The Impact of a New Quality Management Practice on Worker Performance, Worker Turnover and Firm Performance

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DECLARATION

I, Mahvish Faran, confirm that the Thesis is my own work. I am aware of the University's Guidance on the Use of Unfair Means (www.sheffield.ac.uk/ssid/unfair-means). This work has not been previously been presented for an award at this, or any other, university.

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Abstract

This study provides evidence on the impact of a new quality management practice on indicators of worker and firm performance using personnel data and assembly line data from a large garments manufacturer in Pakistan. The analysis suggests that there was a significant improvement in worker productivity and a significant reduction in the number of quality defects made by workers. However, the impact of the implementation of the new quality management practice on the productivity of the firm varies by assembly line. The implementation of the new quality management practice decreases the productivity of very basic and complex lines while increases the productivity of basic lines that produce the most complex products within the basic line category. Employee turnover at the firm is also reduced after the implementation of the new management practice, and this reduction is the greatest for workers in the shortest tenure category as compared to workers with longer tenures. Hence, workers who are still in the process of accumulating information on the job match are less likely to turnover after the implementation of the new practice. There are two important gender differentials found in the analysis. Firstly, the hazard rate of turnover for females was found to be significantly lower than the hazard rate of males in the initial years of employment, after which no significant difference was found in the hazard rate. Secondly, the implementation of the new quality management increases the productivity and earnings of females by a greater magnitude as compared to males but reduces the quality defects made by males by a greater magnitude as compared to females.

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Chapter 1

Aims and Motivation

In order to develop a viable theory of the firm, it is important to understand the internal incentive structure of firms as it determines how individuals behave in an organisation (Baker, Jensen and Murphy, 1988).

This research is motivated by a research strategy known as insider econometrics which uses micro level data on worker, worker groups and firms to analyse the impact of management practices on productivity of firms. One of the questions that insider econometrics addresses is whether a new management practice increases productivity? And why a certain practice may not have the same impact on entities within the same organisation (Ichniowski and Shaw, 2009). This issue can be addressed by identifying the causes of variation in the impact of new management practices between workers or workers teams or firms within the same industry. Building on this theme, this research uses data from a large-scale garments manufacturer in Pakistan to investigate the impact of a new quality management practice on various measures of worker level and firm level performance. The use of data from the readymade garments sector is relevant as the textile sector accounts for over a half of Pakistan's exports (Pakistan, 2018). The readymade garments sector is at the top of the value chain in the textile sector and enhancing productivity in this sector can contribute to higher economic growth.

One interesting feature of the garments industry of Pakistan is the way in which the quality defects of stitched garments are checked. In most firms, quality supervisors check the bundles stitched by the operators, and send the garment for re-work if a quality defect is found or if the quality standard specified by the buyer is not met. Quality is checked twice, there are in-line supervisors who constantly move around the line and inspect workers and later the garments stitched by the workers are inspected again by another supervisor at the end table of each line. Improving the quality of production throughout the assembly line is important as any defects should be rectified earlier in the stage of sewing otherwise if the defective garments continues through the assembly line then the cost of re-doing the garment is greatly increased. However, typically no reward or penalty is given to workers based on the quality of work and workers are usually paid piece rates (payment according to the number of pieces stitched). The incentive effect created by paying piece rates to workers often leads to a quantity-quality trade-off which has been mentioned in the past (Holmstrom and Milgrom, 1991; Paarsch and Shearer, 2000; Chaudhry and Faran, 2015).

One local firm implemented a new quality management practice to motivate workers to strike a balance between quantity and quality, while keeping piece rates intact. In this initiative, every time an in-line quality supervisor checks the pieces stitched by an operator, he/she places a card on the machine. Various cards are used to denote different quality levels maintained by each worker. The cards are ranked: a green card indicates that the worker is maintaining sufficient quality, a red card indicates that the worker has made serious quality defects and a yellow card indicates that the worker needs additional monitoring or is under observation. If a worker gets a red card, production at that point is stopped until the problem is resolved, and the worker is strictly monitored until he/she can get the task done in the right manner.

The cards are visible to all workers on the factory floor and the new practice facilitates better management of the factory floor as supervisors can immediately identify problematic workers and can help eliminate any bottlenecks quickly. Interaction between individuals in the workplace may lead to peer pressure, as workers compare themselves with their co-workers and may experience the pressure of matching up to the performance of their peers (Cornelissen, Dustmann and Schönberg, 2017; Falk and Ichino, 2006; Mas and Moretti, 2009). Hence, this new quality management practice may also bring in an element of peer pressure onto the factory floor.

The operator who makes the least quality defects per line is also presented with a monetary reward once a month, however the reward is set only for certain operations. The reward accounts for 5 percent to 15 percent of the worker's salary. The reward is ranked for each assembly line; the worker who makes the least quality defects on each line receives the first prize and gets a 15 percent bonus, the worker who comes second gets a bonus of 10 percent and the worker who comes third is rewarded with a 5 percent bonus. The idea behind this practice is to introduce differentiation between co-workers and recognize workers per the standards maintained. Consequently, this attaches a status to each operative and rewards the best worker. The unique aspect of this practice is that it aims to enhance quality and quantity simultaneously as when a worker spends less time on re doing defected pieces, this translates into higher productivity as there is more time to work on new pieces. Moreover, Fukunishi and Yamagata (2014) suggest that several industries in low income countries have simultaneously upgraded product quality and experienced productivity growth, but there is a dearth of research on the sources of productivity enhancement at the firm level.

Four important features of the unique data set used in this research sets it apart from previous studies. First, I use data from the personnel records of a large readymade garments manufacturer over a 2.5 year period. The firm records all data electronically which minimises errors. The dataset allows us to analyse daily performance of workers such as productivity and quality defects. Using this data, the research builds upon the idea that rewards for quality (or penalties for low quality) can be provided to workers in addition to paying piece rates which will help minimise the quantity-quality trade-off (Heywood, Siebert and Wei, 2013; Milgrom and Roberts, 1995). The research uses data only on workers who were present at the firm before and after the implementation of the new quality management practice to test whether there is a significant difference between the productivity and quality defects of these workers before and after the implementation of the new quality management practice. The research follows a similar methodology to that used by

Bandiera, Barankay and Rasul (2005). However, they used firm level average quality figures to show that the quality of production did not change significantly after the intervention which did not clarify the impact on the quality of production at the worker level. Our data set is more detailed as we use quality data of individual workers.

The research also draws motivation from the work on management and firm performance by Bloom and Van Reenen (2007, 2010) who differentiate between good and bad management practices. Good management practices are defined as practices that contribute positively to the productivity of the firm. Bloom and Van Reenen (2010) identified that empirical research on the causal effects of management practices on firm performance is at an early stage and the lack of availability of firm level data is one of the obstacles in investigating the impact of management practices on firm performance. More specifically, one measurement issue is the unavailability of direct measures of outputs and inputs (Syverson, 2011). The second feature of this data set is that it fills in this void as high-quality firm level data is available which provides us with direct measures of inputs and outputs of each assembly line at the firm. This allows us to test the impact of the new quality management practice on the productivity of the firm by assembly line. The assembly lines at the firm vary by production complexity as some lines produce basic garments and some produce complex garments. The complexity of production within a line also varies. The research follows the idea by Boning, Ichniowski and Shaw (2007) who provide evidence that the impact of new human resource management practice on assembly lines varies with the complexity of production. Hence, the research also aims to explore whether the impact of the quality management practice differs within and across lines due to the variation in the complexity of production. As the data focuses on a narrow production process, this eliminates sources of heterogeneity that are found in more aggregate or heterogeneous samples.

The research also takes motivation from the theory of Lee and Mitchell (1994) which suggests that shocks at the workplace are likely to impact employee turnover. A shock is described as any positive, negative and neutral expected or unexpected event that shakes the employee out of steady state and initiates feelings about leaving the job. For example, shocks due to negative feedback during informal or formal performance appraisals have been recognised (Allen and Griffeth, 1999) and practices that aim to enhance performance increase the number of quits and dismissals as the enhanced standard may expose individuals who do not match up to the criteria of the new practice (Batt and Colvin, 2011). There is limited empirical work on the effects of new management practices on turnover; hence, this research will fill in this gap. Therefore, the third feature of the dataset is that it contains information on the duration of employees with the firm and using this information, the research will empirically test the impact of the new quality management practice on employee turnover. The research also draws its motivation from the job matching theory (Jovanovic, 1979) and aims to test whether the impact of the new management practice is different for workers with shorter tenures as compared to workers with relatively longer tenures. A strong relationship between the shirking behaviour of workers and turnover was established in the past (Shapiro and Stiglitz, 1984). Data on productivity, defects rate and absenteeism will be used to analyse the impact of shirking on employee turnover. The research also aims to analyse whether the implementation of the new quality management practice impacts the relationship between these three variables and turnover.

The fourth feature of the data set is that it allows us to analyse gender differentials. The justification for hiring female workers in the garments sector is derived from the nimble fingers hypothesis, where the orientation of women towards precise tasks emerges from their traditional designation at home and performing tasks like sewing (Elson and Pearson, 1981; Fuentes and Ehrenreich, 1983; Joekes, 1987) and survey results also indicate that females produce better quality work as compared to males (Haque, 2009). Hence, the research aims to investigate whether there are any gender differentials in productivity and quality defects at the firm.

Gender differentials in turnover have been analysed in the past. Viscusi (1980) mentions that conclusions drawn from data sets that use a diverse set of job characteristics may not be useful. Pakistan has one of the world's largest labour force. It faces many challenges in providing suitable employment opportunities to its labour force. However, industrial firms often find it difficult to find workers with the skill sets they require, which suggests a mismatch between demand and supply of skills. Females are often denied equal opportunities to education and training as males, so they mostly end up in low skilled jobs. The low female participation in Pakistan is also a hurdle to economic growth. However, the data set we use can give us useful results about gender differences as all males and females are at the same level in the hierarchy of the firm and we also control for tasks that the workers perform. The experimental economics literature has suggested that females are more averse to competition but most of these findings have been based on laboratory experiments (Bertrand, 2011). The implementation of the new quality management increases competition at the workplace, therefore this research will further add to the literature on whether gender preferences play any role in labour market outcomes.

Structure and Content of the Thesis

Chapter 2

This chapter uses personnel data to investigate whether the new quality management practices can motivate workers to meet targets while maintaining sufficient quality and keeping piece rates intact.

The data set used in this chapter only contains workers who worked at the firm before and after the implementation of the new practice. The sample covers 648 workers (300 females and 348 males) over 782 days. Various fixed and random effects models were estimated to analyse the impact of the new quality management practice on worker productivity, earnings and quality defects. The results show that the productivity and earnings of workers increased after the implementation of the new quality management practice. While the productivity of workers increased, the number of quality defects were significantly reduced. Gender differences were also found in the impact of the new quality management practice. The magnitude of the impact of the new quality management practice on productivity and earnings of females was greater as compared to males. Females were significantly less productive and earned less than males before the implementation of the practice, hence the new practice also reduces the productivity and earnings gender gap.

Interestingly, females made significantly lower quality defects as compared to males before the implementation of the new management practice. However, after the implementation of the practice, there was a reduction in the number of quality defects made by females but females now made significantly higher quality defects as compared to males. The quality management practice seems to target and minimise the shirking behaviour of workers as it has a greater impact on reducing the quality defects made by males who were making more quality defects before the intervention as compared to females, while the impact of the practice is of a smaller magnitude on the relatively more careful and quality conscious females. External interventions bring in two effects: the disciplining effect and the crowding out effect. Both these effects can co-exist, and the benefit of the intervention depends upon the relative magnitudes of these effects. The crowding out effect is likely to be stronger for females as compared to males, however the overall impact of the intervention cannot be ignored as the implementation of the new practice significantly reduces the quality defects made by both males and females. Hence, rewards can be attached to piece rates and therefore it should be assumed that quality will be compromised for quantity.

Chapter 3

The chapter aims to investigate the impact of the new quality management practice on the line level productivity of the firm. As the assembly lines at the firm produce products of different complexity and the complexity of production within an assembly line also varies, the chapter also aims to analyse whether the impact of the new quality management practice varies by the complexity of production. The daily line level production (the number of garments stitched) at each assembly line was chosen as the dependent variable and the data sample covers 867 days and 9 assembly lines. Fixed effects models were used to estimate the impact of the new quality management practice on the production at the firm. We provide evidence that the impact of the new quality management practice varies by the complexity of production which is in line with Boning, Ichniowski and Shaw (2007). One of the specifications shows that the implementation of the new quality management practice reduces the productivity of the firm, but the magnitude of the reduction is greater for lines that produce complex products. Most of the other specifications that show a more detailed picture of productivity for each assembly line indicate that the implementation of the new quality management practice increases the productivity of basic lines that produce the most complex products within the basic line category, but the new quality management practice reduces the productivity of other basic lines and complex lines. We also find evidence that the impact of the new quality management practice also varies by the change in the complexity of production. This effect also differs by assembly line as some specifications show that a change in the complexity of production after the implementation of the new management practice has a dampening impact on productivity while some specifications show that this effect is insignificant.

Chapter 4

This chapter analyses the impact of the new quality management practice on worker turnover and tests whether there are any gender differentials in turnover. A piece-wise discrete time survival model has been chosen for the analysis as tenure increments in number of discrete days. The observation window consists of a total of 852 working days. An unbalanced data set containing 769,491 worker-day level observations covering 1406 workers and 852 working days was used in this chapter.

The data sample contains workers that were employed by the firm on 1st August 2013 and workers who started working at the firm during the observation window.

The estimated results indicate that the implementation of the new quality management practice reduces turnover at the firm. This research provides results in line with the relationship suggested by Weiss (1984), such that a higher expected utility at the current job is likely to decrease turnover. The lack of job alternatives combined with the potential increase in job attachment due to the recognition and rewards provided by the new management practice may explain the reduction in turnover at the firm. However, the magnitude of the impact of the practice is lower for workers with relatively longer tenures and highest for workers in the shortest tenure category who are still in the process of accumulating information about the job match.

Overall, we do not find evidence that worker effort denoted by performance indicators such as quantity produced and quality defects are significant predictors of turnover but shirking behaviour such as absenteeism is found to have a significant positive relationship with turnover. However, only one specification suggests that before the implementation of the new management practice, workers with higher quality defects are more likely to turnover, but, after the implementation of the new quality management practice, workers with higher quality defects are less likely to turnover.

The estimates reveal an important gender difference i.e. the hazard rate of turnover for females were found to be significantly lower than the hazard rate of males in the initial period on the job, after which no significant gender difference was found in the hazard rate. These results highlight gender differentials in the job matching process. Financial hardship and fewer job alternatives due to restrictions on the mobility of females may also be potential reasons for the lower turnover rate of females.

Chapter 2

I. Introduction

This chapter uses personnel data from a large-scale garments manufacturer in Pakistan to investigate whether innovative management practices can motivate workers to meet targets while maintaining sufficient quality and keeping piece rates intact.

Extensive work has been done on how quality maybe compromised when workers are paid piece rates i.e. pay is dependent upon the quantity of output produced by workers as opposed to being paid fixed wages where a fixed salary is set per day or per month. However, there is a need to study the role that management practices can play in the workplace to induce industrial workers to put in their best efforts in a piece rate setting.

Two strands of literature motivate the research; Firstly, the work on monetary incentives and worker productivity (Prendergast, 1999; Lazear, 1986; Bandiera, Barankay and Rasul, 2005) and secondly, the notion that individuals crave status and have a desire to be recognized (Besley and Ghatak, 2005; Moldovanu, Sela and Shi, 2007; Kosfeld and Neckermann, 2011; Ellingsen and Johannesson, 2007).

The research further elaborates the idea by Heywood, Siebert and Wei (2013) that rewards for quality (or penalties for low quality) can be part of piece rates and as a consequence, it should not be assumed that quality will be sacrificed for quantity.

The study is also of relevance as the textile sector accounts for over a half of Pakistan's exports (Pakistan, 2018). As the readymade garments sector is at the top of the value chain, it is essential for developing countries, like Pakistan, to look for opportunities to increase manufacturing productivity to achieve higher economic growth. Macroeconomic issues in the garments industry have been studied in the past (Nabi and Hamid, 2013; Fukunishi and Yamagata, 2014). Moreover, Fukunishi and Yamagata (2014) suggested that several industries in low income countries have simultaneously upgraded product quality and experienced productivity growth, however, the sources of productivity enhancement need to be investigated at the firm level. Chaudhry and Faran (2015) used a descriptive analysis to explore whether the quantity-quality trade off exists under the piece rate system in the garments industry of Pakistan, where there seems to be no alternative way to fulfil production targets.

One interesting and unexplored phenomenon in the Pakistani garments sector is that quality supervisors check the bundles stitched by the operators and send the garment for re-work if a quality defect is found or if the quality standard specified by the buyer is not met. Quality is checked twice, there are in-line supervisors who constantly move around the line and inspect workers and later the garments stitched by the worked are inspected again by another supervisor at the end table of each line. However, typically workers are neither penalized for making a high number of quality defects nor are they rewarded for reducing quality defects.

One local firm implemented a new quality management practice to motivate workers to strike a balance between quantity and quality, while keeping piece rates intact. In this initiative, every time an in-line quality supervisor checks the pieces stitched by an operator, he/she places a card on the machine. Various cards are used to denote different quality levels maintained by each worker. The cards are ranked: a green card indicates that the worker is maintaining sufficient quality, a red card indicates that the worker has made serious quality defects and a yellow card indicates that the worker needs additional monitoring or is under observation. If a worker gets a red card, production at that point is stopped until the problem is resolved, and the worker is strictly monitored until he/she can get the task done in the right manner.

The cards are visible to all workers on the factory floor and the new practice facilitates better management of the factory floor as supervisors can immediately identify problematic workers and can help eliminate any bottlenecks quickly. This new quality management practice may bring in an element of peer pressure onto the factory floor. Interaction between individuals in the workplace may lead to peer pressure, as workers compare themselves with their co-workers and may experience the pressure of matching up to the productivity of their peers (Cornelissen, Dustmann and Schönberg, 2017; Falk and Ichino, 2006; Mas and Moretti, 2009).

The operator who makes the least quality defects per line is also presented with a monetary reward once a month, however the reward is set only for certain operations. The reward can account for 5 percent to 15 percent of the worker's salary. The reward is ranked for each assembly line; the worker who makes the least quality defects on each line receives the first prize and gets a 15 percent bonus, the worker who comes second gets a bonus of 10 percent and the worker who comes third is rewarded with a 5 percent bonus. The idea behind this practice is to introduce differentiation between co-workers and recognize workers per the standards maintained. Consequently, this attaches a status to each operative and rewards the best worker. The unique aspect of this practice is that it aims to enhance quality and quantity simultaneously. Workers at the firm are paid piece rates throughout the study.

Some evidence about a related practice is provided by Lazear (2000) who looked at an auto glass company where the quality of windshield installation improved after workers were paid piece rates. The worker who made the quality defect was expected to reinstall the windshield and had to pay the firm for the replacement glass before any paying jobs were assigned to him. Moreover, re-doing work was costly to the worker, therefore, the worker was more careful while doing it the first time. In our case, the same worker is expected to re-do the defected pieces and may incur a cost in terms of the earnings that he/she could have earned by working on a new piece. However, the firm reported that the quality defects were high, and workers were not motivated enough to get the pieces done correctly the first time. The aim of the new quality management practice is to motivate workers to get the task done correctly the first time and minimize re-work.

To identify the impact of the new quality management practice, the daily output, daily earnings, and daily quality defects of the same worker are observed before and after the quality management practice was started. This research follows a similar methodology to that used by Bandiera, Barankay and Rasul (2005). They compared productivity of workers who picked fruit under piece rates and relative incentives (worker's pay was dependent upon the ratio of individual productivity to average productivity among all workers on the same day and field) and reported that the productivity of workers was significantly higher under piece rates. The database used to record the productivity of workers and misclassification of fruit was different, hence, the dataset could not match the quality of fruit picked with the productivity of each worker.

