalization is assumed to be the same as the link between smoking and mortality. Multiplying the number of disease-specific bed-days by the estimated attributable fractions yields the number of bed-days attributed to smoking. Estimated in this way the number of bed-days attributed to smoking often remains very small.

The costs of hospital care attributed to smoking are obtained by multiplying the number of bed-days attributed to smoking by the relevant unit costs. Ideally, disease specific cost figures should be used (Stoddart et al 1986), but in practice the relevant cost data has not been available, and the average costs per day have been used as a proxy measure of the true costs (Collishaw and Myers 1984, Leu and Schaub 1983b, Hjalte 1984a, Ellemann-Jensen 1986). These over- or underestimate the true costs of treatment, depending on the disease.

Material and methods

In Finland, smoking-related diseases are treated in general hospitals (central, district and local hospitals, health centre wards, tuberculosis sanatoriums and private hospitals). The number of smoking related bed-days has been estimated separately for men and women by age group, applying the relevant disease-specific attributable fractions.

The study involved persons aged 35-84. The number of bed-days attributed to smoking was obtained by multiplying the total numbers of disease, age and sex-specific bed-days by the corresponding attributable fraction (see Appendix 4).

Smoking-induced costs of hospital care were obtained by multiplying the number of bed-days attributed to smoking by disease-specific costs per day which were estimated separately. Disease-specific costs per bed-day were derived on the basis of the costs and numbers of bed-days for each type of hospital and specialty as described in Appendix 5. The costs also include the estimated capital costs per bed-day.

The numbers of bed-days were obtained from the hospital discharge register kept by the National Board of Health (Lääkintöhallitus 1989).

Results

An estimated 224 000 - 302 000 bed-days at general hospitals were attributed to smoking (Table 13). This is about 1.6-2.2 % of all the bed-days at general hospitals and corresponds to about 770-1030 hospital beds in use all year

Table 13. Estimated number of bed-days and costs of hospital inpatient care attributed to smoking in 1987.

Disease	Attributed to smoking (%)		Smoking related	
	Males	Females	Bed-days (1000)	Costs (million FIM)
Cancer of				
Oral cavity	19-39		2-3	2-4
Abdominal cavity	13-33	5	3-6	4-8
Larynx	35		2	2
Lung	80-84	16-22	82-87	103-108
Urinary bladder	16-32	2	5-7	5-9
Coronay heart disease	22-29	0[a]	56-71	44-56
Other vascular diseases	14-53		1-5	1-4
Bronchitis	57-92	17-36	71-116	59-96
Emphysema	57-92	13-27	2-4	3-4
TOTAL[1]			224-302	222-292

[1] Numbers may not add to totals due to rounding.

[a] Figure is less than half of the measure.

round. Over two thirds of bed-days attributed to smoking were due to bronchitis and lung cancer.

Smoking-induced costs of hospital care were estimated to be FIM 222-292 million in 1987. This is about 2.3-3.0 % of the total expenditure of general hospital inpatient care. About 95 % of bed-days and costs attributed to smoking resulted from smoking by men.

Conclusions

An estimated 2.3-3.0 % of costs of hospital inpatient care were attributed to smoking. This figure is well below, for example, the 11-17 % estimated for Canada (Thompson and Forbes 1983, Collishaw and Myers 1984) or the 8 % for the United States (Luce and Schweitzer 1978, Hinds 1986), but on a par with the 2-3 % estimated for Sweden, Denmark and Switzerland (Leu and Schaub 1983b, Hjalte 1984a, Ellemann-Jensen 1986).

The results reported here support the notion that smoking imposes an economic strain on the hospital system, but the impact may be smaller than generally expected. The influence of reduction in smoking rates on the use of hospital services and hospital costs is, however, unclear (See Thompson and Forbes 1983 and 1985, Leu and Schaub 1983b and 1985). A substantial reduction in smoking would improve the health of the population and simultaneously increase life expectancy.

In the long run, the latter effect may be so large that the influence of reduction in smoking on health care expenditure may turn out to be marginal (Atkinson and Townsend 1977, Leu and Schaub 1983b).

6.1.2 Costs of physician care

Smoking appears to increase the use of some forms of primary medical services. Male smokers or former smokers visit a physician more often than non-smokers (Ashford 1973, Oakes et al 1974). In Switzerland it is estimated that male smokers visit a physician about 8 % more often during a year than non-smokers (Leu and Schaub 1983b).

The relation between physician visits and smoking is not, however, indisputable. For women, especially, the relation appears unclear. Oakes et al (1974) found that women who smoked visited a physician less frequently than those who did not smoke. Chetwynd and Raymer (1986) came to the opposite conclusion.

In the United States Vogt and Schweitzer (1985) did not find any difference between smokers and non-smokers in the use of hospital outpatient services. Former smokers did, however, use outpatient services significantly more than non-smokers.

Smokers seem to use preventive services less frequently than non-smokers or former smokers (Vogt and Schweitzer 1985).

This is interpreted to imply that smokers are less interested in their own health and have a tendency to avoid or to delay the use of health services.

Estimation of the number of smoking-related physician visits is usually based on interview surveys, which have been able to differentiate visits by type but not by illness. Such studies have consistently attributed about 2-3 % of all physician visits to smoking (Leu and Schaub 1983b, Collishaw and Myers 1984).

It is, however, unclear to what extent the observed differences are due to smoking, because the studies have not controlled the influence of confounding factors apart from age and sex.

The impact of smoking on the costs of physician services has not been studied extensively. In studies touching the subject costs have been estimated as the product of the utilization of physician services, the proportion attributed to smoking and the average cost per visit (Collishaw and Myers 1984, Leu and Schaub 1983b, Hjalte 1984a, Ellemann-Jensen 1986). Ideally the costs of physician visits should also be estimated by diagnosis (Stoddart et al 1986). In practice, diagnosis-specific cost data have not been available and the average costs have been applied (Collishaw and Myers 1984, Leu and Schaub 1983b, Hjalte 1984a, Ellemann-Jensen 1986).

Material and methods

The relationship between smoking and physician services was examined in a representative sample of the non-institutionalised Finnish population. The original interview survey was carried out by the Social Insurance Institution in 1976 (Kalimo et al 1982). For the purpose of this study the original sample was limited to persons aged 25 and over (N=11 677). Utilization of occupational health care physician services was studied among the working population aged 25-64 (N=8 000). Interviewees were divided into three smoking groups: non-smokers, former smokers and regular smokers (persons who had smoked regularly during the year preceding the interview). Smokers were not divided into sub-groups according to type of tobacco smoked, number of cigarettes smoked per day or duration of smoking. The results indicate utilization of physician services by an average smoker.

As sociodemographic factors like age, sex, education, occupation and income are associated with both smoking and utilization of physician services, the impact of these likely confounding factors on utilization was standardized with the general linear model (Searle 1971). The numbers of smoking-related visits were estimated separately for general hospital outpatient services, health centres, private sector physician services and occupational health care. The analysis was done separately for men and women. The significance of smoking in explaining the utilization of services was tested by the F-test. Since the interview survey did not include questions about alcohol consumption, it was not possible to control the effect of this.

The proportional share of smoking in the total utilization of services was calculated on the basis of mean values in the use of services among smokers, former smokers and non-smokers. The ratios between mean values in different smoker-groups were assumed to give the correct distribution in use between different groups. Use of services induced by smoking was obtained by deducting from the total use of each group the use not induced by smoking. Average use not induced by smoking was in each group assumed to be the same as the average use by non-smokers.

Proportion of physician visits attributed to smoking - the attributable fraction (Miettinen 1974) - was estimated separately for smokers and former smokers with the following formula:

$$SO_i = p_i(K_i - K_3)/(p_1K_1 + p_2K_2 + p_3K_3),$$

where p_i = proportion of smokers, former smokers and non-smokers (i=3) in population

K_i = average number of physician visits in smoking-group i.

The number of visits attributed to smoking was obtained by multiplying the total number of visits by the attributable fractions. Smoking induced costs of physician services were obtained by multiplying the attributed number of visits by the relevant unit costs.

Total service-specific utilization figures were allocated between men and women in proportion to means and population shares. From total figures were deducted the use by persons aged under 25 estimated in the population survey of the Personal Doctor Program (Vohlonen 1989) and the remainder was allocated to different smoking-groups in proportion to their means and population shares.

The final cost estimation was performed only for those services where the impact of smoking on utilization was statistically significant at least at the 10 % level.

The number of visits to general hospital outpatient departments and the related unit costs were obtained from the Hospital Statistics (Sairaalaliitto 1988). The numbers of visits to physicians in health centres and occupational health care were obtained from the National Board of Health (Niskanen 1989) and the number of visits made in the private sector from age- and occupation statistics of the Social Insurance Institution (Kansaneläkelaitos 1988a). Relevant unit costs per visit were obtained from the cost study of the Personal Doctor Program (Pekurinen 1989) and from the

Ministry of Finance (Luoma 1989). The applied cost figures also cover costs for laboratory-, X-ray- and other examinations, apart from occupational health care where they cover only the direct costs of physician services (cost of labour, office, administration, etc.). The weighted average of the service specific unit cost figures was used for the total number of physician visits.

Results

Smoking appears to increase the total number of visits made to physicians for both men and women (Table 14). The impact is most pronounced for former smokers. Male former smokers visit a physician on average 22 % more frequently during the year than male non-smokers. Among female former smokers the excess figure was 16 % compared to non-smokers. Male smokers visit a physician on average 7% more often than non-smokers and female smokers 3 % more often than non-smokers. Smoking seems to affect utilization of physician services slightly differently in different sectors.

Smoking seems to increase the number of visits made to health centre physicians by men, but not women. Male smokers made on average 16 % more visits to the health centre physician annually than non-smokers. Former smokers visited the health centre physician 25 % more often than male non-smokers.

Table 14. Average number of physician visits by smoking-group and sex in 1976[1]

	MALES				FEMALES			
	Mean	Standard deviation	F	p-value	Mean	Standard deviation	F	p-value
ALL PHYSICAN VISITS								
Smokers	2.85	0.10			3.74	0.17		
Ex-smokers	3.25	0.11	6.64	0.001	4.20	0.23	2.83	0.059
Non-smokers	2.66	0.12			3.63	0.07		
HEALTH CENTRE PHYSICIANS								
Smokers	1.33	0.06			1.64	0.11		
Ex-smokers	1.43	0.07	3.92	0.020	1.85	0.14	0.75	0.471
Non-smokers	1.15	0.07			1.69	0.05		
PRIVATE PRACTITIONERS								
Smokers	0.58	0.05			0.97	0.08		
Ex-smokers	0.74	0.05	3.31	0.037	1.10	0.11	0.50	0.605
Non-smokers	0.59	0.05			1.01	0.04		

Table 14. ... continued.

	MALES				FEMALES			
	Mean	Standard deviation	F	p-value	Mean	Standard deviation	F	p-value
OCCUPATIONAL HEALTH CARE								
Smokers	0.35	0.04			0.39	0.05		
Ex-smokers	0.39	0.04	0.40	0.672	0.37	0.06	2.74	0.065
Non-smokers	0.40	0.05			0.28	0.02		
HOSPITAL OUTPATIENT DEPARTMENTS								
Smokers	0.49	0.04			0.68	0.07		
Ex-smokers	0.58	0.05	1.68	0.187	0.69	0.10	2.63	0.072
Non-smokers	0.43	0.05			0.52	0.03		

[1] Standardized for age, occupation, education and income.

Smoking also affected the utilization of services provided by private practitioners among men but, not women. The influence of smoking seems to be related to quitting smoking, for there were no differences in numbers of visits between smokers and non-smokers for either sex. Male former smokers visited a private practitioner on average 25 % more frequently than other males.

Smoking increased visits to occupational health care among women, but not among men. Female smokers and former smokers had about a third more visits to occupational health care than non-smokers.

Smoking increased visits to outpatient departments among women. Female smokers and former smokers had on average a third more visits to outpatient departments annually than non-smokers. Smoking did not have statistically significant influence on visits to outpatient departments among men, although male smokers made on average 14 % and former smokers 30 % more visits to outpatient departments annually than non-smokers.

Attributable fractions of smoking in the population aged 25 and over in 1987 calculated on the basis of the means presented in Table 14 are shown in Table 15.

In relative terms, smoking seemed to have the greatest impact on utilization of physician services in hospital outpatient departments and in occupational health care. About 5.8 % of outpatient visits and 5.7 % of visits to occupational health care were related to smoking. The influence of smoking on other physician services was not as significant. About 4.3 % of all physician visits among persons aged 25 and over were attributed to smoking.

An estimate of the total number of physician visits and costs attributed to smoking is presented in Table 16.

In 1987 some 590 000 - 620 000 physician visits were attributed to smoking. This amounts to about 3.4-3.6 % of all physician visits. Less than half of the smoking related physician visits were made to health centres and about one third to hospital outpatient departments.

Visits to physicians attributed to smoking accounted for an expenditure of more than 180-190 million marks within outpatient care in 1987. This corresponds to roughly 3.6-3.8 % of the total expenditure for outpatient care. Less than half of the burden fell on general hospitals and more than one third on health centres.

Table 15. Proportion (%) of physician visits attributed to smoking among persons aged 25 and over by smoking-group in 1987[1].

	MALES		FEMALES		TOTAL[2]
	Smoker	Ex-smoker	Smoker	Ex-smoker	
ALL PHYSICAN VISITS	1.0^{***}	1.7^{***}	$0.4^{(*)}$	$1.1^{(*)}$	4.3
HEALTH CENTRE PHYSICIANS	2.0^{*}	1.8^{*}	-0.4	0.7	3.8
PRIVATE PRACTITIONERS	-0.2^{*}	1.8^{*}	-0.6	0.7	1.6
OCCUPATIONAL HEALTH CARE	-2.5	-0.3	$4.0^{(*)}$	$1.7^{(*)}$	5.7
HOSPITAL OUTPATIENT DEPARTMENTS	1.9	2.7	$3.7^{(*)}$	$2.1^{(*)}$	5.8

$^{***} = p < 0.001$, $^{**} = p < 0.01$, $^{*} = p < 0.05$, $^{(*)} = p < 0.10$

1 Standardized for age, occupation, education and income.

2 Includes only the utilization which is statistically significant at least at 10 % level.

Table 16. Estimated number of physician visits and related costs attributed to smoking by smoking-group in 1987[1,2,3]

	TOTAL NUMBER OF VISITS			COSTS (million FIM)		
	Smokers	Ex-smokers	TOTAL	Smokers	Ex-smokers	TOTAL
ALL PHYSICAN VISITS	203 000	420 000	622 000	59	123	182
HEALTH CENTRE PHYSICIANS	145 000	128 000	273 000	32	28	60
PRIVATE PRACTITIONERS	-5 000	42 000	37 000	-1	9	8
OCCUPATIONAL HEALTH CARE	51 000	23 000	74 000	11	5	16
HOSPITAL OUTPATIENT DEPARTMENTS	129 000	74 000	203 000	70	40	109

[1] Standardized for age, occupation, education and income.

[2] Includes only the utilization which is statistically significant at least at 10 % level.

[3] Numbers may not add to totals due to rounding.

Conclusions

The influence of smoking upon the use of different physician services varies. Among men, smoking increases the total number of physician visits and the number of visits to health centre physicians. Among women, smoking influences the total number of physician visits as well as the number of visits to occupational health care and hospital outpatient departments. On the other hand, smoking does not seem to have any influence upon the number of visits to outpatient departments or occupational health care among men, and upon the number of visits to health centre physicians or private practitioners among women.

A one-year follow-up study carried out in England (Ashford 1973) resulted in an estimate of approximately the same order for the influence of smoking on the use of health care services among men. On the other hand, the study did not support the excess use hypothesis for all age groups. In fact, smoking seemed to decrease the number of visits to physicians and outpatient departments among men aged 60 and women aged 45. No systematic differences in utilization of services between former smokers and non-smokers was found.

In an extensive health interview survey carried out in the United States (see USDHEW 1979) a distinctly smaller proportion of smokers than non-smokers reported to have visited a physician five times or more during the year preceding the interview. The proportion of those who had visited a physician often was larger among former smokers than non-smokers.

For most services, the average number of physician visits reported in this study are larger for former smokers than for current smokers. The same phenomenon has been found in epidemiological studies on smoking and mortality as well as in some earlier studies on health services utilization (see USDHEW 1979). This finding suggests that former smokers are selected.

There was an aim to improve reliability of results in this study by standardizing the influence of age, sex, occupation, education and income on the use of health care services. With respect to unstandardized factors smoking-groups were presumed to be similar. As smoking is also an indicator of life-style or way of life, it is likely that there remains significant comparison bias between smoking-groups even after standardizing for sosiodemographic factors.

Because the study was based on cross-sectional data, the results cannot be interpreted to represent a causal relationship between smoking and utilization of physician services, but only an association. On the basis of epidemiological studies on smoking and morbidity it is known that the morbidity risk in many diseases is bigger for smokers than for non-smokers, and this leads to more use of health care services among smokers. It was not possible here, however, to analyze whether physician visits were specifically related to diseases generally associated with smoking.

The above estimates are based on the assumption that the influence of smoking on health is directly transmitted to utilization of health care services, which implies that differences in utilization between smoking-groups arise only because there are more symptoms and diseases resulting from smoking among smokers and former smokers than among non-smokers. A similar link from smoking to utilization of health care services has also been assumed in previous studies.

Enactment of the Tobacco Act in Finland in 1976 stimulated a lively public discussion on the health risks caused by smoking. As the present interview survey was carried out the same year, it is unlikely that the interviewees exaggerated their smoking. Thus it is possible that the proportion of physician visits attributed to smoking in this study is too low. Classification of occasional smokers as non-smokers may have a similar effect.

In the above estimates it was assumed that if no one smoked the mean rates of utilization would equal non-smokers rates for all smoking-groups. This is of course a reasonable assumption for estimation purposes. It is not known, however, what would be, for example, the average use of health services among smokers if they did not smoke. As smoking is an indicator of different life-styles, these average figures might be larger or smaller than for non-smokers only due to differences in life-style. It is also possible that former smokers are in a different way than others worried about their own health (independently of smoking), and this might lead to wider use of health services.

Since 1976 the number of physician visits per capita has grown substantially. In the results it is therefore worth paying attention in the first place to proportional differences in the use of services between smoker-groups, because it is most probable that the proportion of mean values will remain stable even though the mean values change.

6.1.3 Pharmaceutical expenditure

Only a few studies have estimated smoking related pharmaceutical expenditure. Some have estimated this on the basis of hospital expenditure (Thompson and Forbes 1982) or it has been included in the direct costs of smoking (Luce and Schweitzer 1978).

In Sweden, Hjalte (1984a) attempted to estimate the expenditure on prescribed medicines for a few major smoking-related diseases. He had access to data on the number of prescriptions issued to patients in non-institutional care according to diagnosis. Expenditure data was only available for a rough diagnosis grouping. Hjalte estimated the expenditure attributed to smoking by multiplying the diagnosis-specific expenditure by the respective attributable fractions of smoking to mortality. According to Hjalte's estimate about 0.3 % of all pharmaceutical expenditure in Sweden in 1980 was attributed to smoking.

Materials and methods

The relation of smoking and the use of medicines was studied with the same methods and data as the physician visits in section 6.1.2, on the basis of the interview survey data representing the non-institutionalised Finnish population (Kalimo et al 1982). The analysis here covered the population aged 25 and over (N=11 677).

The survey data gives information on the prevalence of use of medicines but not on pharmaceutical expenditure. At the national level expenditure data on pharmaceuticals is poor, and no detailed data by diagnosis is available. Here, the following approach was adopted. We estimated the proportion of those who use medicines (prevalence) in different smoking-groups separately for both sexes and standardized the proportions for age, education, occupation and income by the general linear model (Searle 1971). The proportions were estimated separately for prescribed and over-the-counter products.

Attributable fractions of smoking were estimated in the same way as for physician visits in section 6.1.2. The estimated attributable fractions were then applied to pharmaceutical expenditures.

The retail value of prescribed medicines was estimated from the expenditure refunded by the Social Insurance Institution. The retail value of over-the-counter medicines was estimated as the residual of the pharmacies' total sales after substracting sales of prescribed medicines, veterinary preparations and non-pharmaceutical products. The pharmaceutical expenditure attributed to smoking was obtained by multiplying the total expenditure by the attributable fractions.

Data on refunds for prescribed medicines were obtained from age- and occupation statistics of the Social Insurance Institution (Kansaneläkelaitos 1988a) and for total pharmacy sales from the National Board of Health (Hurme 1989).

Results

Smoking increased the propensity to use all types of medicines among men and over-the-counter medicines among women (Table 17). Use of medicines was slightly more prevalent among male smokers and former smokers than among

Table 17. Proportion (%) of those using medicines in different smoking-groups in 1976 by sex[1]

	MALES				FEMALES			
	Proportion (%)	SD	F	p-value	Proportion (%)	SD	F	p-value
PRESCRIBED MEDICINES								
Smokers	32.8	0.9			46.3	1.6		
Ex-smokers	37.1	1.0	13.14	0.000	49.1	2.1	0.72	0.487
Non-smokers	29.6	1.1			46.6	0.7		
OVER-THE-COUNTER MEDICINES								
Smokers	23.6	0.9			34.1	1.6		
Ex-smokers	21.0	1.0	5.32	0.005	33.3	2.1	4.64	0.010
Non-smokers	19.3	1.0			29.4	0.7		

[1] Standardized for age, occupation, education and income.

non-smokers. Among male smokers there were about 3 % points more users of prescribed medicines and about 5 % points more users of over-the-counter medicines than among male non-smokers. For male former smokers the corresponding figures were 7 and 2 % points. There was no statistically significant difference in the proportion of users of prescribed medicines between female smoking-groups. Among female smokers the use of over-the-counter medicines was 5 % points more prevalent than among female non-smokers. The difference between female former smokers and non-smokers was 4 % points.

Attributable fractions of smoking for the population aged 25 and over in 1987, estimated on the basis of proportions shown in Table 17, are presented in Table 18. An estimate of the pharmaceutical expenditure attributed to smoking is presented in Table 19.

It was estimated that smoking contributed to 3 % of the use of prescribed medicines and to 7.3 % of the use of over-the-counter medicines.

The pharmaceutical expenditure attributed to smoking in 1987 was estimated to be almost 110 million FIM, of which more than half was due to prescriptions. The smoking related expenditure was about 3.9 % of the total pharmaceutical expenditure.

Table 18. Use of medicines attributed to smoking (%) among population aged 25 and over by smoking-group in 1987[1]

	MALES		FEMALES		TOTAL[2]
	Smokers	Ex-smokers	Smokers	Ex-smokers	
PRESCRIBED MEDICINES	1.3***	1.7***	-0.3	0.3	3.0
OVER-THE-COUNTER MEDICINES	3.2**	0.7**	2.4**	1.0**	7.3

*** = $p < 0.001$, ** = $p < 0.01$

1 Standardized for age, occupation, education and income.

2 Includes only the utilization which is statistically significant at least at 10 % level.

Table 19. Pharmaceutical expenditure attributed to smoking by smoking-group in 1987[1,2]

	EXPENDITURE (million FIM)		
	Smokers	Ex-smokers	TOTAL
PRESCRIBED MEDICINES	26	34	60
OVER-THE-COUNTER MEDICINES	37	12	49

[1] Standardized for age, occupation, education and income.

[2] Includes only the utilization which is statistically significant at least at 10 % level.

Everything mentioned about the reliability of the results in connection with the physician services in section 6.1.2 also applies here.

6.1.4 Rehabilitation

The costs of smoking related rehabilitation have received little attention in previous studies, probably because they have been rated as insignificant compared to other cost items. Leu and Schaub (1984) estimated the costs of rehabilitation attributed to smoking as only about 10 % of the corresponding costs of hospital care.

Materials and methods

Here we examine only those rehabilitation costs borne by the Social Insurance Institution. The costs were estimated separately for men and women aged 35-64, by disease and age group. The disease specific average rehabilitation costs in different age groups were obtained by dividing the total rehabilitation costs per disease and age group by the corresponding number of persons in rehabilitation. The number of persons in rehabilitation due to smoking was estimated using the age, sex and disease specific attributable fractions (see Appendix 4). The costs of rehabilitation attributed to smoking by disease, age and sex were obtained by multiplying the number of persons in rehabilitation due to smoking by the corresponding average rehabilitation costs.

The data on costs and the number of people in rehabilitation were obtained from the Social Insurance Institution (Kansaneläkelaitos 1989).

Results

The Social Insurance Institution was estimated to have financed rehabilitation for about 270 people because of smoking in 1987 (Table 20). This is about 0.8 % of all the persons rehabilitated at the expense of the Social Insurance Institution. Rehabilitation attributed to smoking cost the Social Insurance Institution about FIM 1.4 million. This is about 0.5 % of the total rehabilitation costs financed by the Social Insurance Institution.

6.1.5 Financing of smoking related health expenditure

The financing of smoking related health expenditure has not been examined in previous studies. This is, however, essential in order to estimate the external costs.

Materials and methods

In Finland, health expenditure is financed by the state, municipalities, the Social Insurance Institution, employers and patients. Sickness funds and insurance companies also contribute

Table 20. Estimated rehabilitation costs to the Social Insurance Institution attributed to smoking in 1987

Disease	Attributed to smoking (%)		Number of rehabilitees attributed to smoking	Costs attributed to smoking (1000 FIM)
	Males	Females		
Cancer of oral cavity	41		1	3
Cancer of lung	84	32	13	36
Coronary heart disease	46		204	1 128
Other vascular diseases	70		1	7
Bronchitis and emphysema	93	56	50	199
TOTAL			269	1 373

to the financing by reimbursing patients' expenditures, but in practice their contribution to total financing is not significant (Häkkinen 1988). The proportion of health expenditure paid by smokers directly is the same as that paid by the patients.

The financing of smoking related health expenditure by activity was estimated using financing data from different statistical sources (Sairaalaliitto 1988, Suomen kaupunkiliitto 1988, Kansaneläkelaitos 1988b) and allocated to the parties on the basis of their financing shares (see Appendix 6).

Results

The state and municipalities made the major contribution to health expenditure attributed to smoking (Table 21). For smoking related hospital inpatient care they paid about 195-256 million marks, and about 150 million marks for physician services. Smokers themselves paid about 13-18 million marks or roughly 6 % of the costs of hospital inpatient care, and 15 million marks or 9 % of the costs of physician services.

Smokers paid the major part of the pharmaceutical expenditure, i.e. 71 million marks or two thirds of the total. The Social Insurance Institution reimbursed almost 40

Table 21. Financing of health expenditure attributed to smoking in 1987 by institutions (million FIM).

	FINANCED BY						
	State	Munici-palities	SII[1]	Employers	Smokers	Others	TOTAL COSTS[2]
General hospital inpatient care	89-117	106-139	-	-	13-18	13-18	222-292
Health centre physicians	25	27	-	-	5	4	60
Private practitioners	-	-	3	-	5	-	8
Occupational health care	-	-	9	7	-	-	16
General hospital outpatient care	44	52	-	-	7	7	109
Prescribed medicines	-	-	38	-	22	-	60
Over-the-counter medicines	-	-	-	-	49	-	49
Rehabilitation	-	-	1	-	-	-	1
TOTAL FINANCING[2]	158-186	185-218	52	7	99-103	24-28	524-594
(%)	30-31	35-37	9-10	1	17-19	5	100

[1] The Social Insurance Institution.

[2] Numbers may not add to totals due to rounding.

million marks of the pharmaceutical expenditure and paid over one million marks for rehabilitation attributed to smoking.

Of all smoking related health expenditure smokers themselves paid 99-103 million marks or roughly 17-19 %, with the remainder being paid mainly by the public sector.

6.2 Indirect consequences

6.2.1 Potential production lost due to sickness absence

A number of studies have investigated the effect of smoking on absenteeism (Athanasou 1975). It has been estimated that in the United States male smokers have 20-33 % and female smokers 15-45 % more days of absence due to illness than non-smokers (Holcomb and Meigs 1972, Wilson 1973, Van Tuinen and Land 1986, USDHEW 1979). Former smokers also tend to have more days of absence due to illness than non-smokers (Holcomb and Meigs 1972, Wilson 1973, USDHEW 1979). Similar results have also been obtained in England (Townsend 1987) and Finland (Pekurinen et al 1989).

At the national level, about 19-21 % of all days of sickness absence have been attributed to smoking in the United States (USDHEW 1979) and 30 % in Great Britain (Townsend 1987). In Finland, Pekurinen et al (1989), after standardizing for age, occupation, education and income, but not for use of alcohol, estimated smoking to account for 18 % of all days of sickness absence. More conservative estimates have also been presented. In Australia, Athanasou (1979) estimated that at the most 7 % of men's and 2 % of all days of sickness absence could be attributed to smoking.

It is not clear, however, to what extent the observed differences in absenteeism can truly be attributed to smoking, since most of the studies have not controlled for confounding factors other than age and sex. Large variation in the attributable fraction can also be due to other differences. For example, the variation between countries in how and to what extent earnings lost due to sickness are reimbursed by sickness allowance, or how soon a doctor's certificate is required.

The excess absenteeism arising from smoking has commonly been estimated by interview surveys or follow-up studies. These have usually focused on the aggregate level of absenteeism without specifying it by diagnosis. In the interview surveys the number of days lost due to sickness have usually been examined by asking the interviewees how many days they have been absent from work due to illness during a specified time period preceding the interview (e.g. Wilson 1973, Pekurinen et al 1989). In the follow-up studies the number of sickness days have been examined from various working-time-registers retrospectively (e.g. Holcomb and Meigs 1972) or prospectively (e.g. Van Tuinen and Land 1986). In both methods the number of days lost due to sickness is estimated on a per capita basis for smokers and non-smokers and the excess absenteeism of smokers is interpreted to be due to smoking. An estimate of the aggregate number of days lost due to smoking is derived by multiplying the observed difference by the number of smokers.

Follow-up studies have produced substantially lower (commonly one third lower) estimates of the number of sickness days attributed to smoking than interview surveys. Besides the differences in study populations and methods of data collecting this is likely to arise from the fact that studies based on follow-up methods have controlled for variety of other confounding factors apart from age and sex (e.g. Holcomb and Meigs 1972). It is likely that studies based on interview surveys that have not standardised the results for other factors than age and sex have overestimated the effect of smoking on sickness absence (Wilson 1973, USDHEW 1979, Townsend 1987).

The economic significance of smoking related absenteeism has been sparsely studied. Only a few specific references were found in the literature (e.g. Weiss 1981). In earlier social cost studies, costs of smoking related absenteeism were not analysed separately. Instead, they have, at least partly, been included in the production losses due to disability (e.g. Collishaw and Myers 1984, Hjalte 1984a).

Materials and methods

Three methods were used to assess the impact of smoking on sickness absenteeism. The low estimate was based on the number of days covered by the sickness allowance paid by the Social Insurance Institution, and derived using diagnosis specific attributable fractions. The high estimate was derived by analysing the relationship between smoking and sickness absence in a representative sample of the Finnish working population. The intermediate estimate combines these two estimates.

Low estimate. The national sickness insurance scheme administered by the Social Insurance Institution reimburses loss of earnings due to sickness. This sickness allowance is payable to all employed and self-employed people between 16 and 65 for a maximum of 300 working days (Kansaneläkelaitos 1988b). Sickness allowance is paid for weekdays, i.e. for six days per week, but only after an initial waiting period of eight weekdays, including at least one Saturday and Sunday. Therefore a maximum of seven working days and ten days of illness within each spell remain uncovered. So the number of days covered by sickness insurance underestimates the total number of days lost due to illness.

The Social Insurance Institution produces data on the number of days covered by age and diagnosis for males and females separately, but publishes it only for broad disease categories. This study is based on the unpublished diagnosis, sex and age specific data provided by the Social Insurance Institution (Kansaneläkelaitos 1989).

The number of working days lost due to sickness covered by the sickness insurance and the number of associated days of illness were estimated separately for each diagnosis, age and sex group for people aged 35 to 64 years by a method described in Appendix 7. The proportion attributable to smoking was obtained by multiplying the number of days by the relevant diagnosis, age and sex specific attributable fractions (see Appendix 4).

This method cannot be used to estimate the number of working days lost or the associated days of illness for spells lasting less than eight weekdays, as they do not qualify for sickness allowance.

High estimate. The relationship between smoking and sickness absence was examined directly in a representative sample of the Finnish working population aged 25-64 (N=6 552). The original interview survey was carried out by the Social Insurance Institution in 1987 (Kalimo et al 1989). Interviewees were divided into three smoking groups: non-smokers, former smokers and regular smokers (persons who had smoked regularly during the year preceding the interview). Smokers were not divided into sub-groups according to type of tobacco smoked, number of cigarettes smoked per day or duration of smoking. The results indicate sickness absence by an average smoker.

As use of alcohol and sociodemographic factors like age, sex, education, occupation and income are associated with both smoking and sickness absence, the impact of these likely confounding factors on absenteeism was standardized by the direct method (Armitage 1971). The analysis was done separately for men and women.

The proportional share of smoking in total sickness absence was calculated on the basis of mean values of days of sickness absence among smokers, former smokers and non-smokers. The ratios between mean values in different smoking-groups were assumed to give the correct distribution of absenteeism between different groups. Sickness absence related to smoking was obtained by deducting from the total number of days of sickness absence by smokers and former smokers the absenteeism not related to smoking, which in each group was assumed to be the same as the average sickness absences by non-smokers.

The proportion of sickness absence attributed to smoking - the attributable fraction (Miettinen 1974) - was estimated separately for smokers and former smokers with the following formula:

$$SO_i = p_i(SP_i - SP_3)/(p_1SP_1 + p_2SP_2 + p_3SP_3),$$

where p_i = proportion of smokers, former smokers and non-smokers (i=3) in the population,

SP_i = average number of days of sickness absence in smoking-group i.

The numbers of working days lost due to smoking were obtained by multiplying the total number of sickness days by the sex specific attributable fractions estimated in this study. The total number of sickness days by sex were obtained from the unpublished labour force survey data provided by the Central Statistical Office (Tilastokeskus 1989). Relative sizes of smoking groups in 1987 were obtained from the health interview-survey carried out by the Social Insurance Institution (Kalimo et al 1989).

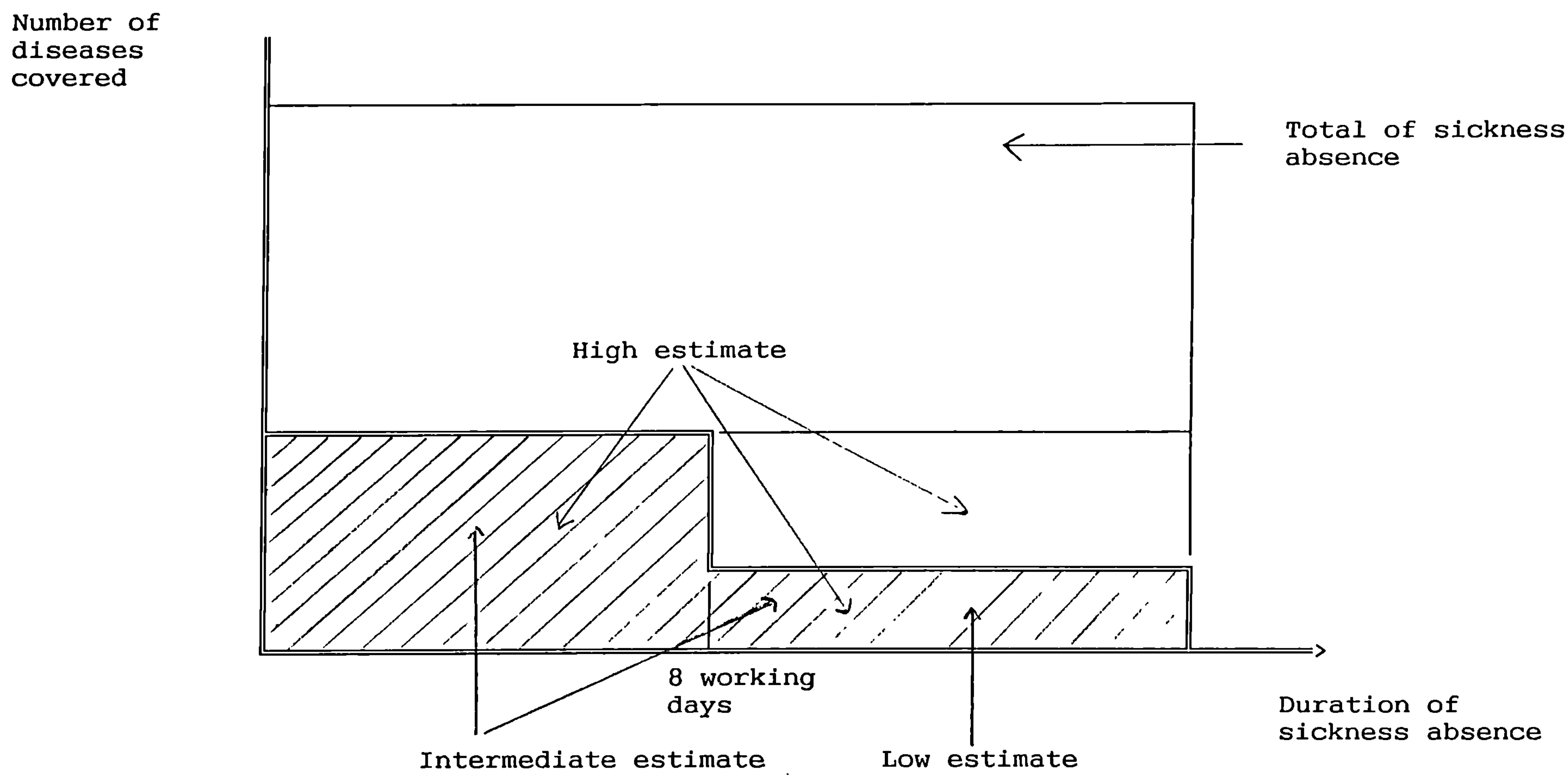
Intermediate estimate. The low estimate includes only those diseases which have 'highly probable' causal relation to smoking while the high estimate includes all diseases. The low estimate is likely to cover more serious illnesses while the high estimate also covers minor conditions including ailments which may not be directly linked with smoking. The high estimate includes all days of sickness absence. The low estimate excludes all spells of sick leave lasting less than eight working days, and yet their share of all absences is significant. Indeed, sick leaves lasting less than eight days account for nearly 80 % of all spells of sickness absence and about 34 % of all work-days lost due to illness (Nyman and Raitasalo 1978).

The intermediate estimate was derived by assuming that 34 % of the total work-days lost due to smoking (high estimate) last less than eight days and that only those spells of sick leave that last eight days or longer are directly related to smoking (low estimate). Thus, the intermediate estimate = low estimate + 0.34 x high estimate. Figure 2 illustrates the relationship between these three estimates.

The value of potential production lost due to smoking related sickness absence was estimated by the human capital approach by transforming the numbers of working day losses to working years and multiplying them by the average sex specific value of potential annual production. The value of an individual's annual production was defined as the sum of his/her earnings, employer's social security contribution and operating surplus. The formula for calculating the average value of annual production and the estimated age- and sex specific values are given in Appendix 8.

The age- and sex specific earnings data were obtained from the unpublished income distribution statistics provided by the Central Statistical Office (Tilastokeskus 1989). Margins for employer's social security contributions and operating surplus were estimated from the National Accounts (Tilastokeskus 1988a).

Figure 2. The relationship between the low, intermediate and high estimates of sickness absence attributed to smoking.



Results

Low estimate. On the basis of the daily sickness benefits paid by the Social Insurance Institution it was estimated that about 218 000 - 262 000 healthy days and 156 000 - 187 000 working days were lost due to sickness attributed to smoking (Table 22). This amounts to about 1.1-1.3 % of all days of sickness and 1.0-1.3 % of all working days lost due to illness estimated on the basis of the data provided by the Social Insurance Institution. The value of potential production lost due to smoking was estimated to be in the range of FIM 118-145 million.

High estimate. Smoking appeared to increase the number of days absent from work due to illness both for men and women (Table 23). Male smokers were absent from work due to illness on average about five working days more than non-smokers in 1987. Female smokers were on average four days more absent from work due to illness than female non-smokers. Also, former smokers were more frequently absent from work due to illness than non-smokers. The difference between former smokers and non-smokers was about three and half working days for men and about three for women.

The attributable fractions for people aged 25-64 in 1987 estimated on the basis of the means shown in Table 23 are given in Table 24, which also gives the estimated number of

Table 22. Estimated number of days of sickness absence and the value of potential production lost attributed to smoking in 1987, low estimate

Disease	Attributed to smoking (%)		Smoking related		
	Males	Females	days of illness (1000)	working days lost (1000)	Lost production (FIM million)
Cancer of					
Oral cavity	41		3	2	2
Abdominal cavity	22-35	15	0[a]-2	0[a]-2	0[a]-1
Larynx	39		1	1	1
Lung	81-86	38-47	26-28	19-20	14-15
Urinary bladder	1	8	0[a]	0[a]	0[a]
Coronary heart disease	35-41	10	150-161	107-115	82-93
Other vascular diseases	10-21		2-4	1-3	1-3
Bronchitis	56-93	26-57	30-53	22-38	16-27
Emphysema	58-93	26-62	6-10	4-7	3-5
TOTAL[1]			218-262	156-187	118-145

[1] Numbers may not add to totals due to rounding.

[a] Figure is less than half of the measure.

Table 23. Days of sickness absence by smoking-group in 1987[1,2]

	Days of sickness absence in a year	
	MALES	FEMALES
Smokers	12.3	16.4
Ex-smokers	11.2	15.0
Non-smokers	7.5	12.3

[1] Standardized for age, occupation, education, income and use of alcohol.

[2] I am grateful to Unto Häkkinen for analysing the health interview-survey data by smoking groups.

Table 24. Estimated proportion and number of days of sickness absence and the value of potential production lost attributed to smoking for people aged 25-64 by smoking group in 1987, **high estimate**[1]

	MALES	FEMALES	TOTAL[2]
PROPORTION OF ALL DAYS OF SICKNESS ABSENCE (%)			
Smokers	8.5	3.6	12.1
Ex-smokers	3.7	1.3	5.0
Total[2]	12.2	4.9	17.1
DAYS OF SICKNESS ABSENCE (1000 days)			
Smokers	1564	665	2228
Ex-smokers	688	235	923
Total[2]	2252	900	3152
LOST PRODUCTION (FIM million)			
Smokers	1209	341	1550
Ex-smokers	532	121	652
Total[2]	1741	462	2202

[1] Standardized for age, occupation, education, income and use of alcohol.

[2] Numbers may not add to totals due to rounding.

working days lost due to illness attributed to smoking and associated loss in potential production.

It was estimated that roughly 17 % of all the days of sickness absence for people aged 25-64 were associated with smoking. About one fourth of this was related to smoking by women. An estimated 3.2 million working days were lost due to smoking related illness. This is about 15.7 % of all days of sickness absence estimated in the labour force survey (Tilastokeskus 1989). This proportion is comparable to estimates published in the United States (USDHEW 1979), but clearly lower than estimates in Great Britain (Townsend 1987).

The value of potential production lost due to sickness absence attributed to smoking was estimated to be about FIM 2.2 billion. About eighty per cent of this figure was attributed to smoking by males.

Intermediate estimate. A combination of the low and high estimate implies that about 1.2 million working days were lost due to smoking-related illness in 1987 (Table 25). This is about 6.1-6.2 % of all days of sickness absence estimated in the labour force survey (Tilastokeskus 1989). The value of potential production lost due to smoking was estimated to be in the range of FIM 863-890 million.

Table 25. Estimated number of days of sickness absence and the value of potential production lost attributed to smoking in 1987, **intermediate estimate**

DURATION OF SICKNESS ABSENCE	Days of sickness absence (1000)	Lost production (FIM million)
Less than eight days (0.34 x Table 24)	1065	744
Eight days or longer (Table 23)	156-187	118-145
TOTAL	1221-1252	863-890

Conclusions

Smoking tends to increase the likelihood of sickness absence for both sexes. On the basis of the Social Insurance Institution data 1.0-1.3 % of all days of sickness absence were attributed to smoking. This **low** estimate is quite close to the Australian estimate of 2 % (Athanasou 1979). The 15.7 % **high** estimate based on the survey data is somewhat lower than the earlier Finnish (Pekurinen et al 1989) and United States (USDHEW 1979) estimates, and clearly lower than the UK estimate (Townsend 1987). However, in the latter two studies the impact of factors other than age, sex and smoking on absenteeism were not controlled for.

The estimate based on the Social Insurance Institution data is probably more accurate, in principle, than that based on the survey data, as the absences were linked to diagnoses in the former. It is, however, clearly a minimum estimate since the Social Insurance Institution data excludes all spells of sick leave lasting less than eight working days, and yet their share of all absences is significant. The labour force survey data includes sick leave lasting less than eight days, which makes it more comprehensive in coverage than the Social Insurance Institution data. The latter data is, of course, likely to cover more serious illnesses, as they need to last longer in order to qualify for sickness allowance.

The reliability of results in this study was improved by standardizing the influence of use of alcohol, age, sex, occupation, education and income on sickness absence. With respect to unstandardized factors, smoking-groups were presumed to be similar. As smoking is also an indicator of life-style or way of life, however, it is likely that there remains significant comparison bias between smoking-groups even after standardizing for these factors.

As smoking and drinking are closely related habits and excess use of alcohol is a common cause of work absenteeism, we also standardized for this counfounding factor. Controlling for use of alcohol reduced the previously published Finnish estimate of attributability (Pekurinen et al 1989) by about two and half percentage points, from 18.4 % to 15.7 %.