Bandiera, Barankay and Rasul (2005) used an aggregate firm level figure to show that piece rate pay did not have an adverse impact on the quality of fruit picking but any changes in the quality of fruit picking at the worker level remained ambiguous. Average figures do not give a clear picture of whether the quality of fruit picking remained the same among all workers or increased for some workers and decreased for some. The analysis in this chapter reflects upon the changes in quality defects using data of individual workers before and after the introduction of the new quality management practice as quality data is recorded during the production process. The lack of reliable firm level data is an obstacle to carrying out research at the firm level, however the comprehensive data set used in this study gives us an opportunity to look inside the black box of firm behaviour. The rich data used in the study makes this research unique; such a scenario has not been analysed in the past in such detail. The data also makes it possible to look at the varying effects of the intervention for men and women.

A linear random effects model was used to estimate the impact of the new quality management practice on productivity and earnings and a negative binomial random effects regression illustrates the impact of the practice on quality defects. The estimated results provide evidence in line with the principal agent theory.

This chapter is organised as follows; Section II presents the literature review, Section III describes the data and methodology, Section IV explains the results, and section V presents the conclusion.

II. Literature Review

A cornerstone of research in personnel economics is that workers respond to incentives (Prendergast, 1999). Mayo (1933) stressed upon the idea that workers are motivated by both non-monetary and monetary incentives, such ideas are now being used in personnel economics (Bloom and Van Reenen, 2011). The notion that individuals desire to be distinguished from others has been recognized (Robson, 1992; Zizzo, 2002; Frey, 2007; Larkin, 2011) and is gaining popularity in field experiments. For example, Bandiera, Barankay and Rasul (2011) mention that new field experiments to motivate employees are being created and one of them is providing non-monetary rewards in the form of status or social recognition.

The following sections shed light on the literature on monetary incentives, non-monetary rewards, and the impact of various incentive schemes on worker productivity. A brief section on the principal agent theory and the crowding out hypothesis was also included. The final section considers how field experiments are used in the literature.

II.A. Piece Rates vs Fixed Wages

The decision to pay piece rates or salaries to workers depends upon how much weight the firm gives to quality, quantity and other factors such as asymmetric information, sorting considerations and monitoring costs (Lazear, 1986). The age earning profiles created by the human capital theory, explained by Becker (1962) and the shirking model presented by Lazear (1981) have similar implications, but they differ significantly on the issue of pay for performance compensation schemes. Lazear (1981) predicts that workers who are paid piece rates should have a flatter age-earnings profile than workers who are paid time rates. The reason is that piece rates are used in occupations where workers are easy to monitor and shirking will lead to immediate dismissal. Piece rates are normally used in jobs where the variance in output and hence income is relatively high. Agency problems should also not be prevalent as there is a direct link between pay and performance. The human capital theory argues that there is no reason to believe that skill acquisition would be less profitable for workers in jobs which pay piece rates in comparison to those jobs that pay time rates. Hutchens (1987) noted that piece rate jobs usually involve doing repetitive tasks which are conducive to monitoring and tend not to have job characteristics such as pensions, long job tenures, and comparatively higher wages for senior workers.

There is evidence that piece rate workers are often considered to be more productive than workers who are paid fixed wages (Lazear, 2000; Shearer, 2004). Articles in Blinder (1990) also suggested that pay for performance mechanisms can motivate individuals to increase their effort levels. Freeman and Kleiner (2005) explain through a case study of an American shoe manufacturing firm that switching to piece rates leads to a rise in worker productivity.

Performance related pay also plays an important role for firm profitability. When pay is tied to performance, firms can improve the quality of workers as high quality workers select jobs that offer performance based schemes (Lazear, 1986; Lemieux, Macleod and Parent, 2009; Grytten and Sorensen, 2003). Jones, Kalmi and Kauhanen (2010) found evidence that team productivity significantly increased when teams of workers received performance related pay.

Gielen, Kerkhofs and van Ours (2010) presented an empirical analysis of the productivity and employment effects of the pay for performance compensation scheme and reported an increase in productivity of firms of approximately 9 percent. They attributed this change partly to the incentive effects generated by pay for performance schemes and partly to worker sorting. Booth and Frank (1999) used data from the British Household Panel Survey to assert that performance related pay is associated with about 9% higher wages for men and 6% for women. Seiler (1984) confirmed the hypothesis that workers who are paid incentives experience higher but more dispersed earnings than those workers who are paid time rates. The incentive effect partly consists of the effort effect and partly of the higher risk borne by the worker.

The evidence that piece rates lead to an improvement in productivity shows one side of the coin. Problems related to piece rates have often been a subject of interest. One issue is that in the presence of asymmetric information, workers may be reluctant to share productivity enhancement methods as an overall increase in productivity may decrease piece rates (Roy, 1952; Gibbons, 1987). Another one is that workers exert too much effort on tasks that generate performance pay, which eventually leads to a misallocation of tasks. Some examples of this include workers concentrating too much on quantity rather than quality, inadequate maintenance of productive tools and lack of willingness to cooperate with the firm and its employees (Moen and Rosen, 2005; Baker 1992; Holmstrom and Milgrom, 1991). If the cost of effort for a worker for two activities is the same, the agent will be indifferent as how he/she allocates his/her time between both activities. However, if the principal offers a higher return for one task as compared to the other, then the agent will have an incentive to focus on the task that generates the higher return even if the principal prefers an equal allocation of time between both tasks (Holmstrom and Milgrom, 1991). Paarsch and Shearer (2000) also present a similar finding that incentive effects created by monetary compensation schemes might compromise on quality by enhancing quantity.

Bandiera, Barankay and Rasul (2007, 2009) reported evidence that managers direct their efforts towards high quality workers after a performance bonus package contingent on the average productivity of low tier workers was introduced. The multi-tasking concerns raised by Holmstrom and Milgrom (1991) were also incorporated into the social experiment; managers were not paid performance bonuses if the percentage of damaged fruit rose by more than 2% as compared to the pre-established figure at the firm.

The quantity quality trade-off associated with piece rates has also been observed in the garments industry of Pakistan. Makino (2012) reveals that the poor performance of the garments industry of Pakistan in the post MFA (Multi-Fibre Arrangement) period maybe attributed to the practice of paying piece rates to workers. The Multi-Fibre Arrangement was an agreement on textile goods and readymade garments that was active between 1974 and 2004. It imposed quotas on textile products that developing countries could export to developed countries.

Chaudhry and Faran (2015) observed that the quantity-quality trade off exists under the piece rate system in the garments industry of Pakistan but there seems to be no alternative way to fulfil production targets. Chaudhry and Faran (2016) further studied the manufacturing process of an identical pair of denim jeans produced in three different factories. Large factories that export garments tend to pay piece rates to workers that are calculated using the standard minute value (the time it takes to produce one garment) and have concluded that smaller firms can save labour costs by paying wages based on stitching times and by adopting some of the technologies used by large exporting firms.

In contrast to the argument that the quantity quality trade off exists under piece rates, Lazear (2000) provided evidence that quality improved after an auto glass company switched to piece rate pay. Bandeira, Barankay and Rasul (2005) found the first evidence on the comparison between relative incentives and piece rates. The productivity of an average worker in a fruit farm is reported to be 50% higher when workers are paid piece rates as compared to when workers are paid according to relative incentives (pay is contingent upon the ratio of individual productivity to average productivity of the farm). They used an aggregate measure of quality to show that after piece rates were implemented, there was no significant effect on the quality of fruit picked on the farm.

Milgrom and Roberts (1995) are of the view that piece rates can function optimally when they are tied to incentives. Heywood, Siebert and Wei (2013) build upon a similar concept presented by Lazear (1995) that piece rates contingent on quality and quantity can help firms minimize the quantity-quality trade off. Rewards for quality (or penalties for low quality) can be part of piece rates and it should not be assumed that quality will be sacrificed for quantity. The results emphasize that worker characteristics and attitudes have a significant impact on the quantity-quality outcome. For example, males have a higher error rate than females and males prefer piece rates more than females do.

II.B. Monetary vs Non-Monetary Incentives

The role of monetary incentives has been studied to a large extent in the past and, there is ample empirical evidence that status considerations, where individuals benefit from receiving higher wages than their peers, play an important role in the workplace (Frank, 1985). Workers care about what employers think about them as this will influence future payments and promotion prospects (Holmström, 1999).

The human need for appreciation and recognition is a vital force behind motivating individuals (Maidani, 1991; Besley and Ghatak, 2005) and Maslow (1987) and Alderfer (1972) further elaborated that these needs maybe fulfilled through public recognition. Agents care about their social status and principals often use this concern as a way to influence agents' output. This status maybe achieved through monetary or non-monetary payoffs or could also be a combination of both (Moldovanu, Sela and Shi, 2007). Firms that use rewards contingent on employee performance also have higher payoffs, ceteris paribus (Besley and Ghatak, 2008). Stajkovic and Luthans (1997) share a similar finding; monetary rewards and social recognition are effective tools to improve average performance of manufacturing and service firms. Auriol and Renault (2008) used a framework where social recognition was a scarce resource in an organisation and introducing differentiation between employees in a dynamic setting proved to be a powerful tool to motivate workers.

Extensive research related to motivational theories suggest that there is a correlation between employee behavior and the desire for recognition (Crandall and Wallace, 1997; Patton, 1999). Skinner (1969) presented the reinforcement theory; individuals behave in accordance with the consequences of their actions. People tend to repeat rewarding behavior and avoid punishable actions. Markham, Scott and McKee (2002) used this reinforcement theory to illustrate the success of a public recognition program which improved worker attendance. Wiley (1997) used data from employee surveys to establish that good wages, job security, full appreciation for work, promotion and growth, and interesting work were the most important factors for motivation of employees.

Linking attendance to recognition of employees has found to be a successful way of improving attendance (Duflo, Hanna and Ryan, 2012). In contrast, Silva, Duncan and Doudna (1981) presented a study of 20 female workers which showed limited success of recognition in achieving reduced absenteeism.

However, in some cases, monetary incentives do not necessarily produce the desired effects. For example, Titmuss (1970) and Mellström and Johannesson (2008) argue that people with altruistic motives resent the use of monetary payments, hence, material incentives have a negative impact on altruistic behaviour such as blood donation.

Ellingsen and Johannesson (2007) emphasized that although economists in the past have focused more on monetary incentives in labour relations, however, workers in organisations also value non-monetary incentives. Workers gain utility from being respected by their employers and fellow colleagues. Employers can help employees gain the recognition they desire by controlling the information about an employee that is available to others and by sharing the traits that gain respect for an employee in an organisation. Deci (1971) and Luthans and Stajkovic (1999) present a similar idea that appreciation of employees instead of monetary rewards is a powerful device in motivating subjects to perform tasks.

Kosfeld and Neckermann (2011) further developed the point raised by Ellingsen and Johannesson (2007) that status and social recognition are strong incentives for agents to improve their work effort, however, an optimal mix of incentives would consist of a combination of monetary awards and non-monetary awards. Stajkovic and Luthans (2003) also reported results in line with Kosfeld and Neckermann (2011) that social recognition with a combination of monetary rewards and feedback can have a significant impact on task performance. Ashraf, Bandiera and Jack (2014) have reported that sales agents who were given non-monetary rewards were more successful than those who were given financial margins on the quantity sold.

Subjects tend to compare themselves with individuals of similar calibre. Variations in reference groups may help to explain the differences in ambition, for example, females tend to compare themselves with females while low ability workers tend to compare themselves with workers of similar ability. Firms can benefit from such interpersonal comparisons to induce subjects to improve work effort levels. It may be more beneficial for firms to introduce promotion-based tournaments that reward winners rather than penalise losers. Segregated tournaments create a levelled playing field; hence subjects exert higher effort in segregated tournaments than in mixed tournaments as males and females may have different ambition levels. Gaps in male-female performance may be explained by differences in ambition without invoking discrimination or differences in other opportunities and abilities. Females are less status seeking than males and, despite having high ability, may fail to climb up the corporate ladder (Ederer and Patacconi, 2010). Falk and Knell (2004) and Gneezy, Niederle and Rustichini (2003) have also found heterogeneity with respect to status seeking behaviour, in particular gender and country differences.

Large peer effects were observed in low skilled occupations where individuals can monitor each other's output (Cornelissen, Dustmann and Schönberg, 2017). Mas and Moretti (2009) observed a similar finding such that when a faster clerk replaced a slower clerk, the productivity of the shift increased not only because of the faster clerk but because other clerks also became more efficient.

Dur (2009) suggested that even if low wages are being offered, the management can persuade workers to stay with the firm if the attention that the employees deserve is being given to them. Nagin *et al.* (2002) also agree that management's empathy while dealing with employees may reduce opportunistic behaviour in the workplace.

II.C. Agency Theory vs. Crowding Out Hypothesis

There are mixed views on the way external interventions are likely to impact worker performance. External intervention may crowd out, crowd in or leave intrinsic motivation unaffected (Frey, 1997). The Principal-Agent theory suggests that an external intervention is likely to improve worker performance as it increases the marginal cost of shirking or increases the marginal benefit of performing (Alchian and Demsetz, 1972; Fama and Jensen, 1983). Frey and Jegen (2001) suggest that the outcome suggested by the agency theory would hold if an external intervention increases intrinsic motivation, hence the effect of the disciplining effect is strengthened by the crowding in effect. Lazear (2000) also reported evidence that monetary incentives will increase output of workers.

Social Psychology presents an alternative view known as the crowding out hypothesis that suggests that an increase in monitoring by the principal can lead to a reduction in effort by the agent. The disciplining effect supported by the agency theory and the crowding out effect may co-exist. The disciplining effect is dominant when an impersonal or abstract relationship exists between the agent and principal, for instance, if employees are controlled by the parent company. The crowding out effect is likely to hold if the relationship between the principal and agent is personal and psychological contracts are of importance (Frey, 1993).

Barkema (1995) used data on 116 managers in medium sized Dutch firms and reported a negative effect of monitoring on the manager's performance when the principal is a CEO but a positive effect when the manager is supervised impersonally by a parent company.

Dickinson and Villeval (2008) provide evidence in line with the agency theory, however, they also support the hypothesis by Frey (1993) such that the crowding out effect will outweigh the disciplining effect when a reduced social distance between the principal and the agent exists. In this case, the crowding out effect is observed in an impersonal relationship when the principal's payoff is dependent on the agent's output. The agent reciprocates intense monitoring by reducing output, while this behaviour was not observed in fixed payoff treatments.

II.D. Field Experiments and Regression Analysis

Falk and Ichino (2006) illustrated through a controlled field experiment that peer effects exist as the behaviour of students who worked alone was found to be significantly different from the behaviour of students who worked in pairs. The average output of students that worked in pairs was found to be higher. When less productive students were paired with highly productive students, overall productivity also went up. Peer effects may also be present in cases where workers are paid piece rates, as they may care about their own productivity and the productivity of their peers.

Ichniowski and Shaw (2009) refer to a research strategy known as 'insider econometrics'. The strategy uses micro level data on workers and aims to address questions related to the impact of new management practices on the productivity of firms. The simplest regression for obtaining estimates of the impact of a management practice on productivity, or any other dependent variable such as quality of the product, or the downtime of an assembly line will include control variables implied by the production function, a dummy variable which equals one when the management practice is present, work specific fixed effects and a common time trend.

Bandiera, Barankay and Rasul (2011) explain that field experiments within firms are usually done at the worker level. The benefit of having a control group and a treatment group is that common trends can be taken care of by employing a difference in difference estimator. The problem arises when the control and treatment groups cannot be geographically isolated and the control group might react to the differential treatment, while firms also might not be willing to treat workers differently within the same vicinity.

Shi (2010) conducted a randomized control trial which aimed to compare productivity under piece rates and fixed wages for workers involved in tree thinning in an orchard in Washington. The firm had multiple sites, however, the workers exchanged information about being treated differently with the result that there was resentment from workers who were not being paid piece rates.

List, Sadoff and Wagner (2010) mentioned that applying the treatment to all agents at a chosen time can eliminate the problem experienced by Shi (2010). The benefit of applying the treatment to all agents increases statistical power and the effect of the treatment can be estimated by comparing the same agent before and after the treatment which will remove unobserved heterogeneity. The cost of this approach is that the estimates might be biased due to unobservable determinants of changes in behaviour. This can be resolved by collecting a long time series data before and after the treatment and control periods or if seasonality seems to be a problem, then data can be collected when the treatment was not available, to purge estimates of variation due to naturally occurring fluctuations.

Prendergast (1999) and Chiappori and Salanié (2003) noted an important empirical identification problem, such that the incentive contracts might be endogenous to firm's performance. The methodology employed by Bandiera, Barankay and Rasul (2005, 2007 and 2009) has addressed this challenge; the exogenous change in incentives created by the natural field experiment, with detailed personnel data and a fixed number of individuals precisely identifies the causal effect of incentives on worker and firm productivity.

Bandiera, Barankay and Rasul (2007) investigated the effect of an exogenous change in managerial incentives on average worker productivity. The compensation mechanism of managers was changed from fixed wages to performance pay contingent on the average productivity of low tier workers. The methodology employed in this case is similar to the one used by Bandiera, Barankay and Rasul (2005). The effect of the change in incentives is captured by a dummy variable that equals one when the performance bonus was introduced and zero otherwise.

II.E. Gender Differences

Various explanations for the gender wage differentials have been studied in the past. Productivity differences due to the gender differences in labour force attachment as females assume household responsibilities under the traditional division of labour (Azmat and Ferrer, 2017; Anderson, Binder and Krause, 2002; Angelov, Johansson and Lindahl, 2016; Bertrand, Kamenica and Pan, 2015) were first explained by Mincer and Polachek (1974). It has been argued that as women spend more time on household responsibilities and childcare than men do, women tend to have high turnover rates and are more likely to have a more discontinuous pattern of labour force participation. The human capital acquired by females might depreciate as females take time off from work for childcare. Decisions related to child rearing, may also induce females to delay training until they re-join their workplace. Hence, on average females will receive less training than males. Women tend to accumulate less total work experience, job specific experience and seniority as compared to men (Polachek, 1981; Barron, Black and Loewenstein, 1993; Corcoran and Duncan, 1979). The time and effort that females spend on housework may induce a lower effort into market jobs, hence productivity and wages are lower (Becker, 1985). Sorting decisions may also play a vital role in the gender wage gap as women may take up lower paying jobs that are compatible with the work and home schedules and may have a higher rate of absenteeism in order to care for children if they are ill (Mincer and Polachek, 1974). In the case of Nordic countries, there is a high rate of female labour force participation, but females often take up roles that are less intense since women are more involved in child care, hence it creates a glass ceiling as females do not reach the best paying positions (Albrecht, Björklund and Vroman, 2003).

Gender discrimination is widely considered to be another factor leading to the gender wage gap. Discrimination is divided into two categories, one that can arise from preferences of employers (Becker, 1957) and one that arises when workers are unable to indicate their true productivity. Men and women may be treated differently due to the expected differences in their productivity. The expected productivity of women might be lower due to other household responsibilities associated with women, hence they may be paid a lower wage (Aigner and Cain, 1977). However, as workers accrue tenure at a particular firm, they will be able to indicate their true productivity; hence, the gender wage gap should be expected to become smaller with tenure and age (Altonji and Pierret, 2001). Exclusion of females from male dominated occupations may depress wages in female dominated occupations due to excess supply of females (Bergmann, 1974).

There is evidence of gender discrimination as the gender pay differential was found to be significantly larger than the gender productivity differential (Hellerstein, Neumark and Troske, 1999; McDevitt, Irwin and Inwood, 2009). On the contrary, there is evidence that the lower productivity of females explains the lower wage that they received in three cases of manufacturing (Cox and Nye, 1989; Hellerstein and Neumark, 1999).

The traditional division of labour that results in the differences in work experience acquired by both genders is one explanation for the gender wage gap. Psychological attributes and non-cognitive skills account for one of the latest explanations of the gender differences (Blau and Kahn, 2017). A part of the male-female wage differential that is unexplained by the differences in human capital can be accounted for by the differences in psychological attributes (Semykina and Linz, 2007; Nyhus and Pons, 2012).

Personality Traits such as self-esteem may contribute to a worker's productivity, acting like other variables that affect human capital wage regressions. Gender differences in the return to five personality traits (extraversion, neuroticism, agreeableness, openness to experience and conscientiousness) could account for 5 percent of the gender wage gap, after controlling for other human capital variables (Mueller and Plug, 2006). For males, earnings were positively associated with antagonism (the opposite of agreeableness), emotional stability (the opposite of neuroticism) and openness to experience. For females, earnings were associated with conscientiousness and openness to experience.

Females are found to be more agreeable than males (Bertrand, 2011; Bouchard and Loehlin, 2001). Agreeableness refers to being more trusting, compliant, modest, straightforward, sympathetic, and acting in accordance with the interest of others. Agreeableness accounts for the greatest difference in gender earnings as men received a wage premium for being more antagonistic (Mueller and Plug, 2006). A sample of Dutch employees also shows that personality traits such as agreeableness and intellect explain the gender wage gap. Intellect is positively related to the wages of males (Nyhus and Pons, 2012). Agreeableness has a negative impact on the wages of women, as it hints at women being less effective in bargaining wages as compared to males (Babcock and Laschever, 2003; Nyhus and Pons, 2012).

Women were found to be more conscientious than men were (Mueller and Plug, 2006; Goldin, Katz and Kuziemko, 2006). Positive correlation between conscientiousness and job performance has been reported (Barrick and Mount, 1991). Females seem to have better 'people skills' and hence the importance of interpersonal interactions in jobs is likely to positively affect wages of women Borghans, Ter Weel and Weinberg (2014).

The rapid global growth of female labour force participation has been attributed to the growth in the services and low-cost manufacturing sectors. A preference for females emerged in labour intensive exporting countries as the firms took advantage of female stereotypes such as nimble fingers, acceptance of low wages and poor working conditions (Elson and Pearson, 1981). The justification for hiring female workers in the garments sector is also derived from the 'nimble fingers' hypothesis, where the orientation of women towards precise tasks emerges from their traditional designation at home and performing tasks like sewing (Elson and Pearson, 1981; Joekes, 1987; Fuentes and Ehrenreich, 1983).

Male and female students were asked to solve mazes under two compensation schemes: piece rates and a tournament scheme. Under the piece rate, each student is paid according to the mazes he/she solves and under the tournament scheme, only the student who solves the highest number of mazes is paid. No gender differences were observed in performance when students were paid piece rates, but males increased their performance in the tournament setting as males solved 40 percent more puzzles as compared to females. As the tournament scheme is more uncertain, this may reflect gender differences in risk aversion. However, a third scheme is implemented in which the tournament winner is selected at random, under this scheme no gender difference in performance was found. An important finding was that females perform as well as males if they are competing against females only. The performance gap in the tournament setting was attributed to the relative failure to maintain a high level of performance when competing against males (Gneezy, Niederle and Rustichini, 2003).

Niederle and Vesterlund (2007) suggests that women are less likely to choose more variable pay schemes as compared to men as they have less of a taste for competition. Dohmen and Falk (2011) also provide evidence that women are less likely to opt for variable compensation schemes, however they find that this result becomes statistically weak after controlling for risk attitudes.

II.F. Conclusion

Extensive evidence has shown that individuals respond to monetary and non-monetary incentives, however there is no clear consensus on whether firms should use monetary or non-monetary rewards. The use of non-monetary incentives is gaining popularity in field experiments related to firms and employees, while some authors have suggested the use of both monetary and non-monetary incentives. Multi-tasking problems may persist with monetary schemes such that workers may only focus on the quantity of production and not on the quality. Other ways have been suggested to motivate workers to maintain quality and quantity, such as tying piece rates with rewards for quality. There is limited use of innovative management strategies in a piece rate setting in the past to address the quantity-quality trade off, and it would be worthwhile to explore this option.

III. Data and Methodology

III.A. Context

Personnel data was analysed from a large scale vertically integrated denim garments production facility in Pakistan. It is located in Pindi Bhattian, Hafizabad district, Pakistan[1]. The dataset has not previously been used for research. The dataset was acquired through personal visits to the firm. The firm agreed to share the information upon the understanding that the data will only be used only for research purposes and will not be shared with any other party such as competitors and buyers etc.

Under the production system of the firm, each worker is given a specialised task and the garment takes shape along the assembly line. Each line has a small parts, a front, a back and an assembly 1 and an assembly 2 section. There are screens along the assembly lines, which indicate the target achieved by each line and the percentage that needs to be completed. The firm has an average of 1400 to 1500 stitching operators present on the assembly line per day.

The level of qualification for all stitching operators must be completed up to middle school or an equivalent level of training from religious schools (*madrassas*) is also acceptable. Different production processes require different training periods which range from 5 weeks to 16 weeks.

Workers are hired based on an aptitude test which analyses an individual's ability to see, touch and make decisions. For example, colour selection and placement of materials in the correct manner on the machine. The workers are categorised into two grades: S5 grade level and S4 grade level. S5 grade level workers are machine operators. S4 grade level workers perform non-machine tasks such as thread trimming.

[1] The nearest garments production facility to this firm is approximately 64 kilometres away. The firm does not operate in a cluster so the distance may hint at some geographical immobility for labour.

Workers are hired mostly from villages within a 30-kilometre radius of the firm. The norm in Pakistan is to hire male stitching operators and only 24 percent of the stitching operators are female in the woven garments industry (Haque, 2009; Makino, 2012)[2]. This firm has a higher female participation rate, as 40% of the stitching operators are female. Workers are paid piece rate plus an attendance allowance throughout the period of the study.

Data on output per worker and quality defects per worker are recorded electronically. This is unusual in a country like Pakistan, as either most of the other firms collect data manually or those firms which collect data electronically, do not collect quality data per worker.

Each worker has a unique ID and there is a barcode attached to each bundle. Each worker is responsible for his/her own bundle, hence the data is recorded at the individual level. A bundle contains 25 to 30 pieces of the garment which is to be stitched. The worker scans the barcode and his/her ID on the reader attached to each machine after the bundle is completed. This ensures that the worker is paid for the correct quantity of pieces and the payments are recorded with minimum error.

III.B. Organisation of Production at the Firm

As the firm is a vertically integrated unit, it buys cotton as raw material and sells finished garments. We will now introduce the stages of production. Workers at the firm are stage specific and the new quality management practice was introduced only in the sewing department(stage three of production).

Firstly, the cotton goes through the spinning and weaving process and then it is finished and inspected at the Fabric Finishing and Grading department. The firm can use 85% to 90% of its fabric to produce garments, and the surplus is sold to other garment manufacturers[3].

[2] The study by Haque (2009) reports this figure based on 150 garment factories.
[3] Source: Personal Interview with Vice President of the firm.

The second stage of the manufacturing process is cutting. The firm uses an automated machine to spread dozens of layers of fabric on a table so that the pieces can be cut simultaneously. The firm cuts all pieces for a garment from the same roll as there could be variations in the shade of fabric from roll to roll especially when the garment goes through chemical washes. A pattern is designed for cutting using Computer Aided Design (CAD) software. The software sets the pattern of the different pieces of the garment on the fabric. However, workers in the CAD section also rearrange the pattern set by the software to further minimise fabric wastage. The pattern is then laid over the fabric for cutting.

Before the fabric is cut, it is inspected for defects, and if some defects are found, that portion of fabric is cut out from the roll. One of the key indicators of any garments manufacturer's performance is the cut to ship ratio i.e. the ratio of the number of pieces cut to the number of pieces shipped. The cut to ship ratio of the firm is around 103% to 105%, however it may rise to 107%, depending on the customer[4]. The firm usually cuts more pieces than the pieces required by the supplier, to keep a cushion in case there are some defected garments at the end of the process and some more garments may need to be stitched. After the fabric is cut, it is divided into bundles and transferred to the stitching unit.

The third stage of the production process is sewing. Under the production system of the firm, each worker produces a part of the garment and the garment takes shape along the assembly line. Each line has a small parts, a front, a back and an assembly 1 and an assembly 2 section. At the first stage small parts are produced to be ready for the back and front section. The front and back of the jeans are stitched individually but then the front and back is assembled during assembly 1 and assembly 2 to complete the garment. As production operations are interdependent, a bottleneck at any stage can reduce the productivity of the line. There are screens along the assembly lines, which indicate the target achieved by each line and the percentage that needs to be completed.

[4] Source: Personal Interview with Vice President of the firm.

Line balancing is an important aspect of the way production is organised. The firm has an extensive industrial engineering department. The task of the industrial engineers is to set targets and balance the assembly line to minimise bottlenecks and idle time of workers. The industrial engineers visit the factory floor from time to time to monitor progress. The key measure used to balance the line is the standard minute value (SMV). The standard minute value is the time it takes to complete one process or more commonly referred to as an operation of the garment. Fewer stitching operators are allocated to operations that have a low SMV and more stitching operators are allocated to operations with a higher SMV. Along the assembly line, it is common to see more than 2 workers working on the same operation side by side. The total SMV i.e. the total time it takes to produce one garment along the line is calculated by adding up the SMV of each operation.

The supervisory structure of the assembly lines consists of quality supervisors and production supervisors. Each line has 5 sections, hence there are 5 quality supervisors at the end of each section, 2 quality supervisors for random in-line quality checking and 2 quality supervisors at the end of the line. The allocation of workers on the line is determined by the Industrial Engineering department but supervisors have some authority in moving operators around the line. They rely on their informal knowledge of the skill of each worker to help balance the line in case a few workers are absent. Industrial engineers regularly visit the floor, on average once every hour, hence the supervisors often discuss the status of production with them. Issues such as breakdown of machines are discussed among supervisors and machines are transferred across lines with the approval of the production supervisor of the respective line. Any disciplinary issues that arise within the assembly lines are also handled by the production supervisors. Production managers are responsible for approving targets and resolving unforeseen incidents on the lines. Assistant production managers resolve any issues that arise among supervisors.

The international standards of SMV were set by a consortium from the German, Swiss and Austrian National Associations, however, the firm uses an adjusted version of the SMV that is known as SAM (Standard Adjusted Minute). The SAM is calculated by giving bundle, machine, and personal allowances to the worker. In most cases, it is assumed that the worker will work at 80% capacity. For example, if the SMV of an operation is 0.15 minutes and the target for that order is 3000 garments, as the factory is in operation for 480 minutes per shift, if 100% efficiency is assumed then the worker can produce 3200 garments in 480 minutes i.e. (480/0.15). However, the factory assumes 80% efficiency and the worker will be able to produce 2560 pieces i.e. (3200*0.8). The firm uses a certain criterion to allocate the number of workers to each order. The number of required workers for each order is calculated by dividing the order size by the number of pieces the worker will be able to produce in one shift. In this example, 3000 divided by 2560 which gives 1.17. As the number of required workers is calculated to be 1.17, only one worker would be allocated to this task. If the SMV of an operation was 0.24, then the number of required workers would be 3000/1600 which would give us 1.88. Hence the actual number of workers allocated for this task would be 2.

Dry and wet processes are the last stage of production and account for the largest share of value addition of denim garments. These include washing the fabric, and processes that damage the garment so that it looks more fashionable. The processes include stone washing, sand blasting, hand scrapping, permanent wrinkles, whiskers, application of potassium permanganate. Retails tags are attached after the garment goes through all the processes and the garments are shipped. The firm produces around 300 styles of denim garments and has the capacity to perform 200 different denim washes. Finished items include skirts, shorts, jeans, and trousers.

III.C. Descriptive Statistics

Daily data from the firm was collected on the quantity of pieces produced by each worker, quality defects made by each worker, payment received by each worker, age of each worker, tenure of the worker, standard minute value of the task performed by the worker, and gender of the worker. Pay only includes the piece rate portion of earnings and does not include the attendance allowance and the incentive received through the new quality management practice. The number of working hours at the firm are fixed, and a worker only works one shift which consists of 480 minutes. The dataset has not been previously used for research. The structure of the dataset is similar to the one used by Bandiera, Barankay and Rasul (2005). However, they used firm level average quality figures to analyse the quality of production before and after the intervention. Our data set is more detailed as we use quality data of individual workers. Previous studies on the garments sector such as Makino (2012) did not control for the stitching speed of workers while comparing the earnings of males and females, however we control for the kind of task performed by each worker.

The motivation behind introducing the new quality management practice was to incentivize workers to reduce quality defects as well as improve productivity as fewer quality defects mean that workers have to spend less time on re-work so the extra time can be spent on stitching new pieces. The new quality management practice was implemented on 15th September 2014. The new quality management practice was announced the same day it was implemented. The data collection period is from 1st August 2013 to 30th May 2016 and this period was chosen due to practical considerations.

The sample of workers is restricted to 648 workers who were a part of the workforce of the firm throughout our period of interest i.e. from 1st August 2013 to 30th May 2016. However, there were days when some of these workers were absent from the factory and were not observed[5]. The missing day-level observations for such workers were dropped out of the working sample. The working sample consists of 462,362 worker-day level observations, covering 648 workers and 782 days in total. Workers

[5] The factory supervisors reported various causes of absenteeism of workers. Some reasons include illness, caring for a sick child or an elderly member of the family, wedding in the family, and death in the family.

were observed for 316 days before the quality management practice was introduced and 466 days after the quality management practice was implemented. The working sample contains 183,539 worker-day level observations before the quality management practice was in place and 278,823 worker-day level observations after the quality management practice was implemented.

Table 2.1: Descriptive Statistics

	Mean	Minimum	Maximum	Observations
Dependent Variables				
Log Quantity	6.66	0	9.60	462362
Log Pay	5.52	0	7.20	462362
Quantity	780.0	1	14764.0	462362
Pay	250.0	1	1339.0	462362
Quality defects	0.16	0	32.0	462362
Independent Variables				
Tenure	5.11	0.33	21.16	462362
Age	28.11	18.60	55.73	462362
Capacity utilization	89.29	32.67	121.98	462362
Standard Minute Value	26.1	3.18	75.0	462362

Table 2.2: After-Before Differences in the Mean of Dependent Variables

	After	Before	Difference
Log of Quantity	6.74	6.54	0.200***
			(72.38)
Log of Pay	5.60	5.40	0.200***
			(93.06)
Quality Defects			-0.159***
	0.10	0.26	(-41.70)
Observations	278823	183539	462362

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.1 illustrates the descriptive statistics for key variables. The average of log quantity is 6.66 and log pay is 5.52, which corresponds to an average of 780 pieces of garments stitched per day and an average earnings of 29.63 Pak Rupees per day. The minimum tenure of a worker at the factory is 4 months and the maximum is 21.16 years. The average tenure at the firm is 5.11 years. The average capacity utilization of the firm is 89.29 percent. The minimum capacity utilization is 32.7 percent and the maximum is 121.98 percent. The firm reported that there have been instances when daily production was above the designated targets/capacity. A worker at the firm makes an average of 0.16 defects per day which means that on average 0.16 pieces per worker do not meet the quality standards set by the firm and need to be redone. The minimum age of a worker is 18.6 years and the maximum age is 55.73 years, while the average age is 28.11 years. The mean of the standard minute value (the time it takes to complete a task) is 26 seconds; a task at the factory can take a minimum of 3.18 seconds and a maximum of 75 seconds.

Table 2.2 describes the differences in the mean of dependent variables before and after the introduction of the new quality management practice. All differences in the mean of dependent variables have been found to be statistically significant. Before the implementation of the new quality management practice, the mean of log quantity was 6.54, corresponding to an average of 665 pieces stitched per worker each day. After the implementation of the quality management practice, the average pieces stitched rises to 812. This signifies an increase of 22 percent. Workers earned an average of 221 Pak Rupees each day before the new quality management practice was implemented. However, the implementation of the quality management practice makes a significant difference to the average earnings of workers as workers make an average of 270 Pak Rupees per day. There is also a significant difference between the average quality defects made before and after the implementation of the quality management practice. Workers made an average of 0.3 quality defects before the quality management practice was introduced, however, after the introduction of the practice workers make an average of 0.1 defects per day.

Table 2.3: Unconditional Differences in Variables by Gender

	Mean of Females	Mean of Males	Difference
Log of Quantity	6.57	6.75	0.183***
			(67.51)
Log of Pay	5.42	5.61	0.194***
			(92.21)
Defect	0.13	0.19	0.0675***
			(18.02)
Age	26.96	29.12	2.158***
			(125.85)
Tenure	4.41	5.72	1.313***
			(116.39)
N	215171	247191	462362

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 2.3 describes the differences in the mean of key variables by gender using data from the entire data collection period i.e. from 1st August 2013 to 30th May 2016. All differences have found to be statistically significant. The average log quantity for males is 6.75 that corresponds to a production of 854 pieces per day. The average log quantity for females is 6.57 which corresponds to 713 pieces produced per day. The average log pay for males is 5.61 while for females is 5.42. The figures correspond to average earnings of 273.1 Pak Rupees and 225.8 Pak Rupees per day respectively. Females make an average of 0.13 quality defects per day while males make an average of 0.19 quality defects. The average age and tenure of females is 26.96 years and 4.41 years respectively. For males, the average tenure and age is 5.72 years and 29.12 years respectively.

Table 2.4: Mean for Males Before and After

	After Males	Before Males	Difference
Log of Quantity	6.82	6.64	0.181***
			(50.00)
Log of Pay	5.68	5.50	0.181***
			(64.30)
Quality Defects	0.11	0.30	-0.192***
			(-33.04)
Observations	149035	98156	

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.5: Mean for Females Before and After

	After Females	Before Females	Difference
Log of Quantity	6.65	6.43	0.223***
			(52.88)
Log of Pay	5.50	5.28	0.222***
			(68.58)
Quality Defects	0.07	0.20	-0.122***
			(-25.51)
Observations	129788	85383	

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Tables 2.4 and 2.5 present the mean of dependent variables for males and females before and after the introduction of the practice. The mean of dependent variables for males and females are significantly different before and after the implementation of the new quality management practice. Before the introduction of the quality management practice, the mean of log quantity for males is 6.64, while for females is 6.43. These figures correspond to an average of 765 pieces produced by males per day and 620 pieces produced by females per day. After the introduction of the quality management practice, the number of pieces stitched by males increases to 915 per day while for females it rises to 772 per day. This indicates an increase in average daily production of 19.6 percent for males and 35 percent for females.

Males earned average earnings of 244.6 Pak Rupees before the implementation of the management practice, while females earned an average of 196.3 Pak Rupees per day. After the implementation of the practice, males earned an average of 292.9 Pak Rupees per day, while females earned an average of 244.6 Pak Rupees. This shows an increase in average earnings of males by 19.6 percent and of females by 24.6 percent.

Males made an average of 0.3 quality defects per day while females made an average of 0.1 quality defects per day before the quality management practice was introduced. After the introduction of the practice, males and females both make an average of 0.1 quality defects per day. This indicates a decrease of 66.6 percent in the average number of quality defects per day for males, while a decrease of 50 percent in the average number of quality defects made by females.

Worker's pay and quantity produced will be estimated separately because although pay is directly proportional to quantity, it does not necessarily mean that workers who produce more garments will also earn more. The reason is that all workers do not perform the same task. Complicated tasks have a higher piece rate as compared to relatively simple tasks. Hence, workers who perform complicated tasks are paid more as compared to workers who perform simple tasks.