Because the study was based on cross-sectional data, the results cannot be interpreted to represent a causal relation between smoking and sickness absence, but only an association. On the basis of epidemiological studies on smoking and morbidity it is known that the morbidity risk in many diseases is bigger for smokers than for non-smokers, and this leads to more days of sickness absence among smokers (Heliövaara 1989). It was not possible, however, to analyze whether sickness absence was specifically related to diseases generally associated with smoking. Other comments made in in connection with the physician services in section 6.1.2 apply also here.

The intermediate estimate was designed to combine information contained in the low and high estimates and will be used to represent the effects of smoking on sickness absence in chapter nine of this study.

6.2.2 Potential production lost due to disability

Smoking appears to increase the risk of disability (e.g. Heliövaara 1989). Extensive population surveys carried out in the United States, Canada and Great Britain have indicated that smokers have substantially more days of short- and long-term disability than non-smokers on average (USDHEW 1979, Collishaw and Myers 1984, Townsend 1987). In Canada, for example, about 5 % of all days of disability have been estimated to be attributable to smoking (Collishaw and Myers 1984).

In Sweden, Hjalte (1984a) studied new disability pensions and estimated that about 4.5 % of all new pensions granted to males were attributable to smoking. The corresponding figure for females was 0.4 %.

The number of cases of smoking related disability is usually estimated by applying diagnosis, age- and sex-specific attributable fractions derived for mortality (e.g. Shillington 1977, Hjalte 1984a). The basic assumption underlying this analysis is that the link between smoking and disability is assumed to be similar to that between smoking and mortality.

The economic significance of smoking-related disability is usually described in terms of potential production lost due to diasability. The value of lost production has been analysed by applying two different methodologies. In most studies it has been estimated for the year in question either on the basis of disability pensions (e.g. Shillington 1977, Hjalte 1984a) or interview surveys (e.g. Collishaw and Myers 1984). This (prevalence) approach attempts to quantify the impact of past years' smoking on the current year's disability. Some studies, on the other hand, have analysed the effect of current smoking on future disability (incidence approach) (e.g. Hjalte 1984b, Ellemann-Jensen 1986).

Material and methods

This study aimed at estimating the prevalence and economic consequences of disability attributed to smoking for diseases commonly attributed to smoking in 1987 for people aged 35-64. All disability pensions were grouped and analysed together without dividing them into sub-groups (old and new, granted for unspecified or specified period). We applied the prevalence approach which relates disability in 1987 to smoking in preceding years. The number of disability pensions in 1987 was estimated as the average of the disability pensioners at the end of 1986 and 1987 from unpublished data provided by the Social Insurance Institution (Kansaneläke-laitos 1989). Hence the results correspond the situation in mid 1987.

The number of smoking related disability pensions was estimated by applying the relevant diagnosis, age and sex specific attributable fractions (see Appendix 4).

The value of potential production lost due to smoking-related disability in 1987 was estimated by the human capital approach. The value of a person's annual production was defined in the same way as in the case of sickness absence in section 6.2.1. In estimating the value of lost production, account was taken of the individual's likelihood of being employed in order to eliminate the effect of unemployment and labour force participation rates (which vary by age and sex) on the results. The formula for calculating the average value of lost production by age and sex is given in Appendix 8.

Results

It was estimated that about 4 600-6 200 individuals were on disability pension due to smoking related illness (Table 26). This amounts to about 1.9-2.5 % of all disability pensioners. Disability pensions attributed to smoking

Table 26. Estimated number of disability pensions and the value of potential production lost attributed to smoking in 1987

Disease	Attributed to smoking (%)		Smoking related			
	Males	Females	days of illness (1000)	working days lost (1000)	disability pensions	Lost production (FIM million)
Cancer of						
Oral cavity	41		8	5	20	2
Abdominal cavity	22-44	15	3-4	2	10	1-2
Larynx	37		16	10	50	4
Lung	81-86	25-35	118-127	71-76	320-350	25-26
Urinary bladder	22-28	6	6-7	4	20	1-2
Coronary heart disease	30-34	7	948-1123	571-677	2600-3080	260-265
Other vascular diseases	8-14		10-19	6-12	30-50	3-5
Bronchitis	58-93	27-54	563-927	339-559	1540-2540	105-173
Emphysema	58-96	30-68	8-14	5-8	20-40	2-3
TOTAL[1]			1679-2246	1012-1354	4600-6150	401-483

[1] Numbers may not add to totals due to rounding.

correspond to 1.7-2.2 million days of illness and 1.0-1.4 working days. The value of potential production lost due to disability attributed to smoking was estimated to be in the range of FIM 401-483 million.

6.2.3 Incidence of potential production lost due to sickness absence and disability

The incidence of lost production has not been analysed in any of the previous studies. It has been examined only from society's point of view. Here we attempt to decompose the lost production on the basis of its composition and redistribution.

The value of production and its redistribution

The value of an employee's labour input to the employer is the wage or salary (wage for short) paid plus the employer's contribution to social security schemes and the operating surplus. Social security contributions are designed to cover part of the employee's social security and are paid to insurance companies by the employer. The operating surplus covers the employer's other variable costs. The cost of labour to the employer is wages plus social security contributions.

The price of labour to the employee equals gross wage. On the basis of gross wage the employee pays income tax to state and municipality and compulsory social security contributions to the Social Insurance Institution. Most employees belong to either of the state churches (Lutheran or Orthodox) and pay church tax to them. Deducting all these taxes and fiscal charges from the gross wage gives the net wage, which the employee is free to consume or save.

Earnings vary by age and sex, but are highest for those aged 40-44 for both sexes. However, males have higher earnings than females in all age groups (Tilastokeskus 1989). The state income tax paid by the employee depends on his earnings, tax allowances and the progression of taxation, which means that high incomes are taxed relatively more heavily than low incomes. Municipal income tax is proportional; all tax payers pay the same proportion of their taxable income in the form of municipal tax which varies according to the local authority. Each employee pays a fixed share of his taxable income in compulsory social security contributions (for national pension and sickness insurance). The church tax is determined on the same basis as the municipal tax.

An employer's social security contributions can be statutory or voluntary. Statutory contributions are aimed to cover part of employees' social security and are paid to insurance companies by the employer. Statutory contributions are a fixed proportion of the wage-bill. The employer can also make voluntary contributions to employees' social security.

Materials and methods

The incidence of lost production was examined on the basis of the 'fincancing' shares derived in Appendix 9. The estimated age- and sex-specific lost production was decomposed into seven categories on the basis of the redistribution of the value of production: employers'operating surplus, employers' contribution to social security schemes, taxes and fiscal charges paid by employees (state and municipal income tax, social security contributions and church tax) and employees' net income.

The proportions of operating surplus and employers' social security contributions in lost production were derived from the National Accounts (Tilastokeskus 1988a) and assumed to be equal for all age and sex groups. The proportions of other categories were derived from the income and property statistics data (Tilastokeskus 1988b) for males and females separately in each age group. In estimating these proportions, account was taken of varying earning levels, deductions in state and municipal taxation, place of residence and membership of state churches by males and females in different age groups.

Results

The estimated incidence of lost production attributed to smoking-related absenteeism and disability is shown in Table

27. Most of the losses (42 %) are borne by smokers themselves or their families, and roughly a quarter by their employers. The state and municipalities bear about 17 % of the losses, and the Social Insurance Institution and other insurance companies about 15 % together.

The state and municipalities both lose from FIM 45-55 million to FIM 220-227 million in tax revenues. From FIM 80-95 million to FIM 400-410 million worth of social security payments are lost by the Social Insurance Institution and other insurance companies as a result of sickness absence and disability attributed to smoking.

6.3 Income transfers

6.3.1 Sickness allowances

The Social Insurance Institution pays earnings-related sickness allowance as compensation for loss of earnings due to illness. This benefit is payable to all employed and self-employed people between 16 and 65 who are incapable of doing their ordinary work or any comparable work because of illness, for a maximum of 300 working days as described in section 6.2.1 (Kansaneläkelaitos 1988b). The sickness allowance is assessed on the basis of the official earnings for the previous tax year, and is taxable income.

Table 27. Estimated incidence of lost production attributed to smoking related absenteeism and disability in 1987, FIM million

	Operating surplus	Employer's social security contributions	State income tax	Municipal income tax	Employee's social security contributions	Church tax	Disposable net income	TOTAL PRODUCTION LOST[1]
SICKNESS ABSENCE								
- Low estimate	30-37	16-20	11-13	10-13	2	1	49-60	118-145
- Intermediate	222-228	119-123	73-75	73-75	14-15	5	358-369	863-890
- High estimate	565	303	185	185	38	12	914	2202
DISABILITY	103-124	55-66	35-42	35-42	4-5	1-2	168-202	401-483
TOTAL[1]								
- Low estimate	133-161	72-87	46-55	45-54	6-7	2	216-262	519-628
- Intermediate	324-352	174-189	108-117	107-117	19-20	6	525-571	1263-1372
- High estimate	668-689	358-370	220-227	220-227	42-43	13-14	1082-1116	2603-2685
(%)	26	14	8	8	2	0[a]	42	100

1 Numbers may not add to totals due to rounding.

[a] Figure is less than half of the measure.

The sickness allowance is payable to the employee. If, however, the employer pays the sick pay, the allowance is paid to the employer. In 1987 about 46 % of such allowances were paid to the employer (Kansaneläkelaitos 1988b).

Materials and methods

Sickness allowances attributed to smoking were estimated by two methods. The **low estimate** was derived on the basis of the sickness allowances paid by the Social Insurance Institution for people aged 35-64. The proportion attributable to smoking was obtained by multiplying the benefits paid by the relevant diagnosis, age and sex specific attributable fractions (see Appendix 4).

The **high estimate** was derived on the basis of the sex-specific attributable fractions for sickness absence shown in Table 24. The total benefits paid to males and females aged 25-64 were multiplied by these fractions in order to estimate the benefits paid due to smoking. The data on sickness allowances paid according to diagnosis, age and sex was provided by the Social Insurance Institution (Kansaneläke-laitos 1989). The **intermediate estimate** was derived in the same way as in chapter 6.2.1.

Results

It was estimated that the Social Insurance Institution paid sickness allowances attributable to smoking for at least 177 000 - 211 000 days (low estimate), for 1.1 million days (intermediate estimate) and at most for 2.8 million days (high estimate) in 1987 (Table 28). This implies that at least 1.2-1.4 % and at most some 16.2 % of all days of illness compensated by the Social Insurance Institution were related to smoking.

The smoking-related sickness allowances paid by the Social Insurance Institution in 1987 range from FIM 36-43 million to FIM 395 million, which equal 1.5-1.8 % and 16.6 % of all the sickness allowances paid. Allowances paid to employers due to smoking range from FIM 17-20 to 182 million and those paid to employees range from FIM 19-23 to 213 million.

6.3.2 Disability pensions

The disability pension paid by the Social Insurance Institution is a minimum social security benefit payable due to disability. Disability pension is payable to all people aged 16-64 who on account of disease, defect or injury are unable to maintain themselves by their usual work or any other kind of work which, considering their age, occupation, education and place of residence, would be suitable for them

Table 28. Estimated number of days compensated and sickness allowances paid due to illness attributable to smoking by the Social Insurance Institution in 1987

Disease	Smoking related	
	days of illness compensated (1000)	sickness allowances (FIM million)
LOW ESTIMATE		
Cancer of		
Oral cavity	2	0[a]
Abdominal cavity	0[a]-2	0[a]
Larynx	1	0[a]
Lung	21-23	5
Urinary bladder	0[a]	0[a]
Coronary heart disease	122-130	25-27
Other vascular diseases	2-3	0[a]-1
Bronchitis	24-42	4-7
Emphysema	5-8	1-2
TOTAL[1]	177-211	36-43
INTERMEDIATE ESTIMATE	1102-1136	170-177
HIGH ESTIMATE (All diseases)	2 384	395

[1] Numbers may not add to totals due to rounding.

[a] Figure is less than half of the measure.

(Kansaneläkelaitos 1988b). Disability pension is granted for a specified or unspecified period. Disability pension is not earnings-related but is integrated with other pensions which reduce or cancel the supplementary component of the disability pension. Thus the disability pensions paid by the Social Insurance Institution cover only part of the pensions payable due to disability.

Materials and methods

The smoking related disability pensions paid by the Social Insurance Institution to people aged 35-64 were estimated by multiplying the disability pensions paid by the relevant attributable fractions (see Appendix 4). The data on disability pensions paid by diagnosis, age and sex were provided by the Social Insurance Institution (Kansaneläke-laitos 1989).

Results

It was estimated that in 1987 the Social Insurance Institution paid FIM 46-64 million in disability pensions attributable to smoking (Table 29). This amounts to 1.4-1.9 % of all disability pensions paid by the Social Insurance Institution.

Table 29. Estimated disability pensions paid by the Social Insurance Institution attributable to smoking in 1987

Disease	Disability pensions attributed to smoking (FIM million)
Cancer of	
Oral cavity	0[a]
Abdominal cavity	0[a]
Larynx	1
Lung	3
Urinary bladder	0[a]
Coronary heart disease	24-29
Other vascular diseases	0[a]
Bronchitis	18-30
Emphysema	0[a]
TOTAL[1]	46-64

[1] Numbers may not add to totals due to rounding.

[a] Figure is less than half of the measure.

7 ECONOMIC CONSEQUENCES OF SMOKING RELATED MORTALITY

7.1 Indirect consequences

7.1.1 Potential production lost due to premature deaths

Smoking is considered the single most important preventable cause of death in industrialised countries (USDHEW 1979, Leu and Schaub 1983a, STM 1987). A high number of premature deaths is attributed to smoking in many countries. In Sweden, for example, nearly 7 000 smokers aged 35-84 are estimated to die prematurely every year because of smoking (Hjalte 1984a). This is over 20 % of all deaths in that age group. In Denmark 12 % of all deaths in the same age group are attributed to smoking (Ellemann-Jensen 1986), while in Canada smoking is reckoned to account for 17 % of all deaths among people aged 15 and over (Collishaw and Myers 1984).

The number of deaths attributable to smoking has generally been estimated in a similar way in previous studies (e.g. Shillington 1977, Collishaw and Myers 1984, Hjalte 1984a, Ellemann-Jensen 1986, Rice et al 1986) on the basis of attributable fractions. The numbers of deaths by age, sex and diagnosis have been multiplied by the respective attributable fractions, which have been estimated on the basis of diagnosis-specific relative risks and the prevalence of smoking among the population, as described in section 5.2 and Appendix 4.

The economic consequences of smoking related deaths are usually described in terms of potential production lost due to premature deaths (e.g. Shillington 1977, Collishaw and Myers 1984, Hjalte 1984a, Leu and Schaub 1984, Ellemann-Jensen 1986, Rice et al 1986). As was mentioned earlier in section 5.3, under certain, very restrictive assumptions, these human capital estimates can be interpreted to reflect the lower limit of an individual's willingness to pay for life.

Material and methods

Here we attempt to estimate the number of premature deaths and the associated loss in working years, life-years and potential production attributable to smoking in 1987 for people aged 35 and over. The number of deaths attributable to smoking was estimated by multiplying the number of deaths in various diagnosis, age and sex groups by the corresponding attributable fractions (see Appendix 4). The numbers of working years and life-years lost due to premature deaths were estimated by the methods described in Appendix 10. The number of deaths was obtained from the causes of death statistics (Tilastokeskus 1989b).

The value of potential production lost due to premature deaths was estimated by the human capital approach. The value of production lost due to an individual's premature death was defined as production the individual would have produced over his remaining life-time had he not died prematurely. The present value of an individual's life-time production was derived by discounting the value of future production to the present value allowing for the expected working-years and expected production in various phases of life. Expected working years were estimated on the basis of survival probabilites. The value of a person's annual production was defined in the same way as sickness absence in section 6.2.1. In estimating the value of an individual's future production an allowance was made for anticipated growth in productivity and an individual's probability of being employed at various ages. The latter refinement was to eliminate the effect of unemployment and labour force participation rates, which vary by age and sex, on the results. The formula for calculating the average value of lost production by age and sex is given in Appendix 8.

Age- and sex specific survival probabilities were derived from vital statistics (Tilastokeskus 1989b) by the method suggested by Chiang (1968). The age- and sex specific earnings data were obtained from the unpublished income distribution statistics provided by the Central Statistical Office (Tilastokeskus 1989). Margins for the employer's social security contributions and operating surplus were estimated from the National Accounts (Tilastokeskus 1988a) and added to the earnings. The Economic Planning Centre's estimate of 2.4 % (Parkkinen and Järviö 1988) was used for the anticipated annual growth in productivity. We used a 4 %

discount rate, which is the same as used by Vinni (1982) and falls within the 2-6 % suggested by the Helsinki Business Research Institute (LTT 1984). Age- and sex specific employment probabilities were estimated from the labour statistics (Työvoimaministeriö 1988).

Results

An estimated 3 440-4 920 premature deaths were attributed to smoking in 1987 (Table 30). Over one third of the deaths were within working age, and 3 % were women. The results imply that about 7.5-10.7 % *of* all *deaths of those aged 35 and over* and 12.7-17.2 % of those aged 35-64 were attributed to smoking. An estimated 49 100 - 69 600 life-years and 10 300 - 14 800 working-years (Table 31) were lost due to smoking related premature deaths. The value of potential production lost due to smoking was estimated to be in the range of FIM 800-1 192 million.

7.1.2 Incidence of potential production lost to premature deaths

The incidence of lost production has not been analysed in any of the previous studies. It was examined with the same classification and methods as in section 6.2.3. The results are shown in Table 32.

Table 30. Estimated number of premature deaths attributed to smoking in 1987

Disease	Attributed to smoking (%)		Premature deaths attributed to smoking	
	Males	Females	Age group 35+	Age group 35-64
Cancer of				
Oral cavity	19-39		10-20	10
Abdominal cavity	17-38	5	70-150	40-70
Larynx	34		20	10
Lung	80-83	15-20	1400-1470	530-570
Urinary bladder	15-30	2	20-40	10
Coronary heart disease	19-30	1	1460-2360	680-1000
Other vascular diseases	13-57		40-170	10-50
Bronchitis	58-92	15-30	390-630	70-110
Emphysema	58-92	15-31	30-60	10
TOTAL[1]			3440-4920	1350-1840

[1] Numbers may not add to totals due to rounding.

Table 31. Estimated number of life-years, working-years and potential production lost due to premature deaths attributed to smoking in 1987

Disease	Life-years lost	Working-years lost	Present value of lost production (FIM million)
Cancer of			
Oral cavity	200-400	60-110	5-9
Abdominal cavity	1210-2470	300-610	22-48
Larynx	210	30	2
Lung	19510-20820	3420-3690	246-264
Urinary bladder	240-460	40-70	3-5
Coronary heart disease	22790-35850	6070-9460	495-805
Other vascular diseases	540-2190	90-330	7-26
Bronchitis	4000-6540	300-500	18-30
Emphysema	380-630	40-60	2-4
TOTAL[1]	49070-69560	10330-14850	800-1192

[1] Numbers may not add to totals due to rounding.

Table 32. Estimated incidence of lost production attributed to smoking related premature deaths in 1987, FIM million

	Operating surplus	Employer's social security contributions	State income tax	Municipal income tax	Employee's social security contributions	Church tax	Disposable net income	TOTAL PRODUCTION LOST[1]
FIM (million)	205-306	110-164	72-107	69-103	10-15	3-5	330-491	800-1192
(%)	26	14	9	9	1	0[a]	41	100

[1] Numbers may not add to totals due to rounding.

[a] Figure is less than one half per cent of the total.

Most of the losses (41 %) are borne by smokers or their families, and roughly a quarter by their employers. The state and municipalities bear about 9 % of the losses in terms of lost tax revenues, while the Social Insurance Institution and other insurance companies account for about 15 % together.

Both the state and municipalities lose FIM 70-105 million in tax revenues, while FIM 120-180 million worth of social security payments are not received by the Social Insurance Institution and other insurance companies as a result of premature deaths attributed to smoking.

7.2 Income transfers

7.2.1 Family pensions

Family pension is payable to the relatives of a deceased person. Family pensions include the widow's pension payable to women under 65, and the orphan's pension (Kansaneläkelaitos 1988b). Widow's pensions comprise a starting pension followed by a maintenance pension. A widow's starting pension is payable for six months after the death of her husband. The maintenance pension is payable when her six-month starting pension ends if she has a child under 16 who is entitled to orphan's pension (widowed mother's maintenance pension) or if she is childless and aged 40-64 with limited income (childless widow's maintenance pension).

Orphan's pension is payable to all half and full orphans under 21 who cannot maintain themselves, for example because they are studying. Different rates of benefit are paid to half and full orphans.

Here we examine only those family pensions paid by the Social Insurance Institution in the event of male deaths attributed to smoking.

Materials and methods

Estimates of the amount paid in family pensions were based on the deaths of men between the ages of 35 and 64. When estimating the widow's pensions it was assumed that she belonged to the same age-group as her dead husband. Widows' starting pensions were estimated separately for each age group by multiplying the average starting pension by the number of smoking related deaths, allowing for the probability that the deceased man was married.

Widowed mother's maintenance pensions were estimated up to the age of 64 and discounted to their present value. Estimation allowed for the probability that the dead man was married, the probability that he had children under 16, the widow's survival probability and the number of children under 16 she was likely to have at different ages.

Childless widow's maintenance pensions were estimated up to the age of 64 and discounted to their present value. Estimation allowed for the probability that the dead man was married, the probability that she had no children and the widow's survival probability.

The present value of orphans' pensions was estimated on the assumption that it would be paid for eight years. The average pension was estimated as the weighted mean of the average pensions for half and full orphans. Estimation allowed for the probability that the dead man was married and the probability that he had children under 20. The formulae for estimating the family pensions are given in Appendix 11.

We used a 4 % discount rate and assumed a 2 % annual real growth rate in pensions. Age-specific average pensions were obtained from the age- and occupation statistics (Kansaneläkelaitos 1988a). Age-specific survival probabilities for females were derived from the vital statistics (Tilastokeskus 1989b) by Chiang's method (1968). The probabilities that the men were married and had children, and that a widow lived alone were estimated from the population statistics (Tilastokeskus 1988).

Results

About 1 270-1 740 male premature deaths between the ages of 35 and 64 were attributed to smoking in 1987. It was estimated that FIM 62-88 million was paid in family pensions by the Social Insurance Institution because of these deaths (Table 33). Of this sum about 92 % was widows' pensions and the rest orphans' pensions.

7.2.2 Avoided health care expenditure and social security benefits

When a person dies prematurely, society loses his potential contribution to production and the taxes and fiscal charges payable on it, but avoids health care costs, pensions and other social security benefits that a person would have received during his remaining life-time if he had not died prematurely. Taxes, pensions and other social security benefits are income transfers that do not as such increase the resources available to society. They only redistribute existing income within society. However, in political decision-making distributive issues are of major concern. Taxes and other revenues lost due to lost production resulting from premature deaths were estimated in section 7.1.2. In this section we examine the avoided health care costs and social security benefits.

Previous studies have not specifically addressed the problem of avoided health care costs and social security benefits. Some studies have analysed the life-time health care expenditures by smokers and non-smokers with conflicting results (Leu and Schaub 1983b, Thompson and Forbes 1983).

Table 33. Estimated family pensions (present value) paid by the Social Insurance

Age group	Male deaths attributed to smoking	Widow's starting pensions	Widowed mother's continuing pensions	Childless widow's continuing pensions	Orphan's pensions	TOTAL[1]
35-39	10-50	0[a]	1-5	0[a]	0[a]-1	1-6
40-44	70-110	0[a]-1	6-9	1	1	7-12
45-49	130-150	1	6-7	1-2	1-2	9-11
50-54	200-280	1	5-7	4-5	1-2	10-15
55-59	330-430	1-2	3	10-13	1	15-19
60-64	550-720	3	0[a]-1	16-21	1	20-26
TOTAL[1]	1270-1740	6-8	20-32	31-42	5-7	62-88

[1] Numbers may not add to totals due to rounding.

[a] Figure is less than half of the measure.

Studies analysing the economic effects of reduced smoking (e.g. Atkinson and Townsend 1977) have also examined the net effects of the reduction in smoking related deaths on health care expenditure, government finances and pension expenditure. Atkinson and Townsend (1977) predicted that reduced smoking would result in a slight fall in health care expenditure and a substantial growth in pension expenditure. Further, when the various income transfers are included, the net effect on government finances would be positive.

Materials and methods

Here we analyse the impact of smoking related premature deaths on health care expenditure and social security benefits for people aged 35-84. Health care expenditure was decomposed into expenditure on hospital care, physician services and pharmaceuticals. Avoided expenditure on physician services was analysed separately for hospital out patient care, health centres, occupational health care, private practitioners and private sector examinations and treatments. Pharmaceutical expenditure was decomposed into expenditure on prescribed medicines and over-the counter-medicines. Age- and sex specific life-time hospital expenditure was derived on the basis of the number of bed-days and average cost per day by hospital type. Expenditure on different physician services was derived on the basis of the age- and sex specific utilization figures and average costs per visit. Pharmaceutical expenditure was estimated similarly. The method for estimating the avoided life-time health care expenditure by age and sex is described in more detail in Appendix 12.

Social security benefits were estimated separately for sickness benefits and pensions. Sickness benefits were divided into sickness allowances and refunds of medical expenses which were further sub-divided into refunds of physicians' services, examinations and treatments, medicines and transportation services. Estimation of the life-time sickness benefits by type was based on the age- and sex specific figures on paid benefits. The method used is described in detail in Appendix 13.

Pensions paid were used as a basis for calculating the pensions for males and females of different ages. The pensions cover the old age and disability pensions paid by the Social Insurance Institution and other occupational pensions paid by the private sector, state, municipalities and other public sector agencies. The analysis does not cover pensions paid under special schemes (e.g. industrial or military injuries) nor the costs of voluntary pensions. The analysis covers 87 % of the total expenditure on pensions. The method for estimating the avoided life-time pensions by age and sex is described in Appendix 14.

The estimation methods allowed for survival probabilities and anticipated real growth in health care expenditure (2.4 %

annually), pensions (2.0 %) and other social security benefits (2.4 %). Health care expenditure avoided due to deaths attributed to smoking was obtained by multiplying the age and sex specific deaths by the respective present values. Avoided social security benefits were estimated in the same way.

Results

An estimated 3 260-4 640 premature deaths for people aged 35-84 were attributed to smoking in 1987. This implies that due to smoking related deaths FIM 350-500 million expenditure was avoided in hospital care, FIM 30-50 million in physician services and FIM 50-70 million in pharmaceutical expenditure (Table 34).

The present value of avoided social security benefits was estimated to be FIM 1 320-1 850 million, of which sickness benefits accounted for FIM 55-74 million and pensions FIM 1 270-1 770 million. Over one third of the pensions avoided was payable by the Social Insurance Institution (Table 35).

Table 34. Estimated health care expenditure (present value) avoided due to deaths attributed to smoking in 1987, FIM million.

Age group	Premature deaths attributed to smoking	Avoided due to smoking		
		hospital costs	costs of physician services	pharma-ceutical expenditure
35-39	10-50	1-5	0-1	0-1
40-44	70-110	7-11	1-2	1-2
45-49	130-150	14-16	2-3	3
50-54	210-300	24-33	3-5	4-6
55-59	360-470	41-53	5-7	7-9
60-64	570-750	65-86	7-9	10-13
65-69	520-750	58-84	5-7	8-11
70-74	560-830	61-91	4-7	7-10
75-79	510-740	52-75	3-5	5-7
80-84	330-480	30-44	1-2	2-3
TOTAL[1]	3260-4640	351-497	33-47	47-66

[1] Numbers may not add to totals due to rounding.

Table 35. Estimated social security benefits (present value) avoided due to deaths attributed to smoking in 1987, FIM million.

Age group	Avoided due to smoking			
	Paid by the SII[2]			Pensions paid by other organizations
	refunds of medical expensis	sickness allowances	pensions	
35-39	0-1	0[a]-1	2-7	3-14
40-44	1-2	2-3	10-15	22-35
45-49	2-3	3	19-23	44-52
50-54	4-5	4-5	36-50	77-109
55-59	6-8	4-5	63-82	132-173
60-64	9-11	2	98-131	200-265
65-69	7-10	-	83-119	151-217
70-74	6-9	-	75-112	111-165
75-79	4-6	-	53-78	58-84
80-84	2-3	-	20-27	13-19
TOTAL[1]	41-57	14-20	456-641	811-1133

[1] Numbers may not add to totals due to rounding.

[2] The Social Insurance Institution.

[a] Figure is less than half of the measure.

8 OTHER ECONOMIC CONSEQUENCES OF SMOKING

8.1 Cost of fires

Some previous studies have also estimated the costs of fires caused by tobacco (Shillington 1977, Luce and Schweitzer 1978, Collishaw and Myers 1984, Ellemann-Jensen 1986). The problem here is to decide whether the costs would have arisen if no one had smoked. It can be argued that fires associated with tobacco are not caused by smoking as such, but rather by careless handling of tobacco by some smokers. On the other hand, if tobacco products did not exist they could not be handled carelessly and this provides grounds for arguing that the fires are caused by smoking.

Cigarettes and other tobacco products caused 274 fires in 1987. Insurance companies paid out FIM 9.3 million damages for fires caused by tobacco (Tilastokeskus 1989). According to the Federation of Finnish Insurance Companies, property in Finland is underinsured by an average of 13 % (Berg K-E 1988). Insurance, therefore, covers only about 87 % of the value of property. The damages paid by individuals are on average 6 % of the damage covered by insurance (Berg K-E 1988). In addition, the damages paid by the various insurance associations are about 11 % of the fire damage shown in the official statistics (Berg K-E 1988). On the basis of this information we can estimate that in 1987 tobacco caused FIM 12.2 million fire damages, of which insurance companies paid

FIM 10.3 million and smokers paid the rest, assuming that smokers compensated all the damage paid by individuals (Appendix 15).

This figure is clearly an underestimate as it does not include forest fires and costs of extinguishing fires. Official statistics do not allow assessment of tobacco's contribution to these costs. Deaths from fires caused by smoking are not included in the estimated fire damages either.

8.2 Costs of health education and research

On the basis of the Tobacco Act part of the excise tax received is used to finance health education and research as well as to fund anti-smoking campaigns. The tax earmarked for this purpose is currently 0.45 % of the estimated annual yield of the tobacco tax. Table 36 shows how the earmarked tax was used in 1987 and the estimated proportion directly aimed at preventing and reducing smoking (Piha 1989). Part of the appropriation has been used for general health education supporting smoking prevention.

The FIM 5.6 million shown in Table 35 does not cover all costs of health education and research associated with smoking. There is no data on the costs incurred by local authorities, hospitals, research institutes or voluntary

Table 36. Use of the earmarked tax in 1987 (FIM 1000)

Purpose	Measures aimed directly at reduction in smoking	Total appropriation
Administration	405	632
Training	63	247
Research and follow-up	1 430	1 745
Health education programmes and mass media	3 747	5 671
Publications	143	480
TOTAL	5 588	8 775

Source: Piha (1989).

organizations. However, the appropriation derived from the Tobacco Act is the most significant source of fincance for smoking related health education (Piha 1989).

8.3 Cleaning costs and additional investments

Tobacco smoke, butts and ash make the environment dirty and may lead to additional cleaning cost in homes and public places. Smoking may cause additional costs to restaurants, Finnair (international flights) and Finnish Rail due to extra ventilation, maintenance and cleaning. Precautions against fires caused by smoking have to be taken in buildings and transportation.

Separate rooms are often reserved for smoking at work, in other public premises, in transportation (e.g. Finnish Rail, Finnair's international flights) etc. in order to reduce the harm and inconvenience caused to non-smokers by smoke and other factors as a result of smoking. No data is available on the additional investments needed to build and maintain separate smoking premises.

In some restaurants smokers have their own area. In others, smoking is totally forbidden, while in some one can smoke anywhere. Smoking on Finnair's domestic flights is forbidden, but it is allowed on international flights. Finnish Rail has decided to set aside 8 % of their new carriages for smokers.

The same applies to the old carriages that need repair but figures for these investments are not available. Smoking on buses and coaches is forbidden on reqular services, but if a coach is hired smoking may be allowed, although there are some that do not even have ashtrays.

There no reliable estimates of the costs due to this source. In principle, the costs of material damage due to smoking can be estimated by applying the approach outlined in Appendix 16.

8.4 Costs and benefits at work-place

Smokers may be less or more efficient than non-smokers at work. The opposite arguments here are that due to smoking breaks and smoking-related complications smokers as a group may exhibit lower productivity than non-smokers in the same job. On the other hand, the stimulating effects of smoking may make smokers more productive than non-smokers while at work. Which of these effects dominate is an empirical matter that has not been thoroughly researched.

Whether or not there will be external costs or benefits arising from this issue depends on the way in which wage rates are determined. If the wage rate reflects an individual's productivity then smokers would bear all the costs/benefits and no external costs/benefits would arise. If, on the other hand, wages are determined via collective bargaining, the wage paid to those who do not smoke will be based on the productivity of the average worker and there will be external costs/benefits. Smokers would gain/lose and non-smokers would lose/gain. The magnitude of the loss/gain depends on the actual productivity difference between smokers and non-smokers as well as on the prevalence of smoking. Appendix 17 indicates how the costs due this source may be derived.

8.5 Disbenefits due to addiction

It is apparent that smoking creates disbenefits to those who would be willing to give up smoking, but cannot do because of addiction. In a recent Finnish health survey (N=752) 58 per cent of current smokers claimed to have attempted to stop smoking sometimes in the past (20 per cent during the previous six months) without success (Vohlonen 1989), severe withdrawal symptoms being one of the major reasons for failure. For economic analysis, the strength of smoking-dependency may be depicted by smokers willingness to pay for means which may help free themselves from dependency.

In the health survey mentioned above, those who had attempted to stop smoking were asked if they would be willing to pay for means to enable them to give up smoking entirely. About 46 per cent (27 % of smokers) were willing to pay an average of FIM 1550 for such means. This implies that the estimated welfare loss due to addiction may be around FIM 428 million[1], which amounts to about 10 per cent of total consumer expenditure on tobacco in 1987. This willingness-to-pay estimate may be interpreted to represent the value of smoking-caused disbenefit (DBA), which smokers would prefer to live without.

[1] There were 3976000 persons aged 15 and over in Finland in 1987 (Tilastokeskus 1988c). About 26 per cent of this population smoked regularly (Kalimo et al. 1989, Tilastokeskus 1988c).

9 HEALTH AND ECONOMIC CONSEQUENCES OF SMOKING IN FINLAND IN 1987

9.1 Summary of the main findings

Health and resource consequences

Smoking was associated with 3440-4920 premature deaths in 1987, over one third being due to smoking by individuals aged 35-64 (Table 37). An estimated 49070-69560 life years were lost due to smoking. Smoking-related sickness absence and disability caused around 3.0-3.7 million days of illness.

Physician visits attributed to smoking corresponded to 200-210 physicians' annual work load in 1987 (Table 38). Smoking-related in-patient hospital care required a capacity equivalent to one and a half or two average central hospitals.

Social costs and benefits

Total social costs of smoking were estimated to amount to FIM 4.5-5.0 billion in 1987, of which nearly half was due to indirect costs (Table 39). The social costs slightly exceed the minimum estimate of the social benefits of smoking, as approximated by consumer expenditure on tobacco.

Table 37. Main **health consequences** of smoking in Finland in 1987.

HEALTH EFFECT	DUE TO SMOKING AS ESTIMATED IN THIS STUDY		PROPORTION OF TOTAL (%)	
	Low estimate	High estimate	Low estimate	High estimate
Individuals in rehabilitation	270	270	0.8	0.8
Days of illness due to sickness absence (x1000)	1360	1410	6.8	7.1
Individuals on disability pension	4600	6150	1.9	2.5
Days of illness due to disability (x1000)	1680	2250	-[a]	
Premature deaths (35+ years)	3440	4920	7.2[b]	10.3[b]
Premature deaths (35-64 years)	1350	1840	2.8[c]	3.8[c]
Life years lost to premature deaths	49070	69560	-[a]	

[a] Not estimated.

[b] 7.5-10.7 % of all deaths in age group 35 and over.

[c] 12.7-17.2 % of all deaths in age group 35-64 years.

Table 38. Main resource consequences of smoking in Finland in 1987.

RESOURCE EFFECT	DUE TO SMOKING AS ESTIMATED IN THIS STUDY		PROPORTION OF TOTAL (%)	
	Low estimate	High estimate	Low estimate	High estimate
Jobs in tobacco industry	1230	1230	-[a]	
Jobs in tobacco trade	-[b]		-[b]	
Bed-days in hospitals (x1000)	224	302	1.6	2.2
Hospital beds engaged	770	1030	2.6	3.5
Physician visits (x1000)	590	620	3.4	3.6
Working days lost to sickness absence (x1000)	1221	1252	6.1	6.2
Working days lost to disability (x1000)	1010	1350	-[b]	
Working years lost to premature deaths	10330	14850	-[b]	

[a] Figure is less than half of the measure.

[b] Not estimated.

Table 39. Main social costs of smoking in Finland in 1987 (FIM million).[1]

COST ITEM	Low estimate	High estimate
INDIRECT COSTS	**2424**	**2494**
RESOURCES DEVOTED TO PRODUCTION AND DISTRIBUTION	1436	1436
DISBENEFITS DUE TO ADDICTION	428	428
HEALTH EXPENDITURE	524	594
- Inpatient care	222	292
- Outpatient care	193	193
- Pharmaceuticals	109	109
- Rehabilitation	1	1
OTHER DIRECT COSTS	18	18
- Health education	6	6
- Fires	12	12
INDIRECT COSTS	**2063**	**2564**
LOST PRODUCTION DUE TO	2063	2564
- Sickness absence	863	890
- Disability	401	483
- Premature death	800	1192
TOTAL SOCIAL COSTS[2]	**4469**	**5040**

[1] Detailed breakdown is presented in Appendix 18.

[2] Numbers may not add to totals due to rounding.

Financial consequences

Ignoring tobacco excise, expenditure due to smoking outweighs the financial savings due to it (Table 40). However, due to tobacco excise smoking appears profitable to the public sector, mainly to the state. For local authorities the net outcome is minus FIM 180 million.

Institutional and final external costs

Smokers themselves pay the major part of the social costs of smoking (Table 41). The estimated institutional external costs amount to about 37-40 % of the total social costs. When smokers' contribution to the financing of the institutions concerned is accounted for, smokers pay two thirds of the total social costs. The estimated final external costs are about 31-33 % of the social costs. The magnitude of the institutional and final external costs is clearly lower than proceeds from tobacco excise.

9.2 Limitations of the study

Estimating the health and economic consequences of smoking at aggregate level is always difficult and the results subject to uncertainty. This also holds good for the estimates at hand. At various stages a whole number of restricting assumptions had to be made.

Table 40. Main financial consequences of smoking in Finland in 1987 (FIM million).[1,2]

REVENUE (+)/ EXPENDITURE (-) ITEM	Low estimate	High estimate
DIRECT CONSEQUENCES	**-678**	**-790**
- Health expenditure	-395	-456
- Social security benefits	-278	-329
- Other direct expenditure	-6	-6
INDIRECT CONSEQUENCES	**389**	**629**
- Tax revenue lost	-486	-605
- Avoided health expenditure	364	516
- Avoided social security benefits	511	718
NET REVENUE (tobacco excise excluded)[3]	-289	-161
PROCEEDS FROM TOBACCO EXCISE	2162	2162
NET REVENUE (tobacco excise included)[3]	**1873**	**2001**

[1] Includes revenue and expenditure effects on state, local authorities and the Social Insurance Institution.

[2] Detailed breakdown is presented in Appendix 18.

[3] Numbers may not add to totals due to rounding.

292

Table 41. **Institutional and final external costs** of smoking in Finland in 1987 (FIM million).[1]

	Institutional external costs		Final external costs	
	Low estimate	High estimate	Low estimate	High estimate
DIRECT COSTS	440	506	338	389
INDIRECT COSTS	1208	1502	1038	1290
TOTAL[2]	1649	2008	1376	1679
Proportion of the total social costs (%)	37	40	31	33

[1] Detailed breakdown is presented in Appendix 18.

[2] Numbers may not add to totals due to rounding.

The quantitative impact of smoking on morbidity and mortality was estimated by applying fairly cautious assumptions throughout the study. Mortality ratios between smokers and non-smokers were based on three well-known non-Finnish studies carried out in the 1960's and early 1970's. The consumption of tobacco products increased significantly thereafter, both in the countries in question and in Finland, although it subsequently declined or at least stabilized in the late 1980's. Longer follow-up studies have suggested the mortality ratios to be somewhat higher than used in this study and there is some evidence that they may have increased as a function of the follow-up time (Rogot and Murray 1980).

This study has covered the main diseases associated with smoking, but omitted, for example, the possible health consequences of passive smoking. No attempt was made to quantify and value the pain and suffering endured by smokers and their families in cases of illness and death. Nor was any consideration given to the smoker's valuation of his own life. Also, investments in smoking premises, as well as the costs of extra cleaning and ventilation, and costs and benefits at the work-place were omitted. On the other hand, not all beneficial effects of smoking, such as consumer surplus, were included.

For all these reasons, the estimated effects may be regarded to indicate only the lower limit of the health and economic consequences of smoking.

9.3 Is there a case for government intervention?

There does not seem to be a case for government intervention to correct for financial externality (Table 42). It seems likely that smokers as a group pay the external costs they generate to others, irrespective of what is assumed about addiction and awareness of the health risks.

There does, however, seem to be a case for intervention to correct for other market failures. The intervention criteria are clearly positive for three of the five models. For modified economic model 3 the criterion is ambiguous.

If consumers are fully informed about the health risks and not addicted to tobacco (traditional economic model), then government intervention may not be justified on economic grounds. However, if the value of the caring externality exceeds FIM 230 000 per life lost due to smoking, or FIM 16 000 per life year lost, then intervention may also be justified in this case.[1]

If consumers are unaware of the health risks, but not addicted to tobacco (medical model and modified economic model 1), then there may be a case for government intervention to correct for the lack of information.

---

[1] These figures are well below those reported in Table 12 on money invested to save lives, or for coronary artery bypass surgery per life-year gained.

Table 42. **Intervention criteria** for different costing models in Finland in 1987 (FIM million).

COST COMPONENT	Traditional economic model		Modified economic model 1		Modified economic model 2		Modified economic model 3		Medical model	
	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate
Final external costs (EXC)	1376	1679	1376	1679	1376	1679	1376	1679	1376	1679
Private costs (CR)[1]			1228	1496	1228	1496	123[a]	150[a]	1228	1496
Disbenefits due to addiction (DBA)					428	428	428	428		
TOTAL COSTS (TC)	1376	1679	2604	3175	3032	3603	1927	2257	2604	3175
PROCEEDS FROM TOBACCO EXCISE (T)	2162	2162	2162	2162	2162	2162	2162	2162	2162	2162
INTERVENTION CRITERIA (TC-T)	-786	-482	443	1014	871	1442	-235	95	443	1014
IMPLIED CARING EXTERNALITY										
- FIM per life lost	228371	98019					68243			
- FIM per life year lost	16010	6933					4784			

[a] Perceived private costs for those who would like to give up smoking, but cannot due to addiction. This has been estimated as DBA's proportion of the total expenditure on tobacco.
[1] Unperceived private costs.

If consumers are unaware of the health risks and addicted to tobacco (modified economic model 2), then there may be a case for government intervention to correct for the lack of information and dependency.

If consumers are fully informed about the health risks and addicted to tobacco (modified economic model 3), the situation is ambiguous. The high estimate would justify intervention while the low estimate would not. However, if the value of caring externality exceeds FIM 68 000 per life lost due to smoking or FIM 4 800 per life year lost, then intervention may also be justified in this case.[1] Government intervention should be directed to prevent addiction and to help smokers to give up smoking.

[1] These figures are well below those reported in Table 12 on money invested to save lives, or for coronary artery bypass surgery per life-year gained.

10 CONCLUSIONS

The purpose of this study was to outline a framework for analysing the economic consequences of smoking from the point of view of different parties and to examine these consequences empirically. Our investigation of the health and economic consequences of smoking in Finland in 1987 leads to six main conclusions:

(1) It appears that it is not possible to create an unambiguous framework which would be suitable for all circumstances. It is, indeed, possible to estimate the social costs of smoking, but it is not feasible to determine unambiguously which proportion of these costs is relevant for designing policy towards smoking. In particular, the estimated costs of smoking vary considerably depending on which economic framework is used.

(2) A theoretically correct economic analysis of the costs of smoking depends on the assumptions made with regard to dependence and information among consumers.

(3) Smoking appears to have a relatively greater impact on public health than on health care resources. Smoking seems to be a major source of illness and premature death while its impact on health services utilization appears smaller than generally expected.

(4) The estimated social costs slightly exceed the social benefits of smoking. The result is inconclusive, however, since both estimates represent the lower limit of the broader social costs and benefits of smoking. It seems evident, nevertheless, that smoking is profitable to the public sector, apart from local authorities.

(5) Smokers themselves pay the major part of the estimated social costs of smoking. It seems likely that smokers as a group pay the external costs they generate to non-smokers and relevant institutions, irrespective of what is assumed about addiction and awareness of the health risks.

(6) There does not appear to be a case for government intervention to correct for financial externality.
There does seem, however, to be a case for intervention to correct for the caring externality, imperfect information and tobacco addiction. The appropriate measures for each case are outlined in the first part of this study.

APPENDICES TO PART II: Page

APPENDIX 1: ECONOMIC EFFECTS OF SMOKING ANALYSED IN PREVIOUS STUDIES

Table A1.1. **Direct** economic effects of smoking analysed in previous studies [Benefit (+), Cost (-)].

EFFECT	SWEDEN				ENGLAND				USA		CANADA			OTHERS	
Study[1]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PRODUCTION, DISTRIBUTION AND DEMAND															
Benefits to smokers															
- Resources devoted to production and distribution								+				+	+	-	
- Proceeds from excise duty	+						+	+				+	+	+	
MORBIDITY															
Total health care costs		-			-			-	-						
Cost of hospital care	-		-	-		-	-			-	-	-	-	-	-
Costs of outpatient care[2]	-		-	-		-	-			-	-	-	-	-	-
Cost of medicines[2]	-					-				-		-			
- Prescribed medicines			-	-											
- Over-the-counter-medicines															
Sickness benefits						-	-							-	
Costs of rehabilitation															-
Disability benefits															
MORTALITY															
Widow's and orphan's pensions						-	-								

Table A1.1. ... continue [Benefit (+), Cost (-)].

EFFECT	SWEDEN				ENGLAND				USA		CANADA			OTHERS	
Study[1]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
OTHER DIRECT EFFECTS															
Fire damages	-				-				-		-		-	-	
Costs of health education and research							-								
Costs of cleaning and extra ventilation															
Investments to smoking premises															

[1] Numbers refer to the following studies: 1 = Lindholm (1973), 2 = Johnsson (1980), 3 = Hjalte (1984a), 4 = Hjalte (1984b), 5 = Peston (1972), 6 = DHSS (1972), 7 = Atkinson and Townsend (1977), 8 = Cohen (1984), 9 = Luce and Schweitzer (1978), 10 = Rice et al (1986), 11 = Shillington (1977), 12 = Thompson and Forbes (1982), 13 = Collishaw and Myers (1984), 14 = Ellemann-Jensen (1986), 15 = Leu and Schaub (1984).

[2] Costs have not been broken down in detail.

Table A1.2. **Indirect** economic effects of smoking analysed in previous studies [Benefit (+), Cost (-)].

EFFECT	SWEDEN				ENGLAND				USA		CANADA			OTHERS	
Study[1]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MORBIDITY															
Lost production due to															
- Sickness absence	-				-	-		-	-	-	-	-	-		-
- Disability			-	-					-	-			-	-	-
Extra costs to employers															
Lost tax-revenues due to															
- Sickness absence															
- Disability															
MORTALITY															
Lost production	-	-	-	-	-	-			-	-	-		-	-	-
Avoided health care expenditure						+	+								
Lost tax-revenues														-	
Avoided pensions						+	+					+		+	
Other avoided social security benefits						+									
OTHER INDIRECT EFFECTS															

[1] Numbers refer to the following studies: 1 = Lindholm (1973), 2 = Johnsson (1980), 3 = Hjalte (1984a), 4 = Hjalte (1984b), 5 = Peston (1972), 6 = DHSS (1972), 7 = Atkinson and Townsend (1977), 8 = Cohen (1984), 9 = Luce and Schweitzer (1978), 10 = Rice et al (1986), 11 = Shillington (1977), 12 = Thompson and Forbes (1982), 13 = Collishaw and Myers (1984), 14 = Ellemann-Jensen (1986), 15 = Leu and Schaub (1984).

APPENDIX 2: AN INDIRECT METHOD FOR ESTIMATING THE β_j:s

The public sector finances most of its expenditure by tax revenue. Tax systems differ from country to country, but a feature common to all systems is that tax revenue is collected by taxing income, consumption, production or sales. By decomposing the relevant tax categories into smokers' and non-smokers' contributions it is possible to estimate the β_j:s. The relevant taxes here are taxes based on income and consumption. Income taxes are paid by smokers and non-smokers alike. Their separate contributions can be estimated if the prevalence of smoking is known by income groups. The relevant consumption tax here is the tobacco excise levy which can be interpreted as compensating for the external costs of smoking, though the fiscal motive has traditionally dominated tobacco taxation policies in Finland (Pekurinen and Valtonen 1987).

Tax categories

By denoting the average taxable income in income group i by y_i, the number of people in the income group by N_i, and the prevalence of smoking by p_i, the total taxable income Y_i in income group i is

$$Y_i = N_i y_i = p_i N_i y_i + (1 - p_i) N_i y_i,$$

where $p_i N_i y_i$ = total taxable income earned by smokers in income group i,
$(1 - p_i) N_i y_i$ = total taxable income earned by non-smokers in income group i.

For the purpose of this study, taxes based on income can be grouped into the following six categories: state income tax (central government), municipal tax (local authorities), sickness insurance premium, national pension contribution, church taxes and other taxes. In Finland, sickness insurance premium and national pension contribution are paid to the Social Insurance Institution. Church taxes are paid either to the Lutheran or the Orthodox church. The total amount of income taxes paid by the income group i (T_i) is thus

$$T_i = \alpha_{iCG}\{Y_i\} + \alpha_{iLG}Y_i + \alpha_{iSI}Y_i + \alpha_{iNP}Y_i + \alpha_{iC}Y_i + \alpha_{iO}Y_i$$

$$T_i = T_{iCG} + T_{iLG} + T_{iSI} + T_{iNP} + T_{iC} + T_{iO}$$

Where α_{iCG} = average state income tax rate in income group i (%),

α_{iLG} = average municipal tax rate (%),

α_{iSI} = sickness insurance premium (%),

α_{iNP} = national pension contribution (%),

α_{iC} = church taxes (%),

α_{iO} = proportion of other taxes on income (%),

T_{iCG} = total state income tax paid by income group i,

T_{iLG} = total municipal income tax paid by income group i,

T_{iSI} = total sickness insurance contribution paid by income group i,

T_{iNP} = total national pension contribution paid by income group i,

T_{iC} = total church taxes paid by income group i,

T_{iO} = total amount of other taxes paid by income group i.

Total amount of taxes j collected from all income groups is

$$T_j = \sum_i T_{ij}$$

of which the amount

$$(2.1) \quad T_j^s = \sum_j \alpha_{ij} p_i N_i Y_i$$

is paid by smokers and the amount

$$(2.2)\quad T_j^{NS} = \sum_j \alpha_{ij}(1 - p_i)N_i y_i$$

by non-smokers.

Decomposing public sector revenues

The public sector has a variety of other sources of revenue than those based on taxpayers' incomes. In order to derive estimates for the β_j:s it is sufficient to consider the financing structure of the state, municipalities, state churches, as well as the Social Insurance Institution, which runs both the public sickness insurance and the national pension schemes in Finland.

The total state revenue (G_C) can be defined as the sum of the total proceeds from income tax (T_{CG}), from the tobacco excise (TEX), and from other revenues from individuals (X_{CI}) and other sources (X_{CO}):

$$(2.3)\quad G_C = T_{CG} + TEX + X_{CI} + X_{CO}.$$

The municipalities' total revenues (G_L) include proceeds from the municipal income tax (T_{LG}), state subsidies (SS_{LG}) and other revenues from individuals (X_{LI}) and other sources (X_{LO}):

$$(2.4)\quad G_L = T_{LG} + SS_{LG} + X_{LI} + X_{LO}.$$

The total revenue of the Social Insurance Institution (SII) is made up of employees' sickness insurance premiums (T_{SI}) and national pension contributions (T_{NP}), employers' sickness insurance premiums (E_{SI}) and national pension contributions (E_{NP}), the state's contribution to sickness insurance (CG_{SI}), the state's (CG_{NP}) and municipalities' (LG_{NP}) contribution to national pensions, and other revenues to finance sickness insurance (X_{SI}) and national pensions (X_{NP}):

$$(2.5) \quad SII = T_{SI} + T_{NP} + E_{SI} + E_{NP} + CG_{SI} + CG_{NP} + LG_{NP} + X_{SI} + X_{NP}.$$

The total revenue of the state churches (CT) is made up of the church taxes from individuals (CT_I) and corporations (CT_C):

$$(2.6) \quad CT = CT_I + CT_C.$$

Derivation of the β_j:s

The total state revenue can be decomposed into smokers' and non-smokers' contributions by formulae (2.1)-(2.3). Assuming that other revenue derived from individuals (X_{CI}) is distributed between smokers and non-smokers in proportion to their population shares, (2.3) can be decomposed as follows

$$\begin{aligned}(2.7) \quad G_C &= T_{CG} + TEX + X_{CI} + X_{CO} \\ &= T_{CG}{}^{S} + T_{CG}{}^{NS} + TEX + pX_{CI} + (1 - p)X_{CI} + X_{CO} \\ &= T_{CG}{}^{S} + pX_{CI} + TEX + T_{CG}{}^{NS} + (1 - p)X_{CI} + X_{CO} \\ &= [\sum_i \alpha_{iCG} p_i N_i\{y_i\} + pX_{CI} + TEX] \\ &\quad + [\sum_i \alpha_{iCG}(1 - p_i)N_i\{y_i\} + (1 - p)X_{CI} + X_{CO}].\end{aligned}$$

The terms in the first brackets in (2.7) refer to the amount of state revenue collected from smokers. The second brackets give the non-smokers contribution. Dividing the terms in the first brackets by the total state revenue (G_C) gives the smokers' share β_{CG} in (5). Thus

$$(2.8) \quad \beta_{CG} = [\sum_i \alpha_{iCG} p_i N_i\{y_i\} + pX_{CI} + TEX]/G_C,$$

where p is the prevalence of smoking among income earners. The non-smokers' share in (4) is then $1 - \beta_{CG}$.

Municipalities' revenue can be decomposed in the same way by formulae (2.1), (2.2) and (2.4)

$$\begin{aligned}(2.9)\quad G_L &= T_{LG} + SS_{LG} + X_{LI} + X_{LC} \\ &= T_{LG}^{S} + T_{LG}^{NS} + SS_{LG}^{S} + SS_{LG}^{NS} + pX_{LI} + (1 - p)X_{LI} + X_{LO} \\ &= T_{LG}^{S} + SS_{LG}^{S} + pX_{LI} + T_{LG}^{NS} + SS_{LG}^{NS} + (1 - p)X_{LI} + X_{LO} \\ &= [\sum_i \alpha_{iLG} p_i N_i y_i + \beta_{CG} SS_{LG} + pX_{LI}] \\ &\quad + [\sum_i \alpha_{iLG}(1 - p_i)N_i y_i + (1 - \beta_{CG})SS_{LG} \\ &\quad + (1 - p)X_{LI} + X_{LO}].\end{aligned}$$

The terms in the first brackets indicate the total amount of municipal taxes and other revenues paid by smokers and the terms in the second brackets indicate those paid by non-smokers. Dividing the terms in the first brackets by the total municipal revenue (G_L) gives us the smokers' share β_{LG} in (5). Thus

$$(2.10)\quad \beta_{LG} = [\sum_i \alpha_{iLG} p_i N_i y_i + \beta_{CG} SS_{LG} + pX_{LI}]/G_L.$$

The non-smokers' share in (4) is then $1 - \beta_{LG}$.

The same method can be used to decompose the revenue of the **Social Insurance Institution** (SII) into smokers' and non-smokers' contributions. Smoking-related benefits paid by the SII fall into either of the two categories: sickness benefits or pension benefits. The revenue collected to finance sickness benefits can be decomposed by formulae (2.1), (2.2) and (2.5) as follows

$$\begin{aligned}(2.11)\quad SII_{SI} &= T_{SI} + E_{SI} + X_{SI} \\ &= T_{SI}^{S} + E_{SI}^{S} + T_{SI}^{NS} + E_{SI}^{NS} + X_{SI} \\ &= \sum_i \alpha_{iSI} p_i N_i y_i + \sum_i p_i N_i y_i (\sum_i Y_i)^{-1} E_{SI} + \beta_{CG} CG_{SI} \\ &\quad + [\sum_i \alpha_{iSI}(1 - p)_i N_i y_i + \sum_i (1 - p_i) N_i y_i (\sum_i Y_i)^{-1} E_{SI} \\ &\quad + (1 - \beta_{CG})CG_{SI} + X_{SI}],\end{aligned}$$

where the first three terms indicate smokers' contribution to financing sickness insurance and the terms in the brackets indicate non-smokers' contribution. Dividing the first three terms by the total amount of sickness insurance contributions (SII_{SI}) gives the smokers' share β_{SI} in (5). Thus

$$(2.12) \quad \beta_{SI} = [\sum_i \alpha_{iSI} p_i N_i y_i + \sum_i p_i N_i y_i (\sum_i Y_i)^{-1} E_{SI} + \beta_{CG} CG_{SI}]/SII_{SI}.$$

The non-smokers's share in (4) is $1 - \beta_{SI}$.

In the same way we can derive the smokers' share in financing national pensions by formulae (2.1), (2.2) and (2.5). The β_{NP} is

$$(2.13) \quad \beta_{NP} = [\sum_i \alpha_{iNP} p_i N_i y_i + \sum_i p_i N_i y_i (\sum_i Y_i)^{-1} E_{NP} + \beta_{CG} CG_{NP} + \beta_{LG} LG_{NP}]/SII_{NP}.$$

and the non-smokers' share is $1 - \beta_{NP}$.

Smokers' share in financing churches' expenditure can be derived by formulae (2.1), (2.2) and (2.6). The β_C is

$$(2.14) \quad \beta_C = \sum_i \alpha_{iC} p_i N_i y_i / CT.$$

and the non-smokers's share is $1 - \beta_C$.

Thus we have derived all the relevant β_j:s in (4) and (5). Substituting (2.8), (2.10), (2.12), and (2.14) for β_j:s in (5) we can estimate the proportion of the costs of service i borne by smokers, i.e.

$$p_i^S = \beta_{CG} p_i^{CG} + \beta_{LG} p_i^{LG} + \beta_{SI} p_i^{SI} + \beta_C p_i^C + p_i^P$$
$$= [\sum_i \alpha_{iCG} p_i N_i \{y_i\} + pX_{CI} + TEX] p_i^{CG}/G_C$$

$$+ [\sum_i \alpha_{iLG} p_i N_i y_i + \beta_{CG} SS_{LG} + pX_{LI}] p_i^{LG}/G_L$$

$$+ [\sum_i \alpha_{iSI} p_i N_i y_i + \sum_i p_i N_i y_i (\sum_i Y_i)^{-1} E_{SI} + \beta_{CG} CG_{SI}] p_i^{SI}/SII_{SI}$$

$$+ [\sum_i \alpha_{iC} p_i N_i y_i] p_i^{C}/CT + p_i^{P}.$$

The proportion of the costs borne by the third parties is

$$p_i^{EX} = 1 - p_i^{S}.$$

By substituting (2.8), (2.10), and (2.12)-(2.14) for β_j:s in (6) and (7) we can estimate the institutional external costs by parties and derive the final external costs of smoking.

The prevalence of smoking in 1987, the p in (2.7)-(2.10), was estimated from a representative sample (N = 13 130) of the non-institutionalised Finnish population aged 15 and over. The original interview survey was carried out by the Social Insurance Institution in 1987 (Kalimo et al 1989). The total amount of income related taxes paid to various taxing institutions by smoking groups, the T_i^j:s in (2.7)-(2.14), was estimated by identifying the smoking status of each individual in the sample and inspecting the amount of taxes they had paid to each institution in 1987 from the national tax registry[1]. The other tax and financing information required, the X_i:s, SS_i:s, E_i:s, C_i:s, and the TEX in (2.7)-(2.14), was derived from various official statistics (Valtion ... 1990, Kansaneläkelaitos 1988b, Kirkkohallitus 1988). The estimates for the β_j:s derived in this study are given in Table A2.1.

[1] I am grateful to Unto Häkkinen for analysing the national tax registry data by smoking groups.

Table A2.1. Final financing of the public institutions concerned by smoking groups in 1987 (%)

	Smokers (β_j)	Former smokers	Non-smokers	Others[1]	Total
OPTION A. **Tobacco excise** is icluded in the state revenue. i.e. tobacco excise is **not ear-marked**					
State[2]	23.94	16.47	43.94	15.64	100.00
Municipalities[3]	23.00	17.26	43.51	16.22	100.00
SII[4]	27.22	20.18	47.45	5.14	100.00
State churches[5]	24.63	20.33	44.73	10.30	100.00
OPTION B. **Tobacco excise** is not icluded in the state revenue, i.e. tobacco excise is **ear-marked**					
State[2]	22.31	16.83	44.89	15.98	100.00
Municipalities[3]	22.53	17.37	43.78	16.32	100.00
SII[4]	26.93	20.25	47.62	5.20	100.00
State churches[5]	24.63	20.33	44.73	10.30	100.00
Prevalence of smoking (%)	25.27	18.18	56.55		100.00

[1] Mainly firms
[2] Central government
[3] Local authorities
[4] Social Insurance Institution
[5] Lutheran and Orthodox

APPENDIX 3: DISEASES EXAMINED IN THE STUDY

The names and ICD-9 codes (9th Revision of the International Classification of Diseases, Injuries and Causes of Death) of the diseases examined in this study as defined by Lääkintöhallitus (1986) are given below.

Cancer of the oral cavity:

Malignant neoplasm of lip (140)
Malignant neoplasm of tongue (141)
Malignant neoplasm of major salivary glands (142)
Malignant neoplasm of gum (143)
Malignant neoplasm of floor of mouth (144)
Malignant neoplasm of other and unspecified parts of mouth (145)
Malignant neoplasm of oropharynx (146)
Malignant neoplasm of nasopharynx (147)
Malignant neoplasm of hypopharynx (148)
Malignant neoplasm of other ill-defined sites within the lip, oral cavity and pharynx (149)

Cancer of the esophagus and pancreas:

Malignant neoplasm of esophagus (150)
Malignant neoplasm of pancreas (157)

Cancer of the larynx (161)

Cancer of the lung:

Malignant neoplasm of trachea, bronchus or lung (162)
Malignant neoplasm of pleura (163)

Cancer of the urinary bladder (188)

Coronary heart disease:

Acute myocardial infarction (410)
Other acute and subacute forms of ischaemic heart disease (411)
Old myocardial infarction (412)
Other forms of chronic ischaemic heart diseases (414)

Other vascular diseases:

Aortic aneurysm (441)
Other peripheral vascular diseases (443)

Chronic bronchitis (491)

Emphysema (492)

APPENDIX 4: ATTRIBUTABLE RISKS

Attributable risks are used in several sections of this study. The attributable risk indicates the fraction of the total number of people affected by a given disease which is due to exposure to the influence of a risk factor e.g. smoking. The attributable risk can be expressed as follows (Miettinen 1974):

$$(4.1) \quad S1_{ijk} = \frac{(r^1_{ijk} - 1)p^1_{ij}}{(r^1_{ijk} - 1)p^1_{ij} + 1}$$

where $S1_{ijk}$ = the proportion of cases of disease k in age-group i and sex j that are due to smoking,

r^1_{ijk} = the relative risk for smokers of age i and sex j to contract the disease k as compared with non-smokers,

p^1_{ij} = the proportion of smokers in the population in age-group i and sex j.

The attributable risk (4.1) was calculated for all the diseases mentioned in Appendix 3.

The joint attributable risk was calculated for smokers and former smokers for the four major diseases commonly thought to be causally related to smoking (ICD-9 codes 162&163, 410-412 & 414, 491 and 492) by the following formula (Miettinen 1974):

$$(4.2) \quad S2_{ijk} = \frac{(r^1_{ijk} - 1)p^1_{ij} + (r^2_{ijk} - 1)p^2_{ij}}{(r^1_{ijk} - 1)p^1_{ij} + (r^2_{ijk} - 1)p^2_{ij} + 1}$$

where $S2_{ijk}$ = the proportion of cases of disease k in age-group i and sex j that are due to current or former smoking,

r^2_{ijk} = the relative risk for former smokers of age i and sex j to contract the disease k as compared with non-smokers,

p^2_{ij} = the proportion of former smokers in the population in age-group i and sex j.

The age, sex and diagnosis specific relative risks derived from the three prospective epidemiologic studies are given in tables A4.1 and A4.2 for smokers and in table A4.3 for former smokers. The relative sizes of smoking groups used in this study are given in table A4.4. The age, sex and diagnosis specific attributable risks estimated in this study on the basis of the data given in tables A4.1-A4.4 are given in tables A4.5 and A4.6 for smokers and in table A4.7 jointly for smokers and former smokers.

The relative risks, the r^1_{ijk} and r^2_{ijk}, were obtained from three major epidemiologic studies (Hammond 1966, Cederlöf et al 1975, Doll and Peto 1976) and the relative sizes of smoking groups, the p^1_{ij} and p^2_{ij}, in Finland from Kalimo et al (1982).

Table A4.1. Relative risks of **male smokers** as compared to male non-smokers for different illnesses (ICD - 9 code) obtained in three studies

<table>
<tr><th rowspan="2"></th><th rowspan="2">Study[1]</th><th colspan="6">AGE GROUP</th></tr>
<tr><th>35-44</th><th>45-54</th><th>55-64</th><th>65-74</th><th>75-84</th><th>85+</th></tr>
<tr><td>Cancer of</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Oral cavity (140-149)</td><td>D&P</td><td colspan="6"><---- 13.0 ----></td></tr>
<tr><td></td><td>H</td><td colspan="6"><---- 2.9 ----></td></tr>
<tr><td>Esophagus (150)</td><td>D&P</td><td colspan="6"><---- 4.7 ----></td></tr>
<tr><td></td><td>H</td><td colspan="6"><---- 1.7 ----></td></tr>
<tr><td>Pancreas (157)</td><td>D&P</td><td colspan="6"><---- 1.6 ----></td></tr>
<tr><td></td><td>H</td><td colspan="3"><---- 2.7 ----></td><td colspan="3"><---- 2.2 ----></td></tr>
<tr><td></td><td>C</td><td colspan="6"><---- 3.1 ----></td></tr>
<tr><td>Larynx (161)</td><td>H</td><td colspan="6"><---- 9.0 ----></td></tr>
<tr><td>Lung (162-163)</td><td>D&P</td><td colspan="6"><---- 14.0 ----></td></tr>
<tr><td></td><td>H</td><td colspan="3"><---- 7.8 ----></td><td colspan="3"><---- 11.6 ----></td></tr>
<tr><td></td><td>C</td><td colspan="6"><---- 7.0 ----></td></tr>
<tr><td>Urinary bladder (188)</td><td>D&P</td><td colspan="6"><---- 2.1 ----></td></tr>
<tr><td></td><td>H</td><td colspan="6"><---- 3.0 ----></td></tr>
<tr><td></td><td>C</td><td colspan="6"><---- 1.8 ----></td></tr>
<tr><td>Coronary heart disease (410-412&414)</td><td>D&P</td><td>8.7</td><td>3.1</td><td>1.5</td><td>1.3</td><td>1.0</td><td>1.0</td></tr>
<tr><td></td><td>H</td><td>1.0</td><td>2.8</td><td>1.8</td><td>1.5</td><td>1.2</td><td>1.2</td></tr>
<tr><td></td><td>C</td><td>1.0</td><td>2.6</td><td>1.7</td><td colspan="3"><---- 1.7 ----></td></tr>
<tr><td></td><td>C[a]</td><td>2.6</td><td>1.7</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Aortic aneurysm (441)</td><td>D&P</td><td colspan="6"><---- 6.6 ----></td></tr>
<tr><td></td><td>H</td><td colspan="3"><---- 2.6 ----></td><td colspan="3"><---- 4.9 ----></td></tr>
<tr><td></td><td>C</td><td colspan="6"><---- 1.6 ----></td></tr>
<tr><td>Other peripheral vascular diseases (443)</td><td>H</td><td colspan="6"><---- 1.2 ----></td></tr>
<tr><td>Brochitis (491) and emphysema (492)</td><td>D&P</td><td colspan="6"><---- 24.7 ----></td></tr>
<tr><td></td><td>H</td><td colspan="3"><---- 6.6 ----></td><td colspan="3"><---- 11.4 ----></td></tr>
<tr><td></td><td>C</td><td colspan="6"><---- 1.6 ----></td></tr>
</table>

[1] D&P = Doll and Peto (1976), H = Hammond (1966), C = Cederlöf et al (1975).

[a] Attributable risks for the latter of the successive five year age groups.

Table A4.2. Relative risks of **female smokers** as compared to female non-smokers for different illnesses (ICD-9 code) obtained in three studies

	Study[1]	AGE GROUP					
		35-44	45-54	55-64	65-74	75-84	85+
Cancer of							
Pancreas (157)	C	<--------------- 2.5 --------------->					
Lung (162-163)	D&P	<--------------- 5.0 --------------->					
	H	<--------------- 2.2 --------------->					
	C	<--------------- 4.5 --------------->					
Urinary bladder (188)	C	<--------------- 1.6 --------------->					
Coronary heart disease (410-412&414)	H	1.0	2.0	1.7	1.4	1.2	1.2
	C	1.0	1.0	2.6	<------ 1.1 ----->		
	C[a]		2.6	1.1			
Brochitis (491) and emphysema (492)	D&P	<--------------- 10.5 --------------->					
	H	<--------------- 4.9 --------------->					
	C	1.0	1.0	1.7	<------ 2.2 ----->		
	C[a]		1.7	2.2			

[1] D&P = Doll and Peto (1976), H = Hammond (1966), C = Cederlöf et al (1975).

[a] Attributable risks for the latter of the successive five year age groups.

Table A4.3. Relative risks of **former smokers** as compared to non-smokers for different illnesses (ICD - 9 code) obtained in three studies

	Study[1]	AGE GROUP 35-44	45-54	55-64	65-74	75-84	85+
MALES							
Lung cancer (162-163)	D&P	7.2	7.5	6.9	6.4	4.6	4.6
	C	4.8	5.2	5.3	5.0	5.0	5.0
Coronary heart disease (410-412&414)	D&P	4.3	2.0	1.3	1.2	1.2	1.2
	C	1.1	1.8	1.5	1.4	1.3	1.3
	C[a]	1.8	1.5				
Brochitis (491) and emphysema (492)	D&P	14.3	15.5	15.0	14.0	11.2	11.2
	C	1.9	2.2	2.4	2.3	2.4	2.4
FEMALES							
Lung cancer (162-163)	D&P	1.9	1.7	1.5	1.2	1.1	1.1
	C	1.6	1.5	1.3	1.1	1.1	1.1
Coronary heart disease (410-412&414)	C	1.0	1.0	1.2	1.0	1.0	1.0
	C[a]		1.3	1.0			
Brochitis (491) and emphysema (492)	D&P	2.9	2.6	2.1	1.5	1.2	1.2
	C	1.4	1.3	1.3	1.2	1.2	1.2
	C[a]		1.4	1.4			

[1] D&P = Doll and Peto (1976), C = Cederlöf et al (1975).

[a] Attributable risks for the latter of the successive five year age groups.

Table A4.4. The estimated proportion (%) of smokers, former smokers and ever smokers in the Finnish population by age and sex in 1976.

	AGE GROUP						
	25-34	35-44	45-54	55-64	65-74	75-99	Total
MALES							
Smokers	44.5	41.3	41.9	34.4	30.8	15.0	39.2
Former smokers	22.8	25.4	33.3	43.4	41.8	48.9	32.0
Never smoked	32.8	33.4	24.8	22.1	27.4	36.1	28.8
N	1415	1199	1361	935	572	180	5662
FEMALES							
Smokers	29.2	16.6	14.3	9.1	3.7	0.7	15.4
Former smokers	14.3	9.0	6.9	6.2	3.5	2.2	8.3
Never smoked	56.5	74.3	78.8	84.7	92.8	97.1	76.3
N	1310	1329	1415	1033	655	273	6015

Source: Kalimo et al (1982).

Table A4.5. Attributable risks (%) for different illnesses (ICD-9 code) estimated in this study for male-smokers by age in 1987

	Study[1]	AGE GROUP 35-44	45-54	55-64	65-74	75-84	85+
Cancer of							
Oral cavity (140-149)*	D&P	41.6	41.7	40.2	39.4	32.1	32.1
	H	22.2	22.4	20.0	18.6	11.2	11.2
Esophagus (150)*	D&P	30.2	30.4	28.0	26.6	17.8	17.8
	H	11.7	11.8	10.1	9.3	5.0	5.0
Pancreas (157)	D&P	19.9	20.1	17.1	15.6	8.3	8.3
	H	41.1	41.5	36.8	26.5	14.9	14.9
	C	46.4	46.8	41.9	39.3	24.0	24.0
Larynx (161)*	H	38.4	38.5	36.7	35.6	27.3	27.3
Lung (162-163)	D&P	84.3	84.5	81.7	80.0	66.1	66.1
	H	73.9	74.1	70.2	76.5	61.4	61.4
	C	71.2	71.5	67.4	64.9	47.4	47.4
Urinary bladder (188)	D&P	31.2	31.5	27.5	25.3	14.2	14.2
	H	44.7	45.1	40.3	37.6	22.7	22.7
	C	24.8	25.1	21.6	19.8	10.7	10.7
Coronary heart disease (410-412&414)	D&P	76.1	46.8	14.7	8.5	0.1	0.1
	H	0.0	43.1	22.4	12.2	3.5	3.5
	C	0.0	40.1	19.4	17.7	9.5	9.5
	C[a]	39.8	22.7				
Aortic aneurysm (441)	D&P	69.8	70.1	65.8	63.3	45.7	45.7
	H	40.1	40.4	35.8	54.7	37.0	37.0
	C	19.9	20.1	17.1	15.6	8.3	8.3
Other peripheral vascular diseases (443)	H	6.9	7.0	5.8	5.3	2.6	2.6
Brochitis (491) and emphysema (492)	D&P	90.7	90.8	89.1	87.9	78.0	78.0
	H	69.6	69.9	65.6	76.2	61.0	61.0
	C	19.9	20.1	17.1	15.6	8.3	8.3

[1] D&P = Doll and Peto (1976), H = Hammond (1966), C = Cederlöf et al (1975).

[a] Attributable risks for the latter of the successive five year age groups.

* 50 % of the excess cases of smokers attributed to other factors.

Table A4.6. Attributable risks (%) for different illnesses (ICD-9 code) estimated in this study for **female-smokers** by age in 1987

	Study[1]	AGE GROUP					
		35-44	45-54	55-64	65-74	75-84	85+
Cancer of							
Pancreas (157)	C	19.9	17.7	12.0	5.3	1.0	1.0
Lung (162-163)	D&P	39.9	36.4	26.7	12.9	2.7	2.7
	H	16.6	14.6	9.8	4.3	0.8	0.8
	C	36.7	33.4	24.2	11.5	2.4	2.4
Urinary bladder (188)	C	9.1	7.9	5.2	2.2	0.4	0.4
Coronary heart disease (410-412&414)	H	0.0	12.5	5.9	1.6	0.1	0.1
	C	0.0	0.0	12.7	0.4	0.1	0.1
	C[a]		18.6	0.9			
Brochitis (491) and emphysema (492)	D&P	61.2	57.6	46.4	26.0	6.2	6.2
	H	39.2	35.7	26.1	12.6	2.7	2.7
	C	0.0	0.0	6.0	4.3	0.8	0.8
	C[a]		9.1	9.8			

[1] D&P = Doll and Peto (1976), H = Hammond (1966), C = Cederlöf et al (1975).

[a] Attributable risks for the latter of the successive five year age groups.

Table A4.7. Attributable risks (%) for different illnesses (ICD-9 code) estimated in this study for **smokers and former smokers** by age and sex in 1987

	Study[1]	AGE GROUP					
		35-44	45-54	55-64	65-74	75-84	85+
MALES							
Lung cancer (162-163)	D&P	86.1	86.7	85.5	84.4	78.3	78.3
	C	79.2	80.8	81.1	80.0	80.0	80.0
Coronary heart disease (410-412&414)	D&P	76.7	50.0	23.1	16.7	13.0	13.0
	C	9.1	44.4	33.3	28.6	23.1	23.1
	C[a]	44.4	33.3				
Brochitis (491) and emphysema (492)	D&P	93.0	93.5	93.3	29.9	91.1	91.1
	C	47.4	54.5	58.3	56.5	58.3	58.3
FEMALES							
Lung cancer (162-163)	D&P	47.4	41.2	33.3	16.7	9.1	9.1
	C	37.5	33.3	23.1	9.1	9.1	9.1
Coronary heart disease (410-412&414)	C	0.0	0.0	16.7	0.0	0.0	0.0
	C[a]		23.1	0.0			
Brochitis (491) and emphysema (492)	D&P	65.5	61.5	52.4	33.3	20.0	20.0
	C	28.6	23.1	23.1	16.7	9.1	9.1
	C[a]		28.6	28.6			

[1] D&P = Doll and Peto (1976), C = Cederlöf et al (1975).

[a] Attributable risks for the latter of the successive five year age groups.

APPENDIX 5: COSTS OF HOSPITAL INPATIENT CARE BY DIAGNOSIS

In Finland, costs of hospital inpatient care by diagnosis are not available. It is highly unlikely that the cost per day of smoking related diagnoses would equal the average cost. Therefore a special two-stage method was developed to estimate these approximately. Estimation of the diagnosis specific costs per day was based on the hospital discharge register data and data on hospital costs.

In the **first stage**, the distribution of bed days by hospital type and specialty was estimated for each diagnosis from the hospital discharge data. Hospitals were classified into six categories: university hospitals, other central hospitals, district hospitals, specialist-led health centre hospitals, ordinary health centre hospitals, and other hospitals. All hospital types were classified into nine specialties: internal medicine, surgery, gynecology, pediatrics, ENT, skin- and veneral diseases, tuberculosis, lung diseases and other specialties. The distribution of bed days by diagnosis was obtained by the following formula

$$(5.1) \quad a_{ijk} = HD_{ijk} / \sum_j \sum_k HD_{ijk},$$

where a_{ijk} = the proportion of bed-days in hospital type j in specialty k of all bed-days for diagnosis i

HD_{ijk} = the total number of bed-days for diagnosis i in specialty k in hospital type j.

In the **second stage**, the diagnosis specific cost per bed-day was estimated as a weighted average of the cost per day by hospital type and specialty, using the proportions derived by (5.1) as weights. The estimated cost per bed-day for diagnosis i (AC_i) was obtained by

(5.2) $AC_i = \sum_j \sum_k a_{ijk} AC_{jk}$

where AC_{jk} = the cost per bed-day in specialty k in hospital type j.

Detailed data on the number of bed-days by diagnosis in various types of hospitals by specialties were obtained from unpublished hospital discharge register data provided by the National Board of Health (Lääkintöhallitus 1989). Cost data were derived from the Hospital Statistics (Sairaalaliitto 1988) and from the Financial Statistics of Health Centres (Suomen kaupunkiliitto 1988).

Cost per day by specialty in university hospitals, other central hospitals and district hospitals for the eight specialities specified above was obtained directly from the Hospital Statistics (Sairaalaliitto 1988). Cost per day in other specialties was calculated as the weighted average of the cost per day in excluded specialties, using the number of bed-days as weights. Reliable specialty costs were not available for health centre hospitals and other hospitals and therefore average cost per day was used as a proxy. Average cost per day in specialist-led and ordinary health centre hospitals was obtained directly from the Financial Statistics of Health Centres (Suomen kaupunkiliitto 1988). Cost per day in other hospitals was approximated by the weighted average of the cost per day in tuberculosis-, local- and private hospitals, using the number of bed-days as weights. The average capital costs per bed-day were estimated on the basis of the capital costs by the type of hospital applying the two-stage method described above. The estimated diagnosis specific costs per bed-day are given in Table A5.1.

Table A5.1. Diagnosis specific cost per bed-day in 1987 used in the study

Diagnosis	ICD-9 code	Cost per bed-day (FIM)
Cancer of		
Oral cavity	140-149	1237.70
Esophagus	150	913.30
Pancreas	157	1262.20
Larynx	161	1143.50
Lung	162&163	1262.20
Urinary bladder	188	1262.20
Coronary heart disease	410-412&414	787.40
Aortic aneurysm	441	810.80
Other diseases of the peripheral vessels	443	680.30
Bronchitis	491	830.10
Emphysema	492	1126.40

APPENDIX 6: HEALTH CARE FINANCING

Distribution of the economic burden arising from the health care expenditure attributed to smoking was estimated using the best available information on health care financing. The proportion of health care expenditure financed by different parties was derived from various statistical sources. Smoking related health care expenditure was allocated between different parties on the basis of the estimated financing shares. The financing shares shown in Table A6.1 include the capital costs of hospitals and health centres.

Table A6.1. Financing of smoking related health expenditure (%) in 1987

	FINANCED BY						
	State	Munici-palities	SII[1]	Employ-ers	Smokers	Others	TOTAL FINAN-CING[2]
HOSPITAL CARE							
General hospital inpatient care[3]	40.2	47.7	-	-	6.0	6.1	100.0
OUTPATIENT CARE							
General hospital outpatient care[3]	40.2	47.7	-	-	6.0	6.1	100.0
Health centres[4]	41.2	46.4	-	-	7.0	5.4	100.0
Private sector[5]	-	-	41.3	-	58.7	-	100.0
Occupational health care[6]	-	-	57.7	42.3	-	-	100.0

Table A6.1. ... continued.

	FINANCED BY						
	State	Munici-palities	SII[1]	Employ-ers	Smokers	Others	TOTAL FINAN-CING[2]
MEDICINES							
Prescribed medicines[5]	-	-	64.1	-	35.9	-	100.0
Over-the-counter medicines	-	-	-	-	100.0	-	100.0
REHABILITATION	-	-	100.0	-	-	-	100.0

[1] The Social Insurance Institution.

[2] Numbers may not add to totals due to rounding.

[3] Finnish Hospital Statistics 1987 (Sairaalaliitto 1988) and Financial Statistics on Health Centres 1987 (Suomen kaupunkiliitto 1988).

[4] Financial Statistics on Health Centres 1987 (Suomen kaupunkiliitto 1988).

[5] Age- and Occupation Statistics 1987 (Kansaneläkelaitos 1988a).

[6] Occupational Health Care Statistics 1985 (Kansaneläkelaitos 1988c).

APPENDIX 7: WORKING DAYS LOST TO SICKNESS AND THE ASSOCIATED DAYS OF ILLNESS

The number of working days lost to sickness absence and the number of associated days of illness were estimated separately for each diagnosis, age and sex group for people aged 35 to 64 years on the basis of sickness allowances paid by the Social Insurance Institution.

Sickness allowance is paid for weekdays, i.e. for six days per week, but only after an initial delay of eight weekdays, including at least one Saturday and Sunday. Therefore a maximum of seven working days or ten days of illness within each spell remain uncovered. So the number of days covered by sickness insurance underestimates the total number of days lost due to illness. The following procedures were developed to estimate the total number of days lost due to illness.

Lost working days. Since a normal week has on average five working days, 5/6 of the days covered by the sickness insurance are working days. Allowing for the waiting period, the number of working days lost due to illness can be approximated with the following formula

$$(7.1) \quad WD_{ijk} = 7SP_{ijk} + \frac{5}{6}DI_{ijk}$$

where WD_{ijk} = the number of working days lost in age group i by sex j due to illness k,

SP_{ijk} = the number of spells of illness covered by the sickness insurance in age group i by sex j due to illness k,

DI_{ijk} = the number of days covered by the sickness insurance in age group i by sex j due to illness k.

Days of illness. The sickness allowance is not payable for Sundays. Thus, the sickness insurance covers 6/7 of the days of the week. Allowing for the waiting period, at least nine (at most ten) days of illness within each spell remain uncovered. The number of days of illness associated with sickness absence can be approximated with the following formula

$$SD_{ijk} = 9SP_{ijk} + \frac{7}{6}DI_{ijk} \quad (7.2)$$

where SD_{ijk} = the number of days of illness in age group i by sex j due to illness k.

Unpublished diagnosis, sex and age specific data provided by the Social Insurance Institution (Kansaneläkelaitos 1989) were used for the number of spells of illness, the SP_{ijk}'s, and the number of days covered by the sickness insurance, the DI_{ijk}.

APPENDIX 8: LOST PRODUCTION

Production losses were estimated for sickness absence, disability and premature deaths. The formulae used for estimating production losses are given below. In order to simplify matters the subscripts defining sex have been omitted.

The annual value of individual's production

The annual value of production of a person belonging to age group i (w_i) was defined as follows:

$$(8.1) \quad w_i = (1 + p_1 + p_2)W_i,$$

where p_1 = operating surplus as a percentage of wages and salaries in the economy,

p_2 = employer contribution to social security schemes as a percentage of wages and salaries in the economy,

W_i = average annual earnings of a person belonging to age group i.

The value of production lost per person

Sickness absence. For the low estimate the value of production lost per day due to sickness absence by a person belonging to age group i ($lp^1{}_i$) was obtained by

$$(8.2) \quad lp^1{}_i = w_i/d,$$

where d = the number of working days in a year.

For the **high** estimate the value of production lost per day due to sickness absence for persons aged 25-64 was calculated as a weighted average of age specific production losses, using the number of employed persons as weights. The estimated lost production per day for persons aged 25-64 was FIM 773 for males and FIM 513 for females.

Disability. Production lost due to disability was estimated only for one year and was defined for a person belonging to age group i as follows

$$(8.3) \quad lp^2_i = w_i\left(\frac{lf_i - ue_i}{P_i}\right),$$

where lp^2_i = expected value of production per year of a person belonging to age group i,
lf_i = labour force in age group i,
ue_i = unemployed persons in age group i,
P_i = mean population in age group i.

Premature deaths. The present value of production lost by the age of 65 due to premature death of a person belonging to age group i was derived by applying the method suggested by Chiang (1968) for estimating life-expectancy:

$$(8.4) \quad lp^3_i = a_i n_i w_i\left(\frac{lf_i - ue_i}{P_i}\right) + \sum_{j=i+1}^{w}[(1 - a_{j-1})n_{j-1} + a_j n_j]w_j\left(\frac{lf_j - ue_j}{P_j}\right)\left(\frac{1+p}{1+r}\right)^{j-i}\frac{l_j}{l_i} + a_w n_w w_w\left(\frac{lf_w - ue_w}{P_w}\right)\left(\frac{1+p}{1+r}\right)^{w-i}\frac{l_w}{l_i}$$

where lp^3_i = expected present value of production per year of a person belonging to age group i,

a_i = fraction of last age interval of life lived by a person who has died in age group i,

n_i = the length of an age interval i,

p = anticipated growth in productivity,

r = discount rate,

l_j = number of survivors at age interval j of those alive at age interval i.

The total value of lost production

The total value of production lost due to smoking related sickness absence, disability and premature deaths was calculated in the same way in all cases.

The total value of production lost in age group i by sex j in disease k due to cases attributed to smoking (LP^s_{ijk}) was calculated as follows

$$(8.5) \quad LP^s_{ijk} = C_{ijk} lp^s_{ij},$$

where C_{ijk} = the number of cases (sickness absence, disability, premature deaths) of disease k attributed to smoking in age group i and sex j.

The total value of production lost in disease k due to cases attributed to smoking (LP^s_k) is

$$(8.6) \quad LP^s_k = \sum_i \sum_j LP^s_{ijk}$$

and the total value of production lost attributed to smoking (LP^s) is

$$(8.7) \quad LP^s = \sum_k LP^s_k.$$

The proportion of operating surplus and employers' social security contribution, the p_1 and p_2, were derived from the National Accounts (Tilastokeskus 1988a) and assumed to be equal for all age and sex groups. The age- and sex specific earnings data, the W_{ij}'s, were obtained from the unpublished income distribution statistics provided by the Central Statistical Office (Tilastokeskus 1989d). The number of working days, d, per year was assumed to be 220. Age and sex specific data on labour force and unemployment, the lf_{ij}'s and ue_{ij}'s, were obtained from the labour statistics (Työvoimaministeriö 1988). Age- and sex specific survival probabilities, the l_{jj}/l_{ij}'s, were derived from the vital statistics (Tilastokeskus 1989a) which also provided the mean populations, the P_{ij}'s. The length of the age interval, the n_i, was five years. The fraction of last age interval of life, a_{ij}'s, were obtained from Chiang (1968).

The Economic Planning Centre's estimate of 2.4 % (Parkkinen and Järviö 1988) was used for the anticipated annual growth in productivity. We used a 4 % discount rate, as did Vinni (1982), which falls between the 2-6 % suggested by the Helsinki Business Research Institute (LTT 1984).

The value of production lost due to sickness absence, disability and premature death per person by age and sex is given in Table A8.1.

Table A8.1. The value of production lost due to sickness absence, disability and premature death per person in 1987.

SEX Age	Production lost due to		
	Sickness absence (FIM per person per day)	Disability (FIM per person per year)	Premature death, present value (FIM per person, 4 % discount rate)
Males			
35-39	833	167 494	2 877 681
40-44	891	177 547	2 246 573
45-49	831	161 554	1 575 970
50-54	778	136 725	954 077
55-59	772	97 573	441 329
60-64	667	44 956	110 396
65+	0	0	0
Females			
35-39	531	101 153	1 799 150
40-44	563	110 059	1 403 761
45-49	542	102 068	968 599
50-54	512	87 008	557 865
55-59	481	54 169	231 780
60-64	411	20 401	51 916
65+	0	0	0

APPENDIX 9: INCIDENCE OF LOST PRODUCTION

The incidence of lost production was estimated separately for sickness absence, disability and premature death by age and sex. The estimated age and sex specific lost production was reclassified into seven categories on the basis of the redistribution of the value of production: employers' operating surplus, employers' contribution to social security schemes, taxes and fiscal charges paid by employees (state and municipal income tax, social security contributions and church tax) and employees' net income.

Operating surplus and employers' contribution to social security schemes

The value of an employee's labour input to the employer is the wage or salary (wage for short) paid to the employee plus the employer's contribution to social security schemes, and operating surplus. Social security contributions are aimed to cover part of the employee's social security and they are paid to insurance companies by the employer. The operating surplus covers the employer's other variable costs. The cost of labour to the employer is the wage plus the employer's social security contributions.

An employer's social security contributions can be statutory or voluntary. Statutory contributions are meant to cover part of the employee's social security (employees' pensions scheme, national pension insurance, national sickness insurance, industrial injuries insurance and unemployment insurance) and are paid to insurance companies by the employer. Statutory contributions are a fixed proportion of the wage-bill. The employer can also make voluntary contributions to an employee's social security.