III.D. Distribution of Dependent Variables

Figure 1: Histogram of Log Quantity

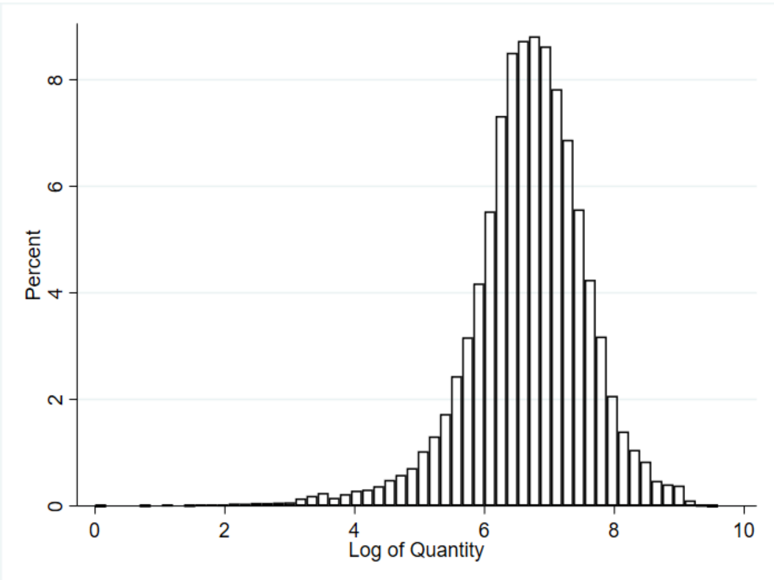
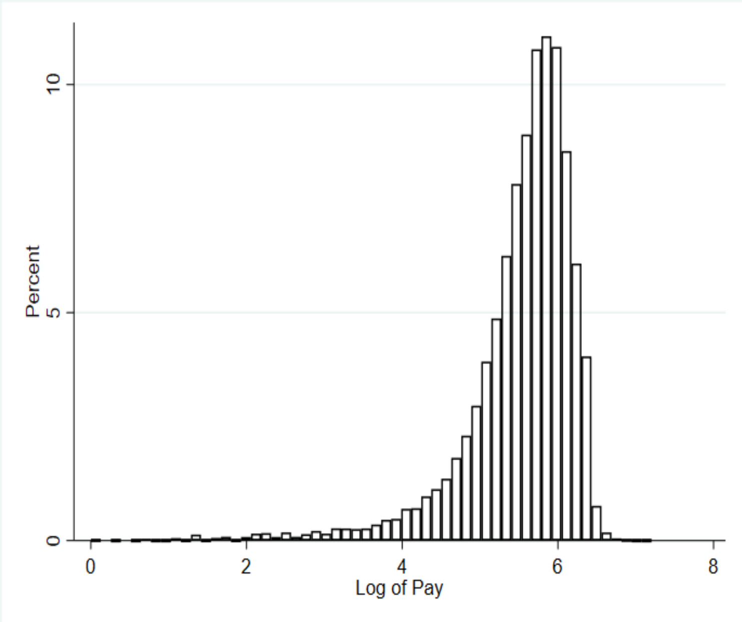


Figure 2: Histogram of Log Pay



The distribution of log quantity and log pay is continuous, which indicates that they can be modelled using continuous regression methods. Fixed effects or random effects can be used to model continuous dependent variables on a set of independent variables.

Assume the following linear model

$Y_{it} = \alpha_i + X_{it}'\beta + \mu_{it}$ (1)

where the independent variable is Y_{it} such as log quantity and X_{it} is a k-dimensional vector of explanatory variables. The intercept term α_i captures the effects of those variables that are peculiar to the i-th individual and are time invariant. μ_{it} is the error term. If we treat α_i as an unobserved random variable that is correlated with the observed regressors X_{it} then the model above can be referred to as a fixed effects model. Fixed effects estimate how changes within an individual across time affect their outcomes and disregard information about differences between individuals.

The within estimator for β can be written as:

$$\hat{\beta}_{FE} = \left[\sum_{i=1}^{N}\sum_{t=1}^{T}(X_{it} - \bar{X}_i)(X_{it} - \bar{X}_i)'\right]^{-1} \sum_{i=1}^{N}\sum_{t=1}^{T}(X_{it} - \bar{X}_i)(Y_{it} - \bar{Y}_i)$$

$Y_{it} = \alpha_o + \alpha_i + X_{it}'\beta + \mu_{it}$ (2)

The random effects model given in equation 2 assumes that the intercept for all individuals are different but are drawn from a distribution with mean μ and variance σ_α^2, hence the individual effects α_i are treated as random. The assumption is that these drawings are independent of the explanatory variables. The error term consists of a time invariant component α_i and a remainder component μ_{it}. α_o is the intercept term and t denotes time.

The between estimator for β is shown below:

$$\hat{\beta}_B = \left[\sum_{i=1}^{N}(\bar{X}_i - \bar{X})(\bar{X}_i - \bar{X})'\right]^{-1}\sum_{i=1}^{N}(\bar{X}_i - \bar{X})(\bar{Y}_i - \bar{Y})$$

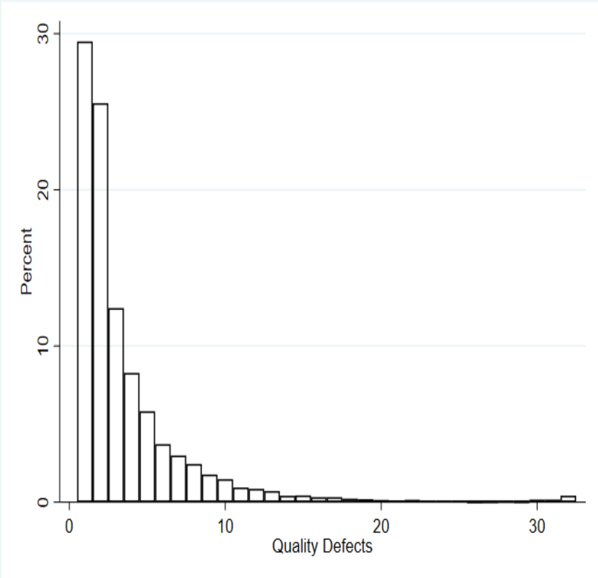
The feasible random effects GLS estimator for β as shown below can be written as the weighted average of the within and between estimator:

$$\hat{\beta}_{GLS} = \left[\sum_{i=1}^{N}\sum_{t=1}^{T}(X_{it} - \bar{X}_i)(X_{it} - \bar{X}_i)' + \psi T\sum_{i=1}^{N}(\bar{X}_i - \bar{X})(\bar{X}_i - \bar{X})'\right]^{-1} \times \left[\sum_{i=1}^{N}\sum_{t=1}^{T}(X_{it} - \bar{X}_i)(Y_{it} - \bar{Y}_i) + \psi T\sum_{i=1}^{N}(\bar{X}_i - \bar{X})(\bar{Y}_i - \bar{Y})\right]$$

Where $\psi = \frac{\sigma_\mu^2}{T\sigma_\alpha^2 + \sigma_\mu^2}$

The advantage with fixed effects is that it can control for time invariant unobserved characteristics like gender or ethnicity. However, fixed effects cannot estimate the effects of time invariant characteristics. Random effects can be used for measuring the impact of time invariant variables, but the method maybe biased as it will not be able to control for time invariant omitted variables. The research question and interest in estimating time invariant characteristics are important factors to choose between fixed or random effects. However, when T is large and ψ approaches zero, both the fixed effects and random effects estimators become equivalent.

Figure 3: Histograms of Quality Defects



The distribution of the quality defects data is discrete. The variable quality defects varies from zero to a maximum of 32 quality defects made by workers per day. The histogram was created for defects greater than zero. However, there are 442,690 observations (95.7 percent of the observations) in the sample where quality defects equal zero. The Poisson regression can be used to model count data. The dependent variable y_i is the number of count of events of interest and X_i is the vector of independent variables that determine y_i.

The basic Poisson regression model specifies that y_i given X_i is Poisson distributed with density

$f(y_i|X_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!}$ where y_i=0,1,2,...

and λ_i *is* the mean parameter

$E[y_i|X_i] = \lambda_i = \exp{(X_i'\beta)}$.

The specification is called the exponential mean function. In the statistics literature, the model is also called a log-linear model, because the logarithm of the conditional mean is linear in the parameters: $\ln E[y_i\,|X_i] = X_i'\beta$. The model assumes that the mean and variance are equal. Data almost always reject the restriction that the variance equals the mean, while maintaining the assumption that the mean is $\exp{(X_i'\beta)}$.

An alternative model to be considered is the negative binomial model, which relaxes the assumption that mean will always equal the variance but maintains the assumption that mean is $\exp(X_i'\beta)$ and the variance is $\omega_i = \lambda_i + \delta\lambda_i^p$. δ is the dispersion parameter. The analysis is restricted to 2 special cases (NB1 and NB2) where p=1 and $p = 2$, in addition to the Poisson case when $\delta = 0$. In both cases the dispersion parameter δ is a parameter to be estimated.

For the panel data specification of the Poisson model, individual specific effects enter multiplicatively rather than additively. The mean for such a model is specified below:

$E[y_{it} \mid X_{it}, \alpha_i] = \alpha_i\lambda_{it}$

$E[y_{it} \mid X_{it}, \alpha_i] = \alpha_i \exp\,(X_{it}'\beta)$

α_i here is defined as the individual specific effect. In the fixed effects Poisson, α_i are correlated with the regressors X_i just like in the linear case given in equation (2). Poisson fixed effects still has the condition that variance should equal mean. For Poisson random effects, α_i are random individual effects. The Poisson random effects has the distribution of negative binomial NB2 where $E[y_{it}] = \lambda_{it}$ and $V[y_{it}] = \lambda_{it} + {\lambda_{it}}^2/\delta$. δ denotes the over dispersion parameter.

In a fixed effects negative binomial case, y_{it} is identically and independently distributed NB1 with parameters $\alpha_i\lambda_{it}$ and ϕ_i. The mean is $\alpha_i\lambda_{it}/\phi_i$ and variance is $\left(\frac{\alpha_i\lambda_{it}}{\phi_i}\right) * \left(1 + \frac{\alpha_i}{\phi_i}\right)$. α_i is the individual specific effect and ϕ_i is the dispersion parameter.

An important restriction of this model is that α_i and ϕ_i can only be identified up to the ratio of α_i/ϕ_i. This model has been criticised for not being a true fixed effects (Allison and Waterman, 2002). If $\frac{\alpha_i}{\phi_i} = \vartheta$ then the conditional mean would be $\vartheta\lambda_{it}$ and ϑ is absorbed in the intercept, hence the coefficients of time invariant variables are identified in the model.

In a random effects negative binomial case, y_{it} is independently and identically distributed NB2 with parameters $\alpha_i\lambda_{it}$ and ϕ_i , where the mean is $\alpha_i\lambda_{it}/\phi_i$ and variance is $\left(\frac{\alpha_i\lambda_{it}}{\phi_i}\right) * \left(1+\frac{\alpha_i}{\phi_i}\right)$. It is assumed that $\left(1+\frac{\alpha_i}{\phi_i}\right)^{-1}$ is a beta distributed random variable with parameters (a,b). The difference between the negative binomial random effects and the Poisson random effects is that the negative binomial allows randomness both across individuals and time. Hence, the negative binomial random effects model allows the variance of the effects to differ in the within and between dimensions which is similar to the specification of the disturbance term in the linear case given in equation (3).

III.E. Empirical Methodology

There is a need to understand the reason why a particular practice may prove to enhance performance among some entities while not among all. Performance is not necessarily output per hour but can also be gauged by the quality of production or service provided (Ichniowski and Shaw, 2009). There have been various empirical studies on the effects of incentives schemes and management practices on performance of employees (Lazear, 2000; Bandiera, Barankay and Rasul, 2005; Hamilton, Nickerson and Owan, 2003; Ichniowski, Shaw and Prennushi, 1997; Knez and Simester, 2001). An equation for earnings was included to see whether productivity changes translate into changes in earnings or not.

The methodology of this research follows a similar approach used by Bandiera, Barankay and Rasul (2005). They observed daily productivity of workers on a fruit farm before and after the implementation of piece rates. The data sample contains 10,215 worker-field-day level observations, covering 142 workers, 22 fields, and 108 days in total. Workers were paid according to relative incentives for the first 54 days and according to piece rates for the remaining 54 days.

The following panel data regression was used to measure the impact of the change in incentives (from relative incentives i.e. pay was dependent upon how the worker has performed as compared to his/her co-workers to piece rates).

$$Y_{ift} = \alpha_i + \lambda_f + \gamma P_t + \delta X_{ift} + \eta Z_{ft} + \kappa t + \mu_{ift} \quad (3)$$

Worker fixed effects α_i capture time invariant determinatants of productivity such as innate ability. Field fixed effects λ_f capture time invariant determinants of field level productivity such as soil quality and plant spacing. P_t represents a dummy variable which equals one when piece rates are in place and zero when relative incentives are in place. X_{ift} represents worker's picking experience, Z_{ft} represents field life cycle (defined below), t represents the farm level trend and μ_{ift} is the disturbance term

Worker picking experience is defined as the number of days the worker has picked fruit on the farm and the field life cycle is defined as the nth day the field is in operation divided by the total number of days the field has operated over the season. The field life cycle is intended to capture the trend in productivity that takes place within each field as the field depletes over time. The productivity of workers was found to be 50% higher under piece rates as compared to under relative incentives.

The data structure used in this research is like the data set used by Bandiera, Barankay and Rasul (2005) as they also used daily data on workers before and after the intervention and used a dummy variable in the regression analysis to analyse the impact of the intervention. However, the type of intervention that Bandiera, Barankay and Rasul studied (2005) is different to what is being studied in this research as Bandiera, Barankay and Rasul (2005) looked at the impact of the introduction of piece rates on worker productivity. However, the workers in our study were paid piece rate throughout the period of study while we are investigating the impact of a new quality management practice on worker productivity, earnings and quality defects.

The following panel data regressions are estimated to investigate the effect of the quality management practice on the output, earnings, and the number of quality defects of workers at the firm.

$LnY_{it} = \gamma_i + \beta_1 P_t + \beta_2 X_{it} + \beta_3 {X_{it}}^2 + \beta_4 C_t + \varepsilon_{1it}$ (4)

(Y_{it} is the number of pieces produced by worker i on day t; P_t is a dummy variable equal to one when the new quality management practice is in place and zero otherwise; X_{it} represents the tenure of the worker; C_t is the capacity utilisation of the firm; γ_i represents the individual effect; ε_{1it} is the error term).

$LnI_{it} = \gamma_i + \phi_1 P_t + \phi_2 X_{it} + \phi_3 {X_{it}}^2 + \varepsilon_{2it}$ (5)

(I_{it} is the payment received by worker i on day t; ε_{2it} is the error term)

$Q_{it} = \exp(\gamma_i + \psi_1 P_t + \psi_2 X_{it} + \psi_3 {X_{it}}^2 + \varepsilon_{3it})$ (6)

(Q_{it} is the expected number of quality defects of each worker; ε_{3it} is the error term)

$LnY_{it} = \gamma_i + \beta_1 P_t + \beta_2 X_{it} + \beta_3 {X_{it}}^2 + \beta_4 C_t + \beta_5 A_{it} + \beta_6 {A_{it}}^2 + \beta_7 G_i + \beta_8 G_i P_t + \beta_9 SMV_i + \beta_{10} t + \varepsilon_{4it}$ (7)

(A_i is the age of each worker; G_i is a dummy variable which equals one if the worker is female and zero when the worker is male; SMV_i is the standard minute value of the operation performed by worker i; t is the firm level linear time trend and ε_{4it} is the error term).

$LnI_{it} = \gamma_i + \phi_1 P_t + \phi_2 X_{it} + \phi_3 {X_{it}}^2 + \phi_4 C_t + \phi_5 A_{it} + \phi_6 {A_{it}}^2 + \phi_7 G_i + \phi_8 G_i P_t + \phi_9 GL_i + \phi_{10} SMV_i + \phi_{11} t + \varepsilon_{5it}$ (8)

(GL_i represents the grade level of the worker ; ε_{5it} is the error term)

$Q_{it} = \exp(\gamma_i + \psi_1 P_t + \psi_2 X_{it} + \psi_3 {X_{it}}^2 + \psi_4 A_{it} + \psi_5 {A_{it}}^2 + \psi_6 G_i + \psi_7 G_i P_t + \psi_8 SMV_i + \psi_9 t + \varepsilon_{6it})$ (9)

(ε_{6it} is the error term)

Equations 4, 5 and 6 provide a basic model of the impact of the new quality management practice which is estimated using fixed effects and random effects. Equations (4) to (6) were estimated after splitting up the data by gender while equations (7) to (9) include a gender dummy. Splitting up the sample by gender provides differential effects on all variables while using the gender dummy is a more restrictive version as it provides a differential effect on only the variable for the new quality management practice. Equations 7, 8 and 9 estimate the impact of the new quality management practice include other variables such as gender, standard minute value, age, grade level of the workers and estimate the equation using random effects.

Tenure of the worker (X_{it}) is defined in terms of years. Productivity of a worker increases as he/she accumulates skills on the job (Becker, 1962). The age (A_i) of each worker is defined in terms of years. A quadratic term for age is added as studies related to piece rate workers show that office workers are productive even at older ages, while the productivity of factory workers fell after the age of 55 (Mark, 1957; Kutscher and Walker, 1960). A quadratic term for tenure was added as Mincer (1974) defined that completion of school education does not correspond to completion of investment in human capital. Earnings increase with age as individuals invest in human capital over time. Investments are concentrated at younger ages but continue to grow at a diminishing rate throughout an individual's life. The growth rate of earnings is a function of the amount invested and of the rate of return. Earnings are dependent upon the investment profile of an individual and the investment profile is a concave function of work experience. The earnings curve represents productivity changes throughout an individual's lifetime; hence, both the tenure-productivity and tenure-wage profile should increase at a diminishing rate.

Capacity utilisation (C_t) refers to the usage of the installed productive capacity of the firm. It is measured as the actual output divided by the maximum output that can be produced by the firm. Capacity utilisation is defined in percentage terms. An increase in capacity utilisation of the factory is expected to have a positive impact on output. An interaction term between gender (G_i) and the quality management practice (P_t) was added which allows the effect of the quality management practice to vary by gender. The standard minute value (SMV_i) is the time it takes to complete a task and is measured in seconds. The standard minute value remains constant over time as the worker performs the same task over the period of observation. The payment (I_{it}) received by worker i on day t is calculated as the product of daily output of the worker and the piece rate set by the firm. Tenure of the worker and capacity utilisation are expected to have a positive relationship with earnings. The grade level (GL_i) of the worker is a dummy variable which equals one when the grade is S4 and zero when the grade is S5. This has only been included in the pay equations and not in the productivity equations as the grade level determines the piece rate of the worker and is not a determinant of productivity.

During factory visits, it has been observed that production supervisors often place more experienced workers with workers who are new to the factory or who are struggling with a process. Also, a common practice is to make a worker observe an experienced worker perform a complex operation until the worker understands how to do the job correctly. It is expected that with more experience, the expected number of quality defects (Q_{it}) will decrease.

IV. Results

Table 2.6: The Effect of the Quality Management Practice on Productivity by Gender
Dependent variable: log of worker's productivity (number of garments produced per day)

	(1) Log of Quantity	(2) Log of Quantity	(3) Log of Quantity	(4) Log of Quantity	(5) Log of Quantity	(6) Log of Quantity	(7) Log of Quantity	(8) Log of Quantity
Quality management practice	0.0574***	0.0976***	0.0274***	0.0715***	0.0615***	0.0906***	0.0303***	0.0675***
	(0.00451)	(0.00447)	(0.00513)	(0.00508)	(0.00435)	(0.00430)	(0.00503)	(0.00497)
Tenure	0.172***	0.0883***	0.219***	0.127***	0.169***	0.0916***	0.217***	0.128***
	(0.00355)	(0.00363)	(0.00405)	(0.00414)	(0.00347)	(0.00354)	(0.00401)	(0.00409)
Tenure-squared	-0.00674***	-0.00651***	-0.00805***	-0.00765***	-0.00671***	-0.00632***	-0.00811***	-0.00750***
	(0.000182)	(0.000180)	(0.000269)	(0.000265)	(0.000180)	(0.000178)	(0.000265)	(0.000261)
Capacity utilization		0.00804***		0.00885***		0.00798***		0.00881***
		(0.0000943)		(0.000107)		(0.0000938)		(0.000106)
Constant	6.073***	5.798***	5.828***	5.407***	6.087***	5.775***	5.829***	5.391***
	(0.0142)	(0.0143)	(0.0119)	(0.0128)	(0.0362)	(0.0364)	(0.0410)	(0.0411)
Model	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Random Effects	Random Effects	Random Effects	Random Effects
Gender	Male	Male	Female	Female	Male	Male	Female	Female
Number of Observations	247191	247191	215171	215171	247191	247191	215171	215171

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

Table 2.6 presents the fixed effects and random effects estimates of the impact of the implementation of the new quality management practice on worker productivity by gender using the specification of equation 4. The advantage of using a fixed effects estimator is that it controls for omitted time-invariant variables. Fixed effects and random effects both show that the impact of the quality management practice is greater for males as compared to females[6]. One point to be noted is that workers were paid piece rates throughout the period of the study. Column (1) shows that the introduction of the new quality management practice increases the productivity of males by 5.7 percent, while column (3) shows that the implementation of the practice increases the productivity of females by 2.7 percent. After including the variable for capacity utilisation, the magnitude of the increase in productivity for males is now 9.8 percentage points and for females is 7.15 percentage points. Column (2) reveals that an additional year of work experience at the firm increases the productivity of males by 8.8 percent but at a diminishing rate of 0.65 percent. Column (4) indicates that an additional year of experience at the firm increases the productivity of females by 12.7 percent but at a diminishing rate of 0.77 percent. Capacity utilisation has a positive impact on worker productivity, a one percent increase in capacity utilisation increases the productivity of males by 0.8 percent and of females by 0.88 percent.

Fixed effects do not allow the inclusion of age, tenure and time trend together as these variables are linearly related. Table 2.7 presents the random effects estimates of the impact of the new quality management practice on worker productivity. The number of time periods in this study is large, hence the random effects estimates are based on the within-person variation. The coefficients estimated by random effects and fixed effects are similar and there is little bias from using random effects[7]. Random effects were preferred since we can include further controls and

[6] The Hausman test prefers fixed effects (see table 1 in appendix A).
[7] The result that fixed effects and random effects estimate similar coefficients for the dummy variable for the quality management practice can be seen in table 3 in appendix A.

in particular consider gender differences in productivity before and after the intervention.

Table 2.7: The Effect of the Quality Management Practice on Productivity
Dependent variable: log of worker's productivity (number of garments produced per day)

	(1) Log of Quantity	(2) Log of Quantity
Quality management practice	0.0372***	0.0787***
	(0.00381)	(0.00377)
Tenure	0.131***	0.126***
	(0.00594)	(0.00591)
Tenure-squared	-0.00587***	-0.00559***
	(0.000188)	(0.000185)
Age	0.0780***	0.0790***
	(0.00823)	(0.00814)
Age-squared	-0.00133***	-0.00134***
	(0.000119)	(0.000118)
Female	-0.124***	-0.125***
	(0.0299)	(0.0299)
Quality Management Practice*Female	0.0136***	0.0148***
	(0.00377)	(0.00371)
Standard Minute Value	-0.0335***	-0.0335***
	(0.000911)	(0.000911)
Time trend	0.0451***	-0.0379***
	(0.00452)	(0.00456)
Capacity utilization		0.00842***
		(0.0000708)
Constant	5.976***	5.313***
	(0.138)	(0.137)
Model	Random Effects	Random Effects
Number of Observations	462362	462362

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

The estimated results of equation 7 are presented in table 2.7. Column (1) reveals that the introduction of the quality management practice increases productivity of male workers by 3.72 percent and the productivity of females by 5.1 percent[8]. Capacity utilisation was added as an explanatory variable in column (2) and the results reveal that the

[8] Column (2) was used to analyse the main results for table 2.7.

introduction of the quality management practice is still positively related to productivity and remains statistically significant at the 1% level. However, the magnitude of the increase in productivity of male workers is now around 7.9 percentage points and of female workers is 9.4 percentage points.

The result that the introduction of the quality management practice is positively related to productivity is in line with the notion that tighter monitoring by the principal will induce workers to improve work effort levels (Alchian and Demsetz, 1972; Prendergast, 1999). The gender differences in the impact of the quality management practice may hint at one of the differences in psychological attributes between men and women. Females are found to be more agreeable than males (Bertrand, 2011; Bouchard and Loehlin, 2001; Mueller and Plug, 2006; Nyhus and Pons, 2012). Agreeableness in this case refers to females being more compliant as compared to males.

The gender dummy in column (2) indicates that females produce 12.5 percent less than males before the quality management practice was implemented. The introduction of the quality management practice has an incremental impact on the productivity of females, and it reduces the gender productivity gap. The introduction of the quality management practice reduces the gender productivity gap by 1.48 percent, but females still produce 11 percent less as compared to males. Females usually put in more time and effort on housework as compared to males, hence this may induce a lower effort into market jobs (Becker, 1985).

An additional year of tenure increases productivity by 12.6 percent but with diminishing returns of 0.6 percent per annum. The return to experience becomes zero at about 11.3 years of tenure[9].

Capacity utilisation has a positive impact on worker productivity, a one percent increase in capacity utilisation increases worker productivity by 0.84 percent. An additional year of age increases productivity by 7.9

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[9] The turning point has been calculated using column (2) of table 2.7. $.LnY_{it} = 0.126T - 0.0059T^2$;$0.126 - 0.01118T = 0; T = 11.3$.

percent but at a diminishing rate of 0.13 percent per year. The turning point for age is 29.4 years, hence after the age of 29.4 years, age has a negative impact on productivity[10].

Worker's perform the same task over the period of observation, however, the coefficient for the standard minute value indicates that a task that takes an additional second is likely to reduce the output of workers by 3.3 percent.

Table 2.8: The Effect of the Quality Management Practice on Worker's Pay
Dependent variable: log of worker's pay

	(1) Log of Pay	(2) Log of Pay	(3) Log of Pay	(4) Log of Pay
Quality management practice	0.0573***	0.0273***	0.0731***	0.0417***
	(0.00449)	(0.00511)	(0.00398)	(0.00473)
Tenure	0.171***	0.218***	0.161***	0.209***
	(0.00353)	(0.00403)	(0.00329)	(0.00388)
Tenure-squared	-0.00672***	-0.00801***	-0.00680***	-0.00819***
	(0.000182)	(0.000268)	(0.000173)	(0.000252)
Constant	4.939***	4.684***	4.992***	4.716***
	(0.0141)	(0.0119)	(0.0204)	(0.0212)
Model	Fixed Effects	Fixed Effects	Random Effects	Random Effects
Gender	Male	Female	Male	Female
Number of Observations	247191	215171	247191	215171

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

The estimated results of equation 5 are presented in table 2.8. Fixed effects and random effects were used to estimate the impact of the implementation of the new quality management practice on worker's pay by gender[11]. Column (1) indicates that the implementation of the quality management practice increases the earnings of males by 5.7 percent. An additional year of tenure increases the earnings of male workers by 17.1 percent but at a diminishing rate of 0.67 percent. Column (2) reveals that the implementation of the quality management practice increases the earnings of females by 2.73 percent. An additional year of tenure increases the earnings of females by 21.8 percent but at a diminishing rate of 0.8 percent. Fixed effects do not allow the inclusion of age, tenure

[10] $LnY_{it} = 0.079A - 0.00134A^2; 0.079 - 0.00268A = 0; A = 29.4.$

[11] The Hausman test shows that fixed effects are preferred in this case (See table 1 in appendix A).

and time trend together as these variables are linearly related. Table 2.9 presents the random effects estimates of the effect of the implementation of the new quality management practice on worker's pay. These results are preferred since we can include other variables and consider gender differences in worker's pay before and after the intervention.

Table 2.9: The Effect of the Quality Management Practice on Worker's Pay
Dependent variable: log of worker's pay per day

	(1) Log of Pay
Quality management practice	0.0372***
	(0.00379)
Tenure	0.133***
	(0.00511)
Tenure-squared	-0.00579***
	(0.000183)
Age	0.0743***
	(0.00774)
Age-squared	-0.00132***
	(0.000115)
Female	-0.160***
	(0.0241)
Quality Management Practice*Female	0.0136***
	(0.00375)
Standard Minute Value	0.00383***
	(0.000730)
Time trend	0.0448***
	(0.00390)
Grade S4	-0.0411
	(0.0415)
Constant	3.964***
	(0.125)
Model	Random Effects
Observations	462362

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.9 illustrates the estimated results of equation 8. The earnings of male workers increase by 3.7 percent after the new quality management was implemented while the earnings of female workers are expected to increase by 5.1 percent. A point to be noted is that the introduction of the quality management practice is positively related to both productivity as shown in table 2.7, see column (2) and worker's pay. Our estimates indicate that workers earn more by improving effort levels.

The gender variable in column (2) of table 2.7 indicates that females are 12.5 percent less productive than males before the new practice was implemented; however, the male-female earnings gap is around 16 percent before the introduction of the quality management practice. However, after the introduction of the practice, females are 11 percent less productive as compared to males and earn 14.6 percent less than males.

The result that females earn less than males is in line with Makino (2012) who revealed that female stitching operators in Pakistan earn 18.2 percent less than males after controlling for factors like education, experience, marital status, type of firm, city, and work hours. However, the estimates do not consider the stitching speed of workers.

We have included a variable for SMV which controls for the task performed by workers. There are 230 different tasks performed by workers in our sample.[12]. As shown in table 2.7, a task that tasks an additional second decreases the output of workers by 3.3 percent, however, table 2.9 shows that a task that takes an additional second increases worker's pay by 0.38 percent.

An additional year of tenure increases earnings by 13.3 percent but with diminishing returns of 0.6 percent per annum. The return to tenure becomes zero at 11.5 years[13]. An additional year of age increases earnings by 7.4 percent but with a diminishing rate of 0.13 percent per year. The turning point for age is approximately at 28.1 years[14], after which age has a negative impact on worker's pay.

[12] These 230 tasks were divided into 45 groups according to the standard minute value such that if two tasks have the same standard minute value then the piece rate is the same. Although most of the tasks are performed both by males and females but task group 1,5 and 14 are performed only by females and task group 7,11,12,18 and 25 are performed only by males (see table 2 in appendix A).

[13] $LnI_{it} = 0.133T - 0.00597T^2; 0.133 - 0.01158T = 0; T = 11.5.$

[14] $LnI_{it} = 0.0743\text{A} - 0.00132A^2; 0.0743 - 0.00132\text{A} = 0; \text{A} = 28.1.$

Table 2.10: The Effect of the Quality Management Practice on Quality Defects (Poisson)
Dependent Variable: quality defects

	(1) Quality Defects	(2) Quality Defects	(3) Quality Defects	(4) Quality Defects
Quality management practice	-0.578***	-0.488***	-0.673***	-0.563***
	(0.0182)	(0.0240)	(0.0170)	(0.0228)
Tenure	-0.274***	-0.375***	-0.230***	-0.331***
	(0.0147)	(0.0204)	(0.0144)	(0.0201)
Tenure-squared	-0.00195**	0.00431***	0.000495	0.00569***
	(0.000774)	(0.00132)	(0.000706)	(0.00120)
Constant			0.494***	-0.0505
			(0.153)	(0.158)
/ lnalpha			1.351***	1.487***
			(0.0675)	(0.0743)
Model	Fixed Effects	Fixed Effects	Random Effects	Random Effects
Gender	Male	Female	Male	Female
Number of Observations	224553	176583	247191	215171

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Ln alpha refers to the log transformed dispersion parameter mentioned for the Poisson random effects model in section III.C. ln_r and ln_s refer to ln(r) and ln(s), where the inverse of one plus the dispersion is assumed to follow a Beta (r, s) distribution.

The estimated results of equation 6 have been reported in tables 2.10 and 2.11. Table 2.10 illustrates the impact of the new quality management practice on the expected number of quality defects made by workers using a Poisson random and fixed effects model[15]. Columns (1) and (2) indicate that the implementation of the quality management practice decreases the expected number of quality defects of males by 44 percent[16] and the expected number of quality defects of females by 38.7 percent respectively. An additional year of tenure decreases the expected number of quality defects of males by 24[17] percent at a diminishing rate of 0.2 percent. An additional year of tenure decreases the expected number of quality defects of females by 31.3 percent but an increasing rate of 0.43 percent.

[15] Hausman test illustrates that fixed effects are preferred (see appendix A).
[16] The coefficient has been interpreted as when the dummy variable for the new quality management practice equals one, it brings about a $(e^{-0.578} - 1 = -0.44) \times 100\%$ change in the average number of quality defects.

Table 2.11: The Effect of the Quality Management Practice on Quality Defects (Negative Binomial)
Dependent variable: quality defects

	(1) Quality Defects	(2) Quality Defects	(3) Quality Defects	(4) Quality Defects
Quality management practice	-0.301***	-0.321***	-0.302***	-0.321***
	(0.0196)	(0.0247)	(0.0196)	(0.0247)
Tenure	0.0467***	0.179***	0.0466***	0.180***
	(0.0108)	(0.0148)	(0.0107)	(0.0147)
Tenure-squared	-0.00445***	-0.00902***	-0.00438***	-0.00908***
	(0.000613)	(0.001000)	(0.000607)	(0.000989)
Constant	-2.412***	-3.120***	-2.414***	-3.121***
	(0.0355)	(0.0439)	(0.0353)	(0.0437)
/				
ln_r			0.0640	-0.0574
			(0.0783)	(0.0887)
ln_s			-0.478***	-0.771***
			(0.0745)	(0.0842)
Model	Fixed Effects	Fixed Effects	Random Effects	Random Effects
Gender	Male	Female	Male	Female
Number of Observations	224553	176583	247191	215171

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Ln alpha refers to the log transformed dispersion parameter mentioned for the Poisson random effects model in section III.C. ln_r and ln_s refer to ln(r) and ln(s), where the inverse of one plus the dispersion is assumed to follow a Beta (r, s) distribution.

Table 2.11 uses a similar functional form as table 2.10 and estimates the impact of the quality management practice on the expected number of quality defects using a negative binomial fixed effects and random effects model[18]. Columns (3) and (4) indicate that the implementation of the quality management practice decreases the expected number of quality defects of males by 26.1 percent and of females by 27.5 percent. An additional year of tenure increases the expected number of quality defects of males by 4.7 percent at a diminishing rate of 0.5 percent. However, for females an additional year of tenure increases the expected number of quality defects by 18 percent but at a diminishing rate of 0.9 percent.

There are other covariates that were included to estimate the quality defects equation in table 2.12. These estimates are preferred since they allow us to include other controls and analyze gender differences before

[18] Random effects were preferred by the Hausman test.

and after the introduction of the new quality management practice.

Table 2.12: The Effect of the Quality Management Practice on Quality Defects
Dependent variable: quality defects

	(1) Quality Defects	(2) Quality Defects
Quality management practice	-0.559***	-0.158***
	(0.0156)	(0.0295)
Tenure	0.0188	0.0459***
	(0.0273)	(0.0102)
Tenure-squared	0.00106	-0.00222***
	(0.000873)	(0.000584)
Age	0.0600	0.0796***
	(0.0386)	(0.0194)
Age-squared	-0.00125**	-0.00124***
	(0.000565)	(0.000312)
Female	-0.131	-0.0726**
	(0.145)	(0.0290)
Quality Management Practice*Female	0.0378**	0.0993***
	(0.0158)	(0.0293)
Standard Minute Value	0.0420***	0.0454***
	(0.00500)	(0.000793)
Time trend	-0.329***	-0.148***
	(0.0206)	(0.0174)
Constant	-3.177***	-5.147***
	(0.647)	(0.284)
Ln alpha	1.103***	
	(0.0495)	
ln_r		-0.0891
		(0.0578)
ln_s		-0.568***
		(0.0568)
Log Likelihood	-179697.95	-105408.64
Model	Poisson Random	Negative Binomial Random
Number of Observations	462362	462362

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01
Ln alpha refers to the log transformed dispersion parameter mentioned for the Poisson random effects model in section III.C. ln_r and ln_s refer to ln(r) and ln(s), where the inverse of one plus the dispersion is assumed to follow a Beta(r, s) distribution.

The estimated results of equation 9[19] are illustrated in table 2.12. The Poisson random effects and negative binomial random effects models both were run for the model specified in equation 9. A large increase in the log likelihood was observed when the negative binomial random effects were estimated. The Poisson regression model shows that ln alpha is significant, indicating that over dispersion exists and Poisson was not the correct specification for the model. The negative binomial random effects model has an advantage over the Poisson random effects model as it allows the variance of the effects to differ in the within and between dimensions. Hence, the negative binomial random effects specification, see column (2) was chosen to interpret the results.

The estimates for quality defects paint a slightly different picture as compared to the estimates for productivity and earnings. After the implementation of the new quality management practice, the expected number of quality defects made by males decrease by 14.7 percent[20]. The magnitude of the impact of the quality management practice for females is less than that of males, as the expected number of quality defects made by females decrease by only 4.27 percent.

The average number of quality defects made by females were 7.1 percent lower than the average number of quality defects made by males before the quality management practice. This finding can be linked to one of the differences in personality traits of males and females; females are found to be more conscientious than males (Mueller and Plug, 2006; Goldin, Katz and Kuziemko, 2006)[21].Positive correlation between conscientiousness and job performance has been reported (Barrick and Mount, 1991). Conscientiousness refers to being more organized, dutiful, disciplined, and deliberate. The result is also in line with the findings of

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[19] Equation 9 was also estimated using random effects where the dependent variable is not the number of quality defects made but defects is a proportion of output produced(defect/quantity) for each worker. The results do not change much as the signs for the coefficients for the quality management practice, female, interaction term between the quality management practice and female, standard minute value and time trend remain the same and are significant. However, tenure, tenure-squared, age and age-squared are not significant in this case. The results are available in table 2.12A in appendix A.

[20] The coefficient has been interpreted as when the dummy variable for the new quality management practice equals one, it brings about a $(e^{-0.158} - 1 = -0.147) \times 100\%$ change in the average number of quality defects.

[21] Factory supervisors of the firm also confirm that females generally make fewer quality defects as they pay more attention to detail and precision and this differentiation maybe attributed to the differences in innate abilities and personality traits of men and women.

Heywood, Siebert and Wei (2013) such that males have a higher error rate than females.

Female participation in the garments industry of Pakistan is lower in Pakistan when compared to other garment manufacturing economies. Hiring female operators on a fixed wage is common in China and Bangladesh while hiring male workers on piece rates is common in Pakistan (Makino, 2012). The justification for hiring female workers is also derived from the 'nimble fingers' hypothesis, where the orientation of women towards precise tasks emerges from their traditional designation at home and performing tasks like sewing (Elson and Pearson, 1981; Fuentes and Ehrenreich, 1983; Joekes, 1987).

The results are also in line with the findings of Haque (2009) who revealed that managers of garment firms think that females produce better quality work, waste less time and are more loyal, honest, and punctual than their male colleagues. However, the efficiency rate which is based on stitching speed is lower for females than males. Managers prefer female stitching operators if firms can fetch orders for medium to high quality garments because the quality of work provided by females compensates for their low stitching speed.

The quality management practice has a dampening effect on the performance of females as compared to males in terms of quality defects. After the introduction of the practice, the average number of quality defects made by females were 3.3 percent higher than the average number of quality defects made by males. Two alternating theories seem to be at work here. An external intervention is expected to improve effort levels of a self-interested agent, as he/she would minimise the possibility of a sanction if caught shirking (Alchian and Demsetz, 1972; Prendergast, 1999; Fama and Jensen, 1983). However, the crowding out hypothesis derived from social psychology (Frey, 1993) illustrates an alternative view; an external intervention may reduce an agent's self-esteem as the worker may feel that his/her intrinsic motivation is not being appreciated hence would reduce effort. Agents who have high intrinsic motivation may also see external interventions as a sign of distrust.

The quality management practice seems to target the shirking behaviour of males as it has a greater impact on reducing the quality defects made by males but has a lower impact on females who were making relatively fewer quality defects before the implementation of the practice.

Generally, both the disciplining and crowding effect are active; external intervention may have two opposing effects on the performance of workers. The benefit of the intervention to the principal depends upon the relative magnitudes of both the effects (Frey and Jegen, 2001). The worsening of the relative performance of females after the implementation of the practice supports the crowding out theory. The crowding out effect seems to be stronger for females as compared to males. However, the disciplining effect of the new management practice seems to be dominant as the implementation of the new quality management practice decreases the expected number of quality defects made by females and males.