The proportions of operating surplus and employers' social security contributions in lost production were assumed to be equal for all age and sex groups and they were estimated in the following way

$$(9.1) \quad os_{ik} = p_k W_i / w_i = p_k W_i / (1 + p_1 + p_2) W_i$$

where os_{ik} = the proportion of operating surplus (i=1)/employers' contribution to social security schemes (i=2) in the production lost by a person belonging to age group i,

p_k = operating surplus/employers' contribution to social security schemes as a percentage of wages and salaries in the economy,

W_i = average annual earnings of a person belonging to age group i,

w_i = the annual value of production of a person belonging to age group i.

Taxes, fiscal charges and net income

The price of labour to the employee equals gross wage. On the basis of gross wage the employee pays income tax to state and municipality and compulsory social security contributions to the Social Insurance Institution. Most of the employees belong to either of the state churches (the Lutheran or the Orthodox) and pay church tax to them. Deducting all these taxes and fiscal charges from the gross wage gives the net wage, which the employee is free to consume or save.

Earnings vary by age and sex. Earnings are highest for those aged 40-44 regardless of sex. However, males have higher earnings than females in all age groups (Tilastokeskus 1989d). The state income tax paid by an employee depends on his earnings, tax deductions and progression of taxation. Due to progression those on high income are taxed more heavily than those on low income. Municipal income tax is a proportional tax;

all tax payers pay the same proportion of their income. Besides earnings and tax allowances, the municipal tax also depends on his place of residence, which determines the tax rate. Each employee pays a fixed share of his income subject to municipal taxation in compulsory social security contributions (for national pension and sickness insurance). Church tax is determined in the same way as the municipal tax.

By estimating the proportion of various taxes and fiscal charges in the income subject to state taxation it is possible to roughly take into account the variations in earning levels according to age and sex (hence progression of state income tax), deductions in state and municipal taxation, place of residence and belonging to state churches.

The proportion of state income tax in the earnings was estimated separately for males and females by age group as follows

$$(9.2) \quad t_{ij} = T_{ij}/Y_{ij}$$

where t_{is} = the proportion of state income tax in age group i of sex j,

T_{ij} = the total value of state income tax paid by sex j in age group i,

Y_{ij} = the total income subject to state income taxation in age group i of sex j.

The proportion of state income tax in the production lost by age group i and sex j (tlp_{ij}) was obtained by

$$(9.3) \quad tlp_{ij} = (1 - os_1 - os_2)t_{ij}.$$

The proportions of municipal income tax, church tax and compulsory social security contributions in the production lost by age and sex was obtained in the same way applying the formulae (9.2) and (9.3).

The proportion of net income (dlp) in the production lost by age group i of sex j was obtained as a residual

$$(9.4) \quad dlp_{ij} = 1 - os_1 - os_2 - \sum_{k=1}^{4} tlp_{kij}.$$

The data for deriving the proportions of operating surplus and employers' social security contributions in lost production, the os_1 and os_2, were given in Appendix 8. The proportions of other categories were derived from the income and property statistics data (Tilastokeskus 1988b) separately for males and females in each age group.

The incidence of production lost due to sickness absence and disability (shown in Table A9.1) was estimated by multiplying the age and sex specific production losses by the proportions derived with the method described.

The incidence of production lost due to premature deaths was estimated by a three-stage method. First, the annual value of production of a person estimated by (8.1) was broken down into parts by applying the proportions derived by formulae (9.1)-(9.4). Second, the present value of various parts of lost production by age and sex was estimated by applying the formula (8.4). Finally, the proportion of each part in the present value of lost production was calculated. The proportions used in the study are given in Table A9.2.

Table A9.1. The incidence of production lost due to sickness absence and disability in 1987 (%)

SEX Age	Operating surplus	Employer's social security contributions	State income tax	Municipal income tax	Employee's social security contributions	Church tax	Disposable net income	TOTAL PRODUCTION LOST[1]
MALES								
35-44	25.7	13.8	9.0	8.3	1.8	0.6	40.9	100.0
45-54	25.7	13.8	9.8	8.8	1.9	0.6	39.4	100.0
55-64	25.7	13.8	8.5	8.7	0.7	0.3	42.4	100.0
25-64	25.7	13.8	9.2	8.5	1.7	0.5	40.6	100.0
FEMALES								
35-44	25.7	13.8	6.0	8.3	1.8	0.6	43.9	100.0
45-54	25.7	13.8	6.7	8.2	1.8	0.6	43.4	100.0
55-64	25.7	13.8	5.4	7.0	1.3	0.5	46.3	100.0
25-64	25.7	13.8	6.2	8.1	1.7	0.6	44.0	100.0

[1] Numbers may not add to totals due to rounding.

Table A9.2. The incidence of production lost due to premature death in 1987 (%)

SEX Age	Opera-ting surplus	Employer's social security contri-butions	State income tax	Munici-pal income tax	Employee's social security contri-butions	Church tax	Dispo-sable net income	TOTAL PRO-DUCTION LOST[1]
MALES								
35-39	25.7	13.8	9.3	8.6	1.7	0.5	40.5	100.0
40-44	25.7	13.8	9.4	8.7	1.6	0.5	40.4	100.0
45-49	25.7	13.8	9.4	8.8	1.5	0.5	40.4	100.0
50-54	25.7	13.8	9.0	8.7	1.2	0.4	41.3	100.0
55-59	25.7	13.8	8.5	8.7	0.7	0.3	42.4	100.0
60-64	25.7	13.8	8.5	8.7	0.7	0.3	42.4	100.0
FEMALES								
35-39	25.7	13.8	6.2	8.1	1.7	0.6	44.0	100.0
40-44	25.7	13.8	6.3	8.0	1.7	0.6	44.0	100.0
45-49	25.7	13.8	6.3	7.8	1.6	0.6	44.2	100.0
50-54	25.7	13.8	5.9	7.5	1.5	0.5	45.1	100.0
55-59	25.7	13.8	5.4	7.0	1.3	0.5	46.3	100.0
60-64	25.7	13.8	5.4	7.0	1.3	0.5	46.3	100.0

[1] Numbers may not add to totals due to rounding.

APPENDIX 10: WORKING YEARS AND LIFE YEARS LOST DUE TO PREMATURE DEATH

The numbers of working and life years lost due to premature death were derived by applying the method suggested by Chiang (1968) for estimating life-expectancy. To simplify matters, subscripts referring to sex have been omitted.

The number of years lost per person

Working years. The number of working years lost by the age of 65 due to premature death of a person belonging to age group i was estimated by the following formula

$$(10.1)\quad e^{w}_{i} = a_i n_i + \sum_{j=i+1}^{w} [(1 - a_{j-1})n_{j-1} + a_j n_j]\frac{l_j}{l_i} + a_w n_w \frac{l_{w+1}}{l_i}$$

where e^{w}_{i} = expected working years of a person belonging to age group i,

a_i = fraction of last age interval of life lived by a person who has died in age group i,

n_i = the length of an age interval i,

l_j = number of survivors at age interval j of those alive at age interval i.

Life years. The number of life years lost due to premature death of a person belonging to age group i was estimated as follows

$$(10.2)\quad e_i = a_i n_i + \sum_{j=i+1}^{k} [(1 - a_{j-1})n_{j-1} + a_j n_j]\frac{l_j}{l_i}$$

where e_i = expected length of life of a person belonging to age group i.

The total number of years lost

The total number of **life years lost** in age group i by sex j from disease k due to premature deaths attributed to smoking (LE_{ijk}) was calculated as follows

(10.3) $LE_{ijk} = D_{ijk}e_{ij}$,

where D_{ijk} = the number of premature deaths of disease k attributed to smoking in age group i and sex j.

The total number of life years lost in disease k due to premature deaths attributed to smoking (LE_k) was obtained by summation

(10.4) $LE_k = \sum_i \sum_j LE_{ijk}$

and the total number of life years lost due to premature deaths attributed to smoking (LE) by

(10.5) $LE = \sum_k LE_k$.

The total number of **working years lost** was calculated in the same way.

Data sources for estimating the e^w_i in (10.1) and e_i in (10.2) were given in Appendix 8. The estimated number of working and life years lost due to premature death used in this study are given in Table A10.1.

Table A10.1 The number of expected working years and life years lost due to premature death in 1987 used in this study

SEX Age	Life expectancy	Expected working years
MIEHET		
35-39	37.50	25.61
40-44	32.96	20.90
45-49	28.56	16.26
50-54	24.33	11.67
55-59	20.39	7.11
60-64	16.75	2.46
65-69	13.52	-
70-74	10.62	-
75-79	8.24	-
80-84	6.28	-
85+	4.87	-
NAISET		
35-39	44.87	26.86
40-44	40.07	21.97
45-49	35.31	17.09
50-54	30.71	12.27
55-59	26.13	7.42
60-64	21.76	2.54
65-69	17.61	-
70-74	13.79	-
75-79	10.45	-
80-84	7.74	-
85+	5.69	-

APPENDIX 11: FAMILY PENSIONS

Family pension is payable to the relatives of a deceased person. Family pensions include a widow's pension, payable to women under 65, and an orphan's pension (Kansaneläkelaitos 1988b). Widow's pensions comprise a starting pension followed by a regular maintenance pension. Widowers are not entitled to this pension.

Family pensions resulting from smoking related premature deaths in males was estimated separately for the four pension categories: widow's starting pension, widowed mother's maintenance pension, childless widow's maintenance pension and orphan's pension. When estimating a widow's pension it is assumed that she belongs to the same age-group as her dead husband.

Widow's starting pension. A widow's starting pension is payable for six months after the death of the deceased. Pensions attributed to smoking were estimated on the basis of the number of smoking related deaths in men, the probability that the deceased man was married and the average starting pension as follows

(11.1) $WSP_i = 6D_i pm_i wsp_i$

where WSP_i = widow's starting pensions due to deaths attributed to smoking in males belonging to age group i,

D_i = the number of deaths attributed to smoking in males belonging to age group i,

pm_i = probability that a man belonging to age group i is married,

wsp_i = the average monthly widow's starting pension in age group i.

Widowed mother's maintenance pension. A widow's maintenance pension is payable to a woman after her six-month starting pension ends if she is a widowed mother with a child under 16 who is entitled to orphan's pension. Widowed mother's maintenance pensions were estimated up to the age of 65 and discounted to their present value. Estimation took the following into account: the probability that the dead man was married, the probability that he had children under 16, widow's survival probability and the number of children under 16 she was likely to have at different ages. The present values of these pensions were estimated by the following formula

$$(11.2) \quad WMP_i = D_i pm_i pc_i pvmp_i$$

where WMP_i = widowed mother's maintenance pensions due to deaths attributed to smoking by males belonging to age group i,

pc_i = the probability that the widow of a deceased man belonging to age group i has a child under 16 who is entitled to orphan's pension,

$pvmp_i$ = expected present value of widowed mother's maintenance pension for widows belonging to age group i.

The term $pvmp_i$ was estimated by applying the method suggested by Chiang (1968) for estimating life-expectancy

$$(11.3) \quad pvmp_i = a_i n_i mp_i + \sum_{j=i+1}^{w} [(1 - a_{j-1}) n_{j-1} + a_j n_j] mp_j \left(\frac{1 + s}{1 + r}\right)^{j-i} \frac{l_j}{l_i} + a_w n_w mp_w \left(\frac{1 + p}{1 + r}\right)^{w-i} \frac{l_j}{l_i}$$

where a_i = fraction of last age interval of life lived by a woman who has died in age group i,

n_i = the length of an age interval i,

mp_i = the average annual maintenance pension of a widowed mother belonging to age group i,

s = anticipated real growth in widow's pension,

r = discount rate,

l_j = number of survivors at age interval j of those women alive at age interval i.

Childless widow's maintenance pension. Widow's maintenance pension is also payable to a childless woman if she is aged 40-64 and with limited income. Childless widows' maintenance pensions were estimated up to the age of 65 and discounted to their present value. Estimation took the following into account: the probability that the dead man was married, the probability that she had no children and widow's survival probability. These pensions were estimated by the formula (11.2) with appropriate modifications. The term pc_i in (11.2) was defined as the probability that the widow had no children and the term $pvmp_i$ in (11.2) as the expected present value of a childless widow's maintenance pension, which was estimated applying formula (11.3).

Orphan's pension. Orphan's pension is payable to all half and full orphans under 16 as well as those between 16 and 21 who cannot maintain themselves, e.g. because they are studying. Different rates of benefit are paid to half and full orphans. The average orphans's pension was estimated as the weighted mean of the average pensions for half and full orphans. Orphans' pensions were estimated on the assumption that they would be paid for eight years. Estimation allowed for the probability that the dead man was married and that he had children under 21. The pensions were discounted to their present value. These pensions were estimated by the formula (11.2) with appropriate modifications. The term pc_i in (11.2) was defined as the probability that the deceased man had children under 21 and the term $pvmp_i$ in (11.2) as the expected present value of an orphan's pension, which was estimated applying formula (11.3).

We used a 4 % discount rate and assumed a 2 % annual real growth rate in pensions. Age-specific average pensions were obtained from the age- and occupation statistics (Kansaneläkelaitos 1988a). Age-specific survival probabilities for females were derived from the vital statistics (Tilastokeskus 1989a) by the method of Chiang (1968). The probabilities of the men being married and with children, and of a widow being childless were estimated from the population statistics (Tilastokeskus 1988h).

APPENDIX 12: EXPECTED LIFE-TIME HEALTH CARE EXPENDITURE

There is no data on health care expenditure by age and sex in Finland. Therefore a specific method was developed to estimate the expected life-time expenditure by age and sex in various health services.

The expected health care expenditure was estimated separately for hospital care, physician services and pharmaceuticals. Expected expenditure on physician services was broken down into five categories: hospital outpatient care, health centres, occupational health care, private practitioners and private sector examinations and treatments. Pharmaceutical expenditure was broken down into expenditure on prescribed medicines and over-the counter-medicines.

The formulae used for estimating the expected life-time expenditure by age and sex are given below. In order to simplify matters subscripts referring to sex have been omitted.

Expected life-time health care expenditure by age and sex

Hospital inpatient care. The expected life-time expenditure on hospital inpatient care by age and sex was determined by applying the Chiang's method (1968) for estimating life-expectancy

$$(12.1)\quad ec_i = a_i n_i c_i + \sum_{j=i+1}^{k} [(1 - a_{j-1}) n_{j-1} + a_j n_j] c_j \left(\frac{1 + t}{1 + r}\right)^{j-i} \frac{l_j}{l_i}$$

where ec_i = the present value of expected life-time expenditure on hospital inpatient care for a person belonging to age group i,

a_i = fraction of last age interval of life lived by a person who has died in age group i,

n_i = the length of an age interval i,

c_i = average annual expenditure on hospital inpatient care for person belonging to age group i,

t = anticipated annual growth in real costs of hospital inpatient care (assumed to be the same for all hospitals),

r = discount rate,

l_j = number of survivors at age interval j of those alive at age interval i.

The age and sex specific annual expenditure on hospital inpatient care, the c_i's in (12.1), were estimated on the basis of the distribution of bed-days by age and sex in various types of hospitals as follows

$$(12.2) \quad c_i = \frac{1}{P_i} \sum_{j=1}^{m} d_{ij} p_j,$$

where d_{ij} = the number of bed-days in hospital type j by persons belonging to age group i,

p_j = the cost per bed-day in hospital type j,

P_i = mean population of age group i.

The data on the number of bed-days by age and sex in various types of hospitals, the d_{ij}'s, were obtained from the unpublished hospital discharge register data provided by the National Board of Health (Lääkintöhallitus 1989). Cost data, the p_j's, were derived from the Hospital Statistics (Sairaalaliitto 1988) and from the Financial Statistics of Health Centres (Suomen kaupunkiliitto 1988). We assumed a 2.5 % growth in real costs of hospital care. Data sources for estimating other elements in (12.1) were given in appendix 8.

Physician services. The expected life-time expenditure on physican services by age and sex was estimated separately for each sector by a formula similar to (12.1)

$$(12.3) \quad ec_{is} = a_i n_i c_{is} + \sum_{j=i+1}^{k}[(1 - a_{j-1})n_{j-1} + a_j n_j]c_{js}\left(\frac{1 + u}{1 + r}\right)^{j-i}\frac{l_j}{l_i}$$

where ec_{is} = the present value of expected life-time expenditure on physician services in sector s for a person belonging to age group i,

c_{is} = average annual expenditure on physician services in sector s for person belonging to age group i,

u = anticipated annual growth in real costs of physician services (assumed to be the same for all sectors).

The age and sex specific annual expenditure on physician services by sectors, the c_{is}'s in (12.3), were estimated on the basis of the distribution of physician visits by age and sex as follows

$$(12.4) \quad c_{is} = \frac{d_{is}}{P_i} p_s,$$

where d_{is} = the number of physician visits in sector s by persons belonging to age group i,

p_s = the cost per physician visit in sector s.

The numbers of physican visits to general hospital outpatient departments, health centres and occupational health care by age and sex, the d_{is}'s, were obtained from the unpublished survey data collected for the Personal Doctor Program (Vohlonen 1989). The cost per visit, the p_s's, were obtained from various sources (Sairaalaliitto 1988, Pekurinen 1989, Luoma 1989) and were assumed to be the same for all age and sex groups. Included in these figures are the costs of laboratory-, X-ray- and other examinations, apart from occupational health care where they cover only the direct costs of physician services (cost of labour, office, administration, etc.). We assumed a 2.4 % growth in real costs of physician services. Data sources for estimating other elements in (12.3) were given in appendix 8.

The c_{is}'s for services provided by the private sector were obtained directly from the age- and occupation statistics of the Social Insurance Institution (Kansaneläkelaitos 1988).

Pharmaceuticals. The expected life-time expenditure on pharmaceuticals by age and sex was estimated separately for prescribed medicines and over-the-counter medicines by applying the formulae (12.3) and (12.4) with appropriate modifications. The product $d_{is}p_s$ in (12.4) was replaced by pharmaceutical expenditure by age and sex.

Expenditure on prescribed medicines by age and sex was obtained from the age- and occupation statistics of the Social Insurance Institution (Kansaneläkelaitos 1988a). The per capita expenditure on over-the-counter medicines was assumed to be the same for all age and sex groups and estimated as follows. The total expenditure on over-the-counter medicines was defined as the pharmacies' total sales minus the sales of prescribed medicines, veterinary preparations and non-pharmaceutical products. The per capita expenditure on over-the-counter medicines was obtained by dividing the total expenditure by the mean population. Unpublished data on the value of pharmacies' total sales was provided by the the National Board of Health (Hurme 1989).

'Avoided' health care expenditure

The health care expenditure 'avoided' due to premature deaths attributed to smoking were estimated separately for each of the services examined and for each age and sex group. The total expenditure 'avoided' in age group i by sex j in service s due to premature deaths attributed to smoking (EXA_{ijs}) was calculated as follows

$$(12.5) \quad EXA_{ijs} = D_{ij}ec_{ijs},$$

where D_{ij} = the number of premature deaths attributed to smoking in age group i and sex j.
ec_{ijs} = the present value of expected life-time expenditure on service s for a person belonging to age group i of sex j.

The total expenditure 'avoided' in service s due to premature deaths attributed to smoking (EXA_s) was obtained by summation

$$(12.6) \quad EXA_s = \sum_i \sum_j EXA_{ijs}$$

and the total expenditure 'avoided' due to premature deaths attributed to smoking (EXA) by

$$(12.7) \quad EXA = \sum_s EXA_s.$$

The present values of expected life-time expenditure, the ec_{ijs}'s, used in this study are given in Table A12.1.

Table A12.1 Estimated present value of expected life-time expenditure on some health care services in 1987, FIM, 4 % discount rate

SEX Age	HOSPITAL INPATIENT CARE	PHYSICIAN SERVICES					MEDICINES	
		Hospital out-patient care	Health centres	Occupa-tional health care	Private physician services	Private examina-nation and treatment	Prescribed medicines	Over-the-counter medicines
MALES								
35-39	94 158	5 400	5 510	1 787	2 535	4 008	18 120	2 764
40-44	98 920	5 147	5 342	1 529	2 436	3 901	18 431	2 500
45-49	103 614	4 761	5 127	1 217	2 306	3 714	18 442	2 228
50-54	107 245	4 199	4 807	823	2 135	3 418	18 043	1 949
55-59	110 285	3 592	4 431	424	1 947	3 077	17 151	1 673
60-64	112 267	3 219	3 918	147	1 739	2 674	15 584	1 404
65-69	111 243	2 879	3 236	20	1 506	2 231	13 676	1 150
70-74	107 237	2 435	2 585	11	1 218	1 700	11 103	908
75-79	101 506	1 997	1 915	5	939	1 222	8 614	689
80-84	90 245	1 931	1 090	2	619	765	5 752	474
FEMALES								
35-39	128 415	6 740	7 913	2 320	5 434	7 348	23 941	3 152
40-44	133 199	6 288	7 821	2 030	4 976	6 893	24 222	2 899
45-49	138 295	5 839	7 637	1 639	4 450	6 256	24 008	2 629
50-54	143 655	5 187	7 235	1 093	3 855	5 403	23 202	2 350
55-59	148 193	4 395	6 584	556	3 299	4 546	21 843	2 053
60-64	152 720	3 662	5 768	205	2 824	3 725	19 910	1 748
65-69	156 427	3 071	4 882	75	2 332	2 919	17 360	1 440
70-74	158 077	2 611	3 897	37	1 832	2 154	14 107	1 135
75-79	156 828	2 199	2 795	17	1 335	1 467	10 677	849
80-84	146 498	1 500	1 674	5	816	857	6 803	579

APPENDIX 13: EXPECTED LIFE-TIME SICKNESS INSURANCE BENEFITS

The expected sickness insurance benefits were estimated separately for sickness allowances and refunds of medical expenses which were broken down into refunds of physicians' services, examinations and treatments, medicines and transportation services.

The formula used for estimating the expected life-time sickness insurance benefits by age and sex and the type of benefit is given below. In order to simplify matters subscripts refering to sex have been omitted. The expected life-time benefits were determined by applying the method of Chiang (1968) for estimating life-expectancy

$$(13.3)\quad esb_{is} = a_i n_i sb_{is} + \sum_{j=i+1}^{k} [(1 - a_{j-1}) n_{j-1} + a_j n_j] sb_{js} \left(\frac{1 + u}{1 + r}\right)^{j-i} \frac{l_j}{l_i}$$

where esb_{is} = the present value of expected life-time sickness insurance benefits of type s for a person belonging to age group i,

a_i = fraction of last age interval of life lived by a person who has died in age group i,

n_i = the length of an age interval i,

sb_{is} = sickness insurance benefits of type s per capita in age group i,

u = anticipated annual real growth in sickness insurance benefits (assumed to be the same for all benefits),

r = discount rate,

l_j = number of survivors at age interval j of those alive at age interval i.

The average annual sickness insurance benefits used to calculate the sb_{is}'s by age and sex were obtained from the age- and occupation statistics of the Social Insurance Institution

(Kansaneläkelaitos 1988a). We assumed a 2.4 % growth in real sickness insurance benefits. Data sources for estimating other elements in (13.3) were given in appendix 8.

The sickness insurance benefits 'avoided' by the Social Insurance Institution due to premature deaths attibuted to smoking were estimated separately for each of the benefit examined and for each age and sex group by applying the formulae (12.5)-(12.7). The present values of expected life-time benefits, the esb_{ijs}'s, used in this study are given in Table A13.1.

Table A13.1 Estimated present value of expected life-time sickness insurance benefits in 1987, FIM, 4 % discount rate

SEX Age	SICKNESS ALLOWANCES	REFUNDS OF MEDICAL EXPENSES			
		Private physician services	Private examinations and treatments	Prescribed medicines	Transportation services
MALES					
35-39	27 487	961	1 758	12 221	2 571
40-44	25 947	924	1 716	12 512	2 626
45-49	22 823	876	1 638	12 574	2 669
50-54	17 579	813	1 510	12 324	2 699
55-59	10 083	743	1 359	11 694	2 674
60-64	3 090	665	1 178	10 542	2 577
65-69	-	577	982	9 148	2 407
70-74	-	467	748	7 280	2 109
75-79	-	360	538	5 514	1 770
80-84	-	236	338	3 587	1 256
FEMALES					
35-39	22 308	2 068	3 228	15 226	2 779
40-44	20 655	1 891	3 027	15 582	2 811
45-49	17 638	1 691	2 747	15 621	2 816
50-54	13 028	1 468	2 376	15 277	2 794
55-59	6 986	1 259	1 999	14 496	2 719
60-64	1 989	1 081	1 635	13 238	2 594
65-69	-	895	1 279	11 512	2 368
70-74	-	703	942	9 237	2 028
75-79	-	512	638	6 891	1 620
80-84	-	312	370	4 312	1 092

APPENDIX 14: EXPECTED LIFE-TIME PENSIONS

There are no published Finnish data on the value of expected life-time pensions of different types paid to an average person of age i of sex j. Therefore a specific two-stage method was developed for the purpose. In the **first stage**, the average annual pensions of different types paid to an average pensioner were estimated for different age and sex groups. In the **second stage**, the expected life-time pensions of different types by age and sex were estimated.

Average annual pensions

Most pensioners receive both the national pension (old age or disability pension) and the employee pension, but some receive only the national pension and others only the employee pension. In order to examine the incidence of pension payments, the first task is to determine the proportions of these three options in the average pension and the second task is to allocate these proportions among the payers. The national pension is paid by the Social Insurance Institution and the employee pension by the employers, which are here grouped into private sector, state, municipalities and other public organisations (e.g. the church, Bank of Finland, Post Office Bank etc.). Thus we have five types of pension payers. The monetary value of these five categories in the average pension was derived in the following way.

The monetary value of the **simultaneous national pension and employee pension** in the average pension in age group i of sex j (KT_{ij}) was estimated as follows

(14.1) $$KT_{ij} = tk_{ij}KE_{ij}$$

where KE_{ij} = the average annual pension in age group i by sex j,

tk_{ij} = the proportion of pensioners receiving both national pension and employee pension in age group i by sex j.

The monetary share of the employee pension in pension (14.1) in age group i of sex j (TY_{ij}) was estimated as follows

(14.2) $TY_{ij} = tm_{ij}KT_{ij}$

where tm_{ij} = the proportion of employee pension in the average pension of a person receiving both national pension and employee pension in age group i by sex j.

The monetary share of the national pension paid by the Social Insurance Institution in pension (14.1) in age group i of sex j (KL_{ij}) was obtained as residual

(14.3) $KL_{ij} = KT_{ij} - TY_{ij}$.

The monetary share of the **national pension** as a pensioner's **only** pension benefit in the average pension in age group i of sex j (VK_{ij}) was estimated as follows

(14.4) $VK_{ij} = vk_{ij}KE_{ij}$

where vk_{ij} = the proportion of pensioners receiving only national pension in age group i by sex j.

The monetary value of the **employee pension** as a pensioner's **only** pension benefit in the average pension in age group i of sex j (VT_{ij}) was estimated in the same way

(14.5) $VT_{ij} = vt_{ij}KE_{ij}$

where vt_{ij} = the proportion of pensioners receiving only employee pension in age group i by sex j.

Thus, the national pension paid by the The Social Insurance Institution covers

$$(14.6)\quad K_{ij} = KL_{ij} + VK_{ij}$$

and the employee pension

$$(14.7)\quad T_{ij} = TY_{ij} + VT_{ij}.$$

of the average pension in age group i of sex j (AP_{ij}) which equals

$$(14.8)\quad AP_{ij} = K_{ij} + T_{ij}.$$

The employee pensions, the T_{ij}'s, are paid by the employers (private sector, state, municipalities and other public organisations). The monetary share of the average employee pension paid by various party s in age group i by sex j (T_{sij}) was estimated as follows

$$(14.9)\quad T_{sij} = t_{sij}T_{ij}$$

where t_{sij} = the proportion of pensioners receiving employee pension from party s in age group i by sex j.

The number of pensioners and the average annual pensions were estimated as the average of the figures at the end of 1986 and 1987. Hence the figures correspond to the pensions in mid 1987. The data on the number of pensioners and the average annual pensions were obtained from various published and unpublished sources (Eläketurvakeskus and Kansaneläkelaitos 1988).

Expected life-time pensions

Expected life-time pensions were estimated separately for each of the five types of pensions mentioned earlier in this section. The formula used for estimating the expected life-time pensions by age and sex and the type of pension is given below. In order to simplify matters subscripts referring to sex have been omitted. The expected life-time pensions were estimated by applying the Chiang's method (1968) for estimating life-expectancy

$$(14.10)\quad ep_{it} = a_i n_i p_{it} q_i + \sum_{j=i+1}^{k} [(1 - a_{j-1})n_{j-1} + a_j n_j] p_{jt} q_j \left(\frac{1+s}{1+r}\right)^{j-i} \frac{l_j}{l_i}$$

where ep_{it} = the present value of an expected life-time pension of type t for a person belonging to age group i,

a_i = fraction of last age interval of life lived by a person who has died in age group i,

n_i = the length of an age interval i,

p_{it} = average annual pension of type t for a person belonging to age group i (estimated by (14.6) and (14.9)),

q_i = the probability that a person belonging to age group i is a pensioner,

s = anticipated annual real growth in average pensions (assumed to be the same for all pensions),

r = discount rate,

l_j = number of survivors at age interval j of those alive at age interval i.

The probability for a person to be a pensioner, the q_{ij}'s, were estimated from the pension statistics (Eläketurvakeskus and Kansaneläkelaitos 1988). We assumed a 2 % real growth in average pensions. Data sources for estimating other elements in (14.10) were given in appendix 8.

The pensions 'avoided' by different parties due to premature deaths attibuted to smoking were estimated separately for each of the pensions examined and for each age and sex group applying the formulae (12.5)-(12.7). The present values of expected life-time pensions, the ep_{ijt}'s, used in this study are given in Table A14.1.

Table A14.1 Estimated present value of expected life-time pensions in 1987, FIM, 4 % discount rate

SEX Age	PENSIONS PAID BY THE SOCIAL INSURANCE INSTITUTION	EMPLOYEE PENSIONS PAID BY				TOTAL PENSIONS
		Private sector	State	Munici-pali-ties	Other public organi-sations	
MALES						
35-39	124 258	211 269	49 601	22 801	2 223	410 152
40-44	134 936	232 867	54 881	25 031	2 442	450 156
45-49	146 648	255 035	60 363	27 206	2 673	491 925
50-54	158 895	275 458	65 490	28 965	2 907	531 715
55-59	168 667	282 522	68 917	28 811	3 070	551 987
60-64	169 912	265 016	67 014	23 647	2 922	528 511
65-69	157 359	219 069	56 432	15 622	2 400	450 883
70-74	132 237	150 613	39 295	9 347	1 720	333 211
75-79	105 088	86 922	22 966	4 597	1 031	220 604
80-84	55 199	29 475	8 428	1 298	382	94 781
FEMALES						
35-39	188 376	124 412	21 074	17 258	1 494	352 614
40-44	205 388	136 206	23 081	18 889	1 633	385 197
45-49	223 497	148 009	25 003	20 525	1 778	418 812
50-54	242 610	159 122	26 601	22 078	1 929	452 341
55-59	256 409	160 996	26 569	22 490	2 022	468 486
60-64	257 759	145 979	22 387	19 965	1 911	448 000
65-69	234 249	112 762	15 636	13 824	1 409	377 881
70-74	186 708	70 866	10 234	7 179	757	275 744
75-79	131 111	35 120	5 897	3 012	341	175 481
80-84	56 781	9 447	2 130	707	98	69 163

APPENDIX 15: COST OF FIRES

Many studies include estimates on the fire costs caused by smoking (e.g. Shillington 1977, Luce and Schweitzer 1978, Collishaw and Myers 1984). Here the magnitude of the external costs depends on who bears the costs and how the fire insurance is financed. Fire damages (FD), are made up of two components: fire indemnity (IN) paid by the insurance company and the premium paid by the insured (DD), i.e.

$$FD = IN + DD.$$

If a smoker i harms his own property and no compensation is paid ($IN_i = 0$) then there will be no external costs as he bears all of them ($FD_i = DD_i$). If compensation is paid there will be institutional external costs equal to compensation

$$FD_i^s - DD_i^s = IN_i^s.$$

Summing all damages paid to smokers gives the total institutional external costs in this case (IN)

$$(15.1)\quad IN^s = \sum_i IN_i^s.$$

If harm is caused to third parties then there will be external costs equal to the damage

$$FD_i^{NS} = IN_i^{NS} + DD_i^{NS}.$$

Summing all fire costs caused by smoking and suffered by non-smokers gives the value of the total damages (FD_i^{NS})

$$(15.2)\quad FD^{NS} = \sum_i FD_i^{NS} = \sum_i (IN_i^{NS} + DD_i^{NS}) = IN^{NS} + DD^{NS}.$$

Adding up (15.1) and (15.2) gives the total costs of smoking-caused fire damages to third parties (CFD)

$$\begin{aligned} CFD &= IN^{S} + FD^{NS} \\ &= IN^{S} + IN^{NS} + DD^{NS}. \end{aligned}$$

That is, the institutional external costs associated with smoking-caused fires equal the damages paid by insurance companies plus non-smokers deductibles.

APPENDIX 16: MATERIAL DAMAGE DUE TO SMOKING

Material damage to third parties includes that caused by tobacco smoke and ash to clothes, furniture, carpets, as well as the cost of cleaning up tobacco butts and ash. Part of the material damage falls on third parties either in terms of higher prices (private sector) or taxes (public sector). The quantitative significance of external costs due to this source is not clear but in principle they can be estimated as follows.

Consider first **the private sector.** Private sector here refers only to firms. It is reasonable to assume that the costs of material damage will eventually be included in retail prices. The retail price (p) is a sum of the original price without a smoking factor (p_o) and the smoking-caused mark-up (π)

$$p = (1 + \pi)p_o.$$

Ultimately, the extent of external costs depends on how the value of the retail sale of commodities including the smoking mark-up is divided between smokers and non-smokers. Assuming that smokers' share of the value of commodities sold by firm i (q_i) is δ_{si} then the value of the retail sale of the firm i (S_i) can be decomposed as follows

$$(16.1)\quad S_i = p_i q_i = (1 + \pi_i)p_{io}q_i = (1 - \pi_i)p_{io}[\delta_{si}q_i + (1 - \delta_{si})q_i]$$

and rearranging terms (16.1) becomes

$$S_i = p_{io}q_i + \delta_{si}\pi_i p_{io}q_i + (1 - \delta_{si})\pi_i p_{io}q_i,$$

where the first term indicates the value of the retail sale not affected by smoking, the second term indicates the smoking related costs paid by smokers and the third term gives an estimate of the final external costs due to smoking-caused damage. Thus, in the case of firm i, the costs to third parties (DC_i) are

$$(16.2)\quad DC_i = (1 - \delta_{si})\pi_i p_{io} q_i .$$

Summing the costs in (16.2) over all firms gives an estimate of the total costs of material damage in the private sector paid eventually by third parties

$$DC = \sum_i (1 - \delta_{si})\pi_i p_{io} q_i .$$

Consider next **the public sector.** Here the magnitude of the external costs depends on which authority is responsible for maintenace of the services affected. If taxes include a mark-up (t_s) as a compensation for smoking-caused damage, then the total tax revenue (T) can be expressed as

$$T = (1 + t_s)T_o ,$$

where T_o is the tax revenue without smoking-damage. The extra tax burden caused by smoking related damage ($t_s T_o$) can be decomposed to smokers' and non-smokers' contributions by authority as follows

$$\begin{aligned} t_s T_o &= t_s^{CG} T_{CG} + t_s^{LG} T_{LG} + t_s^{SII}(T_{SI} + T_{NP} + E_{SI} + E_{NP}) + t_s^{C} CT \\ &= t_s^{CG}[\beta_{CG} + (1 - \beta_{CG})]T_{CG} + t_s^{LG}[\beta_{LG} + (1 - \beta_{LG})]T_{LG} \\ &\quad + t_s^{SII}[\beta_{SI} + (1 - \beta_{SI})]T_{SI} + t_s^{SII}[\beta_{NP} + (1 - \beta_{NP})]T_{NP} \\ &\quad + t_s^{SII}[E_{SI} + E_{NP}] + t_s^{C}[\beta_C + (1 - \beta_C)]CT \\ &= [t_s^{CG}\beta_{CG}T_{CG} + t_s^{LG}\beta_{LG}T_{LG} + t_s^{SII}(\beta_{SI}T_{SI} + \beta_{NP}T_{NP}) + t_s^{C}\beta_C CT] \\ &\quad + [t_s^{CG}(1 - \beta_{CG})T_{CG} + t_s^{LG}(1 - \beta_{LG})T_{LG} \\ &\quad + t_s^{SII}\{(1 - \beta_{SI})T_{SI} + (1 - \beta_{NP})T_{NP} + E_{SI} + E_{NP}\} \\ &\quad + t_s^{C}(1 - \beta_C)CT], \end{aligned}$$

where the β_j:s, T_j:s and E_j:s are as defined in Appendix 2. Terms in the first brackets indicate the costs borne by smokers and the terms in the second brackets indicate the extra taxes paid by third parties to cover the costs of smoking caused damage. The extra taxes collected from other parties than smokers by the state (DT_C), municipalities (DT_L), the Social Insurance Institution (DT_{S11}), and the state churches (DT_C) are

$$
\begin{aligned}
DT_{CG} &= t_s^{CG}(1 - \beta_{CG})T_{CG} \\
DT_{LG} &= t_s^{LG}(1 - \beta_{LG})T_{LG} \\
DT_{SII} &= t_s^{SII}[(1 - \beta_{SI})T_{SI} + (1 - \beta_{NP})T_{NP} + E_{SI} + E_{NP}] \\
DT_C &= t_s^C(1 - \beta_C)CT.
\end{aligned}
$$

APPENDIX 17: PRODUCTIVITY-DIFFERENTIAL BETWEEN SMOKERS AND NON-SMOKERS

Smokers may be less or more efficient than non-smokers at work. The opposite arguments here are that due to smoking breaks and smoking-related complications smokers as a group may exhibit lower productivity than non-smokers in the same job. On the other hand, the stimulating effects of smoking may make smokers more productive than non-smokers while at work. Which of these effects dominate is an empirical matter that has not been extensively researched.

Whether or not there will be external costs or benefits arising from this issue depends on the way in which wage rates are determined. If the wage rate reflects an individual's productivity then smokers would bear all the costs/benefits and no external costs/benefits would arise. If, on the other hand, wages are determined via collective bargaining, the wage paid to those who do not smoke will be based on the productivity of the average worker and there will be external costs/benefits. Smokers would gain/lose and non-smokers would lose/gain. The magnitude of the loss/gain depends on the actual productivity difference between smokers and non-smokers as well as on the prevalence of smoking.

Denote the average annual wage rate reflecting individual's productivity in occupation i by W_i^S for an average smoker and by W_i^{NS} for an average non-smoker. If the prevalence of smoking in occupation i is p_i, the average wage rate based on the productivity of an average worker (W_i) is the weighted average of smokers' and non-smokers' productivity-based wage rates, i.e.

$$(17.1) \qquad W_i = p_i W_i^S + (1 - p_i) W_i^{NS} = W_i^{NS} + p_i(W_i^S - W_i^{NS}).$$

It is obvious from (17.1) that if $0 < p_i < 1$ and if $W_i^S \neq W_i^{NS}$ then $W_i^S \neq W_i \neq W_i^{NS}$. When p_i approaches zero W_i approaches W_i^{NS}. When p_i approaches unity W_i approaches W_i^S. A non-smoker's loss/gain (wl_i^{NS}) can now be defined as the difference between the collectively-determined wage rate (W_i) and the non-smokers's productivity-based wage rate (W_i^{NS}), i.e.

$$(17.2)\quad wl_i^{NS} = W_i - W_i^{NS} = p_i(W_i^S - W_i^{NS}).$$

Given the prevalence of smoking, a non-smokers's wage loss/gain is bigger as smokers' and non-smokers' productivity differential increases. Given the difference in productivity, the more prevalent smoking is, the larger is a non-smoker's wage loss/gain.

The total wage loss/gain to non-smokers in occupation i (WL_i^{NS}) is the average loss/gain in (17.2) multiplied by the number of non-smokers (NS_i) employed in occupation i, i.e.

$$\begin{aligned} WL_i^{NS} &= wl_i^{NS}NS_i = p_i(W_i^S - W_i^{NS})(1 - p_i)N_i \\ &= p_i(1 - p_i)(W_i^S - W_i^{NS})N_i, \end{aligned}$$

where N_i is the total number of people employed in occupation i.

The total wage loss/gain to all non-smokers (WL) is the loss/gain summed over all occupations, i.e.

$$WL^{NS} = \sum_i WL_i^{NS} = \sum_i p_i(1 - p_i)(W_i^S - W_i^{NS})N_i.$$

APPENDIX 18: SUMMARY TABLES

Table A18.1. Incidence of the social costs of smoking to different parties in 1987 (FIM million)[1].

	State	Local authorities	Social Insurance Institution	Firms	Other	Smokers	TOTAL[2]
DIRECT COSTS	**163-191**	**185-218**	**52**	**17**	**24-28**	**529-533**	**970-1039**
Health expenditure	158-186	185-218	52	7	24-28	99-103	524-594
Disbenefits due to addiction					428-428	428-428	
Other direct costs	6			10		2	18
INDIRECT COSTS	**180-224**	**177-220**	**130-160**	**530-658**	**192-239**	**855-1062**	**2063-2564**
Lost production	180-224	177-220	130-160	530-658	192-239	855-1062	2063-2564
TOTAL COSTS	**343-416**	**362-438**	**181-212**	**547-675**	**216-267**	**1384-1595**	**3032-3603**
(%)	11-12	12	6	18-19	7	44-46	100

[1] Excluding costs of production and distribution.

[2] Numbers may not add to totals due to rounding.

Table A18.2. Main financial consequences of smoking in Finland in 1987 (FIM million).[1]

REVENUE (+)/ EXPENDITURE (-) ITEM	Low estimate	High estimate
DIRECT CONSEQUENCES	**-678**	**-790**
HEALTH EXPENDITURE	-395	-456
- Inpatient care	-195	-256
- Outpatient care	-160	-160
- Pharmaceuticals	-38	-38
- Rehabilitation	-1	-1
SOCIAL SECURITY BENEFITS	-278	-329
- Sickness allowances	-170	-177
- Disability pensions	-46	-64
- Widow's and orphan's pensions	-62	-88
OTHER DIRECT COSTS	-6	-6
INDIRECT CONSEQUENCES	**389**	**629**
LOST TAX-REVENUES DUE TO	-486	-605
- Sickness absence	-202	-209
- Disability	-93	-112
- Premature death	-190	-284
AVOIDED HEALTH CARE EXPENDITURE EXPENDITURE DUE TO	364	516
- Hospital care	308	437
- Physician services	27	39
- Pharmaceuticals	28	40
AVOIDED SOCIAL SECURITY BENEFITS DUE TO	511	718
- Refunds of medical expenses	41	57
- Sickness allowances	14	20
- Pensions	456	641
NET REVENUE (tobacco excise excluded)	-289	-161
PROCEEDS FROM TOBACCO EXCISE	2162	2162
NET REVENUE (tobacco excise included)	**1873**	**2001**

[1] Includes revenue and expenditure effects on state, local authorities and the Social Insurance Institution.

Table A18.3. Data for deriving institutional external costs due to smoking in Finland in 1987 (FIM million).

	Smokers		Other parties		TOTAL[1]	
	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate
DIRECT COSTS	**1965**	**1970**	**440**	**506**	**2406**	**2476**
Cost of production and distribution	1436	1436			1436	1436
Disbenefits due to addiction	428	428			428	428
Health expenditure	99	103	425	490	524	594
Other direct costs	2	2	16	16	18	18
INDIRECT COSTS	**855**	**1062**	**1208**	**1502**	**2063**	**2564**
Lost production	855	1062	1208	1502	2063	2564
TOTAL[1]	**2820**	**3031**	**1649**	**2008**	**4469**	**5040**
(%)	60	63	37	40	100	100

[1] Numbers may not add to totals due to rounding.

Table A18.4. Data for deriving final external costs due to smoking in Finland in 1987 (FIM million).

	Smokers		Ex-smokers		Non-smokers		Others[1]		TOTAL[2]	
	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate
DIRECT COSTS	**2068**	**2087**	**73**	**85**	**190**	**219**	**75**	**85**	**2406**	**2476**
- Cost of production and distribution	1436	1436							1436	1436
- Disbenefits due to addiction	428	428							428	428
- Health expenditure	196	215	73	85	190	219	65	75	524	594
- Other direct costs	8	8					10	10	18	18
INDIRECT COSTS	**1025**	**1274**	**128**	**160**	**315**	**391**	**595**	**740**	**2063**	**2564**
Lost production	1025	1274	128	160	315	391	595	740	2063	2564
TOTAL[2]	**3093**	**3360**	**202**	**244**	**504**	**611**	**670**	**824**	**4469**	**5040**
(%)	67	69	5	5	11	12	15	16	100	100

[1] Mainly firms.

[2] Numbers may not add to totals due to rounding.

REFERENCES

Acton JP. Evaluating public programms to save lives: the case of heart attacks. Research report R-73-02. Rand Corporation, Santa Monica 1973.

Armitage P. Statistical methods in medical research. Blackwell, Oxford 1971.

Ashford JR. Smoking and the use of the health services. British Journal of Preventive Medicine 1973, 27,8-17.

Athanasou JA. Sickness absence and smoking behavior and its consequences - a review. Journal of Occupational Medicine 1975, 17, 441-445.

Athanasou JA. Smoking and absenteeism Medical Journal of Australia 1979, 1, 234,236.

Atkinson AB. Smoking and the economics of government intervention. In Perlman F (ed.). The economics of health care and medical care. Macmillan, London 1974.

Atkinson AB and Meade TW. Methods and preliminary findings in assessing the economic and health services consequences of smoking, with particular reference to lung cancer. Journal of the Royal Statisitical Society 1974, Series A, 137, 297-312.