It was expected that workers with more experience would produce fewer quality defects, however the results indicate that an additional year of tenure increases the expected number of quality defects by 4.6 percent but with a diminishing rate of 0.23 percent per annum. The return to tenure becomes zero after accumulating 10.2 years of experience at the firm[22]. An additional year of age increases the expected number of quality defects by 8.28 percent but at a diminishing rate of 0.13 percent. The defects equation shows that the turning point for age is 31.8 years[23].

The coefficient of the standard minute value variable shows that a task that takes an additional second is likely to increase the expected number of quality defects by 4.6 percent, indicating that the longer a task takes, the higher the likelihood of a quality defect.

[22] $Q_{it} = \exp(0.0459T - 0.00222T^2); 0.0469 - 0.0046T = 0; T = 10.2.$

[23] $Q_{it} = \exp(0.0796A - 0.00124A^2); 0.0828 - 0.0026A = 0; A = 31.8.$

V. Conclusion

This research provides evidence of the impact of an innovative quality management practice by comparing worker's performance in terms of productivity and quality defects before and after the implementation of the practice. The estimated results complement the principal-agent theory.

The research follows a similar methodology to that used by Bandiera, Barankay and Rasul (2005). They used firm level average quality figures to show that the quality of production did not change significantly after the intervention; however, this does not clarify how the quality of production at the worker level changed. Our research analyses data on the quality defects of individual workers at a garments factory to show that the quality defects made by all workers were significantly reduced after the implementation of the new quality management practice. Although the magnitude of the impact varies between men and women. The detailed data set analysed in this study is unique as it has never been used for empirical work before and allows us to analyse gender differences in productivity and quality defects.

The estimates reveal that the productivity of female workers increases by 9.4 percent, while the productivity of male workers significantly increases by 7.9 percent after the quality management practice was introduced. This increase in productivity also translates into higher earnings for both males and females. The earnings of females increase by 5.1 percent after the implementation of the practice while the earnings of males increase by 3.7 percent. Females earned 16 percent less than males before the quality management practice was implemented. The introduction of the quality management practice also reduces the gender earnings gap.

Female workers made significantly lower quality defects than male workers before the quality management practice was introduced. However, the introduction of the management practice has an adverse impact on the performance of females with regards to the number of quality defects as females make 3.3 percent more quality defects than males. The adverse effect on the performance of females can be linked to the crowding out hypothesis (Frey, 1993), as external interventions maybe seen as signals of distrust and hence induce agents to reduce effort levels. The crowding out effect is stronger for females than for males. However, the overall impact of the practice on quality defects cannot be ignored as the average number of quality defects made by male workers are expected to decrease by 14.7 percent while the expected number of defects of females are expected to decrease by 4.27 percent.

The quality management practice seems to target and minimise the shirking behaviour of workers as it has a greater impact on reducing the quality defects made by males who were making more quality defects before the intervention as compared to females, while the impact of the practice is of a smaller magnitude for females.

It has often been mentioned that piece rates lead to a misallocation of tasks as workers concentrate on quantity rather than quality. However, this study confirms that the payment mechanism does not have to change to motivate workers to perform better and incentives attached with piece rates can improve quality and quantity simultaneously. Availability of information on how changes in productivity or quality defects after the implementation of the new practice translate into the profit of this firm would be an advantage to motivate other firms to introduce motivational practices on the assembly line.

One of the limitations of the study is that there is no control group. However, throughout the period of observation, the technology used by the operators, other management practices at the firm, number of hours worked, compensation mechanisms remained the same, hence our estimates are reliable. Currently there is a wide gap between academia and the industry in Pakistan. Government policies to disseminate academic research on management practice would be helpful in bridging the gap between academia and industry. Information on the success of management practices may incentivise other firms to come up with firm specific management practices and help the garments industry improve worker productivity at a larger scale.

Appendix A

Table 1: Hausman Test

	Quantity Equations			
	Male No Capacity	Male capacity	Female No Capacity	Female capacity
Chi-squared	34.61	55.9	13.51	17.90
	Quality Equations			
	Poisson (Random vs Fixed)-		Negative Binomial Fixed vs Random	
	Male	Female	Male	Female
Chi-squared	130	98.9	3.42	6.58
	Pay equations			
	Male	Female		
Chi-squared	70.95	68.08		

Table 2: Piece Rate by Tasks

ID	Operation	Task Group	SMV	Piece Rate	Gender
82389	Gap Zipper	1	0.053	0.05	Female
13608	Att. Rt. Fly to zip	2	0.068	0.06	Male
102130	Att. Rt. Fly to zip	2	0.068	0.06	Female
102269	Att. Rt. Fly to zip	2	0.068	0.06	Female
4421	Att. Zip to left fly	2	0.068	0.06	Male
7391	Att. Zip To Left Fly	2	0.068	0.06	Male
12125	Att. Zip to left fly	2	0.068	0.06	Female
111427	Att. Zip to left fly	2	0.068	0.06	Female
7498	Fold & serge left fly	3	0.074	0.07	Male
70625	Fold & serge left fly	3	0.074	0.07	Female
120744	Fold & serge left fly	3	0.074	0.07	Male
123060	Serge Flap	3	0.074	0.07	Male
61118	Serge Round Left & Right Flies & bottom	3	0.074	0.07	Male
123539	Button Hole	4	0.075	0.07	Male
131417	Button Hole	4	0.075	0.07	Female
12727	Button Hole & Stud	4	0.075	0.07	Male
61102	Button Hole & Stud	4	0.075	0.07	Female
102296	Button hole & Stud	4	0.075	0.07	Male
110143	Button Hole /stud	4	0.075	0.07	Male
61588	Button Hole and Stud	4	0.075	0.07	Female

123643	Button Hole Flap	4	0.075	0.07	Male
130060	LoopTacking	4	0.075	0.07	Male
70457	Mark Emb	4	0.075	0.05	Female
60758	Serge round Lft Fly	4	0.075	0.07	Female
111201	Serge watch Pkt Mouth	4	0.075	0.07	Female
62068	Tack Loop With Shell	4	0.075	0.07	Female
131394	Tack Loop With Shell	4	0.075	0.07	Female
11638	Att. Slider & stopper	5	0.115	0.10	Female
120382	Att. Slider & stopper	5	0.115	0.10	Female
123072	Align fusing waist band	6	0.12	0.11	Male
121697	Cut band corners	6	0.12	0.11	Female
130081	Cut band corners	6	0.12	0.11	Male
120290	Mrk Btn Hole	6	0.12	0.11	Female
131484	Make & Fuse Loop-5 /Cut Loop	7	0.125	0.11	Male
62225	Make & fuse loops	7	0.125	0.11	Male
110283	Make & fuse loops	7	0.125	0.11	Male
80146	Make & Fuse Loops-6 & Cut	7	0.125	0.11	Male
120318	Make & Fuse Loops-6 & Cut	7	0.125	0.11	Male
81953	Att Stud	8	0.13	0.12	Male
120967	Att. Stud	8	0.13	0.12	Male
130055	Att. Stud	8	0.13	0.12	Female
131337	Top Stich Wb Bottomside	8	0.13	0.12	Female
81027	Bartack at inseam Crotch	9	0.14	0.13	Male

100821	Bartack at inseam Crotch	9	0.14	0.13	Female
122941	Bartack at inseam Crotch	9	0.14	0.13	Male
122669	Bartack Fly	9	0.14	0.13	Male
9706	Bartack Fly-2	9	0.14	0.13	Female
92249	Bartack fly-2	9	0.14	0.13	Male
110107	Bartack Fly-2	9	0.14	0.13	Female
131354	Bartack inner sides	9	0.14	0.13	Female
111571	Bartack Label	9	0.14	0.13	Female
110801	Bartack Label-1	9	0.14	0.13	Male
63621	Bartack lable	9	0.14	0.13	Male
111204	Bartack lable	9	0.14	0.13	Female
130730	Bartack lable	9	0.14	0.13	Female
60137	Bartack Pkt Bag	9	0.14	0.13	Male
130065	Bartack Pkt Bag	9	0.14	0.13	Female
11178	Bartack sides	9	0.14	0.13	Male
61949	Bartack Sides	9	0.14	0.13	Female
3554	Att Waist Label	10	0.15	0.14	Male
3945	Button Hole-2	10	0.15	0.14	Male
12931	CBE	10	0.15	0.14	Female
101400	CBE	10	0.15	0.14	Male
9838	Close Band End	10	0.15	0.14	Male
123014	Close Band End	10	0.15	0.14	Male
100387	Close band end &cuff end	10	0.15	0.14	Female

6748	Close Band Ends	10	0.15	0.14	Male
71148	Close band ends	10	0.15	0.14	Male
110613	Close band ends	10	0.15	0.14	Female
120458	Hem Watch Pkt	10	0.15	0.14	Female
70948	Hem watch pkt (Chain)	10	0.15	0.14	Female
120555	Hem watch pkt (Chain)	10	0.15	0.14	Male
131288	Hem Watch Pkt (DNLS)	10	0.15	0.14	Female
7791	Hem watch pkt (Mnl SNCS)	10	0.15	0.14	Female
110983	Hem watch pkt (Mnl SNCS)	10	0.15	0.14	Male
130097	Label Packing	10	0.15	0.11	Female
130759	Label Packing	10	0.15	0.11	Female
131329	Label Packing	10	0.15	0.11	Female
102397	Label Tacking	10	0.15	0.14	Male
130054	Label Tacking	10	0.15	0.14	Female
123544	Marking Bottom	10	0.15	0.11	Male
110111	Press watch pkt	10	0.15	0.14	Female
81904	Press watch Pkts (Left Top side)	10	0.15	0.14	Female
10207	Serge Right Pnl Till Crotch	10	0.15	0.14	Male
110046	Serge Right Pnl upto crotch	10	0.15	0.14	Male
101901	Serge Right Pnl with Fly	10	0.15	0.14	Female
120490	Serge Right Pnl With Fly	10	0.15	0.14	Male
130101	Serge Right Pnl With Fly	10	0.15	0.14	Male
130792	Tack Slit	10	0.15	0.14	Male

81819	Turn Garment	11	0.161	0.11	Male
101919	Turn Garment	11	0.161	0.11	Male
130082	Bartack Inner Side-2	12	0.175	0.16	Male
92105	2nd seam J	13	0.2	0.18	Female
102498	2nd seam J	13	0.2	0.18	Female
8801	Att. Leather Patch	13	0.2	0.18	Male
9627	Att. Leather Patch	13	0.2	0.18	Male
80639	Att. Leather Patch	13	0.2	0.18	Male
100035	Att. Leather Patch	13	0.2	0.18	Male
120286	Att. Leather Patch	13	0.2	0.18	Female
11560	Bartack Fly (Outer)	13	0.2	0.18	Male
120973	Bartack Fly-2 (inner+outer)	13	0.2	0.18	Male
111746	Bartack Hip stitch	13	0.2	0.18	Male
131313	Bartack Hip Stitch	13	0.2	0.18	Female
130028	Bartack secure chain	13	0.2	0.18	Male
130032	Bartack secure chain	13	0.2	0.18	Male
130039	Bartack secure chain	13	0.2	0.18	Female
130740	Bartack secure chain	13	0.2	0.18	Male
120452	Bartack Wt Pkt-2	13	0.2	0.18	Female
120719	Bartack Wt Pkt-2	13	0.2	0.18	Female
130768	Diagonal Cut	13	0.2	0.18	Female
7383	J Stich	13	0.2	0.18	Male
12930	J Stich	13	0.2	0.18	Female

131316	J Stich	13	0.2	0.18	Male
120082	J stitch	13	0.2	0.18	Male
131355	J stitch	13	0.2	0.18	Female
122906	Join Crotch 2nd Seam	13	0.2	0.18	Male
110196	Leather Patch	13	0.2	0.18	Male
123538	Marking Bottom Slit	13	0.2	0.18	Male
111955	Mock stitch bk pkt	13	0.2	0.18	Female
101180	Press Placket	13	0.2	0.18	Female
123403	Serge Bone BK.PKT Strips	13	0.2	0.18	Male
131338	Serge Bone BK.PKT Strips	13	0.2	0.18	Female
120498	Stay Frnt pkt	13	0.2	0.18	Male
12261	Stay Front Pkt	13	0.2	0.18	Male
13724	Stay Front Pkt	13	0.2	0.18	Female
90451	Stay Front Pkt	13	0.2	0.18	Male
123073	Stay Front Pkt	13	0.2	0.18	Male
120262	Stay front pkt (Top only)	13	0.2	0.18	Female
131443	Stay front pkt (Top only)	13	0.2	0.18	Male
131387	Tack Bottom	13	0.2	0.18	Female
130721	2nd seam croch	13	0.2	0.18	Male
130755	Att. Binding to Lft& Right Fly-1	14	0.225	0.20	Female
71567	Paste fusing to out band	15	0.23	0.21	Male
101208	Paste fusing waist band	15	0.23	0.21	Male
102509	Paste fusing waist band	15	0.23	0.21	Female

120542	Paste fusing waist band	15	0.23	0.21	Female
130040	Paste fusing waist band	15	0.23	0.21	Female
130042	5 point Band Marking	16	0.24	0.17	Female
100382	Mark Hi Low & Fell Shoulder	16	0.24	0.17	Female
131414	Marking collar and band	16	0.24	0.17	Male
130084	Marking for Finished loops	16	0.24	0.17	Male
131284	Marking for Finished loops	16	0.24	0.17	Female
130108	Marking for Finished Loops-5	16	0.24	0.17	Male
122323	Slit Cut and unpick thread	16	0.24	0.22	Female
100980	Tack Band Ends	16	0.24	0.22	Male
120521	Tack Band Ends	16	0.24	0.22	Male
111166	Unpick chain sleeve	16	0.24	0.22	Female
123076	2nd seam watch Pkt (Mtrd)	17	0.25	0.23	Male
101187	2nd Seam Back Pkt	17	0.25	0.23	Female
12770	2nd Seam Back Pkt	17	0.25	0.23	Male
70966	2nd Seam Back Pkt	17	0.25	0.23	Male
102088	2nd Seam Back Pkt	17	0.25	0.23	Male
102264	2nd Seam Back Pkt	17	0.25	0.23	Female
102274	2nd Seam Back Pkt	17	0.25	0.23	Female
102557	2nd Seam Back Pkt	17	0.25	0.23	Male
110010	2nd Seam Back Pkt	17	0.25	0.23	Female
110011	2nd Seam Back Pkt	17	0.25	0.23	Female
120977	2nd Seam Back Pkt	17	0.25	0.23	Male

122931	2nd Seam Back Pkt	17	0.25	0.23	Male
123018	2nd Seam Flap	17	0.25	0.23	Female
122493	2nd seam top flap	17	0.25	0.23	Male
13606	2nd Sean Watch Pkt	17	0.25	0.23	Male
122688	Att strips(2) to bk pkt bag	17	0.25	0.23	Male
123525	Att strips(2) to bk pkt bag	17	0.25	0.23	Male
110114	Att watch Pkt (Mtrd) 1st seam	17	0.25	0.23	Female
111165	Att watch Pkt (Mtrd) 1st seam	17	0.25	0.23	Female
122523	Att watch Pkt (Mtrd) 1st seam	17	0.25	0.23	Female
110101	Att Wt Pkt-Mittered-Left-2	17	0.25	0.23	Female
111941	Att Wt Pkt-Mittered-Rt-1	17	0.25	0.23	Female
122670	Att Wt Pkt-Mittered-Rt-1	17	0.25	0.23	Male
60905	Att. Rt. Fly to zip/ Fly hole	17	0.25	0.23	Male
120284	Att. Rt. Fly to zip/ Fly hole	17	0.25	0.23	Female
131318	Att. Rt. Fly to zip/ Fly hole	17	0.25	0.23	Female
4721	Att. Stud- Mnl	17	0.25	0.23	Male
131302	Bartack @ Slit	17	0.25	0.23	Female
71451	Fold & Att Zip To Right Fly	17	0.25	0.23	Female
122963	Fold & Att Zip To Right Fly	17	0.25	0.23	Male
7461	Fold & Attach Zip to RT Fly	17	0.25	0.23	Female
101033	Join Crotch 1st seam	17	0.25	0.23	Male
92462	Join Crotch Ist Seam	17	0.25	0.23	Female
100704	Keep label in poly bag and tcking	17	0.25	0.23	Female

120413	Ovr lock Arm Hole	17	0.25	0.23	Female
112010	Sew Collar and Turn	17	0.25	0.23	Male
120195	Sew Collar and Turn	17	0.25	0.23	Female
120543	Show Stitch @ Wt Pkt	17	0.25	0.23	Female
123555	Sleeve close and side	17	0.25	0.23	Female
130812	Sleeve close and side	17	0.25	0.23	Male
110110	Straigt Cut	17	0.25	0.23	Female
123007	Top Collar	17	0.25	0.23	Female
81760	Top Stitch Bone Pkt and Set Strip	17	0.25	0.23	Male
111425	Top Stitch Bone Pkt and Set Strip	17	0.25	0.23	Female
101159	Top Stitch Yoke	17	0.25	0.23	Female
120956	Top Stitch Yoke	17	0.25	0.23	Male
121373	Tuck plaket from Neck and turn	17	0.25	0.23	Female
71508	Tucking and Att. Rt. Fly to zip	17	0.25	0.23	Male
81710	Turn Bone	17	0.25	0.23	Male
130131	Turn Bone	17	0.25	0.23	Female
10588	Att.Woven Label	18	0.26	0.23	Male
12933	Edge stitch	19	0.27	0.24	Female
81319	Edge stitch	19	0.27	0.24	Female
102697	Edge stitch	19	0.27	0.24	Male
110068	Edge stitch	19	0.27	0.24	Male
131468	Edge stitch	19	0.27	0.24	Male

1260	Edge Stitch Left Fly	19	0.27	0.24	Female
111575	Edge Stitch Left Fly	19	0.27	0.24	Female
90144	Set & Top Stitch Left Fly	19	0.27	0.24	Male
3546	Top Stitch Right Fly	20	0.275	0.25	Female
70299	Top Stitch Right Fly	20	0.275	0.25	Male
120207	J/Stitch	21	0.28	0.25	Male
1665	Join Crotch	21	0.28	0.25	Male
2131	Join Crotch	21	0.28	0.25	Male
7390	Join crotch	21	0.28	0.25	Male
11175	Join crotch	21	0.28	0.25	Male
11600	Join crotch	21	0.28	0.25	Female
71420	Join Crotch	21	0.28	0.25	Female
130696	Join crotch	21	0.28	0.25	Female
71424	J-Stitch	21	0.28	0.25	Female
82188	J-Stitch	21	0.28	0.25	Male
111200	J-Stitch	21	0.28	0.25	Female
131332	J-Stitch	21	0.28	0.25	Female
101178	Set Crotch	21	0.28	0.25	Female
4157	Topstitch crotch	21	0.28	0.25	Male
70845	Topstitch crotch	21	0.28	0.25	Male
120585	Topstitch crotch	21	0.28	0.25	Male
2828	Topstitch Rt. Fly & Hem crotch	21	0.28	0.25	Male

9529	Topstitch Rt. Fly & Hem crotch	21	0.28	0.25	Male
92247	Topstitch Rt. Fly & Hem crotch	21	0.28	0.25	Male
101173	Topstitch Rt. Fly & Hem crotch	21	0.28	0.25	Male
111466	Topstitch band	22	0.289	0.26	Male
123037	Topstitch band	22	0.289	0.26	Female
130771	Topstitch band	22	0.289	0.26	Female
101341	Att. Yokes	23	0.29	0.26	Male
102076	Att. Yokes	23	0.29	0.26	Female
111172	Att. Yokes	23	0.29	0.26	Female
130094	Att. Yokes	23	0.29	0.26	Male
130557	Att. Yokes	23	0.29	0.26	Female
131301	Att. Yokes	23	0.29	0.26	Female
12759	Join Yoke	23	0.29	0.26	Male
130021	Att Wt Pkt-Mt	24	0.3	0.27	Male
111564	Att. Facing Cover	24	0.3	0.27	Female
120519	Att. Facing Cover	24	0.3	0.27	Female
121388	Att. Facing Cover	24	0.3	0.27	Male
82454	Att. Facing to Pkt Bag	24	0.3	0.27	Female
102688	Att. Facing To Pkt Bag	24	0.3	0.27	Male
130098	Att. Facing To Pkt Bag (cover stitch)	24	0.3	0.27	Female
10093	Att. Facing To Pkt Bag SNLS	24	0.3	0.27	Male

101399	Att. Facing To Pkt Bag(Cover)	24	0.3	0.27	Male
61134	Att. Fly stud	24	0.3	0.27	Female
6721	Att. Revits	24	0.3	0.27	Male
72086	Att. Revits	24	0.3	0.27	Male
92558	Att. Revits	24	0.3	0.27	Female
90115	Att. Rivits-4	24	0.3	0.27	Male
90823	Att. Rivits-4	24	0.3	0.27	Male
123008	Att. Rivits-4	24	0.3	0.27	Male
123015	Att. Rivits-4	24	0.3	0.27	Female
10247	Att. Watch Pkt	24	0.3	0.27	Male
7923	Att. Watch pkt (Mitered)	24	0.3	0.27	Male
81505	Att. Watch pkt (Mitered)	24	0.3	0.27	Female
92002	Att. Watch pkt (Mitterd)	24	0.3	0.27	Male
100820	Att. Watch pkt (Mitterd)	24	0.3	0.27	Female
71398	Att.Watch Pkt	24	0.3	0.27	Male
131314	Att.Watch Pkt	24	0.3	0.27	Male
131289	Cut & turn bone opening	24	0.3	0.27	Female
121379	Cut corner and Turn Flap	24	0.3	0.27	Female
123045	Cut corner and Turn Flap	24	0.3	0.27	Female
102838	Cutt Corner and turn slit	24	0.3	0.27	Male
122118	Cutt Corner and turn slit	24	0.3	0.27	Male
102066	First Seam 7"	24	0.3	0.27	Male
81316	Hem back pkt (LS)/Helper	24	0.3	0.27	Female

101923	Hem back pkt (LS)/Helper	24	0.3	0.27	Male
81705	Hem Bk Pkt	24	0.3	0.27	Male
11004	Hem Bk Pkt (SNLS)	24	0.3	0.27	Male
11197	Hem Bk Pkt (SNLS)	24	0.3	0.27	Male
123012	Hem Bk Pkt (SNLS)	24	0.3	0.27	Female
63441	Hem Bk Pkt CS (Mnl)	24	0.3	0.27	Male
111988	Hem Wt Pkt Mouth and bk Pkt	24	0.3	0.27	Female
82409	Hip Stitch	24	0.3	0.27	Male
131431	Hip Stitch	24	0.3	0.27	Male
102263	HipStitch	24	0.3	0.27	Female
120623	Top Stitch Back Tab	24	0.3	0.27	Female
121548	Marking for attach bk pkt	25	0.32	0.23	Male
60942	Top Stitch Inseam	26	0.345	0.31	Male
120339	Top Stitch Inseam	26	0.345	0.31	Male
130115	Top Stitch Inseam	26	0.345	0.31	Female
102812	2nd Seam 7 inch	27	0.35	0.32	Male
123089	3rd Seam 7 inch	27	0.35	0.32	Male
111838	Allign patch and Bottom Stitch Bone Pkt and secure side	27	0.35	0.32	Male
71458	Back seam	27	0.35	0.32	Female
100819	Back seam	27	0.35	0.32	Female
122973	Back seam	27	0.35	0.32	Male
130053	Back seam	27	0.35	0.32	Female
130727	Back seam	27	0.35	0.32	Female

101002	Bartack back pkt	27	0.35	0.32	Female
130011	Bartack back pkt	27	0.35	0.32	Male
8544	Bartack Bk Pkt	27	0.35	0.32	Female
120307	Bartack Bk Pkt	27	0.35	0.32	Male
12409	Bartack Bk Pkt-4	27	0.35	0.32	Female
90124	Bartack Bk Pkt-4	27	0.35	0.32	Male
111957	Bartack Bk Pkt-4	27	0.35	0.32	Female
131462	Bartack Bk Pkt-4	27	0.35	0.32	Female
130132	Bartack Bone	27	0.35	0.32	Female
63341	Hem back pkt (DNCS)	27	0.35	0.32	Male
11932	Join Seat Seam	27	0.35	0.32	Female
122978	Join Seat Seam	27	0.35	0.32	Male
123050	Join Seat Seam	27	0.35	0.32	Male
131069	Join Seat Seam	27	0.35	0.32	Male
123059	Make Slit at Hem Bottom Side	27	0.35	0.32	Female
102678	Press band crease	27	0.35	0.32	Male
111565	Press band crease	27	0.35	0.32	Female
120734	Press band crease	27	0.35	0.32	Male
121190	Press band crease	27	0.35	0.32	Male
123020	Press band crease	27	0.35	0.32	Female
130061	Press band crease	27	0.35	0.32	Male
130089	Press band crease	27	0.35	0.32	Female
131494	Press band crease	27	0.35	0.32	Male

101864	Press band edge	27	0.35	0.32	Male
130069	Press band edge	27	0.35	0.32	Female
61221	Press busted	27	0.35	0.32	Female
81328	Press busted	27	0.35	0.32	Male
101917	Press busted	27	0.35	0.32	Male
110098	Press Busted	27	0.35	0.32	Female
122926	Press busted	27	0.35	0.32	Male
130019	Press busted	27	0.35	0.32	Female
130038	Press Busted	27	0.35	0.32	Female
122980	Press Busted Seam	27	0.35	0.32	Male
130719	Seat Seam	27	0.35	0.32	Female
61406	Set flap	27	0.35	0.32	Female
123547	Set Flap	27	0.35	0.32	Male
123551	SN	27	0.35	0.32	Male
131390	SN	27	0.35	0.32	Female
123047	Turn band corners	27	0.35	0.32	Female
130076	Turn band corners	27	0.35	0.32	Female
130088	Turn band corners	27	0.35	0.32	Female
130012	Turn Band Ends	27	0.35	0.32	Female
61059	Bartack Belt Loops-5 (AUTO)	28	0.4	0.36	Male
91983	Bartack Belt Loops-5 (AUTO)	28	0.4	0.36	Male
102270	Bartack Belt Loops-5 (AUTO)	28	0.4	0.36	Female
60206	Bartack loops (Auto)	28	0.4	0.36	Male

92470	Bartack loops (Auto)	28	0.4	0.36	Male
102248	Bartack loops (Auto)	28	0.4	0.36	Female
110279	Bartack loops (Auto)	28	0.4	0.36	Male
122443	Bartack loops (Auto)	28	0.4	0.36	Female
123061	Bartack loops (Auto)	28	0.4	0.36	Male
100977	Bartack sleeve, Hanger loop	28	0.4	0.36	Female
13761	Hem Bottom	28	0.4	0.36	Male
12006	Hem Bottom-	28	0.4	0.36	Male
1756	Hem Bottom SNCS	28	0.4	0.36	Male
13320	Hem Bottom SNCS	28	0.4	0.36	Female
90572	Hem Bottom SNCS	28	0.4	0.36	Male
1331	Hem bottoms	28	0.4	0.36	Male
102260	Hem bottoms	28	0.4	0.36	Female
111980	Hem bottoms	28	0.4	0.36	Male
130041	Hem bottoms	28	0.4	0.36	Female
100258	Hem bottoms (Lock)	28	0.4	0.36	Male
100381	Hem bottoms (Lock)	28	0.4	0.36	Female
101686	Hem bottoms (Lock)	28	0.4	0.36	Male
122938	Hem bottoms (Lock)	28	0.4	0.36	Female
3526	Hem Bottom-SNLS	28	0.4	0.36	Male
61740	Hem Bottom-SNLS	28	0.4	0.36	Female
120349	Join back Pcs	28	0.4	0.36	Female
131293	Join Back Pkt Pcs	28	0.4	0.36	Female

101920	Join band pcs	28	0.4	0.36	Male
102961	Join band pcs	28	0.4	0.36	Male
120438	Join Band Pcs	28	0.4	0.36	Female
121278	Join Band Pcs	28	0.4	0.36	Female
123025	Join band pcs	28	0.4	0.36	Male
111506	Make Pleat @ Bk Pnl	28	0.4	0.36	Female
13840	Serge Back Panel	28	0.4	0.36	Female
100028	Serge Back Panel	28	0.4	0.36	Male
110473	Serge Back Pannel	28	0.4	0.36	Female
120613	Serge Back Pkt Pcs	28	0.4	0.36	Female
13487	Serge Back Pnl	28	0.4	0.36	Male
13342	Serge bk panel	28	0.4	0.36	Male
102831	Serge bk panel	28	0.4	0.36	Male
120668	Serge bk panel	28	0.4	0.36	Male
122921	Serge bk panel	28	0.4	0.36	Male
130051	Serge bk panel	28	0.4	0.36	Female
101650	Serge Bk Pnl from outside	28	0.4	0.36	Female
121246	Serge Bk Pnls	28	0.4	0.36	Male
122441	Top stitch bone	28	0.4	0.36	Male
123550	Top stitch bone	28	0.4	0.36	Male
123552	Top stitch bone	28	0.4	0.36	Male
123563	Top stitch bone	28	0.4	0.36	Male
12064	Topstitch Inseam	28	0.4	0.36	Male

130703	Topstitch Inseam	28	0.4	0.36	Male
10210	Close Pkt Bag (Safety)	29	0.42	0.38	Female
91409	Close Pkt Bag (Safety)	29	0.42	0.38	Male
120070	2nd Seam Sleeve Placket	30	0.45	0.41	Female
123561	Att. Strip & pkt bag to panel	30	0.45	0.41	Female
82486	Bottom Seam Collar	30	0.45	0.41	Male
71564	Fold & Top stitch Out side(Front)	30	0.45	0.41	Female
120436	Fold & Top stitch Out side(Front)	30	0.45	0.41	Female
120957	Fold & Top stitch Out side(Front)	30	0.45	0.41	Male
82186	Join Front Pcs	30	0.45	0.41	Male
123023	Join Front Pcs	30	0.45	0.41	Female
92176	Join Yoke Safety	30	0.45	0.41	Male
101155	Join Yoke Safety	30	0.45	0.41	Female
100029	Seat Seam Safety	30	0.45	0.41	Male
12135	Set Front Pkt	30	0.45	0.41	Male
12280	Set Front Pkt	30	0.45	0.41	Female
60136	Set Front Pkt	30	0.45	0.41	Male
62924	Set Front Pkt	30	0.45	0.41	Male
63123	Set front pkt	30	0.45	0.41	Male
90123	Set front Pkt	30	0.45	0.41	Female
100715	Set Front Pkt	30	0.45	0.41	Female
102530	Set Front Pkt	30	0.45	0.41	Female

110614	Set front Pkt	30	0.45	0.41	Female
111479	Set front Pkt	30	0.45	0.41	Male
121266	Set front pkt	30	0.45	0.41	Female
122444	Set front pkt	30	0.45	0.41	Male
130036	Set front Pkt	30	0.45	0.41	Male
120202	Top stitch Bk pkt Flap	30	0.45	0.41	Male
130765	Top stitch Bk pkt Flap	30	0.45	0.41	Male
123577	Top stitch bone Top side	30	0.45	0.41	Male
121376	Att. Front Pkt	31	0.466	0.42	Female
12589	Fold & Top stitch Out side	31	0.466	0.42	Male
8584	Top st front plaket	31	0.466	0.42	Male
4346	Turn & Top Stitch front Pkt	31	0.466	0.42	Male
6468	Turn & Top Stitch front Pkt	31	0.466	0.42	Male
111641	Turn & Top Stitch Front Pkt	31	0.466	0.42	Male
120014	Turn & Top Stitch front Pkt	31	0.466	0.42	Male
120264	Turn & Top Stitch front Pkt	31	0.466	0.42	Male
13674	Turn & topstitch frnt pkt	31	0.466	0.42	Male
100088	Turn & topstitch frnt pkt	31	0.466	0.42	Male
120749	Turn & topstitch frnt pkt	31	0.466	0.42	Male
121440	Turn & topstitch frnt pkt	31	0.466	0.42	Male
122528	Turn & topstitch frnt pkt	31	0.466	0.42	Female
131285	Turn & topstitch frnt pkt	31	0.466	0.42	Female
4275	Turn and Top stitch Front Pkt	31	0.466	0.42	Female

102826	Turn and Top stitch Front Pkt	31	0.466	0.42	Male
111421	Turn and Top stitch Front Pkt	31	0.466	0.42	Female
120557	Turn and Top stitch Front Pkt	31	0.466	0.42	Male
92098	Press Bk Pkt	32	0.48	0.43	Female
102511	Press Bk Pkt	32	0.48	0.43	Female
121267	Press Bk Pkt	32	0.48	0.43	Female
122672	Press Bk PKt	32	0.48	0.43	Male
123044	Press Bk Pkt	32	0.48	0.43	Female
123029	Prs Bk Pkt	32	0.48	0.43	Male
12766	Att. Facing SNLS	33	0.5	0.45	Male
61446	Att. Facing SNLS	33	0.5	0.45	Female
82252	Att. Facing SNLS	33	0.5	0.45	Male
123051	Att. Facing SNLS	33	0.5	0.45	Male
130698	Att. Facing SNLS	33	0.5	0.45	Female
121288	Make Crease Band	33	0.5	0.45	Female
130017	Make Crease Band	33	0.5	0.45	Female
61897	Hem bottoms (Chain stitch)	34	0.53	0.48	Male
62605	Hem bottoms (Chain stitch)	34	0.53	0.48	Female
102830	Hem bottoms (Chain stitch)	34	0.53	0.48	Female
63141	Hem Bottom-SNCS	34	0.53	0.48	Male
101727	Hem Bottom-SNCS	34	0.53	0.48	Female
123554	Set Bone strip with bk pnl	35	0.55	0.50	Male
131385	Set Bone strip with bk pnl	35	0.55	0.50	Female

8550	Top stitch waistband Bottom side	35	0.55	0.50	Male
11177	Top stitch waistband Bottom side	35	0.55	0.50	Male
60980	Top stitch waistband Bottom side	35	0.55	0.50	Male
62742	Top stitch waistband Bottom side	35	0.55	0.50	Male
63625	Top stitch waistband Bottom side	35	0.55	0.50	Female
70802	Top stitch waistband Bottom side	35	0.55	0.50	Female
80888	Top stitch waistband Bottom side	35	0.55	0.50	Male
111874	Top stitch waistband Bottom side	35	0.55	0.50	Male
121480	Top stitch waistband Bottom side	35	0.55	0.50	Female
61971	Close Inseam	36	0.58	0.52	Male
122318	Close Inseam	36	0.58	0.52	Male
130772	Close Inseam	36	0.58	0.52	Female
100430	Close Inseam (Safety)	36	0.58	0.52	Female
130063	Close Inseam (Safety)	36	0.58	0.52	Female
130070	Close Inseam (Safety)	36	0.58	0.52	Female
102516	Close Inseam(Safety)	36	0.58	0.52	Female
102259	O/L Inseam (16 SPI)	36	0.58	0.52	Female
102262	O/L Inseam (16 SPI)	36	0.58	0.52	Female

110834	O/L Inseam (16 SPI)	36	0.58	0.52	Male
12130	Secure Top & Side	36	0.58	0.52	Female
12633	Secure Top & Side	36	0.58	0.52	Male
60174	Secure Top & Side	36	0.58	0.52	Male
123005	Secure Top & Side	36	0.58	0.52	Female
120486	Secure top and sides	36	0.58	0.52	Female
120610	Secure top and sides	36	0.58	0.52	Female
120616	Secure top and sides	36	0.58	0.52	Female
120762	Secure top and sides	36	0.58	0.52	Male
11066	Serge front panel	36	0.58	0.52	Male
82210	Serge front panel	36	0.58	0.52	Female
100827	Serge front panel	36	0.58	0.52	Male
102093	Serge front panel	36	0.58	0.52	Male
120621	Serge front panel	36	0.58	0.52	Female
130093	Serge front pnl from side	36	0.58	0.52	Male
60583	Serge Rt. Panel	36	0.58	0.52	Female
81501	Serge Rt. Panel	36	0.58	0.52	Male
92185	Serge Rt. Panel	36	0.58	0.52	Male
92306	Serge Rt. Panel	36	0.58	0.52	Female
102492	Serge Rt. Panel	36	0.58	0.52	Male
102652	Serge Rt. Panel	36	0.58	0.52	Male
120330	Serge Rt. Panel	36	0.58	0.52	Male
122908	Serge Rt. Panel	36	0.58	0.52	Male

10031	Top Stitch Bk Pkt	36	0.58	0.52	Male
131399	Topstitch sdies	36	0.58	0.52	Male
81376	Topstitch sides	36	0.58	0.52	Male
130014	Topstitch sides	36	0.58	0.52	Female
122975	Att. Rivits-12	37	0.6	0.54	Female
130074	Bone Pkt(SN)	37	0.6	0.54	Male
6696	Att. Back Pkt (Auto)	38	0.621	0.56	Male
11596	Att. Back Pkt (Auto)	38	0.621	0.56	Male
82034	Att. Back Pkt (Auto)	38	0.621	0.56	Female
92183	Att. Back Pkt (Auto)	38	0.621	0.56	Male
101842	Att. Back Pkt (Auto)	38	0.621	0.56	Female
110532	Att. Back Pkt (Auto)	38	0.621	0.56	Male
111023	Att. Back Pkt (Auto)	38	0.621	0.56	Female
120018	Att. Back Pkt (Auto)	38	0.621	0.56	Male
122919	Att. Back Pkt (Auto)	38	0.621	0.56	Female
12620	Fell Inseam	39	0.64	0.58	Male
70806	Fell Inseam	39	0.64	0.58	Female
70986	Fell Inseam	39	0.64	0.58	Male
80104	Fell Inseam	39	0.64	0.58	Male
80566	Fell Inseam	39	0.64	0.58	Female
91989	Fell Inseam	39	0.64	0.58	Male
101142	Fell Inseam	39	0.64	0.58	Male
110625	Fell Inseam	39	0.64	0.58	Male

111731	Fell Inseam	39	0.64	0.58	Male
122445	Fell Inseam	39	0.64	0.58	Male
130738	Fell Inseam	39	0.64	0.58	Male
3219	Close out seam (Busted)	40	0.7	0.63	Female
5513	Close out seam (Busted)	40	0.7	0.63	Female
8798	Close out seam (Busted)	40	0.7	0.63	Male
71914	Close out seam (Busted)	40	0.7	0.63	Female
71984	Close out seam (Busted)	40	0.7	0.63	Female
90380	Close out seam (Busted)	40	0.7	0.63	Male
102140	Close out seam (Busted)	40	0.7	0.63	Male
120174	Close out seam (Busted)	40	0.7	0.63	Female
100380	Close Out Seam Busted	40	0.7	0.63	Female
120437	Close Out Seam Busted	40	0.7	0.63	Female
120755	Close Out Seam Busted	40	0.7	0.63	Male
122925	Close Out Seam Busted	40	0.7	0.63	Male
12978	Close Outseam (Busted)	40	0.7	0.63	Female
100710	Close Outseam (Busted)	40	0.7	0.63	Female
91753	Close Outseam (Safety)	40	0.7	0.63	Male
100428	Close Outseam (Safety)	40	0.7	0.63	Female
101777	Close Outseam Outseam-Busted(from Pkt Bag)	40	0.7	0.63	Male
123000	Close Outseam Outseam-Busted(from Pkt Bag)	40	0.7	0.63	Male
123086	Close Outseam(Busted)	40	0.7	0.63	Male