Atkinson AB, Townsend JL. Economic aspects of reduced smoking. Lancet 1977, 2, 492-494.

Blomquist G, The value of life saving: implications of consumption activity. Journal of Political Economy 1979, 87, 540-558.

Blomquist G, The value of human life: an empirical perspective. Economic Inquiry 1981, 19, 157-164.

Burch PRJ. Smoking and lung cancer. Tests of a causal hypothesis. Journal of Chronic Diseases 1980, 33, 221-238.

Cederlöf R, Friberg L, Hrubec Z, Lorich U. The relationship of smoking and some covariables to mortality and cancer morbidity. A ten-years follow-up in a probability sample of 55 000 Swedish subjects age 18-69. Karolinska Institutet, Stockholm 1975.

Cederlöf R, Friberg L, Lundman T. The interaction of smoking, environment and heredity and their implications for disease etiology. A report of epidemiological studies on the Swedish twin registries. Acta Medica Scandinavica 1977, Supplement 612, 105-117.

Chetwynd J, Rayner T. Impact of smoking on health care resource use. New Zealand Medical Journal 1986, 99, 230-232.

Chiang CL. Introduction to stochastic processes in biostatistics. John Wiley and Sons, New York 1968.

Cohen DR. Economic consequences of a non-smoking generation. University of Aberdeen. Health Economics Research Unit, Discussion paper 6/84. Aberdeen 1984.

Collishaw NE, Myers G. Dollar estimates of the consequences of tobacco use in Canada 1979. Canadian Journal of Public Health 1984, 75, 192-199.

Conley BC. The value of human life in the demand for safety. American Economic Review 1976, 66, 45-55.

Cooper BS, Rice DP. The economic cost of illness revisited. Social Security Bulletin 1976, 39, 2, 21-36.

Dardis R. The value of life: new evidence from the market place. American Economic Review 1980, 70, 1077-1082.

Dawson RFF, Cost of road accidents in Great Britain. In Cooper MH, Culyer AJ (eds.), Health Economics, Penguin Books, Harmondsworth 1973.

Department of Health and Social Services (DHSS). Smoking and health. A study of the effects of a reduction in cigarette smoking on mortality and morbidity rates, on health care and social security expenditure and on productive potential. HMSO, London 1972.

Doll R, Peto R. Mortality in relationship to smoking: 20 years' observations on male British doctors. British Medical Journal 1976, 2, 1525-1536.

Ellemann-Jensen P. Analyser af de samfundsokonomiske omkostninger ved tobaksrygning. Odense Universitet. Institut for Sundhedsokonomi og Sygdomsforebyggelse. Forskningrapport 1986, 1. Odense 1986.

Friedman GD, Siegelaub AB, Dales LG, Seltzer CC. Characteristic predictive of coronary hearth disease in ex-smokers before they stopped smoking: comparison with persistent smokers and non- smokers. Journal of Chronic Diseases 1979, 32, 175-190.

Ghosh D, Lees D, Seal W. Optimal motorway speed and some valuations of time and life. Manchester School 1975, 43, 134-143.

Goddeeris JH. Theoretical considerations on the cost of illness. Journal of health Economics 1983, 2, 149-159.

Hakama M. Keuhkosyövän epidemilogiaa. Tuberkuloosi ja keuhkosairaudet, Vuosikirja 1976, 5.

Hammond EC. Smoking in relation to the death rates of one million men and women. Teoksessa: Haenszel W, toim. Epidemiological approaches to the study of cancer and other chronic diseases. National Cancer Institute Monograph No. 19. Washington 1966.

Hartunian NS, Smart CN, Thompson MS. The incidence and economic costs of major health impairments. Lexington Books, Lexington 1981.

Heliövaara M. Työkyvyttömyyden ilmaantumista ennustavat tekijät. In Juhlakirja Jakko Pajula, osa II. Kansaneläkelaitos, Helsinki 1989.

Hinds MW. Medical care costs attributable to cigarette smoking in Kentucky. Southern Medical Journal 1986, 79, 665-668.

Hjalte K. Rökningens effekter och kostnader i Sverige 1980 en prevalensstudie. Institutet för hälsooch sjukvårdsekonomi. Meddelande 1984, 4. Lund 1984a.

Hjalte K. Ekonomiska effekter av att sluta röka. IHE meddelande 1984:5, IHE, Lund 1984b.

Hodgson TA, Meiners MR, Cost-of-illness methodology: a guide to current practices and procedures. Milbank Quarterly 1982, 60, 429-462.

Holcomb HS, Meigs JW. Medical absenteeism among cigarette, and cigar and pipe smokers. Archives of Environmental Health 1972, 25, 295-300.

Häkkinen U. Terveyspalvelujen kustannukset, rahoitus ja hinnat Suomessa 1960-1985. Kansaneläkelaitoksen julkaisuja M:65. Helsinki 1988.

Jones-Lee MW, The value of life: An economic analysis. Martin Robertson, London 1976.

Jones-Lee MW, The value of life and safety: a survey of recent developments. The Geneva Papers on Risk and Insurance 1985, 10, 141-173.

Jones-Lee MW, Hammerton M, Philips PR. The value of safety: results of a national sample survey. Economic Journal 1985, 95, 49-72.

Jonsson E. Tobaksskadorna och samhällets kostnader. Socialmedicinsk tidskrift 1980, 4-5, 207-211.

Kahn HA. The Dorn study of smoking and mortality among U.S. veterans: a report on eight and one-half years of observation. In Epidemiologic study of cancer and other chronic diseases. National Cancer Institute Monograph No. 19, 1966.

Kalimo E, Nyman K, Klaukka T, Tuomikoski H, Savolainen E. Terveyspalvelusten tarve, käyttö ja kustannukset 1964-1976. Kansaneläkelaitoksen julkaisuja A:18. Kansaneläkelaitos, Helsinki 1982.

Kalimo E, Häkkinen U, Klaukka T, Lehtonen R, Nyman K. Tietoja suomalaisten terveysturvasta. Kansaneläkelaitoksen julkaisuja M:67. Kansaneläkelaitos, Helsinki 1989.

Keeney RL. Evaluating mortality risks from an organisational perspective. In Jones-Lee ML (ed.). The value of life and safety: Proceedings of a conference held by the Genava Association. North-Holland, Amsterdam 1982.

Konttinen M. Costs, effects and benefits of coronary artery bypass surgery. Helsinki 1987.

Landefeld JS, Seskin EP. The economic value of life: linking theory to practice. American Journal of Public Health 1982, 72, 555-566.

Lehtinen I, Koskenkylä T. Kuluttajahintaindeksi 1985=100. Tilastokeskuksen tutkimuksia 144. Helsinki 1988.

Leu RE, Schaub T. Der Einfluss des Rauchens auf die Mortalität und die Lebenserwartung der Schweizer Wohnbevölkerung. Schweizerische Medizinische Wochenschrift 1983, 113, 3-14.

Leu RE, Schaub T. Does smoking increase medical care expenditure? Social Science and Medicine 1983b, 17, 1907-1914.

Leu RE, Schaub T. Economic aspects of smoking. Effective Health Care 1984, 2, 111-122.

Leu RE, Schaub T. More on the impact of smoking on medical care expenditures. Social Science and Medicine 1985, 21, 825-827.

Liiketaloustietellinen Tutkimuslaitos (LTT). Tutkimus kioskikaupan rakenteesta ja kehityksestä sekä vaikutuksista muuhun kauppaan. Helsinki 1982.

Liiketaloustietellinen Tutkimuslaitos (LTT). Energiataloudellisten vaihtoehtojen vertailun perusteet. Kauppa- ja teollisuusministeriö, energiaosasto, sarja B:38. Helsinki 1984.

Liiketaloustietellinen Tutkimuslaitos (LTT). Tupakkatuotteiden myynnin kannattavuus päivittäistavaramyymälöissä. Helsinki 1986.

Liiketaloustietellinen Tutkimuslaitos (LTT). Tieliikenteen onnettomuuskustannukset Suomessa. Laskentaperiaatteet ja suuruus vuonna 1987. Liiketaloustieteellinen Tutkimuslaitos. Sarja B58. helsinki 1990.

Lilienfeld AM, Lilienfeld DE. Foundations of epidemiology. Oxford University Press. Oxford 1980.

Lindholm B. Samhäälsekonomiska verkningar av rökningen. In Tobaksrökning. Allmänna Forlaget, Stockhom 1973.

Linnerooth J, The value of human life: a review of the models. Economic Inquiry 1979, 17, 52-74.

Littlechild SC, Wiseman J. Principles of public policy relevant to smoking. Policy Studies 1984, 4, 54-67.

Luce BR, Schweitzer SO. Smoking and alcohol abuse: a comparison of their economic consequences. New England Journal of Medicine 1978, 17, 52-74.

Lundman T. Comment. In Boström H, Ljungstedt N (eds.). Medical aspects of mortality statistics. Scandia International Symposia. Almqvist and Wiksell International, Stockholm 1981.

Marin A, Psacharopoulos G. The reward for risk in the labor market: evidence from the United Kingdom and a reconciliation with other studies. Journal of Political Economy 1982, 90, 827-853.

Markandya A, Pearce DW. The social costs of tobacco smoking. British Journal of Addiction 1989, 84, 1139-1150.

Marmot MG, Rose G, Shipley M, Hamilton PJS. Employment grade and coronary heart disease in British civil cervants. Journal of Epidemiology and Community Health 1978, 32, 244-249.

Melinek SJ. A method of evaluating human life for economic purposes. Accident Analysis and Prevention 1974, 6, 103-114.

Melinek SJ, Woolley SKD, Baldwin R. Analysis of a questionnaire on attitudes to risk. Joint Fire Research Organisation, Fire Research Note 962, Borehamwood 1973.

Miettinen OS. Proportion of disease caused or prevented by a given exposure, trait or intervention. Am J Epidemiol 1974, 99, 325-332.

Mishan E, Evaluation of life and limb, a theoretical approach. Journal of Political Economy 1971, 79, 687-705.

Mooney GH, The valuation of humanm life. Macmillan, London 1977.

Muller A, Reutzel TJ. Willingness to pay for reduction in fatality risk: an exploratory survey. American Journal of Public Health 1984, 74, 808-812.

Needleman L. The valuation of changes in the risk of death by those at risk. Manchester School 1980, 48, 229-254.

Nyman K, Raitasalo R. Työstä poissaolot ja niihin vaikuttavat tekijät Suomessa. Kansaneläkelaitoksen julkaisuja A:14. Helsinki 1978.

Oakes TW, Friedman GD, Seltzer CC, Siegelaub AB, Collen MF. Health service utilization by smokers and nonsmokers. Medical Care 1974, 12, 958-966.

Oster G, Colditz GH, Kelly NL. The economic costs of smoking and benefits of quitting. Lexington Books, Lexington 1984.

Parkkinen P, Järviö M-L, Terve Suomi 2030: terveysmenojen kehityspiirteitä. Taloudellinen suunnittelukeskus, Helsinki 1988.

Pekurinen M, Valtonen H. Price, policy and consumption of tobacco: the Finnish experience. Social Science and Medicine 1987, 25, 875-881.

Pekurinen M. Kokeilun kustannukset. In Vohlonen I (ed.). Sosiaali- ja terveysministeriön omalääkärikokeilu: Tutkimuksen aineisto, tulokset ja johtopäätökset. Lääkintöhallituksen tutkimuksia 50. Helsinki 1989.

Pekurinen M, Valtonen H, Heliövaara M, Klaukka T. Tupakointi, lääkärissäkäynnit, lääkkeiden käyttö ja sairauspoissa-olot. Sosiaalilääketieteellinen Aikakauslehti 1989, 5-6, 309-322.

Persson U. The value of risk reduction: results of a Swedish sample survey. Paper presented at the 9th Nordic HESG meeting in Oslo 2-3 September 1988.

Peston MH. Economics of cigarette smoking. In Richardson RG (ed.). Proceedings of the second world conference on smoking and health. Pitman, London 1972.

Rice DP, Hodgson TA. Social and economic implications of cancer in the United States of America. Vital and health statistics, series 3, no. 20. National Centre for Health Statistics. Washington 1981.

Rice DP, Hodgson TA, Sinsheimer P, Browner W, Kopstein AN, The economic costs of the health effects of smoking, 1984. Milbank Quarterly 1986, 64, 489,547.

Rimpelä M. Tupakoinnin vähentämisestä uudenlaisiin tavoitteisiin. Sosiaalinen Aikakauskirja 1978, 72, 11-19.

Rimpelä A. Enintään 10 mg tervaa antavat savukkeet - terveyshaitat ja toimenpidesuositukset. Pubilications of the National Board of Health, Health Education. Series Statistics and Reviews 4/1986. Helsinki 1986.

Rogot E, Murray JL. Smoking and causes of death among U.S. veterans: 16 years of observation. Public Health Reports 1980, 15, 213-222.

Rose G, Hamilton PJS. A randomized controlled trial of the effect on middle-aged men of advice to stop smoking. Journal of Epidemiology and Community Health 1978, 32, 275-281.

Rosen S. Valuing health risk. American Economic Review 1981, 71, 241-245.

Saxen E, Hakama M. Tupakointi ja keuhkosyöpä. Duodecim 1979, 426-445.

Schelling TC, The life you save may be your own. Teoksessa Chase SB (ed.), Problems in public expenditure analysis. Brookings Institution, Washington DC 1968.

Searle SR. Linear Models. Wiley. New York 1971.

Seltzer CC. Smoking and coronary heart disease: what are we to believe? American Heart Journal 1980, 100, 275-280.

Shillington ER, Selected economic consequences of cigarette smoking. Department of National Health and Welfare, Ottawa 1977.

Sintonen H. An approach to economic evaluation of actions for health. Official Statistics of Finland, Special Social Studies SVT XXXII:74, Helsinki 1981.

STM (Ministry of Social Affairs and Health). Health for all by the year 2000. The Finnish national strategy. Helsinki 1987.

Stoddart GL, Labelle RJ, Barer ML, Evans RG. Tobacco taxes and health care costs. Do Canadian smokers pay their way? Journal of Health Economics 1986, 5, 63-80.

Thaler R, Rosen S. The value of saving life: evidence from the labor market Teoksessa Terleckyj NE (toim.). Household production and consumption, National Bureau of Economic Research, New York 1976.

Thompson ME, Forbes WF. Costs and 'benefits' of cigarette smoking in Canada. Canadian Medical Association Journal 1982, 127, 831-832.

Thompson ME, Forbes WF. Estimating the health care costs of smokers. Canadian Journal of Public Health 1983, 74, 183-190.

Thompson ME, Forbes WF. Reasons for the disagreements on the impact of smoking on medical care expenditures: a proposal for a uniform approach. Social Science and Medicine 1985, 21, 771-773.

Tie- ja vesirakennushallitus (TVH). Henkilövahinkojen arvottaminen tieliikenteessä. Tie- ja vesirakennushallitus, liikennetoimisto, tutkimustoimisto. Helsinki 1979.

Townsend JL. Smoking and lung cancer: a cohort data study of men and women in England and Wales 1935-79. Journal of the Royal Statistical Society 1978, A141, 95-107.

Townsend JL, Meade TW. Ischaemic heart disease mortality risks for smokers and non-smokers. Journal of Epidemiology and Community Health 1979, 33, 243-247.

Townsend JL. Economic and health consequences of reduced smoking. In Williams A (ed.), Health and Economics, Macmillan, London 1987.

Tversky A, Kahneman D. Judgment under uncertainty: heuristics and biases. Science 1974, 185, 1124-1131.

U.S. Department of Health, Education and Welfare (USDHEW). Public Health Service. Smoking and health. A report to the Surgeon General. U.S. Government Printing Office. Washington 1979.

U.S. Department of Health and Human Services (USDHHS). Public Health Service. The health consequences of involuntary smoking. A report of the Surgeon General. U.S. Government Printing Office. Washington 1986.

Usher D. An imputation to the measure of economic growth for changes in life expectancy. In Moss M (ed.), Measurement of economic and social performance. Columbia University Press, New York 1973.

Vainiomäki J, Pekurinen M, Vohlonen I. Menetelmä lääkärissäkäynnin yksikkökustannusten vertailemiseksi terveyskeskuskissa. Lääkintöhallituksen tutkimuksia 40. Helsinki 1987.

Valtonen H, Rimpelä M. Aikuisväestön tupakointitottumukset 1978-1982. Lääkintöhallituksen julkaisuja. Terveyskasvatus. Sarja tutkimukset 3/1984. Helsinki 1984.

Van Tuinen M, Land G. Smoking and excess sick leave in a department of health. Journal of Occupational Medicine 1986, 28, 33-35.

Veljanovski C. The economics of job safety regulation: theory and evidence part I - the market and common law. Mimeo, Centre for Socio-Legal Studies, Oxford 1978

Vinni K, Sairauden, työkyvyttömyyden ja kuolemantapausten aiheuttamat ammattiryhmittäiset tuotannonmenetykset Suomessa. Tampereen yliopisto, lääketieteellisen tiedekunnan julkaisuja, Tampere 1982.

Viscusi WK. Labor market valuations of life and limb: empirical evidence and policy implications. Public Policy, 1978, 26, 359- 385.

Vogt TM, Schweitzer SO. Medical costs of cigarette smoking in a health maintenance organization. American Journal of Epidemiology 1985, 122, 1060-1066.

Vohlonen I. Sosiaali- ja terveysministeriön omalääkärikokeilu: Tutkimuksen aineisto, tulokset ja johtopäätökset. Lääkintöhallituksen tutkimuksia 50. Helsinki 1989.

Warner K. Possible increases in the underreporting of cigarette consumption. Journal of the American Statistical Association 1978, 73, 314-318.

Weisbrod BA. Economics of Public Health. University of Pensylvania Press, Philadelphia 1961.

Weiss WL. Can you afford to hire smokers? Personnel Administrator 1981, 26, 71-73, 75-78.

Weinstein MC, Shepard DS, Pliskin JS. The economic value of changing mortality probabilities: a desicion-theoretic approach, Quarterly Journal of Economics 1980, 94, 373-396.

Wilhelmsson C, Vedin A, Ulvenstam G, Åberg A, Johansson S, Wilhelmssen L. Tobacco smoking and mortality from various causes. In Boström H, Ljungstedt N (eds.). Medical aspects of mortality statistics. Scandia International Symposia. Almqvist and Wiksell International, Stockholm 1981.

Wilson RW. Cigarette smoking, disability days and respiratory conditions. Journal of Occupational Medicine 1973, 15, 236-240.

STATISTICAL SOURCES

Berg K-E. Unpublished data provided by Kaj-Erik Berg of the Finnish Federation of the Insurance Companies in 1989.

Eläketurvakeskus and Kansaneläkelaitos 1988. Tilastoja Suomen eläkkeensaajista 1987.

Hurme M-L. Unpublished data provided by Marja-Liisa Hurme of the National Board of Health in 1989.

Kansaneläkelaitos 1988a. Ikä- ja ammattitilastot 1987. T3:16 A.

Kansaneläkelaitos 1988b. Kansaneläkelaitoksen tilastollinen vuosikirja 1987. T1:23

Kansaneläkelaitos 1988c. Työterveyshuoltotilastot 1985. T3:5 E.

Kansaneläkelaitos 1989. Unpublished data provided by the Social Insurance Institution.

Kirkkohallitus 1988. Tilastoja Suomen evankelis-luterilaisten seurakuntien taloudesta vuonna 1987.

Luoma K. Unpublished data provided by Kalevi Luoma of the Ministry of Finance in 1989.

Lääkintöhallitus. Tautiluokitus 1987. Valtion painatus-keskus, Helsinki 1986.

Lääkintöhallitus 1989. Unpublished hospital discharge register data provided by the National Board of Health.

Niskanen T. Unpublished data provided by Tapani Niskanen of the National Board of Health in 1989.

Piha T. Unpublished data provided by Tapani Piha of the National Board of Health in 1989.

Sairaalaliitto 1988. Suomen sairaalatilasto 1987.

Suomen kaupunkiliitto 1988. Terveyskeskusten taloustilasto 1987.

Tilastokeskus 1988a. Kansantalouden tilinpito 1982-1987. Kansantalous 1988:6.

Tilastokeskus 1988b. Tulo- ja varallisuustilasto 1986. SVT, Tulot ja kulutus 1988:6.

Tilastokeskus 1988c. Tupakkatilasto 1987. SVT Terveys 1988:1.

Tilastokeskus 1988d. Ulkomaankauppa 1987, osa 3. SVT IA:107.

Tilastokeskus 1988h. Väestötilasto 1987.

Tilastokeskus 1989a. Kuolemansyyt 1987. Terveys 1989:6.

Tilastokeskus 1989b. Suomen tilastollinen vuosikirja 1989.

Tilastokeskus 1989c. Teollisuuden vuosikirja 1987 osa 1, Teollisuus 1989:16.

Tilastokeskus 1989d. Unpublished data provided by the Central Statistical Office.

Työvoimaministeriö 1988. Työvoimakatsaus nro 2/ 1988.

Valtion tulo- ja menoarvioesitys 1991. Valtion painatuskeskus, Helsinki 1990.

PART III:

THE DEMAND FOR TOBACCO PRODUCTS IN FINLAND

CONTENTS

Page

1 INTRODUCTION

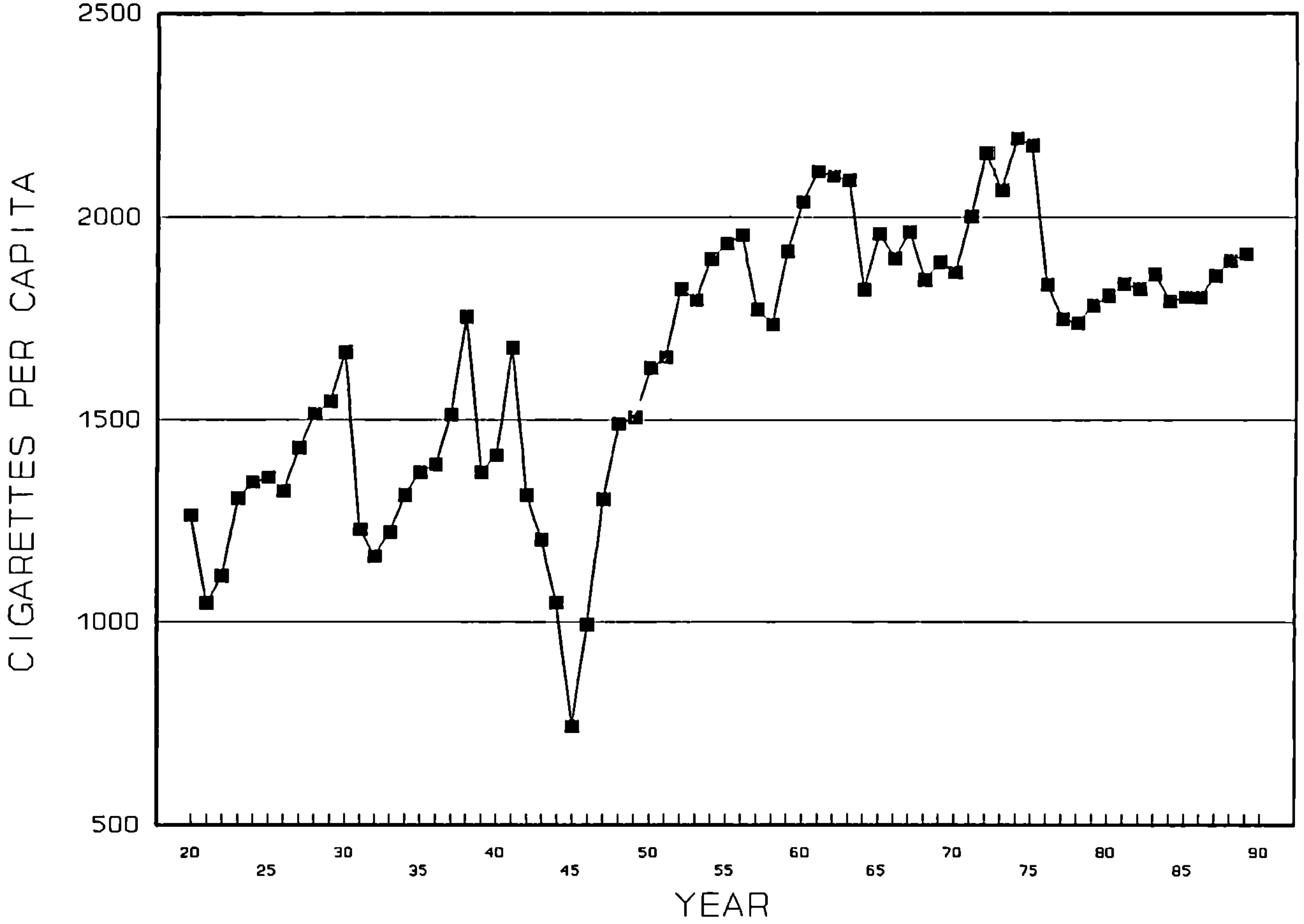
1.1 Main trends in the Finnish tobacco markets

1.1.1 Consumption

Finnish males have traditionally been heavy smokers. Finland's cigarette consumption was the highest in the world in the 1920s, and much higher than in the other Nordic countries until the late 1930s (Lee 1975, Nordic Council 1975). In the 1920s and 1930s the consumption of cigarettes was about 1300-1400 cigarettes per capita (people aged 15 and over). After the Second World War consumption continued to increase rapidly. Growth stopped in 1976, probably as a result of substantial price increases and the public debate provoked by legislative measures. Since 1977 the average per capita consumption has remained virtually unchanged (Figure 1).

The prevalence of smoking in the adult population has changed in a manner similar to other developed countries: the proportion of smoking men has decreased since the 1960s but has remained steady during the last ten years at about 35 per cent. Smoking among women has become more popular, and the proportion of smoking women has gradually increased to about 20 per cent (STM 1987). Smoking among adolescents decreased between 1973 and 1981

Figure 1. The annual consumption of cigarettes per capita in Finland 1920-89.



but subsequently appeared to rise once again. During the past few years a great number of smokers have switched to tobacco products containing less harmful substances.

At present the total consumption of tobacco products is divided between three product groups: manufactured cigarettes (90 % of total consumption in 1987), pipe tobacco (9 %) and cigars (1 %). Light cigarettes (containing less than 10 mg tar) now account for one third of cigarette consumption (Tilastokeskus 1988).

1.2.2 Prices and revenues

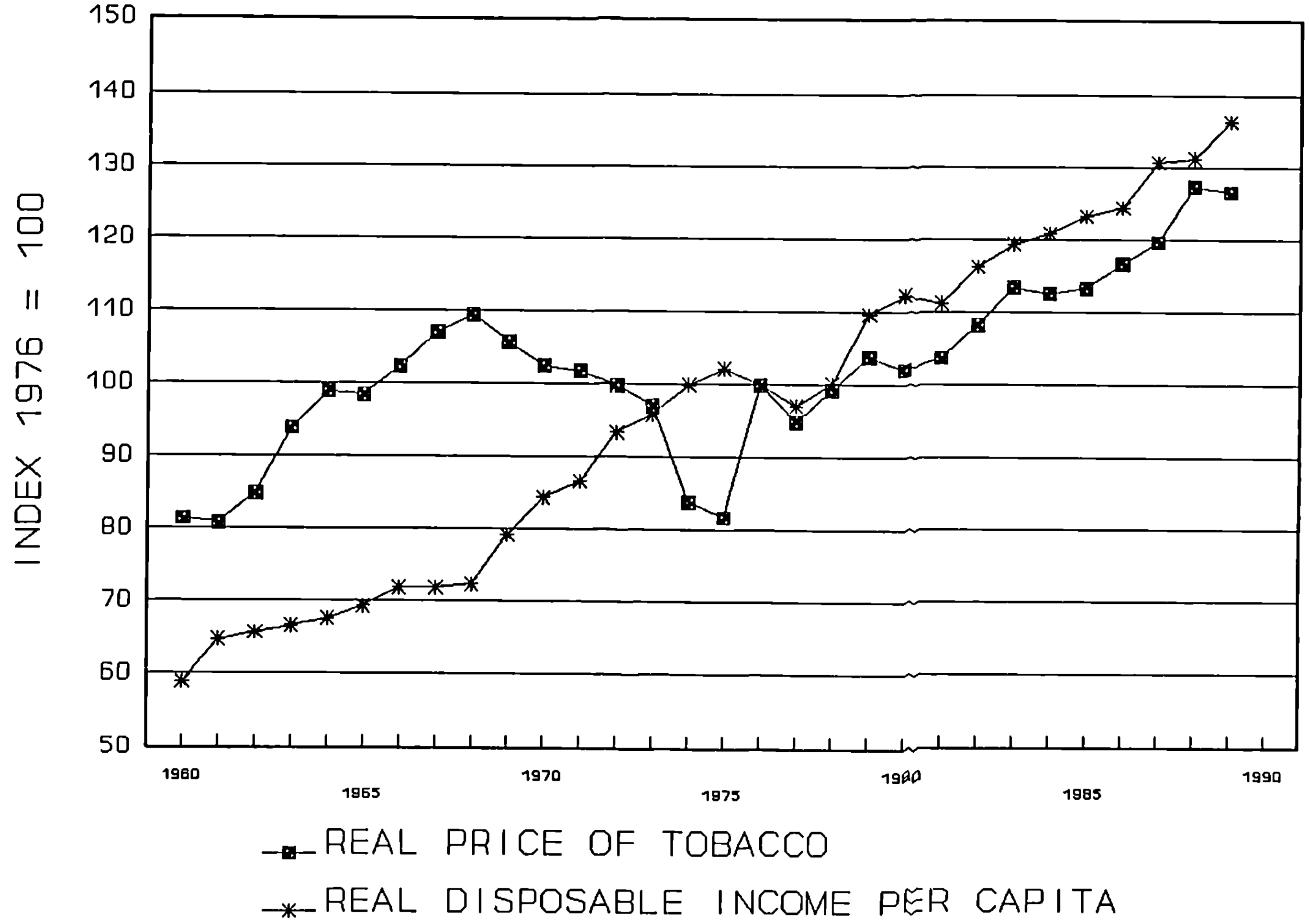
The change in the real price of tobacco in FIM from 1950 to 1989 is shown in Figure 2. Three distinct phases can be distinguished. The real price of tobacco products increased from 1950 to 1968, and then fell until 1975. Tobacco prices rose substantially in 1975-76[1], but since 1977 annual increases in the real prices have been modest.

The price of tobacco is controlled by the government by means of an excise tax levied on tobacco products. Decision-making takes a number of factors into account: the state budget, income agreements, curbing inflation, cost developments in trade and industry, etc. No special attention has been

---

[1] In 1976 the real price of cigarettes was 27 per cent higher than in the previous year. The rise in the real price of pipe tobacco and cigars was 49 per cent and 8.5 per cent respectively.

Figure 2. The real price of tobacco and the real disposable income per capita in Finland 1960-1989.



paid to the public health objective of controlling the demand for tobacco (ACHE 1985).

Since the late 1970s a major goal of economic policy has been to curb inflation. The price of tobacco has been regulated in accordance with this objective. The price structure of tobacco products has also been manipulated by altering the proportions received by the retail trade, the tobacco industry and taxes to ensure sufficient profit margins for retailers and to maintain employment levels in the tobacco industry. The price structure of tobacco products has been substantially altered in favour of the retail trade and tobacco industry over the past few years.

Tobacco is a significant source of government revenue. In 1987, taxes on tobacco accounted for 3.2 per cent of all government revenues derived from taxes and other duties. Taxing tobacco is a simple way of raising revenue.

1.2.3 Anti-smoking publicity

Anti-smoking publicity in Finland has long and extensive history. Numerous restrictions have been imposed on the promotion and advertising of tobacco products. The National Board of Health published a short report on the health risks of smoking in 1964 following the publication of the U.S. Surgeon General's report the same year, and put forward proposals covering the main issues. The year 1964 was dedicated to the promotion of healthy lifestyles and a comprehensive information campaign was undertaken. Tobacco advertising on television was banned in 1971.

In the 1970s attitudes towards smoking swung from one extreme to the other: at the beginning of the decade there was a very pro-smoking discussion, with older students seriously demanding their adult right to smoke at school, for instance. The atmosphere then changed drastically, and the Tobacco Act came into force in 1977 after an extensive public debate about the health risks of smoking.

The Tobacco Act of 1977 imposed major restrictions on advertising and the availability of tobacco and was one of the first attempts in the whole world to establish a comprehensive strategy to reduce smoking by legislation. Advertising and sales promotion of tobacco and the sale of tobacco products to persons under 16 were prohibited by the Tobacco Act (Leppo 1978). Smoking in public places (buses, trams and trains, kindergartens and schools, reception and waiting rooms of public offices, showrooms, and sport events open to children) was strictly prohibited or limited. Upper limits were set on the harmful components of tobacco products. Labels warning of health damage from smoking were made compulsory on all retail tobacco product packages. Half a percent of the tobacco tax revenue was to be set aside annually in the State budget for the development of healthoriented tobacco policies; health education, research and evaluation. Pricing policy was excluded from the Tobacco Act.

1.2 The purpose and the structure of the study

The main purpose of this study is to examine whether the demand for various tobacco products can be affected by policy measures. The specific purpose of the study is

(1) to estimate the demand elasticities of tobacco products in Finland,

(2) to analyse the effects of anti-smoking publicity and various advertising bans independently on the demand for tobacco, and

(3) to test the appropriateness of alternative demand models for explaining the demand for tobacco products.

The main differences between this and other non-Finnish studies are that the possibility of asymmetric demand responses to changes in prices and income are examined, the stability of the estimated elasticities in respect to major price increases is tested, and the analysis is extended to the three broad tobacco categories; cigarettes, pipe tobacco and cigars.

Furthermore, explicit analysis of the effects of anti-smoking publicity and tobacco advertising bans, as well as testing the validity of the constant elasticities implicitly assumed in earlier investigations distinguishes this study from the previous Finnish studies on tobacco demand.

The study is divided into the following chapters. Relevant demand models to be tested are derived in chapter two. Previous studies are reviewed in chapter three. The empirical demand functions are specified in chapter four. Materials and methods of the study are introduced in chapter five. Empirical results of the study are reported in chapter six. The results are discussed in chapter seven. Conclusions and policy implications of the study are outlined in chapter eight.

2 FORMULATION OF THE DEMAND MODELS

2.1 The basic model

A natural starting point for a demand analysis is to assume that the demand for a product is a function of its price, all other consumer prices and the consumers' disposable income. As in most previous studies in the area, our starting point is a general single-equation, log-linear specification of the demand function which is compatible with this idea:

$$(1) \quad \ln Q_i = \alpha_i + e_i \ln y + \sum_{k=1}^{n} e_{ik} \ln p_k + u_i,$$

where Q_i is the quantity of tobacco product i consumed in period t, y is income in period t, p_k is the price of commodity k in the period t, e_i is the income elasticity, e_{ik} is the cross-price elasticity of the kth price on the demand of tobacco product i, and u_i is the error term which incorporates the effects of the all excluded independent variables in the demand function.

As the number of parameters to be estimated in equation (1) is high, reducing the degrees of freedom, some prior restrictions are necessary in order to estimate the equation. Setting the majority of the cross-price elasticities at zero is an obvious solution, though not theoretically an attractive one, as price elasticities contain both income and substitution effects. While the latter may be zero for unrelated goods, such as tobacco and butter, there is no reason to suppose the former to be non-zero. This problem may be solved by decomposing the cross-elasticities according to the Slutzky equation (Deaton and Muellbauer 1980):

$$(2) \quad e_{ik} = e^{*}_{ik} - e_i w_k$$

where e^{*}_{ik} is the compensated cross-price elasticity and w_k is the budget share. Substituting (2) into (1) we get

$$(3) \quad \ln Q_i = \alpha_i + e_i(\ln y - \sum_{k=1}^{n} w_k \ln p_k) + \sum_{k=1}^{n} e^{*}_{ik} \ln p_k + u_i.$$

As the expression $\sum_{k=1}^{n} w_k \ln p_k$ can be interpreted as the logarithm of a general price index p (3) becomes

$$(4) \quad \ln Q_i = \alpha_i + e_i \ln(y/p) + \sum_{k=1}^{n} e^{*}_{ik} \ln p_k + u_i$$

which gives the demand in terms of real income and compensated prices. Imposing the homogeneity restriction $\sum_{k=1}^{n} e^{*}_{ik} = 0$ allows us to deflate all prices in (4) by the general price index p.

Thus we get

$$(5) \quad \ln Q_i = \alpha_i + e_i \ln(y/p) + \sum_{k \in K} e^{*}_{ik} \ln(p_k/p) + u_i$$

and denoting real valued independent variables by capital letters, (5) becomes

$$(6) \quad \ln Q_i = \alpha_i + e_i \ln Y + \sum_{k \in K} e^*_{ik} \ln P_k + u_i.$$

In (5) and (6) the price variables are restricted to close substitutes and complements. This procedure is now acceptable since there is no reason not to rule out zero substitution between unrelated goods. Model (6) is the most commonly applied model in the demand analysis of a single good. The advantage of the model is that its parameters have a simple interpretation. Estimated parameters indicate directly the values of price and income elasticities.

Elasticities indicate how many percentage points the demand tends to change as a result of a one percent change in price or income when other influences have been controlled for. Knowledge of elasticities is valuable to all interested parties: the producers, distributors and the Ministry of Finance; and in the case of tobacco and other potentially hazardous substances, to the Ministry of Health.

2.2 Habit formation

It is widely acknowledged that tobacco causes psychological and physical dependency. Smoking easily becomes a habit difficult to abandon. The basic model does not take account of the effects of habit formation directly on the demand.

Indirectly, its effects are seen in the low elasticity estimates; the demand for tobacco is not very responsive to price increases. It is not possible, however, to isolate the direct effect of habit formation in the basic model. Furthermore, the model (6) is completely static, which means that consumption is assumed to adjust instantaneously, within a given period, to the new equilibrium level when prices and income change. If the price of a tobacco product increases during a certain period, the demand for that product is supposed to react 'immediately' and to assume its new equilibrium value during the same period. In the case of goods which are characterized by habit formation the above assumption may be too strong; ideally we would have liked to take account of the habit forming nature of tobacco in our specification of the demand functions.

While we are neither interested in explaining why the smoking habit evolves, nor in the actual habit forming process, it is of great interest to examine its effect on the demand for tobacco, as habit formation clearly determines the extent to which the demand can be influenced by various policy instruments.

Marshall (1927, p. 807) discussed the effects of habit formation on the demand analysis, suggesting that:

> "... the increase in consumption arising from a fall in price is gradual: and further, habits which have once grown up around the use of a commodity while its price

is low, are not quickly abandoned when its price rises again."

The three ideas introduced here

(1) adaption to a change in prices is gradual; there is a partial adjustment,

(2) the effect of habits is positive, i.e. demand increasing,

(3) the movement along a demand curve is irreversible when habits have developed in the meantime,

lead to three different models incorporating the habit forming nature of tobacco: the partial adjustment model, the habit stock model, and the addiction asymmetry model. All of these are discussed in turn.

2.2.1 The partial adjustment model

The simplest way to reformulate the basic demand model (6) is to postulate a partial adjustment scheme assuming that the actual level of demand ($\ln Q_{it}$) adjusts gradually to the desired level ($\ln Q^{*}_{it}$):

$$(7) \quad \ln Q_{it} - \ln Q_{i,t-1} = \delta_i(\ln Q^{*}_{it} - \ln Q_{i,t-1}),$$

with $0 < \delta_i < 1$. Suppose that the desired demand is a linear function of the same variables as in equation (6):

$$(8) \quad \ln Q^*_{it} = \alpha_i + e_i \ln Y_t + \sum_{k \in K} e^*_{ik} \ln P_{kt} + u_{it},$$

then after solving (7) for $\ln Q^*_{it}$ and substituting it into (8) we arrive at the demand function

$$(9) \quad \ln Q_{it} = \alpha_i \delta_i + e_i \delta_i \ln Y_t + \sum_{k \in K} e^*_{ik} \delta_i \ln P_{kt}$$

$$+ (1 - \delta_i) \ln Q_{i,t-1} + w_{it},$$

where $w_{it} = \delta_i u_{it}$, and which does not include the unobservable variable $\ln Q^*_{it}$.

Postulating the partial adjustment scheme we have introduced lagged consumption into our model, which implies that testing the statistical significance of the coefficient of the lagged consumption variable is equal to testing the hypothesis that the consumption of tobacco adjusts gradually to changes in prices and income.[1] The smaller the estimated coefficient of the lagged consumption variable $Q_{i,t-1}$ the faster actual demand will reach the desired level. When $\delta_i = 1$, in the model (9), the coefficient of the lagged endogenous variable is zero, and the model is reduced back to the basic model (6), thus implying total and immediate adjustment and also equal short run and long run elasticities.

---

[1] In fact we test whether the short-term response to price changes, for example, given by $e^*_{ik}\delta_i$, would be smaller than that faced in the long-run, e^*_{ik}.

2.2.2 The habit stock model

In the partial adjustment model (9) habits enter into the demand function indirectly through past decisions which are reflected in the lagged consumption variable. Houthakker and Taylor (1970) introduce habits explicitly into the demand function postulating a model in which smoker's current demand for tobacco depends not only on income and prices, but also on a psychological stock of smoking habits that a consumer has built up over his smoking life.

This unmeasurable stock of habits is represented by a 'stock variable' S_{it}, which describes a consumer's current smoking habits as the result of past behaviour. The model is defined by two structural equations, one for the quantity demanded:

$$(10) \quad Q_{it} = \beta_{0i} + \beta_{1i}S_{it} + \beta_{2i}Y_t + \sum_{k \in K}\beta_{ki}P_{kt} + u_{it}$$

and the other for a state variable which relates the net change in the psychological stock of smoking habits at time t to the flow of purchases minus depreciation of the stock which is assumed to occur at a constant rate δ_i:

$$(11) \quad \dot{S}_{it} = Q_{it} - \delta_i S_{it}.$$

The stock variable represents the strength of habit, and it is expected that $\beta_{ik} > 0$ by the argument that the more a consumer has smoked in the past, the more he will want to smoke currently.

In practice we cannot observe or measure the state variable S_{it}, but that does not cause any problems, since we can eliminate it from the equations. From the two structural equations, the following dynamic estimating equations, in discrete time, can be derived:[1]

$$(12) \quad Q_{it} = a_{0i} + a_{1i}\Delta Y_t + a_{1i}\lambda_i Y_{t-1} + \sum_{k\in K} a_{ki}\Delta P_{kt} + \sum_{k\in K} a_{ki}\lambda_i P_{k,t-1} + \sum_{k\in K} a_{ni} Q_{i,t-1} + v_{it}$$

where Δ is the difference operator, $\Delta x_t = x_t - x_{t-1}$, λ_i is a non-linear expression in the structural coefficients, and v_{it} is the disturbance term of the reduced form.

Estimates of the structural coefficients β_{ji}, may be derived from the estimated coefficients of the reduced form, a_{ji} and λ_i, but the latter must be estimated subject to the non-linear restriction that the ratios of the coefficient of each lagged independent variable to the coefficient of the corresponding first difference of that variable are constrained to be equal to λ_i.

---

[1] The estimating equations for the three tobacco products are derived explicitly in Appendix 1, in which it is also shown how the estimates of the structural parameters β_{ij} and δ_i may be derived from the a_{ji} and λ_i.

As in the partial adjustment model, the demand for tobacco does not adjust immediately to changes in prices and income, and furthermore current consumption is positively influenced by consumption in the more or less recent past, that is, by the psychological stock of smoking habits accumulated. Given tastes and income, a smoker's current consumption will be affected by the stock, i.e. the more he has smoked in the past, the more he will smoke currently. In this model, unlike the partial adjustment model (9), the estimated parameter a_{ni} of the lagged consumption variable does not measure the speed of adjustment, nor has any particular interpretation been given to it. The difference of the estimated coefficients δ_i and β_{1i} ($k_i = \delta_i - \beta_{1i}$) gives an estimate of the adjustment coefficient, that is, k is the portion of the desired change in the stock of habits that takes place in one interval (Phlips 1974). The greater the rate of depreciation δ_i, the faster they wear off and the faster habits adjust to their equilibrium level.

2.2.3 The addiction asymmetry model

While the partial adjustment model (9) and the habit stock model (12) can be interpreted to incorporate the habit forming nature of smoking through their dynamic structure, they suffer from the same shortcoming. The consumer's response to changes in prices and income are assumed to be symmetric, that is, the strength of his reaction to declining and increasing prices will be equal, despite the habits he has developed.

Following Marshall (1927) and Scitovsky (1976, 1978), among others, it can be argued that the asymmetric rather than the symmetric response to changes in prices and income may well be a typical feature of consumption of goods, particularly, of those goods such as tobacco and alcohol for which a psychological and physiological dependency may exist. This asymmetry stems from the consumer's tendency to acquire habits of consumption more easily than to abandon them (Scitovsky 1976, 1978). This has an important consequence for the slope of the demand curve: the curve becomes kinked so that the response to a price rise becomes less elastic than to a price fall (Figure 3), which in turn, would have significant policy implications.

Recently, Young (1982, 1983) has suggested a ratchet model which provides direct estimates of the degree of asymmetry to price and income changes. The major economic assumption distinguishing the ratchet model from the habit stock model is that consumers revise their consumption habits in discrete terms. The demand curve is saw-toothed, given a series of price changes (Figure 4).

The demand curve is kinked at the prevailing price, irrespective of past price changes. Thus the model assumes that new smokers are encouraged to enter the market in the event of any price decrease, and that habits thus formed are assumed to persist when prices subsequently rise. Hence, price variation expands the tobacco markets.

The adjustment process can be modelled by a price decomposition method suggested by Wollfram (1971), which can be summarized briefly as follows.

A linear asymmetric demand function, corresponding to the symmetric demand function

$$Q_{it} = \alpha_{0i} + \alpha_{1i}P_{it} + \alpha_{2i}Y_t + u_{it}$$

will be

$$(13) \quad Q_{it} = \beta_{0i} + \beta_{1i}PR_{it} + \beta_{2i}PF_{it} + \beta_{3i}YR_t + \beta_{4i}YF_t + u_{it},$$

where PR_{it}, the sum of all period-to-period rises in P_{it}, is defined as

$$PR_{it} = \sum_{k=1}^{t}\phi_k(P_{ik} - P_{i,k-1}),$$

with $$\phi_k = \begin{cases} 1, & \text{if } P_{ik} > P_{i,k-1} \\ 0, & \text{otherwise} \end{cases}$$

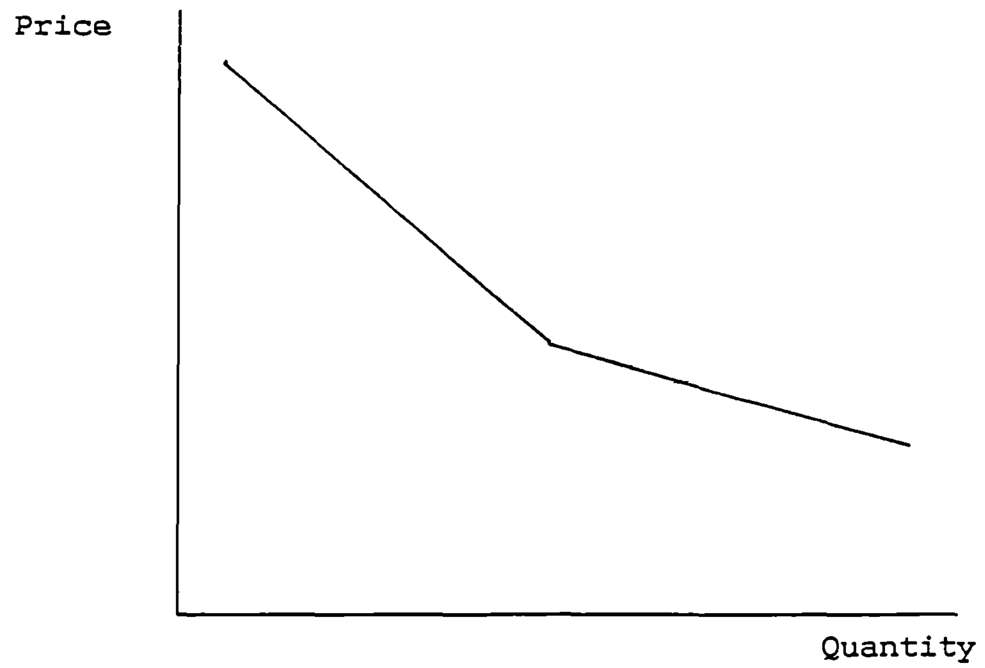


Figure 3. Asymmetric response to price change

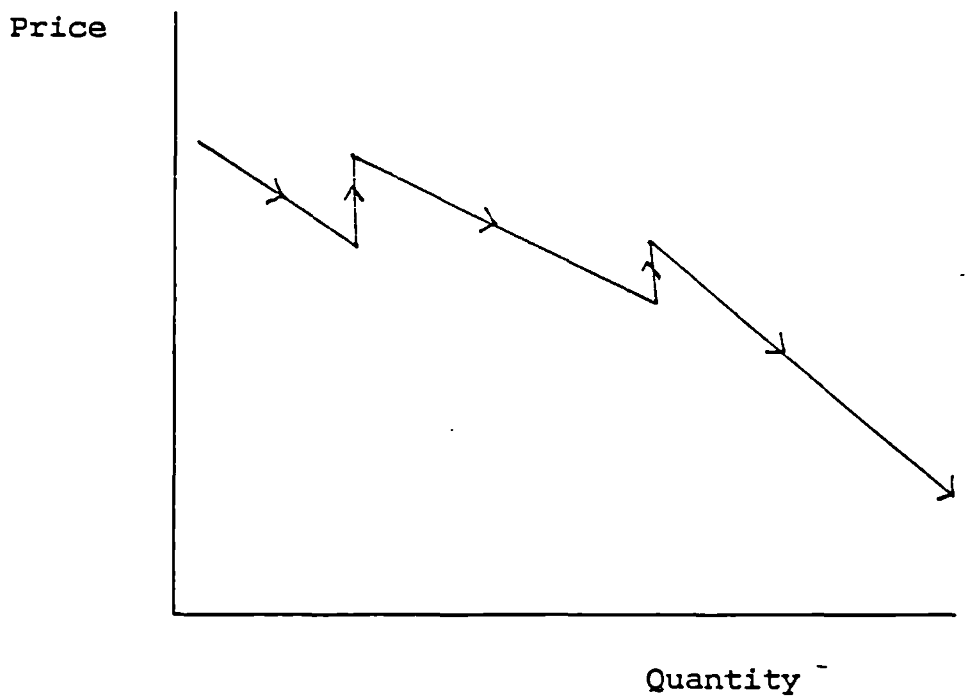


Figure 4. Saw-toothed time-path of the demand

and PF_{it}, the sum of all period-to-period falls in P_{it}, is

$$PF_{it} = \sum_{k=1}^{t} \theta_k (P_{ik} - P_{i,k-1}),$$

with $$\theta_k = \begin{cases} 1, \text{ if } P_{ik} < P_{i,k-1} \\ 0, \text{ otherwise.} \end{cases}$$

In the log-linear specification of the addiction asymmetry model the variable PR_t is defined as

$$PR_{it} = \begin{cases} PR_{i,t-1}\dfrac{P_t}{P_{i,t-1}}, & \text{if } \dfrac{P_t}{P_{i,t-1}} > 1 \\ PR_{i,t-1}, & \text{otherwise} \end{cases}$$

and the variable PF_t as

$$PR_{it} = \begin{cases} PF_{i,t-1}\dfrac{P_t}{P_{i,t-1}}, & \text{if } \dfrac{P_t}{P_{i,t-1}} < 1 \\ PF_{i,t-1}, & \text{otherwise .} \end{cases}$$

Variables YR_t, the income rising series, and YF_t, the income falling series, are defined in similar ways. If the demand for product i exhibits aspects of addiction asymmetry, then $|\beta_{2i}| > |\beta_{1i}|$ and $|\beta_{3i}| > |\beta_{4i}|$.

Noting that $P_{it} = P_{i0} + PR_{it} + PF_{it}$ and $Y_t = Y_0 + YR_t + YF_t$, where P_{i0} and Y_0 are values of prices and income in the initial period, and substituting for PR_{it} and YF_t in equation (13) the model can be re-specified in linear form as follows[1,2]

$$(14) \quad Q_{it} = \beta_{0i} + \beta_{1i}P_{it} + \beta^*_{2i}PF_{it} + \beta_{3i}Y_t + \beta^*_{4i}YR_t + u_{it},$$

and in log-linear form as

$$(15) \quad \ln Q_{it} = \beta_{0i} + \beta_{1i}\ln P_{it} + \beta^*_{2i}\ln PF_{it} + \beta_{3i}\ln Y_t + \beta^*_{4i}\ln YR_t + u_{it},$$

where $\beta^*_{2i} = \beta_{2i} - \beta_{1i}$ and $\beta^*_{4i} = \beta_{3i} - \beta_{4i}$.

The usual t-statistic of the estimated coefficients β^*_{2i} and β^*_{4i} (with H_0: $\beta^*_{2i} = 0$, H_0: $\beta^*_{4i} = 0$) provides an appropriate test of the equality of the slope parameters. Addiction asymmetry, with respect to both price and income change is confined if $\beta^*_{2i} < 0$ and $\beta^*_{4i} > 0$.

While the ratchet specification offers a simple means of exploring asymmetric consumer responses, it should be noted that no account is taken of erosion of memory of distant price

---

[1] It is straightforward to expand models (14) (15) to include the prices of close substitutes and complements. This is done when the empirical estimating equations are specified.

[2] Young (1982, 1983) also specifies an alternative model where the behavioural hypothesis is that new smokers are captured only at record low prices and/or record high income. We shall not, however, pursue this hypothesis further in this study.

and income changes in models (14) and (15). The partial adjustment model (9) and the habit stock model (12) do not suffer from this omission. This problem can be solved by respecifying the models to incorporate the partial adjustment to the desired level of demand, as in the model (9), which implies the following estimating equations:

$$(16)\quad Q_{it} = \beta_{0i}\delta_i + \beta_{1i}\delta_i P_{it} + \beta^*_{2i}\delta_i PF_{it} + \beta_{3i}\delta_i Y_t + \beta^*_{4i}\delta_i YR_t + (1 - \delta_i)Q_{i,t-1} + u_{it}.$$

$$(17)\quad \ln Q_{it} = \beta_{0i}\delta_i + \beta_{1i}\delta_i \ln P_{it} + \beta^*_{2i}\delta_i \ln PF_{it} + \beta_{3i}\delta_i \ln Y_t + \beta^*_{4i}\delta_i \ln YR_t + (1 - \delta_i)\ln Q_{i,t-1} + u_{it}.$$

The models (16) and (17) imply that consumers adapt to a price or income change gradually, but movement along the demand curve is irreversible when smoking habits have developed. Consumers' asymmetric response is not only a brief phenomenon but may persist in the long run.

While the habit stock model (12) can be utilized to model the stock adjustment by the consumer, the main novelty of models (14) and (15) is in that they directly isolate the effects of an asymmetric response to changes in prices and income on the market demand.

2.3 The future effects of current consumption

In all the above models the consumer is assumed to take account of past decisions only, but they do not allow him to take account of the future effects of his present decisions. In particular, they do not allow for his reactions to an increasing flow of information about the undesirable side effects of smoking. When consumers have incomplete knowledge the number of smokers is higher and they are induced to purchase more tobacco products than had they been adequately informed.

Anti-smoking publicity increases the flow of information about the adverse health effects of smoking, allowing consumers to reevaluate the characteristics of tobacco and adjust consumption accordingly, which will shift the demand curve. This in turn requires a reformulation of the demand equations (6), (9), (12), (14) and (15). Ideally it would be desirable not simply to postulate an adjustment to a static equilibrium level of demand, but to derive the optimal adjustment path from utility maximizing behaviour. As the consumer's response to increased information is likely to depend on his past smoking history and hence on the age at which he receives the information regarding the hazard, it would seem impossible to incorporate this fact into the above models. However, the theoretical analysis of Ippolito (1981) implies a simple solution to the problem.

Ippolito studies the effects of new information on the optimal life cycle consumption of hazardous goods within the investment in health framework. The addictive nature of tobacco is ignored in the model, but that does not affect the predictions of the model. The starting point of the analysis is that the utility associated with the consumption of a hazardous good is traded for an increase in life expectancy or a reduction in the likelihood of illness. Thus the individual's decision to reduce or to give up smoking can be regarded as one aspect of his overall decision to invest in health.

Ippolito shows that a U-shaped life time consumption path is consistent with rational behaviour for consumption of tobacco products. The shape of the consumption path is explained by the age and discount effects. The age effect increases consumption over time; the expected cost of dying in terms of expected future utility is decreasing as an individual ages. The discount effect acts in the opposite direction. As each cigarette is consumed, the risk associated with further consumption increases. As the individual ages, the likelihood of dying from other causes increases, hence he will discount the future consumption of tobacco in favour of current consumption, that is, it is optimal to smoke before the risk of dying from other causes becomes significant.

Of these two factors, age is the primary factor determining consumption. The health cost of smoking depends on the expected number of years remaining in life as well as the past smoking history. Because of the long latent period between exposure and onset of a disease, as in the case of lung cancer, it is optimal to smoke several years when young, ignoring the addictive nature of tobacco, to abstain while middle-aged and start again in old age when the shadow price of consumption is small if not zero.

Moreover, those who have smoked excessively for many years before the revealing of the health hazards know there is a probability that they have already triggered the development of, for example, lung cancer during that period. Since their chance of dying is now higher than otherwise, their health cost of current smoking is less, thus they will consume more than otherwise.

The predictions of Ippolito's model indicate that, depending on age, it is not always optimal to reduce consumption; it may in fact be optimal to increase consumption after receiving information about the health hazards.[1]

Ippolito then relates the predictions of her model to aggregate consumption statistics. Assuming that the age profile of the population remains unchanged over time, then at the time of the hazard announcement individuals would

---

[1] A similar conclusion was also reached by Atkinson (1974), who showed that while the spread of information about the health hazards reduces the number of smokers, it may increase consumption among young continuing smokers where publicity is directed particularly at the risk in later life.

adjust their consumption of tobacco as a function of age; once the information has been received by individuals, there will be an initial drop in the average consumption rate. As time passes, the average consumption rate should rise until reaching an equilibrium which is less than the preannouncement rate. This erosion of the initial reduction reflects the smaller average reaction required to compensate for past non-optimal behaviour.

As consumption decisions are reflected in consumption statistics, the above analysis suggests that the effects of the possible exogenous changes in tastes due to increased knowledge of the health risks of smoking can be incorporated into the models (6), (9), (12), (14) and (15) by adding two dummy variables to the estimating equations; one being a dichotomous variable (demand shift DS) taking the value zero before the announcement of the new information and one after, which measures the initial effect, the other being a time trend (relapse rate RR), taking zero values before the new information, which reflects the erosion of the initial effect.

Assuming only a single announcement of the new information about the health risks of smoking, the estimating equations become:

$$(18) \quad \ln Q_{it} = \alpha_{0i} + e_i \ln Y_t + \sum_{k \in K} e^*_{ik} \ln P_{kt} + \alpha_{1i} DS + \alpha_{2i} RR + u_{it}$$

$$(19) \quad \ln Q_{it} = \alpha_{0i}\delta_i + e_i\delta_i \ln Y_t + \sum_{k\in K} e^*_{ik}\delta_i \ln P_{kt} + (1 - \delta_i)\ln Q_{i,t-1} + \alpha_{1i}\delta_i DS + \alpha_{2i}\delta_i RR + u_{it}$$

$$(20) \quad Q_{it} = a_{0i} + a_{ii}\Delta Y_t + a_{ii}\lambda_i Y_{t-1} + \sum_{k\in K} a_{ki}\Delta P_{kt} + \sum_{k\in K} a_{ki}\lambda_i \Delta P_{k,t-1} + a_{ni}Q_{i,t-1} + a_{n+1,i}DS + a_{n+2,i}RR + u_{it}$$

$$(21) \quad Q_{it} = \beta_{0i} + \beta_{1i}P_{it} + \beta^*_{2i}PF_{it} + \beta_{3i}Y_t + \beta^*_{4i}YR_t + \beta_{5i}DS + \beta_{6i}RR + u_{it}$$

$$(22) \quad Q_{it} = \beta_{0i}\delta_i + \beta_{1i}\delta_i P_{it} + \beta^*_{2i}\delta_i PF_{it} + \beta_{3i}\delta_i Y_t + \beta^*_{4i}\delta_i YR_t + (1 - \delta_i)Q_{i,t-1} + \beta_{5i}\delta_i DS + \beta_{6i}\delta_i RR + u_{it}.$$

The equations (18) and (19) are also estimated in linear form and the equations (21) and (22) in log-linear form.

3 PREVIOUS STUDIES

Previous studies have centered on estimating the demand functions either for the aggregate tobacco consumption or for cigarettes only. Static specification of the basic demand model (18) has been commonly applied and deemed satisfactory to describe the demand for tobacco products in various countries (Atkinson and Skegg 1973, 1974, Johnston 1980, Kouytsouyannis 1963, McGuinness and Cowling 1975, Rimpelä and Kuuluvainen 1976, Russel 1973, Sehm 1977, Sumner 1971, Valtonen 1982, Witt and Pass 1981). In the U.S. the demand for cigarettes seems to be compatible with the partial adjustment hypothesis (19) (Fujii 1975, 1980, Hamilton 1972, Warner 1977, 1981).

Empirical results do not generally lend support to the habit stock model (20) (Comanor and Wilson 1974, Leu 1984) which is also found unsatisfactory in econometric studies on the demand for alcohol (Comanor and Wilson 1974, Duffy 1980). The addiction asymmetry hypothesis (22) is confirmed by Young (1983), who found strong asymmetric responses to changes in cigarette prices and income in the U.S.

Empirical findings of all the previous studies are consistent in that the demand for cigarettes appears to be rather inelastic with respect to its own price, and income elasticity is small but positive and significant (Table 1). The studies suggest that own-price elasticity lies between

Table 1. Price and income elasticities of the demand for cigarettes in some European countries.

Study	Price Elasticity	Income Elasticity
Finland		
Rimpelä and Kuuluvainen (1976)	- 0.36	+ 0.29
Sehm (1977)	- 0.33	+ 0.39
Valtonen (1982)	- 0.35	+ 0.16
United Kingdom		
Sumner (1971)	- 0.25	+ 0.48
Atkinson and Skegg (1973)	- 0.25	+ 0.50
Witt and Pass (1981)	- 0.32	+ 0.13
Switzerland		
Leu (1984)	- 0.50	+ 0.80

-0.2 and -0.6 both in the U.K. and in the U.S. (Atkinson and Skegg 1973, 1974, Fujii 1975, 1980, Hamilton 1972, Harris 1980, Johnston 1980, Kouytsoyannis 1963, Lewit and Coate 1982, McGuinness and Cowling 1975, Peto 1974, Russell 1973, Sumner 1971, Warner 1977, 1981, Witt and Pass 1981). In Finland it is about -0.35 (Rimpelä and Kuuluvainen 1976, Sehm 1977, Valtonen 1982).

The results obtained by Young (1983), who respecified Fujii's model (1980) to allow for asymmetric responses to changes in prices and income, suggest that the symmetric elasticities derived in the previous studies may be somewhat misleading. His findings indicate consumers to be more sensitive to declining prices and increasing income than to rising prices and declining income. They also imply that increasing the price of cigarettes may be less effective in reducing smoking than has been previously assumed. There is also some evidence that male and female smokers differ in their responses to changes in prices, though this is conflicting. In the U.K. cigarette price elasticity appears to be small for women and insignificant for men (Atkinson and Skegg 1973, 1974), while in the U.S. the price effect appears to be larger for males than for females (Lewit and Coate 1982).

Smoker's responsiveness to price changes also seems to depend on the age of the smoker. Lewit and Coate (1982) found significant differences in price elasticities between age groups in a cross-sectional study on the U.S. The adult price elasticity of the demand for cigarettes was -0.42, which corresponds with the results of time series studies. The price appears to have its greatest effect on the smoking behaviour of young smokers, particularly males (whose price elasticity is -1.4) and it seems to operate primarily on the decision to smoke (price elasticity -0.28) rather than via adjustments in the quantity of cigarettes smoked (price elasticity -0.10) (Table 2). In particular, the decision by males under 25 years old to start smoking regularly is price elastic, which is consistent with the notion that smoking is addictive behaviour starting in youth.

Demand equations for tobacco products other than cigarettes have been estimated in only two Finnish studies (Rimpelä and Kuuluvainen 1976, Valtonen 1982). In Finland cigarettes and pipe tobacco are close substitutes, which is based on the fact that the price of hand-rolled cigarettes is about half of the price of manufactured cigarette. Currently about 50-60 per cent of pipe tobacco is used in hand-rolled cigarettes. Demand for pipe tobacco is very sensitive to changes in cigarette price. The cross-elasticity is about two (Valtonen 1982).

Advertising has a small but significant effect on the demand for tobacco. In the U.K. a 10 per cent increase in advertising appears to increase cigarette consumption by 1 per cent in the short run (McGuinnes and Cowling 1975) and

Table 2. Cigarette price elasticities at means according to age, sex and smoking status in the U.S. (Lewitt and Coate 1982).

	20 - 25 years		26 - 35 years		Over 35 years	
	Males	Females	Males	Females	Males	Females
1. Demand for cigarettes by smokers and non-smokers	-1.401*	-.302	-.320	-.577	-.658*	-.118
2. Smoking participation rate	-1.276**	-.136	-.292	-.388	-.246	.066
3. Demand for cigarettes by smokers	-.171	-.025	.029	-.134	-.204	-.077

* statistically significant at the 5 per cent level, two tail test

** statistically significant at the 1 per cent level, two tail test by 7-9 per cent in the long run (Johnston 1980, Witt and Pass 1981). In the U.S. a 10 per cent increase in advertising expenditure increases cigarette consumption by 2-4 per cent in the short run and by 2-6 per cent in the long run (Fujii 1980, Hamilton 1972). Consequently an advertising ban or restrictions imposed on cigarette advertising can be expected to reduce consumption slightly. There is some evidence that this would specifically discourage teenage smoking (Lewit et al 1981).

Effects of health 'scares' vary, but in general anti-smoking publicity in the form of health scares reduces consumption by a small but significant amount. Although little is known about the specific behavioural responses to anti-smoking publicity, the available evidence indicates that decreases in per capita consumption during and after periods of anti-smoking publicity *mainly reflect individuals' quitting* smoking rather than reductions in smoking levels of continuing smokers (USDHEW 1979).

In the U.K. the publication of the Royal College of Physicians (RCP) 1962 report and the television advertising ban of tobacco in 1965 reduced consumption by 4.6 per cent and 4.9 per cent respectively but the effect died away at a rate of about 1 per cent a year (Atkinson and Skegg 1973, 1974). This would seem to support the predictions of *Ippolito's (1981) model*. The results of Atkinson and Skegg also indicate that publicity has a temporary effect on the number of cigarettes smoked by men, while women's consumption has been reduced only through increases in taxation. A slightly different interpretation of the effects of anti-smoking publicity is given by Witt and Pass (1981) who estimated that the cigarette consumption decreased by 4.2 per cent after the 1962 report of the RCP, by 7.1 per cent after the report of the U.S. Surgeon General in 1964 and by 3.4 per cent after publication of the 1971 RCP report, during the year in which the 'scare' occurred and the subsequent year.

In the U.S. Warner (1977, 1981) and Hamilton (1972) found anti-smoking publicity in the form of anti-smoking advertisements on the television and radio to be very effective in the short run - even more effective than advertising, but it is possible that this marginal effectiveness would have diminished over time as their early successes reduced the smoking population to more 'hard core' smokers. Specifically Lewit et al (1981) found that anti-smoking advertising had a substantial negative impact on teenage smoking participation rates, but little or no impact on the quantity smoked.

In Switzerland the extended publicity following the 1964 U.S. Surgeon General's Report, various concurrent tax increases, and an earlier preceeding vote for an advertising ban on tobacco products, decreased consumption permanently by 11 per cent (Leu 1984).

4 SPECIFICATION OF THE EMPIRICAL DEMAND FUNCTIONS

Previous studies suggest that apart from the price and income, anti-smoking publicity, advertising and advertising bans affect the demand for tobacco products and should therefore be included as explanatory variables in the empirical demand functions. Studies do not give a clear cut answer as to which model is an appropriate formulation for estimating the demand for tobacco products. Some level of dissaggregation by age and sex would also seem necessary.

Casual inspection of Finnish consumption statistics suggests that the effect of the 1964 report did not extend beyond that year. The television advertising ban in 1971 does not seem to have had any direct effect. The Tobacco Act and the extensive public debate provoked by it in 1976 together with the total advertising ban in 1977 appear to have had a major effect on smoking.

The following hypothesis would therefore be appropriate: anti-smoking publicity caused a temporary decline in demand for tobacco in 1964, the television advertising ban did not have any major effect on demand, and a comprehensive tobacco policy caused a permament fall in consumption. The specifications of these hypotheses are given by

$$D64 = \begin{cases} 1, & \text{for } 1964 \\ 0, & \text{otherwise} \end{cases}$$

$$D71 = \begin{cases} 1, & \text{for 1971} \\ 0, & \text{otherwise} \end{cases}$$

$$D76S = \begin{cases} 1, & \text{for 1976 onwards} \\ 0, & \text{otherwise.} \end{cases}$$

Possible erosion of the 1976 intervention effect is examined with a time trend which is specified as follows:

$$RR76 = \begin{cases} 1, 2, 3, \ldots & \text{for 1977 onwards} \\ 0, & \text{otherwise.} \end{cases}$$

The theoretical argumentation in section 2.3 and the previous studies would suggest the expected signs of the dummy variables to be negative except for the trend dummy which is assumed to be positive for all tobacco products.

As we do not have any data on the volume of tobacco advertising or information about the advertising expenditure used to promote tobacco products before 1977, we have to exclude the advertising variable from our demand equations. We do not believe that this omission will result in a serious misspecification of our models, particularly as the previous studies indicate that advertising has only a marginal impact on the aggregate demand for tobacco products.

Previous Finnish studies (Rimpelä and Kuuluvainen 1976, Valtonen 1982) suggest that the price of cigarettes largely determines the demand for pipe tobacco and the price of pipe tobacco affects the demand for cigars. Thus the demand functions corresponding to the models (18) - (22) include the following variables:

Cigarettes: $Q_s = f_s(P_s, Y, D64, D71, D76S, RR76, u_s)$,

Pipe tobacco: $Q_{pt} = f_{pt}(P_s, P_{pt}, Y, D64, D71, D76S, RR76, u_{pt})$,

Cigars: $Q_c = f_c(P_c, P_{pt}, Y, D64, D71, D76S, RR76, u_c)$,

where Q_s, Q_{pt}, Q_c = the number of cigarettes, pipe tobacco (grammes) and cigars consumed per capita (people over 15 years of age),

P_s, P_{pt}, P_c = the real price of cigarettes, pipe tobacco and cigars,

Y = the real disposable income per capita (people over 15 years of age),

D64, D71, D76S, RR76 = dummy variables defined above,

u_s, u_{pt}, u_c = error terms.

5 MATERIALS AND STATISTICAL METHODS

As no disaggregated time series data by age and sex are available for Finland, the demand functions were estimated using aggregated annual data for the three broad tobacco categories. Per capita consumption of cigarettes, pipe tobacco and cigars was obtained by dividing the total consumption figures by the number of potential consumers, i.e. by the mean population over 15 years of age. Respective price series were derived by dividing the value of the retail sale by consumption. The real price series were obtained by deflating the price series by the consumer price index at 1980 prices. The income variable was obtained by dividing the households' disposable income by the mean population over 15 years of age and deflating it further by the consumer price index. The data was derived from various publications of the Central Statistical Office (Putkonen 1980, Tilastokeskus 1988).

All the models were first estimated for the period 1960-81. The models were estimated by ordinary least squares, except the habit stock models. The coefficients of the reduced form equations of the habit stock models were estimated subject to the non-linear constraint that the ratios of the coefficient of each lagged independent variable to the coefficient of the corresponding first difference of that variable are equal to λ_i. To achieve this, equations were estimated using the Gauss method (see Hall and Hall 1980).

The initial conditions for a_{ji} were the least squares estimates of the coefficients of the unconstrained model. The initial condition for λ_i was the average of the relevant ratios of the coefficients for lagged independent variables to the respective coefficients for the first differences of these variables.

The adequacy of the log-linear models was tested by Andrews' method (Andrews 1971, Godfrey and Wickens 1981) against the linear alternative. In our case, Andrews' method consists of estimating the specified models both in linear and log-linear forms:

$$Q_t = \sum_{i=1}^{k} \beta_i x_{ti} + \sum_{j=1}^{n} \alpha_j D_{tj} + \mu_1 \hat{q}_{t1} + u_t \quad (23)$$

$$\ln Q_t = \sum_{i=1}^{k} \beta_i \ln x_{ti} + \sum_{j=1}^{n} \alpha_j D_{tj} + \mu_2 \hat{q}_{t2} + u_t \quad (24)$$

where Q_t is the dependent variable, the x_{ti}'s are the relevant price and income variables, the D_tj's are the relevant dummy variables, α_1 is the intercept, u_t is random error, and $\hat{q}_{t1}$ and $\hat{q}_{t2}$ are artificial variables which do not involve unknown parameters and which depend upon the dependent variables only through the OLS coefficient estimates of the linear and log-linear models, where the variables $\hat{q}_{t1}$ and $\hat{q}_{t2}$ are not included. The equations (23) and (24) are then estimated by

OLS and the usual t-test of $\mu = 0$ provides an appropriate test of the adequacy of the functional form:

$$H_0: \mu = 0 \iff \text{accept the functional form}$$

$$H_1: \mu \neq 0 \iff \text{reject the functional form.}$$

Multicollinearity was diagnosed by two methods. Firstly, all the independent variables were regressed on each other in order to examine whether the $R^2_y < R^2_i$, where $R^2_y = R^2_{y.x1x2...xk}$ and $R^2_i = R^2_{xi.other\ x's}$, which some (e.g. Maddala 1981) feel indicate serious multicollinearity. Secondly the method proposed by Gilbert (1978) was used.

Gilbert's method is based on the correlation matrix of the independent variables. The advantage of this method is that it provides an easy method to diagnose for multicollinearity through the C^2 statistic, which is related to the structure of the data moment matrix, and to analyse the location of collinearity. The collinearity measure C^2 is defined as:

$$C^2 = k^{-1}\sum_{i=1}^{k} r^{ii},$$

where k is the number of coefficients and r^{ii} is the ith diagonal element of the inverse of the correlation matrix. The contribution of variable i to the data is measured by

$$c^2_i = (r^{ii} - 1)/k,$$

which is related to C^2 through the following expression

$$C^2 = 1 + \sum_{i=1}^{k} c_i$$

as shown by Gilbert (1978). For an orthogonal data set $C^2 = 1$ and the statistic becomes infinitely large as interdependence between the explanatory variables grows and the moment matrix approaches singularity.

Gilbert (1978) regards the data matrix as generated by a badly designed experiment and seeks, through the C^2 measure, to ask by how much the precision of the regression estimates would be improved by the use of an orthogonal design. In this framework the derived statistic $G = (100/C^2)*100$ % provides a measure of the efficiency of the experimental design implicit in the sample observations on the regressors. Inefficiency of the design implicit in the sample would be indicated by low values for G. A value of 100 per cent for G corresponds to an orthogonal set of regressors and thus the estimated coefficients would be completely unaffected by collinearity.

Autocorrelation was tested with a standard Durbin-Watson statistics. Normality of the residuals was tested by a method suggested by Jarque and Bera (1980). Apart from the standard statistical tests, the post-estimation forecast performance in the period 1982-1987 was tested with the method proposed by Theil (1966).

Let A_t be the actual consumption of a tobacco product in period t and P_t the predicted or forecast consumption for the same period. The actual relative change is $a_t = (A_t - A_{t-1})/A_{t-1}$ and the predicted relative change is $p_t = (P_t - A_{t-1})/A_{t-1}$.

Theil (1966) suggested the use of

$$U = [\sum_{t=1}^{n}(p_t - a_t)^2/n]^{½}/[\sum_{t=1}^{n}A^2{}_t/n]^{½}$$

for measuring the accuracy of forecasts. This statistic lies between zero and infinity. It is equal to zero in the case of perfect forecasts, i.e. when $P_t = A_t$ for all t. When it is equal to one, forecasts do not perform better than no change forecasts. If the statistic is greater than one forecasts make the situation worse than if it had not been used.

The final models were selected both on the basis of standard statistical tests and their forecast performance of the models. The final models were re-estimated for the period 1960-87.

6 EMPIRICAL RESULTS

6.1 The basic model

6.1.1 The log-linear specification

Our initial specification is the log-linear model (18)[1] with the corresponding estimating equations:

Cigarettes:

$$(25)\quad \ln Q_s = a_0 + e_s \ln Y + e^*_{ss} \ln P_s + d_1 D64 + d_2 D71 + d_3 D76S + d_4 RR76 + u_s,$$

Pipe tobacco:

$$(26)\quad \ln Q_{pt} = b_0 + e_{pt} \ln Y + e^*_{pt.pt} \ln P_{pt} + e^*_{pt.s} \ln P_s + d_1 D64 + d_2 D71 + d_3 D76S + d_4 RR76 + u_{pt},$$

Cigars:

$$(27)\quad \ln Q_c = c_0 + e_c \ln Y + e^*_{cc} \ln P_c + e^*_{c.pt} \ln P_{pt} + d_1 D64 + d_2 D71 + d_3 D76S + d_4 RR76 + u_c.$$

---

[1] All the previous Finnish studies are based on the log-linear specification (6) (Rimpelä and Kuuluvainen 1976, Sehm 1977, Valtonen 1982). As distinct from other Finnish studies, dummy-variables relating to anti-smoking publicity and advertising bans are included in our basic model.

From the demand theory the expected signs of the parameters are:

$$e_i > 0,\ e^*_{ii} < 0,\ e^*_{ji} > 0,\ d_1,\ d_2,\ d_3 < 0.$$

Furthermore, if the limited duration hypothesis holds, then $d_4 > 0$. In this specification price and income elasticities are restricted to be constant over the relevant range of values, and moreover anti-smoking publicity and advertising bans are not assumed to alter the price and income elasticities, i.e. they only shift the demand curves. The estimation results are shown in Table 3.

All the estimated price elasticities are statistically significant[1] with the expected signs. Income elasticity is statistically significant with correct sign only in the cigarette equation. In other equations the income elasticity is negative and insignificant. The anti-smoking publicity variables, D64 and D76S, have the expected signs in the cigarette and cigar equations, while their signs are positive in the pipe tobacco equation. All the estimated coefficients of the anti-smoking variables D64 and D76S are statistically significant, with the exception of the 1964 variable for cigars. The relapse rate is negative in all equations and, with the

[1] At this preliminary stage our criterion is the 10 per cent significance level in the one-tail test.

Table 3. Estimates of the basic model, log-linear specification, 1960 - 1981. (t-ratios in parentheses)

	Cigarettes ($\ln Q_s$)	Pipe tobacco ($\ln Q_{pt}$)	Cigars ($\ln Q_c$)
Cigarette price ($\ln P_s$)	-.334 (-4.885)	2.160 (11.092)	-
Pipe tobacco price ($\ln P_{pt}$)	-	-.557 (-3.007)	1.073 (6.266)
Cigar price ($\ln P_c$)	-	-	-2.409 (-17.852)
Income ($\ln Y$)	.136 (2.597)	-.093 (-.402)	-.013 (-.035)
Anti-smoking publicity in 1964 (D64, shift)	-.067 (-1.880)	.255 (2.763)	-.029 (-.303)
Television adevertising ban (D71, shift)	.009 (.265)	-.091 (-1.034)	-.121 (-1.293)
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	-.117 (-4.050)	.248 (2.798)	-.313 (-3.312)
Relapse rate (RR76, 1977-81)	-.003 (-.391)	-.070 (-3.439)	-.044 (-1.555)
Intercept	8.122 (13.617)	-5.021 (-1.928)	13.657 (2.885)
$\bar{R}^2$	.777	.913	.986
DW	1.86	2.11	1.98
F (v_1, v_2)	13.16 (5,16)	32.46 (7,14)	219.45 (7,14)

exception of cigarettes, is also significant. The television advertising ban in 1971 seems to have encouraged cigarette smoking, while having the expected opposite effect on the demand for pipe tobacco and cigars, although the effect is not statistically significant in any of the equations.

The possibility that the insignificant coefficients arise from multicollinearity was diagnosed by two methods. The results, shown in Table 4, do not indicate that multicollinearity is a problem in this data set. The $R^2_y > R^2_i$ in all equations, the G statistics are high and the c^2_i's are very low compared to values calculated either by Gilbert (1978) or Duffy (1982). The implicit efficiency (G) in Gilbert's example was 7.75 per cent and in Duffy's study as low as 1 per cent. The suprisingly low values of the statistics in Table 4 arise from the fact that the real prices of tobacco products did not have any clear systematic trends during the study period while an almost continous increase in the real income was observed.

The Durbin-Watson statistics (DW) do not indicate the presence of the first order autocorrelation, and the normality tests did not reject the hypothesis of normally distributed residuals. Scatter plots of the residuals did not indicate heteroscedasticity. Hence the observed insignificant coefficients are likely to arise from the absence of true correlation between the dependent variable and the independent

Table 4. R^2_i, G and C^2_i measures of multicollinearity, log-linear specification, 1960-81.

	Cigarettes ($\ln Q_s$)		Pipe tobacco ($\ln Q_{pt}$)		Cigars ($\ln Q_c$)	
	R^2_i	C^2_i	R^2_i	C^2_i	R^2_i	C^2_i
Own price (lnP)	.123	.029	.800	.571	.856	.850
Cross price (lnP*)	-	-	.390	.091	.724	.374
Income (lnY)	.498	.180	.857	.859	.937	2.111
Shift (D64)	.074	.013	.189	.033	.199	.038
Shift (D71)	.078	.014	.111	.018	.135	.022
Shift (D76S)	.688	.368	.809	.605	.814	.626
Relapse rate (RR76)	.620	.271	.707	.345	.796	.557
R^2	.840	-	.942	-	.991	-
G	-	53.50	-	28.38	-	17.93

variable in question. We feel therefore that dropping the variables with insignificant coefficients from this and alternative model specifications does not result in a serious omitted variable bias.

The results of the functional form test are presented in Table 5. The relevant F-statistics do not reject either of the functional forms in the case of cigarettes and pipe tobacco; but the linear model is found inadequate for cigars, while the log-linear model is not rejected. Thus either linear or log-linear models may be employed except for cigars, where the log-linear model should be applied.

Following Fujii (1980), those variables with insignificant coefficients (at the 10 per cent level in one-tail test) were dropped from respective equations, and the equations were re-estimated. The results are shown in Table 6.

In the demand equation for cigarettes all the estimated parameters have the expected signs. The coefficient relating to the 1964 anti-smoking publicity is not significantly different from zero at the 5 per cent level in the two-tail test. Despite that, we did not drop the variable from the equation since the estimated coefficient is quite near the acceptance region and the implied fall in consumption corresponds with the observed reduction in demand.

Table 5. Andrews' test for the functional form, estimates of the parameters μ_1 and μ_2. (t-ratios in parentheses)

	Cigarettes ($\ln Q_s$)	Pipe tobacco ($\ln Q_{pt}$)	Cigars ($\ln Q_c$)
Linear	-4.068	-.195	1.368
specification μ_1	(-1.442)	(-.168)	(6.479)
Log-linear	-4.772	-.272	-.046
specification μ_2	(-1.664)	(-.577)	(-1.425)

Table 6. The demand functions for tobacco products, log-linear specification, 1960-81. (t-ratios in parentheses)

	Cigarettes (lnQ_s)	Pipe tobacco (lnQ_{pt})	Cigars (lnQ_c)
Cigarette price (lnP_s)	-.331 (-5.207)	2.160 (13.589)	-
Pipe tobacco price (lnP_{pt})	-	-.617 (-6.193)	1.053 (7.856)
Cigar price (lnP_c)	-	-	-2.390 (-23.853)
Income (lnY)	.135 (2.781)	-	-
Anti-smoking publicity in 1964 (D64, shift)	-.068 (-2.018)	.261 (2.953)	-
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	-.125 (-6.010)	.346 (4.480)	-.249 (-2.923)
Relapse rate (RR76, 177-81)	-	-.066 (-3.439)	-.044 (-2.204)
Intercept	8.121 (14.944)	-3.922 (-4.290)	13.736 (33.918)
$\bar{R}^2$	.800	.917	.987
DW	1.88	1.87	1.65
F (v_1, v_2)	21.97 (4,17)	47.23 (5,16)	411.26 (4,17)

In the pipe tobacco and cigar equations all the estimated elasticities have the expected signs. Apart from that, all other estimated coefficients have the wrong signs, except the 1976 dummy for cigars which has the expected sign.

According to the equations the demand for cigarettes is highly price and income inelastic. The estimated elasticities are in close agreement with those obtained in previous Finnish studies (Rimpelä and Kuuluvainen 1976, Sehm 1977, Valtonen 1982) as well as in other studies (Atkinson and Skegg 1973, 1974, Fujii 1975, 1980, Hamilton 1972, Harris 1980, Johnston 1980, Kouytsoyannis 1963, Lewit and Coate 1982, McGuinness and Cowling 1975, Peto 1974, Russell 1973, Sumner 1971, Warner 1977, 1981, Witt and Pass 1981). The prices of other tobacco products do not seem to determine the demand for cigarettes, which sounds intuitively plausible since cigarette consumption amounts to nearly 90 per cent of total tobacco consumption.

The demand for pipe tobacco is inelastic in terms of its own price, but highly elastic with respect to the price of cigarettes. The real disposable income does not explain the demand for pipe tobacco. Thus the demand for pipe tobacco is determined mainly by the price of cigarettes. The cross elasticity is about the same size as found in previous studies (Rimpelä and Kuuluvainen 1976, Valtonen 1982), but the own price elasticity is about twice as high as that estimated by Valtonen (1982). Rimpelä and Kuuluvainen (1976) did not find a significant own price elasticity. This discrepancy is due to the incorrect specification of the pipe tobacco demand function in previous studies, which ignored the variables relating to anti-smokin publicity. This omission caused serious autocorrelation in Valtonen (1982) study, which has been removed in this study by an alternative specification of the demand function.

The demand for cigars appears to be highly elastic with respect to its own price and slightly elastic to the price of pipe tobacco. Income does not seem to have any explanatory power. These results are consistent with the findings of Rimpelä and Kuuluvainen (1976), but the own price elasticity is higher than found by Valtonen (1982), who also discovered negative income elasticity. In the latter study the demand function for cigars is probably misspecified, since the effects of the anti-smoking publicity from 1976 onwards were ignored.

The effects of the anti-smoking publicity appear to be somewhat ambiguous. While publicity seems to reduce cigarette consumption, at the same time it seems to boost the demand for pipe tobacco. As the anti-smoking publicity was directed against all tobacco products, not cigarettes particularly, this would suggest an error in our results. We shall return to this problem in the following sections.

The ban on television advertising of tobacco in 1971 does not appear to have had a direct effect on the demand for tobacco. In this analysis it was not possible to separate the independent effect of the 1977 total advertising ban on consumption. The trend dummies did show significant annual decline in the demand for pipe tobacco and cigars, but it is highly unlikely that this was caused by the advertising ban. We were not able to find a significant trend coefficient for cigarettes, although we would have expected to find one for cigarettes particularly rather than for other tobacco products, since the latter were hardly advertised before the ban. Moreover, there is no reason to assume that cigarette advertising was the least effective of the three.

6.1.2 Stability of the estimated elasticities

The log-linear specification applied implies that the price and income elasticities are constrained to be constant over the relevant range of prices and income. Elasticities measure how the demand tends to respond to small changes in the explanatory variables. The same elasticities cannot, a priori, be assumed to hold good for large changes. In the previous section this assumption was made. There, we implicitly assumed that the events in 1976 only shifted the demand curves, leaving the estimated price and income elasticities unchanged. These shifts should therefore be interpreted to measure the direct effects of other factors than prices and income, e.g. the effects of anti-smoking publicity. The results indicated, however, that this interpretation may not be quite appropriate.

In this section we shall test whether the price and income elasticities have remained stable over the study period. This will also enable us to examine the hypothesis that the sharp fall in the demand for tobacco in 1976 was caused directly by the exceptionally high price increases and only indirectly by the anti-smoking publicity. The slope dummies assumed to capture the possible changes in the elasticities were defined as follows:

$$DlnP_i = \begin{cases} lnP_i, \text{ for } 1976,\ldots,1981 \\ 0, \textit{ otherwise}, \end{cases}$$

$$DlnP_{ij} = \begin{cases} lnPij, \text{ for } 1976,\ldots,1981 \\ 0, \text{ otherwise}, \end{cases}$$

$$DlnY = \begin{cases} lnY, \text{ for } 1976,\ldots,1981 \\ 0, \text{ otherwise}, \end{cases}$$

where P_i is the real price of the tobacco product, P_{ij} is the real price of the substitute and Y is the real disposable per capita income. Because of the high collinearity between the dummy variables D76S, $DlnP_i$, $DlnP_{ij}$, and DlnY only one of the variables can be included in the models at a time.

The stability of the price elasticities were tested by models[1]

$$\ln Q_s = a_0 + e^*_{ss}\ln P_s + \hat{e}^*_{ss}D\ln P_s + e_s\ln Y + d_1D64 + u_s,$$

$$\ln Q_s = a_0 + e^*_{ss}\ln P_s + e_s\ln Y + \hat{e}_sD\ln Y + d_1D64 + u_s,$$

$$\ln Q_{pt} = a_0 + e^*_{pt,s}\ln P_s + e^*_{pt,pt}\ln P_{pt} + \hat{e}^*_{pt,pt}D\ln P_{pt} + d_1D64 + d_3RR76 + u_{pt},$$

$$\ln Q_{pt} = a_0 + e^*_{pt,s}\ln P_s + \hat{e}^*_{pt,s}D\ln P_s + e^*_{pt,pt}\ln P_{pt} + d_1D64 + d_3RR76 + u_{pt},$$

$$\ln Q_c = a_0 + e^*_{cc}\ln P_c + e^*_{c,pt}\ln P_{pt} + \hat{e}^*_{c,pt}D\ln P_{pt} + d_4RR76 + u_c,$$

$$\ln Q_c = a_0 + e^*_{cc}\ln P_c + \hat{e}^*_{cc}D\ln P_c + e^*_{c,pt}\ln P_{pt} + d_4RR76 + u_c.$$

The ordinary t-statistic for $\hat{e}^*_i$, $\hat{e}^*_{ii}$, $\hat{e}^*_{ij}$ provides a test for the stability of the price elasticities. For example, the hypotheses for the stability of the cigarette price elasticity are

$$H_0: \hat{e}^*_{ss} = 0$$

$$H_1: \begin{cases} \ln Q_s = a_0 + e^*_{ss}\ln P_s + e_s\ln Y + d_1D64, & \text{for 1960-75} \\ \ln Q_s = a_0 + (e^*_{ss} + \hat{e}^*_{ss})\ln P_s + e_s\ln Y, & \text{for 1976-81.} \end{cases}$$

Other hypotheses are similar.

---

[1] Note that estimating the dummy variable model is equal to estimating two separate models for subsamples. The difference between the two approaches is that the estimates of the error variance is efficient in the dummy variable model whereas in the latter approach it will not be efficient, because in this case the information about the error variance contained in the other subsample is not utilized.

The above specifications imply that the price elasticities are assumed to change only as a result of substantial price increases. Yet, in fact, they may change as a result of substantial price increases, anti-smoking publicity or both.

Examining the signs of the slope dummies we may trace the likely cause of the possible change in price elasticities. In the first case, provided the price elasticities have changed only as a result of huge price increases we would expect the demand to become more elastic with respect to prices, i.e. $\hat{e}^*_{ii} < 0$, $\hat{e}^*_{ij} > 0$.

In the second case the direction of the effect depends on the functional form employed. The full price of tobacco products may be interpreted broadly to incorporate both the actual price paid by the consumer and the indirect cost of consuming tobacco products. The latter pertains to the perceived cost of the health hazards associated with smoking, which presumably will rise as a result of anti-smoking publicity. Although an increase in the perceived cost of smoking alters the demand elasticity with respect to actual money price, the direction of the effect is not unambiguous. In the log-linear specification the price elasticity will reduce as a result of increased knowledge of the health risks of smoking, while in the linear specification the price elasticity will increase[1].

---

[1] Assuming that the full price of cigarettes (z) is a sum of their monetary price (p) and the perceived cost of health risks of smoking (c) and the quantity of cigarettes smoked (q) is a function of its full price $q = f(z) = f(p + c)$, then in the log-linear specification, in which the demand

Hence in the case where changes in price elasticities are caused solely by the anti-smoking publicity the expected signs of the slope dummies would be, $\hat{e}^{*}_{ii} > 0$, $\hat{e}^{*}_{ij} < 0$.

In the third case the behavioural hypothesis is that while anti-smoking publicity makes consumers more aware of the health risks of smoking, the huge price increases would be the final trigger to stop to smokers wanting to give up smoking. If this hypothesis is true we would expect the combined effect of anti-smoking publicity and price increases to result in higher own price elaticities in all demand equations, leaving the cross-elasticities unchanged or reducing them (i.e. $\hat{e}^{*}_{ii}$, $\hat{e}^{*}_{ij} < 0$). If the combined effect were mainly due to anti-smoking publicity we would not expect smokers to substitute pipe tobacco for cigarettes (or cigars for pipe tobacco) more easily than they did before the 1976 events, since the anti-smoking publicity was directed against all tobacco products, not particularly against cigarettes.

The results for cigarettes (Table 7) indicate a small increase in the price elasticity. The demand has become slighty more responsive to changes in the real price of

---

elasticity with respect to full price (α) is constant; $\ln q = a - \alpha \ln z$, $-(\partial \ln q/\partial \ln p) = e = p(p+c)^{-1}\alpha$, and $(\partial e/\partial c) = -p(p+c)^{-2}\alpha < 0$. On the other hand, in the linear specification, in which the elasticity rises in absolute value as c rises: $q = a - bz = a - b(p+c)$, $e = bpq^{-1}$, $(\partial e/\partial c) = b^2pq^{-2} > 0$.

Table 7. Stability of the demand elasticities for cigarettes, log-linear specification, 1960-81. (t-ratios in parentheses).

	(1)	(2)	(3)
Cigarette price ($\ln P_s$)	-.331 (-5.200)	-.331 (-5.190)	-.331 (-5.200)
Cigarette price shift ($D\ln P_s$)[a]	-	-.022 (-5.990)	-
Income ($\ln Y$)	.135 (2.780)	.135 (2.780)	.135 (2.780)
Income shift ($D\ln Y$)[b]	-	-	-.012 (-5.990)
Anti-smoking publicity in 1964 (D64, shift)	-.068 (-2.020)	-.068 (-2.020)	-.068 (-2.010)
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	-.125 (-6.000)	-	-
Intercept	8.122 (14.940)	8.119 (14.910)	8.117 (14.910)
$\bar{R}^2$	.800	.800	.800
DW	1.88	1.88	1.88
F (v_1, v_2)	21.97 (4,17)	21.89 (4,17)	21.92 (4,17)

[a] $D\ln P_s = \begin{cases} \ln P_s, & \text{for 1976-81} \\ 0, & \text{otherwise} \end{cases}$

[b] $D\ln Y = \begin{cases} \ln y, & \text{for 1976-81} \\ 0, & \text{otherwise} \end{cases}$

cigarettes, which is compatible with the first and the third hypothesis. The result implies that huge price increases may make demand more elastic, thus improving the effectiveness of the pricing policy. However, the change in demand elasticity is very small indeed, indicating that the price elasticity has remained rather stable over time. The change in the income elasticity also seems to be very small.

The results for pipe tobacco (Table 8) indicate that demand has become more inelastic with respect to its price, whereas the cross-elasticity has increased slightly. These results are compatible with the first and the second hypothesis. However, as the demand for pipe tobacco has become less elastic in respect to its own price (despite the 49 per cent increase in its real price) and the cross-elasticity has increased, these together would seem to suggest that the drastic changes observed in the demand for pipe tobacco since 1976 are mainly a direct result of the huge increases in the real price of cigarettes, and the publicity effect has been mainly indirect. Moreover, together with the results in Table 8, those for pipe tobacco would suggest that smokers have become slightly more sensitive to changes in the price of cigarettes; nowadays, cigarette smokers switch to pipe tobacco more easily than before 1976.

Table 8. Stability of the demand elasticities for pipe tobacco, log-linear specification, 1960-81. (t-ratios in parentheses).

	(1)	(2)	(3)
Cigarette price ($\ln P_s$)	2.158 (13.590)	2.159 (13.500)	2.158 (13.580)
Cigarette price shift ($D\ln P_s$)[a]	-	-	.050 (4.490)
Pipe tobacco price ($\ln P_s$)	-.617 (6.190)	-.620 (-6.170)	-.617 (-6.190)
Pipe tobacco price shift ($D\ln P_{pt}$)[b]	-	.064 (4.400)	-
Anti-smoking publicity in 1964 (D64, shift)	.261 (2.950)	.262 (2.940)	.261 (2.950)
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	.280 (4.500)	-	-
Relapse rate (RR76, 1977-81)	-.066 (-3.440)	-.068 (-3.440)	-.067 (-3.440)
Intercept	-3.922 (-4.290)	-3.916 (-4.250)	-3.920 (-4.290)
$\bar{R}^2$	.917	.915	.917
DW	1.87	1.90	1.87
F (v_1, v_2)	47.23 (5,16)	46.52 (5,16)	47.17 (5,16)

[a] $D\ln P_s = \begin{cases} \ln P_s, & \text{for 1976-81} \\ 0, & \text{otherwise} \end{cases}$

[b] $D\ln P_{pt} = \begin{cases} \ln P_{pt}, & \text{for 1976-81} \\ 0, & \text{otherwise} \end{cases}$

The demand for cigars (Table 9) seems to have become more elastic with respect to its own price and less elastic with respect to the price of pipe tobacco, which is compatible with the third hypothesis.

The results suggest that the price and income elasticities may have changed as a result of the exceptionally high increases in the real price of cigarettes, but that the likely changes have been only marginal.

The slope and shift dummies seem to capture the effects of the 1976 events equally well (in terms of goodness of fit), which is not surprising as we have examined the same phenomenon by altering only the specification of the dummy variables. However, the policy implications of the alternative specifications differ. Models with shift dummies imply that the reduction in demand has been *caused by* exogenous shocks such as anti-smoking publicity, whereas the models specified with slope dummies imply that the reduction is caused directly by huge price increases and possibly indirectly by anti-smoking publicity. Instead of studying the effects separately it would be preferable to incorporate both these variables into the models in order to isolate their separate effects. Because of the high collinearity between the dummy variables it was not possible to estimate their parameter values reliably in the log-linear specification. An obvious solution to this kind of multicollinearity problem is to estimate linear demand equations, in which the demand

Table 9. Stability of the demand elasticities for cigars, log-linear specification, 1960-81. (t-ratios in parentheses).

	(1)	(2)	(3)
Cigar price ($\ln P_c$)	-2.390 (-32.850)	-2.390 (-32.790)	-2.392 (-32.650)
Cigar price shift ($D\ln P_c$)[a]	-	-.048 (-4.180)	-
Pipe tobacco price ($\ln P_{pt}$)	1.053 (7.860)	1.053 (7.840)	1.053 (7.840)
Pipe tobacco price shift ($D\ln P_{pt}$)[b]	-	-	-.068 (-4.160)
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	-.293 (-4.190)	-	-
Relapse rate (RR76, 1977-81)	-.044 (-2.200)	-.041 (-2.010)	-.042 (-2.060)
Intercept	13.737 (33.920)	13.736 (33.860)	13.726 (33.760)
$\bar{R}^2$	.987	.987	.987
DW	1.65	1.65	1.66
F (v_1, v_2)	411.26 (4,17)	409.84 (4,17)	408.02 (4,17)

[a] $D\ln P_c = \begin{cases} \ln P_c, & \text{for 1976-81} \\ 0, & \text{otherwise} \end{cases}$

[b] $D\ln P_{pt} = \begin{cases} \ln P_{pt}, & \text{for 1976-81} \\ 0, & \text{otherwise} \end{cases}$

elasticities are allowed to vary with the values of the explanatory variables. The linear specification should also enable us to isolate the independent effects of the price increases from the effects of anti-smoking publicity. As the linear specification was not rejected in the case of cigarettes and pipe tobacco we shall experiment with them below.

The scatter diagrams indicate that the demand curve for cigars has shifted with respect to its own price, whereas no change has happened in respect to the price of pipe tobacco. In fact, the demand for cigars appears to be negatively correlated with the price of pipe tobacco, which is exactly the opposite to what the elasticities indicated. Because of this puzzling finding we felt it necessary to experiment also with the linear models in this case in order to examine whether the substitution is found in the linear specification as well.

6.1.3 The linear specification

We estimated the linear models corresponding to the log-linear models in Table 6, with one exception. When both the 1976 dummy variable (D76S) and the relapse rate (RR76) were included in the cigar equation simultaneously they became statistically insignificant. We did not, however, drop both of them, as this would have caused serial correlation in the residual series. Instead we dropped only the relapse rate variable.[1] The scatter plots did not justify dropping of the shift dummy. The estimating results are shown in Table 10.

All the estimated coefficients have the same signs as in the log-linear specifications, with the exception of the price of pipe tobacco in the cigar equation, which is now negative and insignificant.

In the cigarette equation the estimated income and shift (D76S) coefficients are insignificant. The low value of the Durbin-Watson statistic (DW) and the unrealistically high value of the shift coefficient (D76S) point to model misspecification.[2] We did not, however, respecify the basic model on an ad hoc basis, as the alternative models below allow us to do this in a more attractive theoretical setting.

The estimated results for pipe tobacco are consistent with those obtained with the log-linear model, and the model seems appropriate by all statistical criteria.

The results for cigars differ dramatically from those of the log-linear specification. The demand for cigars is negatively, not positively, influenced by changes in the

---

[1] In various specifications this variable indicated an annual fall of two cigars per capita after 1976.

[2] Estimation of the model with the first order autocorrelated errors did not produce statistically significant estimates for $\hat{\rho}_1$, which gives further support to our conclusion.

Table 10. Estimates of the basic model, linear specification, 1960-81. (t-ratios in parentheses).

	Cigarettes (Q_s)	Pipe tobacco (Q_{pt})	Cigars (Q_c)	
Cigarette price (P_s)	-2.323 (-4.260)	1.977 (13.212)	-	-
Pipe tobacco price (P_{pt})	-	-2.102 (-5.775)	-.054 (-.442)	-
Cigar price (P_c)	-	-	-.057 (-7.961)	-.059 (-11.034)
Income (Y)	.022 (1.033)	-	-	-
Anti-smoking publicity in 1964 (D64, shift)	-170.777 (-2.270)	65.177 (2.906)	-	-
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	-736.207 (-1.342)	73.295 (4.784)	-9.346 (-2.717)	-10.208 (-3.681)
Relapse rate (RR76, 1977-81)	-	-18.504 (-3.852)	-	-
Intercept	2599.50 (16.930)	-122.795 (-2.770)	65.880 (9.532)	63.332 (16.958)
$\bar{R}^2$	.729	.913	.845	.852
DW	1.20	1.83	1.89	.179
F (v_1, v_2)	15.09 (4,17)	45.15 (5,16)	39.16 (3,18)	61.24 (2,19)

price of pipe tobacco. This result is consistent with the shape of the empirical demand curve, but it is exactly opposite to the results of the log-linear specification. Moreover, the independent effect of pipe tobacco price is not significant in the linear specification. Both these findings contradict the results obtained in previous Finnish studies (Rimpelä and Kuuluvainen 1976, Valtonen 1982), which concluded that the price of pipe tobacco has a significant positive effect on the demand for cigars. Our results imply that this relationship is spurious, possibly arising from the research strategy employed in those studies. The authors postulated a log-linear estimating equation, in which income and the own price of the tobacco product were the only independent variables set in advance, the other explanatory variables being chosen by computer using the forward selection procedure. The price of pipe tobacco was picked up as the residuals indicated serious autocorrelation when it was not included. However, as its sign appears to be wrong, and the residuals were autocorrelated when the relapse rate (RR76) was excluded from the log-linear specification, this would suggest that the basic model is misspecified for the demand for cigars. We shall examine alternative specifications of the demand function in the following sections.

As the linear specifications of the basic model prove to be satisfactory only for pipe tobacco we shall not discuss their implications before we have examined alternative linear specifications of the demand functions.

6.2 Habit formation

6.2.1 The partial adjustment model

Our findings do not lend any support to the partial adjustment hypothesis (Tables 11, 12). None of the estimated parameters of the lagged dependent variables were statistically significant. As a matter of fact all of them were practically zero, which implies that the partial adjustment model is an inappropriate formulation for estimating the demand for tobacco products between 1960 and 1981 in Finland. This, in turn, would suggest that the adjustment of the actual level of demand to the desired level is instantaneous, taking place within a year, for all tobacco products. This result is consistent with the findings of Leu (1984) and McGuinness and Cowling (1975) which did not support the partial adjustment formulation either for Switzerland or the U.K., but contradicts the results obtained with the U.S. data (Fujii 1975, 1980, Hamilton 1972, Warner 1977, 1981, Young 1983) which indicate gradual adjustment.

Table 11. Estimates of the partial adjustment model, log-linear specification, 1961-81. (t-ratios in parentheses).

	Cigarettes ($\ln Q_s$)	Pipe tobacco ($\ln Q_{pt}$)	Cigars ($\ln Q_c$)
Lagged consumption ($\ln Q_{t-1}$)	.097 (.616)	.171 (1.322)	-.013 (-0.083)
Cigarette price ($\ln P_s$)	-.312 (-3.582)	1.920 (6.653)	-
Pipe tobacco price ($\ln P_{pt}$)	-	-.464 (-2.929)	1.047 (6.821)
Cigar price ($\ln P_c$)	-	-	-2.380 (-12.296)
Income ($\ln Y$)	.115 (2.020)	-	-
Anti-smoking publicity in 1964 (D64, shift)	-.078 (-2.079)	.273 (3.163)	-
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	-.116 (-4.684)	.264 (4.258)	-.295 (-3.816)
Relapse rate (RR76, 1977-81)	-	-.071 (-3.728)	-.043 (-2.002)
Intercept	7.476 (4.986)	-4.190 (-4.427)	13.532 (9.920)
$\bar{R}^2$	.789	.917	.983
h	.224	1.224	.863
F (v_1, v_2)	15.93 (5,15)	37.59 (6,14)	238.99 (5,15)

Table 12. Estimates of the partial adjustment model, linear specification, 1961-81. (t-ratios in parentheses).

	Cigarettes (lnQ_s)	Pipe tobacco (lnQ_{pt})	Cigars (lnQ_c)
Lagged consumption (Q_{t-1})	-.089 (-.582)	.124 (.907)	-.038 (-.223)
Cigarette price (P_s)	-2.377 (-3.762)	1.821 (6.674)	-
Pipe tobacco price (P_{pt})	-	-1.699 (-2.837)	-
Cigar price (P_c)	-	-	-.059 (-5.054)
Income (Y)	-.011 (-2.181)	-	-
Anti-smoking publicity in 1964 (D64, shift)	-153.579 (-2.170)	65.783 (2.859)	-
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	-233.806 (-4.804)	70.856 (4.420)	-10.006 (-3.380)
Relapse rate (RR76, 1977-81)	-	-19.494 (-3.875)	-
Intercept	2258.87 (5.415)	-143.041 (-2.909)	61.829 (5.633)
$\bar{R}^2$	.800	.904	.831
h	.058	.712	.403
F (v_1, v_2)	16.97 (5,15)	32.28 (6,14)	33.87 (3,17)

Given the annual data and a frequently purchased item with the relatively low cost of adjustment to desired consumption levels, our result is not suprising, particularly as the gradual adjustment found in the U.S. studies seems to arise from the chosen study period which covered years of market expansion as well as saturation.[1]

6.2.2 The habit stock model

This dynamic model is consistent with a linear demand equation only. Therefore we were not able to experiment with logarithmic transformations of the variables. However, as the results presented in Table 5 did not reject the linear models, except for cigars, this would suggest that the linear transfomations may be employed. We also estimated the linear model for cigars, although it did not pass the functional form test.

From the structural equations, ignoring the dummy variables,

$$(28)\quad Q_{st} = \beta_{01} + \beta_{21}P_{st} + \beta_{31}Y_t + \beta_{41}S_{st} + u_{st}$$

---

[1] This phenomenon is adequately captured by the lagged dependent variable together with a constant term in equation. As Schneider et al (1981) have pointed out, the high trend growth at the beginning of the sample (starting from around 1930) leads to unreasonably high income elasticity in the latter years of the sample. This would suggest that the elasticities may not have remained stable over time, which, if holds good, would necessitate estimation of separate demand functions for different sub-periods. In the studies referred to, the stability of the estimated elasticities has not been tested.

$$(29) \quad Q_{ptt} = \beta_{02} + \beta_{22}P_{st} + \beta_{32}P_{ptt} + \beta_{42}S_{ptt} + u_{ptt}$$

$$(30) \quad Q_{ct} = \beta_{03} + \beta_{23}P_{pt} + \beta_{33}P_{ct} + \beta_{43}S_{ct} + u_{ct}$$

$$(31) \quad \dot{S}_{it} = Q_{it} - \delta_i S_{it}.$$

the following estimating equations can be derived (see Appendix):

$$(32) \quad Q_{st} = a_{01} + a_{11}Q_{s,t-1} + a_{21}\Delta P_{st} + a_{21}\lambda_1 P_{s,t-1} + a_{31}\Delta Y_t + a_{31}\lambda_1 Y_{t-1} + v_{st}$$

$$(33) \quad Q_{ptt} = a_{02} + a_{12}Q_{pt,t-1} + a_{22}\Delta P_{st} + a_{22}\lambda_2 P_{s,t-1} + a_{32}\Delta P_{ptt} + a_{32}\lambda_2 P_{pt,t-1} + v_{ptt}$$

$$(34) \quad Q_{ct} = a_{03} + a_{13}Q_{c,t-1} + a_{23}\Delta P_{ptt} + a_{23}\lambda_3 P_{pt,t-1} + a_{33}\Delta P_{ct} + a_{33}\lambda_3 P_{c,t-1} + v_{ct}.$$

The structural parametrs β_{ji} are related to the reduced form coefficient estimates, the a_{ji} and λ_i, through the following formulae:

$$\beta_{0i} = \frac{2a_{0i}(1 - \lambda_i/2)}{\lambda_i(a_{1i} + 1)}$$

$$\beta_{ji} = \frac{2a_{ji}(1 - \lambda_i/2)}{a_{1i} + 1}, \quad j = 2,3$$

$$\beta_{4i} = \frac{2(a_{1i} - 1)}{a_{1i} + 1} + \frac{\lambda_i}{1 - \lambda_i/2}$$

$$\delta_i = \frac{\lambda_i}{1 - \lambda_i/2}.$$

The estimated equations are presented in Table 13. For cigarettes and pipe tobacco the results correspond with those obtained from the static models. In the cigarette equation all coefficients are significant with the expected signs, apart from the coefficient of lagged consumption, which is insignificant. In the pipe tobacco equation all coefficients have the same sign as in the static model and, with the exception of the lagged consumption and cross-price, all are statistically significant.

The cigar equation differs drastically from the static and partial adjustment models. The cross-price-coefficient and the coefficients of the dummy variables were statistically insignificant (the t-statistics being less than one) and were therefore dropped. The demand for cigars is adequately explained by the demand in the previous year, and year to year changes in its price. We shall return to the demand for cigars later on.

The appropriateness of the habit stock model can be judged, apart from with the standard statistics, by examining the plausability of the structural coefficient estimates. The implied coefficients are presented in Table 14.

Table 13. Estimates of the habit stock model, 1961-81. (t-ratios in parentheses).

	Cigarettes ($\ln Q_s$)	Pipe tobacco ($\ln Q_{pt}$)	Cigars ($\ln Q_c$)
Lagged consumption (Q_{t-1})	.017 (0.054)	.023 (.094)	.503 (2.592)
Income (ΔY)	.011 (2.441)	-	-
Own price (ΔP)	-2.151 (-1.996)	-1.075 (-1.182)	-.097 (-5.219)
Cross price (ΔP^*)	-	1.487 (2.442)	-
Anti-smoking publicity in 1964 (D64, shift)	-149.858 (-2.009)	63.142 (2.639)	-
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	-259.917 (-2.303)	84.132 (2.752)	-
Relapse rate (RR76, 1977-81)	-	-24.687 (-2.405)	-
λ	1.214 (1.391)	1.397 (1.685)	.311 (2.462)
Intercept	2420.730 (3.384)	-199.960 (-2.004)	29.186 (2.458)
$\bar{R}^2$	.786	.898	.831
DW	1.96	1.81	2.25
h	-	-	-1.249
ρ	-1.260 (-1.438)	.132 (.307)	-.375 (-1.010)

Table 14. Derived estimates of the structural coefficients of the Houthakker-Taylor model.

	Cigarettes ($\ln Q_s$)	Pipe tobacco ($\ln Q_{pt}$)	Cigars ($\ln Q_c$)
Cigarette price (P_s)	-1.663	.876	-
Pipe tobacco price (P_{pt})	-	-.633	-
Cigar price (P_c)	-	-	-.109
Income (Y)	.008	-	-
Stock of habits (S)	1.156	2.728	-.294
Depreciation rate (δ)	3.091	4.637	.368
Intercept	1540.946	-84.279	105.510

The estimates of β_{4i} imply that the stock effect is positive for cigarettes and pipe tobacco, which is consistent with the interpretation of the stock variable as a psychological stock of smoking habits, tending to increase consumption. For cigars the coefficient is negative, and thus we have to relax the psychological stock hypothesis in this case. However, it may be possible to interpret the negative effect in physical stock adjustment terms in this case.

The rate of depreciation of the stock variable, δ_i, falls outside the range of acceptability [0,1] in the cigarette and pipe tobacco equations. Furthermore, the values of λ_i are insignificantly different from 2/3 which is consistent with δ_i being unity, that is, the stock dying out rapidly within a year.

In the case of cigars the physical stock seems to wear out quite rapidly, the results *implying that 2/3 of the desired* change in the stock takes place in a year.

The implausible values of δ_i rule out these models as our preferred specifications for cigarettes and pipe tobacco, whereas the cigar equation is not rejected. Our empirical results do not lend support to the habit stock model, which is consistent with findings obtained in the other econometric studies using post-war data (Comanor and Wilson 1974, Leu 1984).

6.2.3 The addiction asymmetry model

As the partial adjustment model was previously rejected we estimated only the static addiction asymmetry model (21). The following estimating equations were specified:

$$(35) \quad Q_{st} = a_0 + a_1P_{st} + a^*_2PF_{st} + a_3Y_t + a^*_4YR_t + a_5D64 + a_6D76S + v_{st}$$

$$(36) \quad Q_{ptt} = b_0 + b_1P_{st} + b^*_2PR_{st} + b_3P_{ptt} + b^*_4PF_{ptt} + b_5D64 + b_6D76S + b_7RR76 + v_{ptt}$$

$$(37) \quad Q_{ct} = c_0 + c_1P_{ct} + c^*_2PF_{ct} + c_3D76S + c_4RR76 + v_{ct}.$$

The results for cigarettes are presented in Table 15. In cigarette equation (1), the coefficient of the falling cigarette price variable is negative and significant, whereas the income rising coefficient is insignificant. Thus we shall reject the hypothesis of the equal slopes of the demand curves which imply a kinked demand curve for cigarettes. The markets' responses to rising or falling cigarette prices differ. We are not able to reject the hypothesis of symmetric responses to changes in income.

We dropped the income rising variable from the model and re-estimated the cigarette demand equation. In the resulting equation (2) in Table 15 all other coefficients are

Table 15. Estimates of the addiction asymmetry model for cigarettes, linear specification, 1960-81. (t-ration in parentheses).

	(1)	(2)
Cigarette price (P_s)	-3.457 (-5.142)	-3.463 (-5.258)
Cigarette price falling (PF_s)	-3.408 (-1.908)	-3.423 (-1.956)
Income (Y)	.076 (1.264)	.042 (2.719)
Income rising (YR)	-.034 (-.592)	-
Anti-smoking publicity in 1964 (D64, shift)	-125.237 (-2.049)	-126.179 (-2.108)
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	-81.568 (-.763)	-125.591 (-1.671)
Intercept	2932.24 (9.648)	2941.76 (9.896)
$\bar{R}^2$	.829	.836
DW	2.25	2.20
F (v_1, v_2)	18.00 (6,15)	22.44 (5,16)

statistically significant except that of the shift dummy (D76S). We did not, however, drop that variable, since the coefficient is almost significant, and the approriate F-test did not reject model (2) against model (1) ($F = .37 < F_{(1,15)}$). The corrected R-square is rather high and the Durbin-Watson statistic does not indicate the presence of the first order autocorrelation in the residual series.

The estimated results for pipe tobacco do not support the addiction asymmetry hypothesis (Table 16). Neither the coefficient of the own-price falling variable nor the cross-price increasing variable differ significantly from zero, irrespective of whether the variables are included in the equation simultaneously (equation (1)) or separately (equations (2, 3)), which implies that the previously estimated basic model adequately represents the demand for pipe tobacco.

The asymmetry hypothesis does not seem to hold true for cigars either (Table 17). In equation (1), all the coefficients are insignificant. When the trend dummy was dropped the price falling coefficient became almost significant but the shift dummy remained insignificant in equation (2). When tested against the previously estimated linear model the symmetric model was not rejected ($F = 2.7 < F_{(1,18)}$).

Table 16. Estimates of the addiction asymmetry model for pipe tobacco, linear specification, 1960-81. (t-ratios in parentheses).

	(1)	(2)	(3)
Pipe tobacco price (P_{pt})	-2.763 (-2.245)	-1.648 (-2.114)	-1.692 (-2.912)
Pipe tobacco price falling (PF_{pt})	-2.564 (-.987)	.381 (.662)	-
Cigarette price (P_s)	1.155 (1.708)	1.912 (10.555)	1.761 (6.277)
Cigarette price rising (PR_s)	1.364 (1.162)	-	.233 (.909)
Anti-smoking publicity in 1964 (D64, shift)	53.084 (2.186)	62.364 (2.688)	59.884 (2.574)
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	56.936 (2.041)	57.722 (2.046)	52.570 (1.910)
Relapse rate (RR76, 1977-81)	-17.971 (-3.009)	-20.393 (-3.602)	-20.587 (-3.850)
Intercept	-15.956 (-.098)	-173.816 (-1.947)	-163.270 (-2.591)
$\bar{R}^2$	.912	.910	.912
DW	2.22	1.83	1.88
F (v_1, v_2)	32.10 (7,14)	36.38 (6,15)	37.35 (6,15)

Table 17. Estimates of the addiction asymmetry model for cigars, linear specification, 1960-81. (t-ratios in parentheses).

	(1)	(2)
Cigar price (P_c)	-.103 (-1.672)	-.114 (-3.391)
Cigar price falling (PF_c)	-.040 (-.726)	-.049 (-1.648)
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	-1.943 (-.307)	-1.532 (-.260)
Relapse rate (RR76, 1977-81)	-.518 (-.221)	-
Intercept	149.907 (1.247)	171.869 (2.605)
$\bar{R}^2$	.856	.864
DW	1.73	1.71
F (v_1, v_2)	32.27 (4,17)	45.94 (3,18)

The results for the log-linear specifications of the addiction asymmetry model are presented in Table 18. Those for cigarettes are similar to the linear specification results. The estimating results for pipe tobacco would seem to support the addiction asymmetry hypothesis with respect to cigarette price. The results for cigars do not allow us to reject the symmetric model.

Our results imply that the addiction asymmetry model may be appropriate for cigarettes in both linear and log-linear forms. The log-linear formulation of the model is applicable to pipe tobacco. The addiction asymmetry model is not appropriate for cigars.

Our results are consistent with those obtained by Young (1983) as far as the cigarette prices are concerned. However, habit formation is not confirmed in respect of income in the case of cigarettes, and the estimated results for other types of tobacco products do not allow us to reject symmetric linear models.

6.2.4 The demand for cigars

In the previous sections we have derived alternative demand functions for cigars, though none proved fully satisfactory. The functional form test rejected the basic linear specification, yet the log-linear specification produced spurious results. Both the partial adjustment model and the

Table 18. Estimates of the addiction asymmetry models log-linear specification, 1960-81. (t-ration in parentheses).

	Cigarettes (lnQ_s)	Pipe tobacco (lnQ_{pt})	Cigars (lnQ_c)
Own price (lnP)	-.486 (-5.413)	-.361 (-2.463)	-3.114 (-7.185)
Own price falling (lnPF)	-.399 (-1.883)	-	6.139 (1.637)
Cross price (lnP^*)	-	1.643 (5.789)	-
Cross price rising ($lnPR^*$)	-	.546 (2.076)	-
Income (lnY)	.414 (2.872)	-	-
Anti-smoking publicity in 1964 (D64, shift)	-.059 (-2.060)	.222 (2.718)	-
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	-0.076 (-1.997)	.059 (.560)	0.230 (1.358)
Relapse rate (RR76, 1977-81))	-	-.066 (-3.490)	-
Intercept	6.257	-2.285	23.452
$\bar{R}^2$	.872	.930	.942
DW	2.18	1.86	1.72
F (v_1, v_2)	30.23 (5,16)	47.79 (6,15)	73.09 (3,18)

addiction asymmetry model turned out to be inappropriate formulations for estimating the demand for cigars. The habit stock model was not found inadequate, but being consistent only with the linear specification, which was rejected, it is not acceptable.

We can, however, adapt the habit stock formulation as a starting point for further analysis by the argument that, while the structural form of the model is compatible with the linear specification only, the same does not necessary apply to the reduced form. The reduced form can be treated as a dynamic estimating equation without setting any prior restrictions on its functional form.[1] Thus we can estimate the reduced form equation in both linear and log-linear forms. The results in Table 13 indicate that the estimating equation is of the form

$$Q_t = c_0 + c_1 Q_{t-1} + c_2 \Delta P_t + c_2 \lambda P_{t-1} + u_t,$$

which equals

$$(38) \quad Q_t = c_0 + c_1 Q_{t-1} - c_2(1 - \lambda) P_{t-1} + c_2 P_t + u_t.$$

As the equation (38) is no more over-identified, the estimating equation can be written as:

---

[1] Of course, the parameters of the structural form can be derived only from the linear estimating equation.

$$Q_t = \alpha_0 + \alpha_1 Q_{t-1} + \alpha_2 P_t + \alpha_3 P_{t-1} + u_t$$

in linear form, and

$$\ln Q_t = \beta_0 + \beta_1 \ln Q_{t-1} + \beta_2 \ln P_t + \beta_3 \ln P_{t-1} + u_t$$

in log-linear form. The estimating results are presented in Table 19.

All the coefficients of the explanatory variables are statistically significant and neither the DW and h statistics nor the estimate of the first order autocorrelation coefficient ($\hat{\rho}_1$) indicate model inadequacy.

However, the Andrews' test rejects the linear form (μ_1), while the log-linear form is not rejected (μ_2). Thus the dynamic log-linear model appears to be an appropriate formulation for the demand for cigars.

The demand for cigars is adequately explained by the demand in the previous year, and the year to year changes in price. The anti-smoking publicity appears to have had no effect on the demand for cigars, which disproves our earlier results.

Table 19. The demand for cigars, 1961-81. (t-ratios in parentheses).

		Q_c		$\ln Q_c$
Lagged consumption	Q_{t-1}	.503 (2.592)	$\ln Q_{t-1}$	.648 (3.521)
Cigar price	P_c	-.097 (-5.219)	$\ln P_c$	-2.088 (-8.041)
Lagged cigar price	P_{t-1}	.067 (3.363)	$\ln P_{t-1}$	1.509 (4.596)
Intercept		29.186 (2.458)		4.725 (1.585)
$\bar{R}^2$		.831		.964 (.945)[a]
DW		2.25		2.35
h		-1.270		-1.496
F (v_1, v_2)		33.72 (3,17)		180.33 (3,17)
$\hat{\rho}_1$		-.375 (-1.009)		-.421 (-1.332)
μ		.653 (4.035)		-.130 (-.810)

[a] Adjusted R-square calculated from the anti-logged transformations of the actual and predicted values of the dependent variable.

6.3 Selection of the final demand models

The results in previous sections suggest various appropriate models for estimating the demand for cigarettes and pipe tobacco, while only the dynamic log-linear model adequately represents the demand for cigars.

The basic log-linear demand model was found appropriate for all tobacco products. The empirical results did not lend support to the partial adjustment model nor to the habit stock model. None of the estimated parameters of the lagged consumption variables in the partial adjustment models were statistically significant. The habit stock model produced implausible parameter estimates and was therefore rejected. The addiction asymmetry model was found appropriate for cigarettes and pipe tobacco but not for cigars.

The goodness of fit criterion (in terms of adjusted R-squares) suggests the log-linear formulation of the addiction asymmetry model for cigarettes (Table 20). It is also a potential candidate for pipe tobacco, together with the basic models. All the estimated models for cigars fit well to the data, but apart from the dynamic log-linear model they were rejected.

The addiction asymmetry model had the best forecast performance in 1982-87 for cigarettes and pipe tobacco (Table 21). The forecast performance of the basic log-linear

Table 20. The goodness of fit (the adjusted R-square) of the alternative models.[a,b]

MODEL	Cigarettes	Pipe tobacco	Cigars
BASIC MODEL			
Linear	(.729)	.913	(.852)
Log-Linear	.796	.902	(.945)
PARTIAL ADJUSTMENT MODEL			
Linear	(.800)	(.904)	(.831)
Log-linear	(.728)	(.907)	(.943)
HABIT STOCK MODEL	(.786)	(.898)	(.831)
ASYMMETRIC MODEL			
Linear	.836	.912	(.864)
Log-linear	.869	.882	.942
DYNAMIC LOG-LINEAR MODEL	-	-	.945

[a] The adjusted R-squares of the log-linear models are calculated from the anti-logged transformations of the actual and predicted values of the dependent variables in order to render this measure comparable with those for the linear models.

[b] Rejected models in parentheses.

Table 21. The forecast performance (the U-coefficient) of the alternative models in 1982-87.[a]

MODEL	Cigarettes	Pipe tobacco	Cigars
BASIC MODEL			
Linear	(.019)	.050	(.432)
Log-Linear	.022	.042	(.401)
PARTIAL ADJUSTMENT MODEL			
Linear	(.035)	(.120)	(.396)
Log-linear	(.026)	(.066)	(.397)
HABIT STOCK MODEL	(.020)	(.259)	(.313)
ASYMMETRIC MODEL			
Linear	.043	.045	(.994)
Log-linear	.018	.040	.513
DYNAMIC LOG-LINEAR MODEL	-	-	.206

[a] Rejected models in parentheses.

model was somewhat inferior to the addiction asymmetry model. All the cigar models had poor forecast performance, but the dynamic log-linear model was clearly superior to others.

On the basis of the explanatory power and post-estimation forecast performance, our favoured model for cigarettes is the log-linear asymmetric model, for pipe tobacco the basic log-linear model, and for cigars the dynamic log-linear model. The final models were re-estimated for the period 1960-87. The estimation results are presented in Table 22.

Table 22. The demand models for tobacco products in Finland. (t-ratios in parentheses).

	Cigarettes ($\ln Q_s$)	Pipe tobacco ($\ln Q_{pt}$)	Cigars ($\ln Q_c$)
Cigarette price ($\ln P_s$)	-0.493 (-6.251)	2.144 (15.562)	-
Cigarette price falling ($\ln PF_s$)	-0.445 (-2.581)	-	-
Pipe tobacco price ($\ln P_{pt}$)	-	-0.599 (-7.011)	-
Cigar price ($\ln P_c$)	-	-	-1.697 (-6.542)
Lagged cigar price ($\ln P_{c,t-1}$)	-	-	1.536 (4.793)
Lagged cigar consumption ($\ln Q_{c,t-1}$)	-	-	0.821 (4.987)
Income ($\ln Y$)	0.450 (3.994)	-	-
Anti-smoking publicity in 1964 (D64, shift)	-0.057 (-2.221)	0.257 (3.342)	-
Anti-smoking publicity and the Tobacco Act in 1976 (D76S, shift)	-0.067 (-2.157)	0.260 (6.112)	-
Relapse rate (RR76, 1977-87)	-	-0.056 (-8.038)	-
Intercept	5.953 (7.588)	-3.920 (-4.958)	1.581 (0.602)
$\bar{R}^2$	0.885	0.927	0.941
DW	2.12	1.88	2.28
F (v_1, v_2)	42.45 (5,22)	69.72 (5,22)	139.98 (3,23)

7 THE DEMAND FOR TOBACCO PRODUCTS IN FINLAND

The demand equations in Table 22 imply that the demand for cigarettes is adequately explained by its real price, real disposable income and variables relating to anti-smoking publicity. The demand for pipe tobacco is mainly determined by its real price and the price of cigarettes. The demand for cigars depends on the demand in the previous year and the year to year changes in its price. In this section we shall examine more closely how various factors influence the demand for tobacco products in Finland.

7.1 Prices and income

The price of tobacco products, particularly of cigarettes, is the most important single determinant of the demand for tobacco products in Finland. By controlling the price of cigarettes it is possible to regulate the demand for cigarettes and pipe tobacco.

The most important feature of the cigarette demand is its asymmetric response to its price. The demand for cigarettes is twice as sensitive to falling prices (elasticity -0.94) as to rising prices (elasticity -0.49). This supports the hypothesis that new smokers are encouraged to enter the cigarette markets in the event of any price decrease and that the habits, when developed, would persist when prices subsequently rise. This interpretation is consistent with the results obtained by Lewit and Coate (1982), who found that the price has its greatest impact on the decision to smoke rather than on the quantity smoked (see also USDHEW 1979). This is particularly true for young smokers, and we feel that the most likely explanation of why falling price elasticity is so much higher than rising price elasticity is to be found from the smoking behaviour of young smokers. The results of Lewit et al (1981) would seem to support this notion. They found the demand for cigarettes by teenageers to be elastic with respect to its price. Similar result were obtained by Lewit and Coate (1982), who found that smoking by young adults aged twenty through twenty four is much more responsive to price than smoking by older adults.

If the real price of cigarettes is allowed to fall new consumers are encouraged to enter the cigarette market, and when habits are formed price increases are less effective in discouraging smoking. The results imply that if the real price is allowed to fall by e.g. 5 per cent, the real price would later have to be increased by 10 per cent in order to restore the per capita demand to the level obtaining before the price fall.

The demand for cigarettes is also responsive to changes in real disposable income. The income elasticity for cigarettes is +0.45, which is somewhat higher than found in previous studies (Rimpelä and Kuuluvainen 1976, Sehm 1977, Valtonen 1982).

The most important factor influencing the demand for pipe tobacco is the price of cigarettes. The cross-elasticity (+2.14) is three and half times higher than the own price elasticity (-0.60). This arises from the fact that the price of hand-rolled cigarettes is only half that of manufactured cigarettes. As about 50-60 per cent of pipe tobacco is used for hand-rolled cigarettes, increases in the cigarette price result partly in a reduced demand for cigarettes and partly in increased consumption of cheap hand-rolled cigarettes. The cross-elasticity is about the same as in previous studies (Rimpelä and Kuuluvainen 1976, Valtonen 1982), while the own-price elasticity is twice as high (Valtonen 1982). The results imply that increasing the price of pipe tobacco appears to be more effective in discouraging smoking than previous studies have suggested.

There is some indication that the demand for pipe tobacco may respond asymmetrically to changes in the price of cigarettes. The demand elasticity for pipe tobacco with respect to falling cigarette price was +1.64 and to increasing cigarette price +2.19 (Table 18). This may indicate that some of the smokers who substitute pipe tobacco (hand-rolled cigarettes) for cigarettes may adopt new smoking habits and start to smoke a pipe instead of cigarettes. The strength of the asymmetric behaviour is not very strong. When cigarette prices decline, most of those who had earlier switched from cigarettes to hand-rolled cigarettes adopt their previous smoking habits and start to smoke cigarettes again. This, however, is not shown in the cigarette demand function because the substitution is relatively small compared to the total cigarette consumption, and is likely to be concealed by the ever present random variation in demand.

The demand for cigars is adequately explained by changes in its price. The short run price elasticity is -1.70 and the long run elasticity -0.90. Thus the demand for cigars may be effectively influenced by manipulating its price.

7.2 Anti-smoking publicity

The effects of the anti-smoking publicity appear ambiguous. While reducing cigarette consumption it also seems to encourage pipe tobacco smoking. As publicity has been directed against all tobacco products, not merely cigarettes, this would suggest something wrong with our results. However, this seemingly odd finding can be explained quite easily with the help of simple diagramms.

In Figure 5, the demand for cigarettes at time t_0 is Q_0 at price P_0. Anti-smoking publicity shifts the demand curve towards the origin, from D_0 to D_1^A, and hence at the same price less, Q_1^A, will be demanded. Provided the price of cigarettes is raised simultaneously with publicity, from P_0 to P_1, then the quantity demanded will be Q_1^{AP}, which is less than either Q_1^A or Q_1^P, the quantities demanded when the measures are taken separately. This is, of course, rather obvious and does not raise any complications in interpreting our results when the price of a substitute remains unchanged. Complications arise when the price of the substitute rises simultaneously with the own-price and the anti-smoking publicity has a further impact on the consumption as in the case of pipe tobacco.

In Figure 6, the pipe tobacco demand curve shifts from D_0 to D_1^A as a result of publicity and the demand falls from Q_0 to Q_1^A. In the absence of publicity, a rise in cigarette price would shift the demand curve from D_0 to D_1^{PS} and the demand would increase from Q_0 to Q_1^{PS}. Anti-smoking publicity will reduce the cross-price effect so that the resulting demand curve will be D_1^{APS} and hence less pipe tobacco will be demanded, Q_1^{APS}, compared to the situation when only the substitution effect takes place. Hence depending on the strength of the substitution effect, demand may increase despite anti-smoking publicity provided the cross-price effect is greater than the publicity effect. Thus our estimated results are not as suprising as they look at first sight. From Figure 6 we also note that what our shift dummies actually measure in this case is the magnitude of the net effect of substantial cigarette price increases on the demand for pipe tobacco, which is given by the difference $Q_1^{APS} - Q_0$.

Figure 5. The demand for cigarettes, anti-smoking publicity (A) and price increase (P).

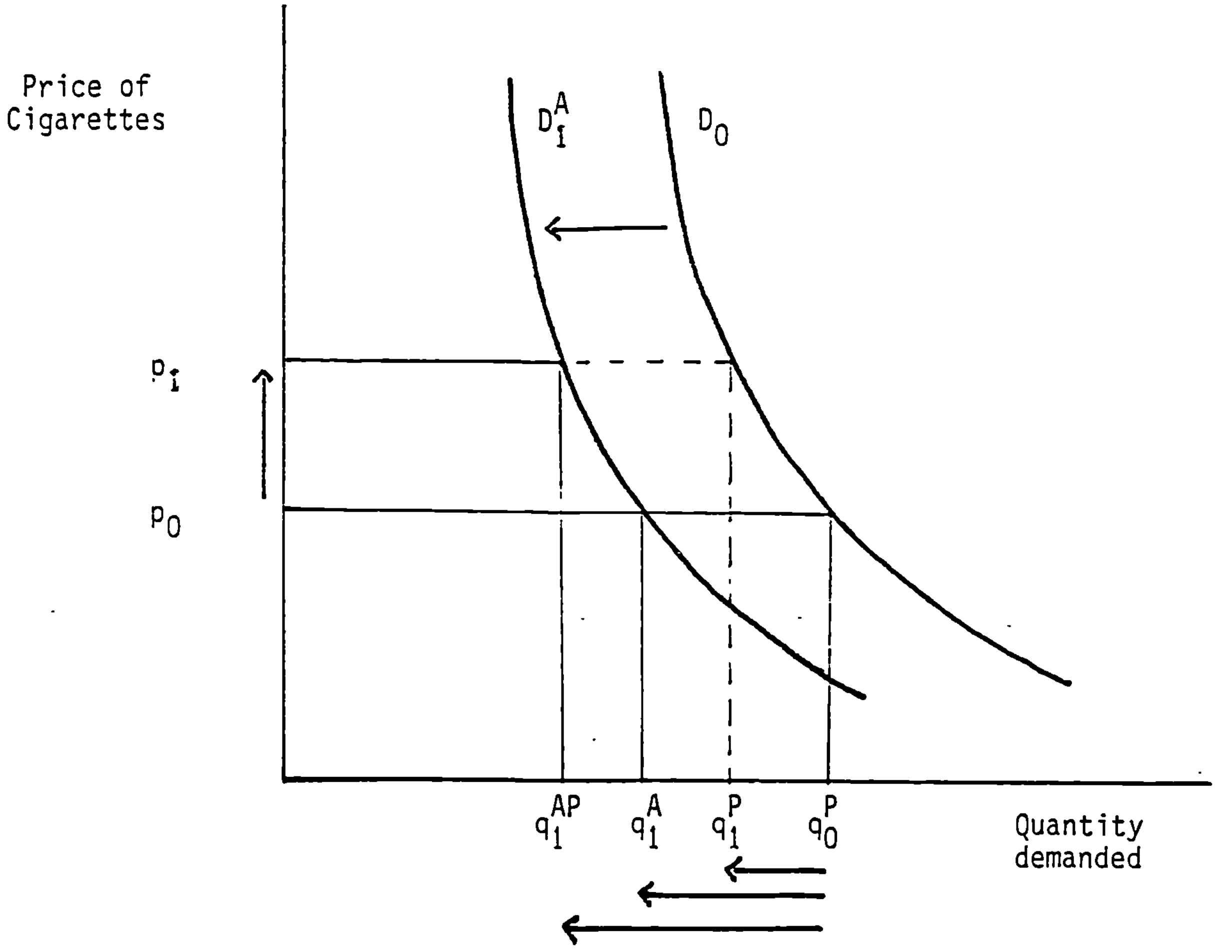


Figure 3. The demand for cigarettes, anti-smoking publicity (A) and price increase (P).

Figure 6. The demand for pipe tobacco, anti-smoking publicity (A) and increase in the price of cigarettes (PS).

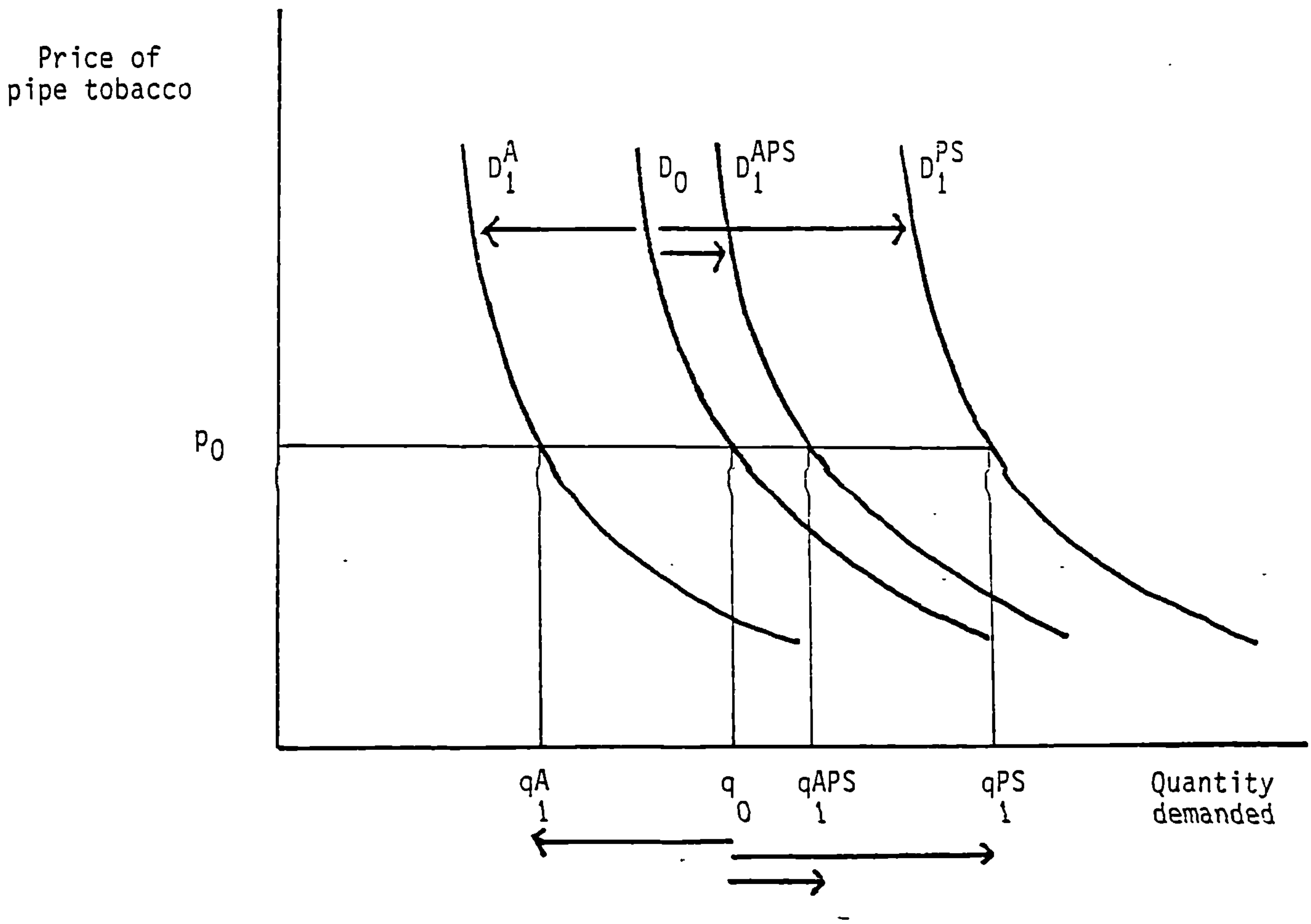


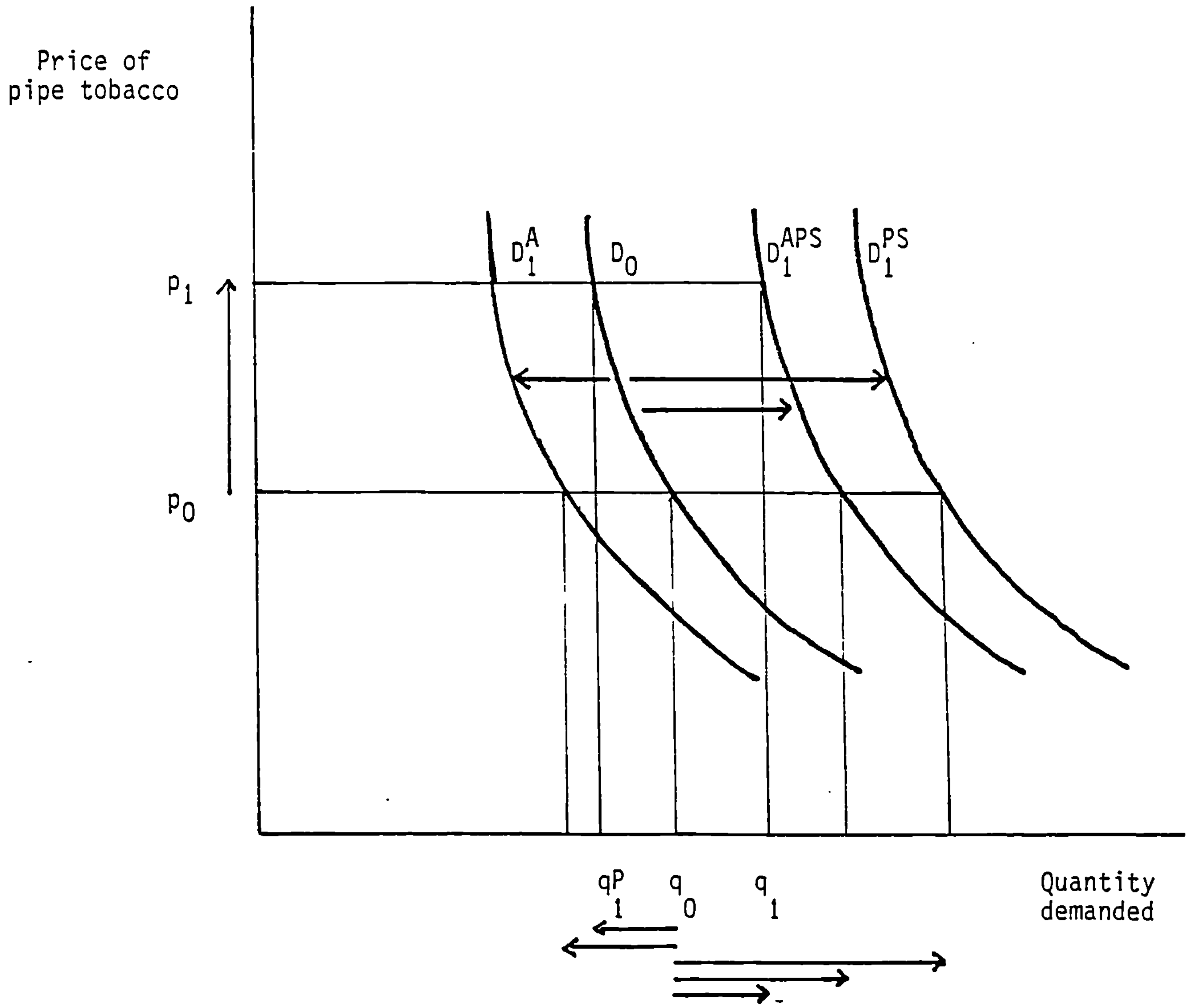
Figure 7 points out how an increase in the price of pipe tobacco affects its demand when accompanied by cigarette price rise and anti-smoking publicity. Provided the rise in cigarette price is substantial and the anti-smoking publicity not too effective, even huge increases in the price of pipe tobacco may not be sufficient to reduce consumption. This seems to provide a plausible explanation of why the demand for pipe tobacco increased substantially in 1976 despite a 49 per cent rise in its real price.[1]

In other words, our analysis indicates that the shift dummies in the cigarette equation reflect the direct publicity effect, while in the pipe tobacco equation they measure the net effect of the increases in cigarette price over the publicity and own-price effects. It should be noted however that anti-smoking publicity also reduces the pipe tobacco consumption but its direct effect is concealed by the cross-price effect.

The shift dummies imply that the 1964 publicity caused a 5.7 per cent immediate, but temporary, reduction in cigarette demand, while the 1976 events reduced it permanently by 6.7 per cent. By comparison, estimates in other studies (Atkinson and Skegg 1973, 1974, Fujii 1975, 1981, Hamilton 1972, Leu

[1] A similar explanation can be given to the 1964 anti-smoking variable. The real price of cigarettes and pipe tobacco rose 22 and 18.5 per cent respectively from 1962 to 1964. At the same time the demand for pipe tobacco increased nearly 88 per cent.

Figure 7. The demand for pipe tobacco, anti-smoking publicity (A), and increase in the price of cigarettes (PS) and pipe tobacco (P).



1984, Peto 1974, Warner 1977, 1981, Witt and Pass 1981) imply at least a 5 per cent reduction in cigarette consumption as a result of anti-smoking publicity.

The results do not indicate that the demand effects of the Tobacco Act and the related anti-smoking publicity have weakened over time. It is possible, however, that the initial effect has been eroded, but been compensated by the extensive health education programme implemented by the Act. If true, it would emphasize the significance of continous health education. This notion is supported by the observation that the 1964 intervention appeared to have only temporary effect.

The trend variable showing an annual 5.6 per cent fall in pipe tobacco consumption seems to capture the effects of the underlying declining trend, which presumably reflects changes in consumers' tastes, starting from the late 60's, rather than the effects of either the anti-smoking publicity, the Tobacco Act or the total advertising ban in 1977.

A minimum estimate of the annual welfare gain produced by the Tobacco Act and related anti-smoking publicity can be derived by consumer surplus analysis as shown by Fujii (1985). Given the elasticity of demand and the reduction in cigarette consumption due to the 1976 events it can be estimated that the initial welfare gain in 1976 was FIM 7.4 million which equals a FIM 17.4 million annual welfare gain in 1987 prices.[1] This estimate is clearly only a minimum estimate of the welfare gain as it does not allow for addiction and habit formation and assumes perfect perception of the risks associated with smoking by consumers. It is not possible to derive a similar estimate for pipe tobacco.

7.3 Advertising bans

The banning of televised tobacco advertising in 1971 does not appear to have had a direct effect on the demand for tobacco. In this analysis it was not possible to isolate the independent effect of the 1977 total advertising ban on consumption. The trend variables did show significant annual decline in the demand for pipe tobacco and cigars, but it is highly unlikely that this was caused by the advertising ban. We were not able to find the expected significant trend coefficient for cigarettes, although they were heavily

---

[1] Given the cigarette demand elasticity (e_p = -0.493) and the reduction in consumption due to the Tobacco Act and related anti-smoking publicity in 1976 (D76S = 6.74 % annually), the implied change in cigarette price (ΔP_s) which would have resulted in the same reduction in consumption is given by $\Delta P_s = (D76S/e_p)P_s$. The average retail price of cigarettes in 1976 was FIM 3.99 per pack. This implies that ΔP_s is FIM 0.5455 per pack of cigarettes. The per capita consumption of cigarettes (Q) in 1975 was 2178 cigarettes. The reduction in consumption (ΔQ) due to the 1976 events is given by ΔQ = D76SQ, which is equal to 146.8 cigarettes per capita, i.e. 7.34 packs.

The gain in welfare in 1976 is given by $N\Delta P\Delta Q/2$, where N (= 3 701 865) is the mean annual population of people aged 15 and over. Thus the initial welfare gain in 1976 was FIM 7.4 million, which is equal to FIM 17.4 million at 1987 prices.

advertised before the ban, unlike the other tobacco products. However, there is no reason to assume that cigarette advertising was the least effective of the three.
In the short-run we would have expected the advertising ban to have exerted only a marginal effect on demand (Atkinson and Skegg 1973, 1974, Fujii 1980, Hamilton 1972, McGuinness and Cowling 1975). The anti-smoking publicity associated with the implementation of the Tobacco Act in 1976 appears to have reduced the consumption of cigarettes permanently. This effect is likely to dominate the possible marginal effect of the 1977 advertising ban, and it was not possible therefore to isolate its independent effect.

We would expect the total advertising ban to have had a slightly greater effect on demand over the long-run than in the short term (Fujii 1980, Hamilton 1972, Johnston 1980, Witt and Pass 1981), but our present specification of the model did not shed any light on this. In the long run banning of advertising is likely to effect the social acceptance of smoking by removing the social overtones associated with it, and thus reducing the demand for tobacco. Clearly, this hypothesis is not testable using a time series analysis based on highly aggregate data.

7.4 Comparison of the demand effects of price and anti-smoking publicity

Using the estimates, in Table 22, of cigarette and pipe tobacco demand functions, Table 23 compares the effects of prices, income and anti-smoking publicity on demand. In 1964 the per capita cigarette consumption decreased by 267 cigarettes, while pipe tobacco consumption rose by 96 grammes.[1] During the period 1975-87 per capita cigarette consumption declined by 319 cigarettes and pipe tobacco consumption decreased by 28 grammes. Using the estimated coefficients for the independent variable, the change in its measured value can be converted to the amount consumption would have changed during the period had all other independent variables remained unchanged.

Cigarette price increases have reduced cigarette consumption by 488 cigarettes over the period 1975-87 while increasing the consumption of pipe tobacco by 212 grammes. The corresponding mean annual decline in cigarette consumption was 40.7 cigarettes and the mean annual increase in pipe tobacco consumption 17.7 grammes. Thus, over 40 per cent of the observed reduction in cigarette consumption, resulting from price increases, has been compensated for by the increased demand for pipe tobacco. The relatively low price of pipe tobacco, compared to cigarettes, makes switching from

---

[1] A gramme of pipe tobacco is approximately equal to one cigarette.

Table 23. Effects of income, price, anti-smoking publicity and the Tobacco Act on change in per capita consumption in 1964 and during 1975-87.

	Change in consumption in 1964		Change in consumption in 1975-87	
	Cigarettes	Pipe tobacco	Cigarettes	Pipe tobacco
Consumption 1963/1975	2092	191	2178	218
Income effect	14.6	-	273.7	-
Cigarette price effect	-92.1	36.5	-488.0	212.0
Pipe tobacco price effect	-	-4.9	-	-134.3
Anti-smoking publicity effect in 1964	-119.9	49.0	-	-
Anti-smoking publicity and the Tobacco Act effect in 1976-87	-	-	-146.7	56.6
Preference change effect 1977-87	-	-	-	-140.9
Residual	-69.7	15.4	41.9	-21.5
Consumption 1964/1987	1825	287	1859	190
Change in consumption	-267	96	-319	-28
Direct anti-smoking publicity effect	-119.9	-	-146.7	-

cigarettes to pipe tobacco economical and dramatically reduces the effectiveness of pricing policy. The anti-smoking publicity seems to have depressed cigarette consumption, but boosted the consumption of pipe tobacco. Assuming that the observed shifts in pipe tobacco demand reflect the net effect of huge increases in cigarette prices over other effects we may credit the fall in cigarette demand to the direct effects of anti-smoking publicity, and the rise in the demand for pipe tobacco to increases in the cigarette price. Hence the anti-smoking publicity appears to have reduced cigarette demand temporarily by 119.9 cigarettes in 1964 and permanently by 146.7 cigarettes in 1976-87. The corresponding mean annual decline in cigarette consumption was 12.2 cigarettes in 1975-87. This gives only a minimum estimate of the overall publicity effect as the cross-price effect dominated the demand for pipe tobacco, thus concealing the magnitude of the direct publicity effect in this case.

The results imply that price measures were about three times more effective than publicity in deterring cigarette consumption in 1975-87, whereas the reverse is true for 1964, when anti-smoking publicity was more effective than the price of cigarettes. As the huge price increases can be interpreted by smokers as a final trigger to give up smoking the overall publicity effect may be larger than our results suggest.

The results in Table 23 highlight the importance of income in determining the demand for tobacco. The growth in real disposable income in 1975-87 eliminated about 56 per cent of the fall in cigarette consumption induced by price measures. Income growth was almost twice as effective in boosting cigarette consumption as was anti-smoking publicity in deterring it. The growth in real income compensated for 43 per cent of the reduction in cigarette consumption induced by the price measures and anti-smoking publicity during 1975-87.

8 CONCLUSIONS AND POLICY IMPLICATIONS

The main findings of this study are summarized in Figure 8. Our investigation of the demand for tobacco products in Finland leads to nine main conclusions:

(1) The price of tobacco products, in particular of cigarettes, is the most important determinant of demand. Cigarette price elasticity is -0.49 with respect to increasing prices and -0.94 with respect to falling prices. The own-price elasticity of pipe tobacco is approximately -0.60 and the elasticity of demand with respect to cigarette price about +2.14. The short-run cigar price elasticity is -1.70 and the long run elasticity -0.90. The results imply that increasing the price of cigarettes and pipe tobacco appears to be more effective in discouraging smoking than earlier studies have suggested.

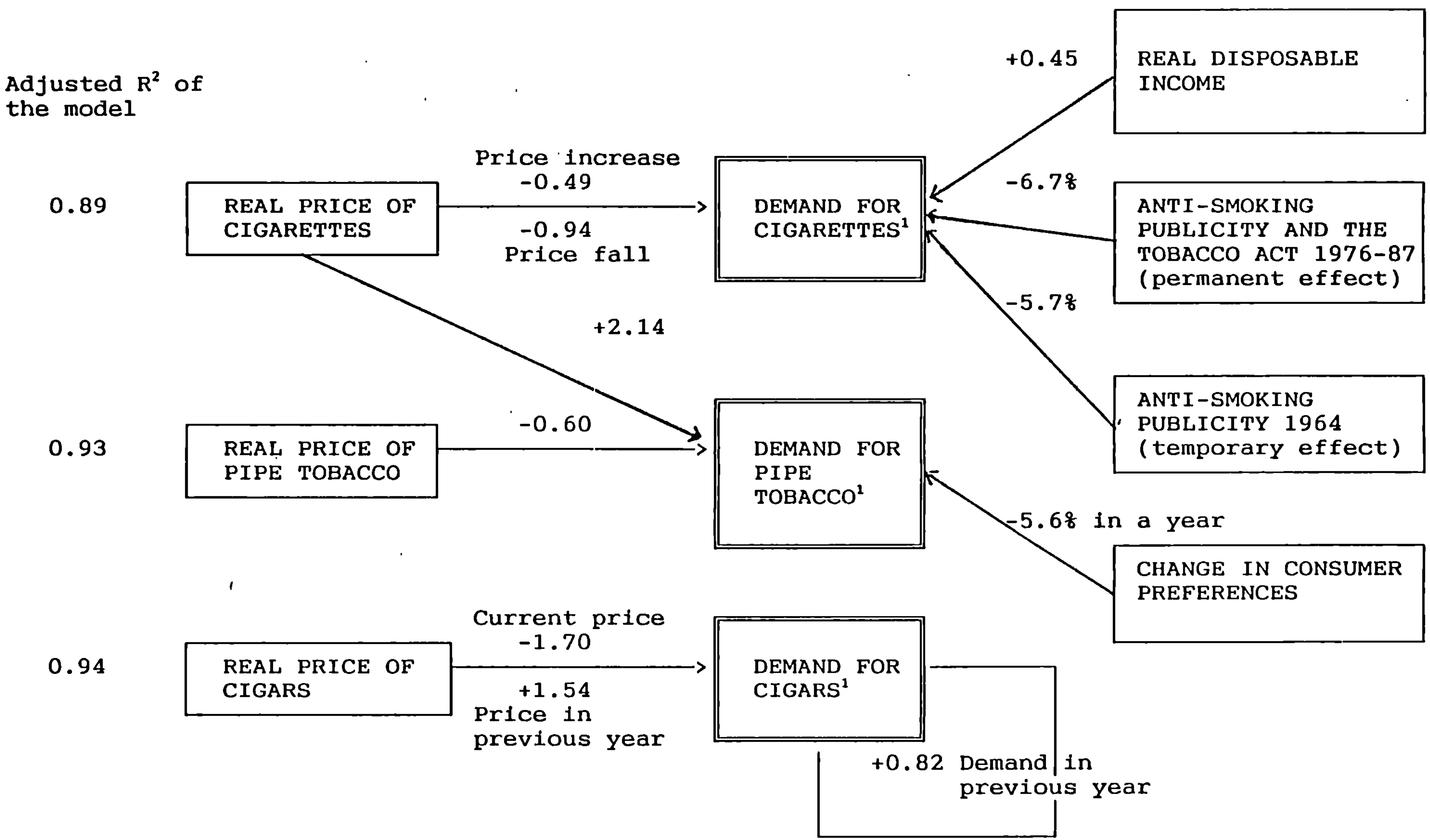
(2) Because of the relatively low price elasticities the real price of cigarettes and pipe tobacco must be raised considerably in order to cut down consumption substantially. As the elasticity estimates reflect only small changes in respective variables, the same estimates cannot, a priori, be assumed to hold for large changes. Our results showed, however, that though elasticities may have altered as a result of major price increases, changes in them have been very small indeed indicating that the price elasticities have remained rather stable over time. Thus we feel the elasticity

estimates can be used to approximate the effects of non-marginal changes in prices as well.

(3) The most important finding of this study is that the demand for cigarettes responds asymmetrically to changes in its price. An obvious policy implication is to index-link the price of cigarettes in order to prevent the cigarette markets from expanding further. This would discourage young smokers in particular from starting to smoke, or would postpone them starting. Such indexing would not decrease the welfare of current smokers, yet it would have favourable effects on the incidence of smoking related diseases in the long run.

(4) Indexing would not be sufficient however, because the demand for cigarettes is also influenced by real disposable income. The income elasticity is +0.45. Although rather low, this elasticity estimate does imply that, to be effective, price increases should also allow for the anticipated growth in real income. Thus price increases aimed only at keeping pace with inflation would allow cigarette consumption to increase. In order to stabilize per capita consumption of cigarettes the price of cigarettes should be raised annually by a percentage which equals the anticipated rate of inflation plus the anticipated growth in real disposable income. The demand for other tobacco products does not respond to changes in real disposable income.

Figure 8. Price and income elasticities, and the percentage effect of anti-smoking publicity on the demand for tobacco products in Finland in 1960-87.



1 Consumption per capita (people aged 15 and over)

(5) The fact that pipe tobacco is a substitute for manufactured cigarettes must be taken into account in tobacco pricing policy. A substantial increase in the price of cigarettes will lead to some cigarette smokers switching to cheaper, hand-rolled cigarettes. This reduces the effectiveness of taxation in deterring smoking if it is not controlled for. Our estimating equations imply that if the price of cigarettes and pipe tobacco is increased by the same percentage, about half of the fall in per capita consumption of cigarettes will be taken up by the increase in consumption of hand-rolled cigarettes.[1] Assuming the price increases do not change the prevailing parameter estimates, the pipe tobacco equation implies that increasing the real price of pipe tobacco about three and half times more than the price of manufactured cigarettes would prevent the substitution effect.[2]

When the price of pipe tobacco approaches the price of cigarettes substitution is likely to vanish and the demand for pipe tobacco will decrease. If the real price of all tobacco products is raised at the same time it would seem possible both to reduce demand and alter the consumption

---

[1] From $\Delta Q_s/Q_s = b_1(\Delta P_s/P_s)$ and $\Delta Q_{pt}/Q_{pt} = b_2(\Delta P_s/Ps)$ we get $\Delta Q_{pt}/\Delta Q_s = (b_2/b_1)(Q_{pt}/Qs)$, where $b_2 = 2.144$ and $b_1 = -.493$ as in Table 22 and $Q_s = 1798$ and $Q_{pt} = 198$ in 1987 (Tilastokeskus 1988).

[2] From $\Delta\%Q_{pt} = e^*_1\Delta 2\%p_s + e^*_2\Delta\%p_{pt} = 0$ follows $\Delta\%p_{pt}/\Delta\%p_s = -e^*_1/e^*_2$, where $e^*_1 = 2.144$ and $e^*_2 = -.599$ as in Table 22.

structure in a more favourable direction. Then it would be possible, as McGuinness and Cowling (1975) argue, for the price elasticity of total consumption to increase and the effectiveness of price measures to improve. Given the addictive nature of tobacco, however, we would expect that after a certain point the effectiveness would again diminish, as the huge increases reduce the smoking population to more 'hard core' smokers, who, due to addiction, would presumably be less sensitive to price increases than light smokers.

(6) Substantial price icnreases may not be politically feasible for three reasons. Firstly, tobacco is a considerable source of government revenue; dramatic reductions in demand may have an adverse effect on government's finances. However, the estimated low price elasticities imply that there is ample scope for increasing tax revenue by rising the rates of duty. As the proportion of excise duty in the retail price rises, the government's ability to increase its revenue will be reduced. Due to prevailing low elasticities, however, prices can be raised considerably before this point of diminishing returns is reached.[1,2]

---

[1] Assuming for simplicity that all revenue from tobacco is raised through an excise duty, then $TR = tQ$, where TR = tax revenue, t = tax per unit, and Q = the total quantity of tobacco products purchased per period. Then $\partial TR/\partial t = Q + t(\partial Q/\partial p)(dp/dt)$ and assuming that the tax is completely passed to the consumer, the elasticity of TR with respect to t is given by $\phi = 1 + (t/p)e$, where e is the uncompensated own price elasticity. Thus, in general, for ϕ to be positive p/t must be greater than -e.

Secondly, increases in the price of tobacco and other products which are set by the government are widely interpreted to reflect its expectations of inflation. Moreover, changes in these prices do actually affect the general rate of inflation. If price increases are justified by health objectives, the inflation expectation argument can be relaxed. The actual impact of price rises on the inflation rate (measured as a change in the consumer price index) can be estimated directly by employing the known weighting structure of the consumer price index.

In the case of pipe tobacco, the elasticity of tax revenue depends both on the own-price elasticity and cross elasticity. The elasticity of TR with respect to pipe tobacco tax rate is given by the above formula, and the elasticity of TR with respect to the cigarette tax rate is given by $\phi_{\cdot s} = (t_s/p_s)e_{pt,s}$, where subscript s refers to cigarettes, and $e_{pt,s}$ is the uncompensated cross-price elasticity. Thus, as long as the cross elasticity is positive and p/t is greater than -e, ϕ will be positive for pipe tobacco.

[2] While the price elasticities have a crucial role to play in determining the elasticty of tax revenue with respect to tax rate, our estimates imply ample scope for increasing tax revenue by raising the rates of duty since the products of these elasticities and the proportion of tax in the final price is less than unity for cigarettes and pipe tobacco.

In the case of cigarettes, tax accounts for about 70 per cent of total price. Therefore, as long as the magnitude of the price elasticity is less than 1.4, an increase in tax rate will increase excise revenue. In the case of pipe tobacco, taxes amount to about 55 per cent of the final price, therefore as long as the cross elasticity remains positive and the own-price elasticity is less than 2, the result is the same. It is, of course, true that as the proportion of t in the final price increases, the government's ability to increase its revenue will be reduced, i.e. ϕ falls, but due to prevailing low elasticities, prices can be raised considerably before a point of diminishing returns is reached.

Thirdly, smoking is highly related to socio-economic class. Tobacco tax is a regressive tax; an increase in excise duty will fall more heavily on poor than rich, assuming the same price elasticities in all socio-economic groups. When prices are raised by increasing taxation, compensatory changes in other taxes or prices ought to be made for the poor. Given the positive income elasticity for cigarettes, this would reduce the effectiveness of the price policy, yet this effect would be only marginal as the relative changes in income would not be substantial.

(7) The anti-smoking publicity does seem to have had a substantial effect on per capita tobacco consumption, although its exact magnitude was not tracable, due to the confounding effects of huge price increases. Our results imply that the 1964 anti-smoking publicity may have caused a 5.7 per cent temporary reduction in cigarette consumption and the extensive anti-smoking debate provoked by the Tobacco Act in 1976 publicity resulted in a 6.7 per cent permanent reduction in the consumption. We were not able to isolate the magnitude of the publicity effect for other tobacco products.

(8) The banning of television advertising did not seem to have a direct influence on the demand. And there is some doubt whether the total advertising ban had any significant short-run effect either. The permanent demand impact of the huge price increases and the anti-smoking publicity effect in

1976 were so large that the possible marginal effect of the ban in 1977 seem to be concealed under these, as there was no systematic variation in the residuals left to be explained by the ban, or any other variables.

(9) Our results show that taxation would seem to be a powerful instrument for achieving the objectives of restricting consumption of tobacco products and raising government revenue. Yet taxation together with extensive anti-smoking publicity would have a more advantageous effect on public health than either of them used in isolation.

APPENDIX: Derivation of the estimating equations for the habit stock model.

The habit stock model introduced by Houthakker and Taylor (1970) is defined by two structural equations. For cigarettes these are the quantity demanded Q_t, real price of cigarettes P_t, real disposable income Y_t and a state variable S_t:

(1) $$Q_t = \alpha + \beta S_t + \gamma . Y_t + \eta . P_t$$

and the state variable which relates the net change in the psychological stock at time t to the flow of cigarette purchases net of depreciation which is assumed to accrue at a constant rate δ:

(2) $$\dot{S} = Q_t - \delta S_t .$$

Ignoring the time subscripts and substituting (1) into (2) we get

(3) $$\dot{S} = Q - (\delta/\beta)(Q - \alpha - \gamma . Y - \eta . P).$$

Differentiating (1) with respect to time

(4) $$\dot{Q} = \beta \dot{S} + \gamma . \dot{Y} + \eta . \dot{P}$$

and substituting (3) into (4) we obtain

(5) $$\dot{Q} = \alpha\delta + (\beta - \delta)Q + \gamma . \dot{Y} + \delta\gamma . Y + \eta . \dot{P} + \delta\eta . P.$$

A finite approximation for (5) can be derived defining

$$\Delta Q = Q - Q_{-1}, \qquad \bar{Q} = (Q + Q_{-1})/2.$$

Then $$\Delta Q = \alpha\delta + (\beta - \delta)\bar{Q} + \gamma\Delta Y + \delta\gamma . \bar{Y} + \eta\Delta P + \delta\eta . \bar{P}.$$

is equal to

$$(6)\quad Q - Q_{-1} = \alpha\delta + (\beta - \delta)2^{-1}(Q + Q_{-1}) + \gamma\Delta Y + \delta\gamma.2^{-1}(Y + Y_{-1}) + \eta\Delta P + \delta\eta.2^{-1}(P + P_{-1}).$$

Reorganising terms in (6) we arrive at

$$(7)\quad Q = \frac{\alpha\delta}{1 - (\beta - \delta)/2} + \frac{1 + (\beta - \delta)/2}{1 - (\beta - \delta)/2}Q_{-1} + \frac{\gamma.(1 + \delta/2)}{1 - (\beta - \delta)/2}\Delta Y + \frac{\delta\gamma.}{1 - (\beta - \delta)/2}Y_{-1} + \frac{\eta.(1 + \delta/2)}{1 - (\beta - \delta)/2}\Delta P + \frac{\delta\eta.}{1 - (\beta - \delta)/2}P_{-1}$$

Denoting $k = (\beta - \delta)/2$ we get

$$Q = \frac{\alpha\delta}{1 - k} + \frac{1 + k}{1 - k}Q_{-1} + \frac{\gamma.(1 + \delta/2)}{1 - k}\Delta Y + \frac{\delta\gamma.}{1 - k}Y_{-1} + \frac{\eta.(1 + \delta/2)}{1 - k}\Delta P + \frac{\delta\eta.}{1 - k}P_{-1}$$

Thus we have derived the estimating equation (the reduced form of the model):

$$(8)\quad Q = \beta_0 + \beta_1 Q_{-1} + \beta_2\Delta Y + \beta_2\lambda Y_{-1} + \beta_3\Delta P + \beta_3\lambda P_{-1}$$

where

$$(9)\quad \beta_0 = \frac{\alpha\delta}{1 - k}$$

$$(10)\quad \beta_1 = \frac{1 + k}{1 - k}$$

(11) $$\beta_2 = \frac{\gamma.(1 + \delta/2)}{1 - k}$$

(12) $$\beta_2\lambda = \frac{\delta\gamma.}{1 - k}$$

(13) $$\beta_3 = \frac{\eta.(1 + \delta/2)}{1 - k}$$

(14) $$\beta_4\lambda = \frac{\delta\eta.}{1 - k}$$

Parametres of the structural form (1) and (2) can be derived from the estimated coefficients of the reduced form (7). From (11) and (12) we get

$$\delta = \frac{\lambda}{1 - \lambda/2}$$

From (10) we get

$$\beta = \frac{2(\beta_1 - 1)}{\beta_1 + 1} + \frac{\lambda}{1 - \lambda/2}$$

From (11) we get

$$\gamma. = \frac{2\beta_2(1 - \lambda/2)}{(\beta_1 + 1)}$$

From (11) and (13) we get

$$\eta. = \frac{2\beta_3(1 - \lambda/2)}{(\beta_1 + 1)}$$

and from (9)

$$\alpha = \frac{2\beta_0(1 - \lambda/2)}{\lambda(\beta_1 + 1)} .$$

When the anti-smoking dummy variables D64 and D76S are introduced to the model, the corresponding coefficients of the reduced form are for D64

$$(15) \qquad \beta_4 = \frac{a_1\delta}{1 - k}$$

and for D76S

$$(16) \qquad \beta_5 = \frac{a_2\delta}{1 - k} .$$

From the estimated parametres (15) and (16) the following coefficients of the structural form can be derived for D64

$$a_1 = \frac{\beta_4[1 - (\beta - \delta)/2]}{\delta}$$

and for D76S

$$a_2 = \frac{\beta_5[1 - (\beta - \delta)/2]}{\delta} .$$

REFERENCES

Advisory Committee on Health Education (ACHE). An evaluation of the effects of an increase in the price of tobacco and a proposal for the tobacco price policy in Finland in 1985-87. Publications of the National Board of Health, Finland, Health Education, Series Statistics and Reviews 7/1985, Helsinki 1985.

Andrews DF. A note on the selection of data transformations. Biometrika, 1971, 58, 2, 249-254.

Atkinson AB. Smoking and the economics of government intervention. In Perlman M (ed.), The Economics of Health and Medical care, 428- 441. Macmillan 1974.

Atkinson AB, Skegg JL. Anti-smoking publicity and the demand for tobacco in the U.K. The Manchester School, 1973, 41, 265-282.

Atkinson AB, Skegg JL. Control of smoking and price of cigarettes - a comment. British Journal of Social and Preventive Medicine, 1974, 28, 45-48.

Comanor WS, Wilson TA. Advertising and market power. Harvard University Press 1974.

Deaton A, Muellbauer J. Economics and consumer behaviour. Cambridge University Press 1980.

Duffy M. Advertising, taxation and the demand for beer, spirits and wine in the United Kingdom, 1963-1978. Department of Management Sciences, University of Manchester, Institute of Science and Technology. Occasional Paper No. 8009, 1980.

Fujii ET. On the value of information on product safety: an application to health warnings on the long run medical implications of cigarette smoking. Public Finance, 1975, 30, 3, 323-332.

Fujii ET. The demand for cigarettes: further empirical evidence and its implications for public policy. Applied Economics, 1980, 12, 479-489.

Gilbert CL. The diagnosis of multicollinearity. Oxford Bulletin of Economics and Statistics, 1978, 40, 87-91.

Godfrey LG, Wickens MR. Testing linear and log-linear regressions for functional form. Review of Economic Studies, 1981, XLVIII, 487- 496.

Hall BH, Hall RE. TSP - time series processor, version 3.5, user's manual. University of York, Computing Service 1980.

Hamilton JL. The demand for cigarettes: advertising, the health scare, and the cigarette advertising ban. Review of Economics and Statistics, 1972, 54, 401-411.

Harris JE. Taxing tar and nicotine. American Economic Review, 1980, 70, 300-311.

Houthakker JE, Taylor LD. Consumer demand in the United States: analyses and projections. Second and enlarged edition, Harvard University Press 1970.

Ippolito PM. Information and the life cycle consumption of hazardous goods. Economic Inquiry, 1981, XIX, 529-558.

Jarque CM, Bera AK. Efficient tests for normality, homoscedasticity and serial independence of regression residuals. Economics Letters, 1980, 6, 255-259.

Johnston J. Advertising and the aggregate demand for cigarettes: a comment. European Economic Review, 1980, 14, 117-125.

Koutsoyannis AP. Demand functions for tobacco. The Manchester School, 1963, 31, 1-19.

Lee PN (Ed). Tobacco Consumption in Various Countries. Tobacco Research Council, London 1975.

Leppo K. Smoking control policy and legislation. British Medical Journal, 1978, 1, 6109, 345-347.

Leu RE. Anti-smoking publicity, taxation, and the demand for cigarettes. Journal of Health Economics, 1984, 3, 101-116.

Lewit EM, Coate D. The potential for using excise tax to reduce smoking. Journal of Health Economics, 1982, 1, 121-145.

Lewit EM, Coate D, Grossman M. The effects of government regulation on teenage smoking. Journal of Law and Economics, 1981, 24, 545-569.

Maddala G. Econometrics. McGraw-Hill 1981.

Marshall A. Principles of economics, 9th edition. Macmillan 1961.

McGuinness T, Cowling K. Advertising and the aggregate demand for cigarettes. European Economic Review, 1975, 6, 311-328.

Nordic Council. Report of the Nordic Smoking and Health Committee, Nordisk Utredningsserie 1975:24. Nordic Council, Helsinki 1975.

Peto J. Price and consumption of cigarettes: a case for intervention? British Journal of Social and Preventive Medicine, 1974, 28, 241-245.

Phlips L. Applied consumption analysis. North-Holland 1974.

Putkonen C. Tupakkatuotteiden kulutus. Tutkimuksia no. 55. Tilastokeskus 1980.

Rimpelä M, Kuuluvainen J. Hintojen yhteys tupakkavalmisteiden kulutuksen määrään ja laatuun Suomessa. Sosiaalilääke-tieteellinen Aikakauslehti, 1976, 4, 908-924.

Russell MAH. Changes in cigarette price and consumption by men in Britain, 1946-71: a preliminary analysis. British Journal of Social and Preventive Medicine, 1973, 27, 1-7.

Schneider L, Klein B, Murphy KM. Governmental regulation of cigarette health information. Journal of Law and Economics, 1981, XXIV, 575- 612.

Scitovsky T. The joyless economy. Oxford University Press 1976.

Scitovsky T. Asymmetries in economics. Scottish Journal of Political Economy, 1978, 25, 227-237.

Sehm M. Savukkeiden hinta kulutuksen säätelijänä. Sosiaalilääketieteellinen Aikakauslehti, 1977, 15.

STM (Ministry of Social Affairs and Health). Health for all by the year 2 000 - the Finnish National Strategy. Ministry of Social Affairs and Health, Helsinki 1987.

Sumner MT. The demand for tobacco in the U.K. The Manchester School, 1971, 39, 23-26.

Theil H. Applied economic forecasting. North-Holland, Amsterdam 1966.

Tilastokeskus. Tupakkatilasto 1987. Terveys 1988:1. Tilastokeskus 1988.

U.S. Department of Health, Education, and Welfare. Public Health Service, 1979. Smoking and Health. A Report to the Surgeon General.

Valtonen H. Tupakkatuotteiden hinnat kulutuksen ja tupakasta saatavien tulojen säätelijöinä. Sosiaalilääketieteellinen Aikakauslehti, 1982, 19, 168-180.

Warner KE. The effects of the anti-smoking campaign on cigarette consumption. American Journal of Public Health, 1977, 67, 7, 645-650.

Warner KE. Cigarette smoking in the 1970's: the impact of the antismoking campaign on consumption. Science, 1981, 211, 729-731.

Witt SF, Pass CL. The effects of health warnings and advertising on the demand for cigarettes. Scottish Journal of Political Economy, 1981, 28, 1, 86-91.

Wolffram R. Positivistic measures of aggregate supply elasticities: some new approaches - some critical notes. American Journal of Agricultural Economics, 1971, 53, 356-359.

Young T. Addiction asymmetry and the demand for coffee. Scottish Journal of Political Economy, 1982, 29, 1, 89-98.

Young T. The demand for cigarettes: an alternative specification of Fujii's model. Applied Economics, 1983, 15, 203-211.

PART IV:

SUMMARY AND CONCLUSIONS

PART IV: SUMMARY AND CONCLUSIONS

The purpose of the study was to examine the case for government intervention on the tobacco markets in Finland. The first part of the study indicated that there may exist several market failures which could lead to an inefficient allocation of resources. Consumption externalities, imperfect information about the health risks, smoking dependency and inefficient levels of prevention may lead to a situation where free competitive tobacco markets may create external costs to third parties and may not maximize smokers' and nonsmokers' welfare. Therefore, if left alone, the competitive markets may fail to lead to an efficient allocation of resources. Thus there may be a case for the government to intervene in tobacco markets on other than purely paternalistic grounds.

It was shown that the choice of an appropriate method of intervention depends on the market failure that government wishes to remedy. If the main concern is financial externality, prevention of addiction or an inefficient level of prevention, then taxation, health education, restrictions and improvements in risk technology will be appropriate. If the government attempts to diminish caring externality then health education, restrictions, improvements in risk technology and subsidies will be suitable. The same measures, excluding subsidies, are appropriate for correcting direct consumption externalities. Market failure due to imperfect information may be correcte d by health education and taxation. If the government attempts to help smokers free themselves of dependency, then improvements in risk technology, subsidies to smokers wanting to give up and to firms helping smokers in their endeavour will all be suitable measures to take.

It seems indeed possible, in principle, to reduce the external costs of smoking by taxation, health education, restrictions and by changing risk technology. The social optimum can be achieved by taxation and, in principle, by restricting consumption, but in the latter option there will still be external costs. The socially optimal level of consumption cannot be attained by health education, unless the optimum is zero, nor by changing risk technology, unless the new risk technology completely removes the hazardous components of tobacco.

If, in addition to reducing the external costs, the aim of the intervention is to reach the social optimal level of consumption then health education and changes in risk technology ought to be combined with taxation or restriction measures. Taxation is the only measure that will internalize externalities. Other measures will reduce external costs, but there will always be some costs to third parties.

It appeared possible to estimate the social costs of smoking, but not feasible to determine unambiguously which proportion of these costs is relevant for designing policy towards smoking. In particular, the estimated costs vary considerably depending on which economic framework is used. A theoretically correct economic analysis of the costs of smoking depends on the assumptions made with regard to dependence and information among consumers.

Our investigation of the health and economic consequences of smoking in Finland in 1987 showed that smokers themselves pay the major part of the estimated social costs of smoking. It seems likely that smokers as a group pay the external costs they generate to non-smokers and relevant institutions, irrespective of what is assumed about addiction and awareness about the health risks. There does not seem to be a case for government intervention to correct for financial externality. There does appear, however, to be a case for intervention to correct market failures due to caring externality, imperfect information and tobacco addiction.

Our investigation of the demand for tobacco products in Finland indicated that the price of tobacco products, in particular cigarettes, is the most important determinant of demand. The demand for cigarettes appeared to respond asymmetrically to changes in its price. The demand for cigarettes was also influenced by real disposable income. Cigarette price also affected the demand for pipe tobacco.

Anti-smoking publicity did seem to have had a substantial effect on per capita tobacco consumption, although its exact magnitude was not identifiable. Our results imply that the extensive anti-smoking debate provoked by the Tobacco Act in 1976 resulted in a 6.7 per cent permanent reduction in cigarette consumption. It was not possible to isolate the magnitude of the publicity effect on other tobacco products.

The study indicates that there may be a case for the government to intervene in tobacco markets in Finland on other than purely paternalistic grounds, and that taxing tobacco would appear to be a particularly effective tool for remedying market failures.

The study does not, however, give any guidance as to whether or not the government should intervene in the end. That decision needs to be based on overall analysis of the marginal costs and benefits of intervention. The total social costs of smoking as estimated in this study are clearly not the relevant figures for that purpose.

The study indicates that smoking is not primarily an economic problem in Finland; the main concern is with health-related matters. Thus actions taken to reduce tobacco consumption may be seen as one way of improving the health of the population. The benefits of such activities need to be evaluated primarily in health terms, such as improvements in health-related quality of life.