121415	Close Outsem (Busted)	40	0.7	0.63	Male
130663	Close Outsem (Busted)	40	0.7	0.63	Male
61416	Close Pkt Bag	40	0.7	0.63	Male
80904	Close Pkt Bag	40	0.7	0.63	Male
101177	Close Pkt Bag	40	0.7	0.63	Female
101183	Close Pkt Bag	40	0.7	0.63	Female
120297	Close Pkt Bag	40	0.7	0.63	Female
131339	Close Pkt Bag	40	0.7	0.63	Female
10034	Set band to shell	40	0.7	0.63	Male
12247	Set band to shell	40	0.7	0.63	Male
13118	Set band to Shell	40	0.7	0.63	Male
91488	Set band to shell	40	0.7	0.63	Male
92380	Set band to shell	40	0.7	0.63	Female
101728	Set band to shell	40	0.7	0.63	Female
102305	Set band to shell	40	0.7	0.63	Male
120487	Set band to shell	40	0.7	0.63	Female
123035	Set band to shell	40	0.7	0.63	Male
123048	Set band to shell	40	0.7	0.63	Male
123141	Set band to shell	40	0.7	0.63	Female
122920	Set Band With Shell	40	0.7	0.63	Male
63249	Top Stitch Outseam-DNCS	40	0.7	0.63	Male
120117	Top Stitch Outseam-DNCS	40	0.7	0.63	Male
122992	Top Stitch Outseam-DNCS	40	0.7	0.63	Female

130770	Top Stitch Outseam-DNCS	40	0.7	0.63	Female
131303	Top Stitch Outseam-DNCS	40	0.7	0.63	Female
123049	Top stitch Pkt Bag	40	0.7	0.63	Female
131420	AT BK PKT 2ND SEAM	41	0.8	0.72	Female
110956	Att Bk Pkt-Symt Seam	41	0.8	0.72	Female
111864	Att Bk Pkt-Symt Seam	41	0.8	0.72	Male
90109	Att. Bk Pkt 2nd seam	41	0.8	0.72	Female
92250	Att. Bk Pkt 2nd seam	41	0.8	0.72	Male
12735	Att. Waist band	41	0.8	0.72	Female
13675	Att. Waist band	41	0.8	0.72	Male
60653	Att. Waist band	41	0.8	0.72	Female
101334	Att. Waist band	41	0.8	0.72	Male
110368	Att. Waist band	41	0.8	0.72	Male
120288	Att. Waist band	41	0.8	0.72	Male
120980	Att. Waist band	41	0.8	0.72	Male
131340	Att. Waist band	41	0.8	0.72	Female
131404	Att. Waist band	41	0.8	0.72	Female
131446	Att. Waist band	41	0.8	0.72	Male
10151	Att. Waist band Auto	41	0.8	0.72	Male
70822	Att. Waist band Auto	41	0.8	0.72	Male
82032	Att. Waist band Auto	41	0.8	0.72	Female
131416	Att. Waist band Auto	41	0.8	0.72	Female
123569	Close pkt bag	41	0.8	0.72	Male

62211	Close Pkt Bag (SN)	41	0.8	0.72	Female
120549	Close Pkt Bag (SN)	41	0.8	0.72	Female
131493	Close Pkt Bag (SN)	41	0.8	0.72	Male
131495	Close Pkt Bag (SN)	41	0.8	0.72	Male
10986	Close Pkt Bag (SN)	41	0.8	0.72	Female
71495	Close Pkt Bag (SN)	41	0.8	0.72	Male
100985	Close Pkt Bag (SN)	41	0.8	0.72	Male
7452	Close pkt bag SNLS	41	0.8	0.72	Male
60147	Close pkt bag SNLS	41	0.8	0.72	Male
60820	Close pkt bag SNLS	41	0.8	0.72	Male
62963	Close pkt bag SNLS	41	0.8	0.72	Female
121468	Close pkt bag SNLS	41	0.8	0.72	Male
121472	Close pkt bag SNLS	41	0.8	0.72	Female
122603	Close pkt bag SNLS	41	0.8	0.72	Male
130714	Close pkt bag SNLS	41	0.8	0.72	Female
120392	Hem Bottom (mnl)	41	0.8	0.72	Female
123535	Hem Bottom (mnl)	41	0.8	0.72	Male
120292	Att CB Loop-(mnl)	42	0.96	0.87	Female
120608	Att CB Loop-(mnl)	42	0.96	0.87	Male
130073	Attach L/P	42	0.96	0.87	Female
62738	Bartack Belt Loops-5	42	0.96	0.87	Male
80301	Bartack Belt Loops-5	42	0.96	0.87	Male
82044	Bartack Belt Loops-5	42	0.96	0.87	Male

90119	Bartack Belt Loops-5	42	0.96	0.87	Male
102470	Bartack Belt Loops-5	42	0.96	0.87	Male
10571	Att Bk Pkt-1st Seam	43	1	0.90	Male
111801	Att Bk Pkt-1st Seam	43	1	0.90	Male
122895	Att Bk Pkt-1st Seam	43	1	0.90	Male
62064	Att. Back Pkt	43	1	0.90	Female
102022	Close Bag with Label	43	1	0.90	Female
101184	Close Pkt Bag-SNLS	43	1	0.90	Female
111103	Close Pkt Bag-SNLS	43	1	0.90	Male
131356	Close Pkt Bag-SNLS	43	1	0.90	Female
11986	First Seam bk pkt	43	1	0.90	Male
70979	First Seam bk pkt	43	1	0.90	Male
81894	First Seam bk pkt	43	1	0.90	Female
130117	First Seam bk pkt	43	1	0.90	Female
90130	THRD TRMING	44	1.13	0.80	Male
90474	Triming Jkt	44	1.13	1.02	Female
122977	Triming Jkt	44	1.13	1.02	Female
123558	Triming Jkt	44	1.13	1.02	Female
6897	Triming Thread	44	1.13	0.80	Male
123028	Triming Thread	44	1.13	0.80	Female
130016	Triming Thread	44	1.13	0.80	Male
130037	Triming Thread	44	1.13	0.80	Female
131392	Triming Thread	44	1.13	0.80	Female

110606	Trimming thread	44	1.13	0.80	Female
111567	Trimming thread	44	1.13	0.80	Female
120394	Trimming Thread	44	1.13	0.80	Female
121280	Trimming Thread	44	1.13	0.80	Female
122976	Trimming thread	44	1.13	0.80	Female
130044	Trimming Thread	44	1.13	0.80	Male
130047	Trimming Thread	44	1.13	0.80	Female
131304	Trimming thread	44	1.13	0.80	Female
131386	Trimming thread	44	1.13	0.80	Female
131419	Trimming thread	44	1.13	0.80	Female
90116	Topstitch band top edge with CBE	45	1.25	1.13	Male
110013	Topstitch band top edge with CBE	45	1.25	1.13	Female
110957	Topstitch band top edge with CBE	45	1.25	1.13	Female
111862	Topstitch band top edge with CBE	45	1.25	1.13	Male
111929	Topstitch band top edge with CBE	45	1.25	1.13	Female
122896	Topstitch band top edge with CBE	45	1.25	1.13	Male
122987	Topstitch band top edge with CBE	45	1.25	1.13	Male
130741	Topstitch band top edge with CBE	45	1.25	1.13	Male

Table 3: The Effect of the Quality Management Practice on Productivity
Dependent variable: log of worker's productivity (number of garments produced per day)

	(1) Fixed Effects	(2) Random Effects
Quality management practice	0.0789*** (0.00377)	0.0789*** (0.00377)
Tenure	0.175*** (0.00642)	0.133*** (0.00931)
Tenure-squared	-0.00560*** (0.000192)	-0.00557*** (0.000190)
Capacity utilization	0.00842*** (0.0000708)	0.00842*** (0.0000708)
Age		0.0864*** (0.00962)
Age-squared	-0.00148*** (0.000125)	-0.00145*** (0.000123)
Female		-0.133* (0.0524)
Quality Management Practice*Female	0.0140*** (0.00371)	0.0143*** (0.00371)
Time trend		-0.0466*** (0.00725)
Constant	6.415*** (0.0693)	4.297*** (0.180)
Model	Fixed Effects	Random Effects
Number of Observations	462362	462362

Table 2.12A: The Impact of the New Quality Management Practice on the Proportion of Defects

	(1)
	ratio
Quality management practice	-0.000276***
	(0.0000375)
Tenure	-0.0000225
	(0.0000263)
Tenure-squared	0.00000136
	(0.00000134)
Age	0.00000605
	(0.0000460)
Age-squared	-8.88e-08
	(0.000000711)
Female	-0.000225***
	(0.0000793)
Quality Management Practice*Female	0.000130***
	(0.0000369)
Standard Minute Value	0.00106***
	(0.000139)
Time trend	-0.000122***
	(0.0000239)
Constant	0.000236
	(0.000689)
Observations	462362

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Chapter 3

I. Introduction

The causes of productivity differentials have become an important theme in various fields of economics including industrial organization and labour economics (Syverson, 2011). This chapter contributes to an important area of research in economics that has gained momentum in the past few years; the link between productivity differentials in firms due to differences in management practices (Bloom and Van Reenen, 2007; Bloom *et al.*, 2013).

Bloom and Van Reenen (2010) identified that empirical research on the causal effects of management practices on firm performance is at an early stage. One of the obstacles in investigating the impact of management practices on firm performance is the lack of availability of high-quality firm level data.

One measurement issue that was identified in the literature is the unavailability of direct measures of outputs and inputs. Deflated sales are usually used as a measure of output when a direct measure is not available. However, this research aims to fill in this gap as data on inputs and outputs has been directly measured and is available at the line level for a readymade garments manufacturer in Pakistan.

This research complements the study by Bloom and Van Reenen (2007) as they differentiate between good and bad management practices. Good management practices are likely to contribute positively to the productivity of the firm. We analyze a different management practice from Bloom and Van Reenen (2007) with the aim of investigating the impact of a new quality management practice on the line level productivity of a garments manufacturing firm. The new quality management practice brings in three new features on the factory floor: rewards and recognition according to the performance of workers, increased monitoring and peer pressure.

Chapter 2 provides evidence that the new quality management practice increases the individual productivity of workers. However, we used data on only 648 workers who worked at the firm throughout the period of interest; it is still unclear how the new quality management practice affects the overall performance on the factory floor as there are 1400 to 1500 operators at the firm each day. The productivity of each assembly line is determined by total output produced per line.

The research is also motivated by the research strategy known as 'insider econometrics' which uses micro level data on worker, worker groups and firms to analyse the impact of management practices on productivity of firms. The basic question that insider econometrics addresses is whether a new management practice increases productivity? And why a practice may enhance performance among some entities while not among all (Ichniowski and Shaw, 2009). This issue can be addressed by identifying the causes of variation in the impact of new quality management practices between workers, teams of workers, or firms operating within the same industry. This unique data set makes the estimated results of this research convincing because it focuses on a narrow production process which eliminates sources of heterogeneity that are found in more aggregate or heterogeneous samples.

This chapter also aims to analyse whether there is any variation in the impact of the new quality management practice across assembly lines i.e. does the new quality management practice enhance the productivity of some lines while having a negligible impact on others? The research also seeks to explore whether the impact of the quality management practice differs within and across lines due to the variation in the complexity of production. The research follows a similar theme as Boning, Ichniowski and Shaw (2007) who provide evidence that human resource management practices such as problem-solving teams had a higher impact on the productivity of lines associated with more complex production processes as compared to those with less complex production processes. However, we provide evidence that the implementation of the new quality management practice has a positive impact on basic lines which produce products of a higher complexity as compared to the rest of the basic lines while the new practice has a negative impact on basic lines with a lower complexity and complex lines.

The layout of this chapter is as follows. Section II discusses the literature review, Section III explains the data and methodology, Section IV illustrates the results and analysis and Section V presents the conclusion.

II. Literature Review

The survival of businesses depends on their relative productivity as high productivity businesses are more likely to survive as compared to their less efficient competitors (Syverson, 2011). Research in labour economics has also explored the significance of the quality of human capital (Abowd *et al.*, 2005; Fox and Smeets, 2011), the incentive effects of pay for performance (Lazear, 2000) and the role of social connections and the implementation of piece rates as a compensation mechanism (Bandiera, Barankay and Rasul, 2005) in explaining productivity differences.

One of the most important results that micro data research has found is that there is a significant degree of heterogeneity in firm productivity within industries (Bartelsman and Doms, 2000). One explanation for productivity differences among firms and countries is the variation in management practices, where better management has been found to be positively associated with firm productivity (Bloom and Van Reenen, 2007; Bloom and Van Reenen, 2010).

The following sections discuss the concept of productivity as a measure of firm performance, the methods to measure productivity and some common measurement issues, and the relationship between management practices and firm productivity.

II.A. The concept of productivity

Productivity at the firm level is defined as the efficiency with which firms convert inputs into output. A common measure of single-factor productivity is labour productivity which is output produced per unit of labour, although at times capital productivity or materials productivity is also used. Single factor productivity levels may be different between firms as they may face different factor prices and some firms may use other inputs such as capital more intensively.

A better measure of productivity as compared to single factor productivity is considered to be total factor productivity (TFP) productivity as it is invariant to the intensity by which observable inputs are used. Differences in total factor productivity illustrate the differentials in output given a fixed level of inputs. Higher total factor productivity indicates that a firm will produce more output given the same inputs as compared to a firm with lower total factor productivity. Factor price variations will have no effect on total factor productivity as it will bring about shifts along isoquants rather than shifts in isoquants.

Productivity at the plant level or national level has usually been calculated as the differential between inputs and output. Total factor productivity at the country level was labelled as 'a measure of our ignorance' by Abramovitz (1956) as it captures the variation in output not explained by inputs. Productivity differences at the firm level is also a topic that has been under-researched. Differences in technology, research and innovation were associated with productivity differentials within firms, however, productivity differences were seen even after controlling for such variables (Bloom and Van Reenen, 2007).

The models of productivity evolution vary in assumptions regarding the stability of productivity over time. Jovanovic (1982) suggests that firms have a time invariant efficiency parameter. A firm's productivity will vary initially and then will become constant at a certain value. Ericson and Pakes (1995) suggest that contrary to Jovanovic (1982), negative shocks can cause efficiency losses. Lambson (1991) suggests that firms become locked into their technological choices. Olley and Pakes (1996) suggest that changes in regulatory structure also impacts productivity through the reallocation of capital towards more productive units.

II.B. Measurement of Productivity

In order to understand the sources of aggregate growth productivity, macroeconomists separate differences at the country level into micro components (Hsieh and Klenow, 2009; Foster, Haltiwanger and Syverson, 2010). Models of economic fluctuations due to productivity shocks are also estimated using micro level data such as firm level or plant level data rather than aggregate data (Campbell and Fisher, 2004).

Syverson (2011) suggests that micro data has advantages as it provides us with an opportunity to analyse the research question closer to the level where the economic decisions are made, but it also raises a number of measurement and data quality issues. Researchers need to make measurement choices while taking into consideration that any output driven by unmeasured variations in inputs will be included in productivity.

One of the issues with micro data is that sometimes a direct measure of output is not available and instead only revenues are reported. The standard method in this case is to use deflated revenue to measure output. This method may be problematic if the price differentials indicate the differences in market power across firms and the value of deflated revenue may not reflect the producer's output accurately. Manufacturers may also produce a variety of output so it might be challenging to create a single measure of output.

Another measurement issue arises on how to include inputs such as capital, labour and intermediate materials. A researcher can either include the number of workers or the hours worked by employees or a quality adjusted measure such as the compensation of employees as wages reflect marginal product. A typical measure of capital is the firm's book value of the capital stock. This may raise questions regarding whether capital stock is an appropriate measure for the flow of capital services. A similar problem to the one faced in the revenue-output situation occurs if only the total expenditure on inputs is available rather than the quantities of intermediate inputs. There is no clear strategy on how to include intermediate inputs when they are not directly measurable. In this case, a researcher can either use a gross output function and directly include intermediate inputs or alternatively treat the production function as a value-added function and subtract intermediaries from output.

One other measurement concern is regarding the inclusion of multiple inputs into the production function. As total factor productivity measures the shifts in output given a fixed set of inputs, the weight of individual inputs needs to be included appropriately.

Total factor productivity can be represented by the time varying production function below:

$$Y_t = A_t F(K_t, L_t, M_t)$$

Where Y_t is output at time t and is a function of inputs such as capital at time t (K_t), labour at time t (L_t), materials at time t (M_t) and A_t (factor neutral shifter) at time t. Total factor productivity is A_t at time t, which captures the variations in output that are unexplained by changes in inputs.

The weighting of inputs is easiest to see when the Cobb Douglas specification of the production function is used.

$$Y_t = A_t(K_t^{\alpha_k} L_t^{\alpha_l} M_t^{\alpha_m})$$

$$TFP_t = A_t = \frac{Y_t}{K_t^{\alpha_k} L_t^{\alpha_l} M_t^{\alpha_m}}$$

In the case above, the inputs are aggregated where the exponent of each input is its respective output elasticity. This specification is also considered to be the first order approximation to any production function.

Several approaches are used in literature to measure the output elasticities. One approach uses the concept of cost minimization to measure the elasticities directly from the available data. A cost minimizing firm will equate the input elasticity of an input with the product of the scale elasticity and the input's cost share. If the cost shares are measurable and the value of the scale elasticities is measured or assumed, then the output elasticities (α_j) can be constructed easily. If additional assumptions are made for example, constant returns to scale, then the output elasticities equal the revenue paid to each input.

Another approach is to calculate the elasticities by estimating the production function. In the Cobb-Douglas case, logged total factor productivity is the estimated sum of the constant and the residual. The double log form of the Cobb-Douglas case is given below:

$$Ln\, Y_i = \alpha_0 + \alpha_k Ln\, K_i + \alpha_l Ln\, L_i + \alpha_m Ln\, M_i + w_i$$

In the case above, the total factor productivity estimate would be $\hat{\alpha}_0 + \hat{w}_i$, where $\hat{\alpha}_0$ is common across the production units in the data and $\hat{w}_i$ is the specific effect of each unit. Marschak and Andrews (1944) point out that this approach may raise some econometric issues as the input choices may be correlated with $\hat{w}_i$ as producers may make input choices based on their beliefs about their efficiency. There is no consensus on which of the methods is the best, but the choice of method depends upon which assumption the researcher is comfortable with. However, studies have provided evidence that the calculations of productivity are not very sensitive to the method used. The inherent variation in firm level data is able to swamp any small differences in productivity due to measurement errors. High productivity producers will tend to look efficient regardless of the method used to estimate productivity (Syverson, 2011).

II.C. Management and Firm Productivity

The impact of management on the productivity of inputs was mentioned as early as Walker (1887). Nelson (1981) suggested that firms strive to find better ways to meet market demand. Decisions related to technology, inputs and production are taken by the management, hence different forms of management may lead to better choices regarding important decisions. Bertrand and Schoar (2003) also provide evidence that managerial differences are related to differences in the performance of an organization. The exclusion of a measure for management in the production function was mentioned by Mundlak (1961). However, as it was difficult to measure the quality of management, it was assumed that management is fixed over time. This assumption would not hold if there is a reason to believe that management will change over time.

The quality of management became an important variable in the model of firm size by Lucas (1978) where firm performance is denoted by firm size. Firms with better management should be larger because in equilibrium, the market will allocate a greater share of sales to these firms and these larger firms have the resources to use better quality management.

One of the most puzzling questions regarding management practices is that if better management practices offer improved profitability to firms, then why are improved management practices not adopted by all firms? Bloom and Van Reenen (2010) gave various reasons for differences in management practices across countries and firms, such as product market competition, quality of human capital, labour regulation and ownership status of firms. Highly competitive product markets will tend to have better average management practices, and this may drive poorly managed firms out of the market which will encourage other firms to improve management practices. Managers with college education are more likely to be aware of the advantages of modern management practices. Labour regulations that limit the ability of managers to hire, fire, pay and promote employees has been negatively associated with the quality of incentives at firms, but labour regulation is not significantly correlated with other dimensions such as monitoring and targets. Family owned firms that were managed by an external chief executive officer were better managed as compared to firms that were family owned and family managed. The reason being that some family owned firms were run by their eldest sons without taking into consideration the ability to manage and run a firm. Firms owned by private equity are better managed as compared to government owned and family owned firms.

Bloom *et al.* (2013) found evidence that in the Indian textile sector, informational constraints were the most important factor behind firms not adopting new management practices. Some simple widespread practices like measuring quality defects or machine downtime were also not adopted as firms believed that this would not increase profits. The owners believed that their quality was comparable to the rest of the local firms and because they were profitable, they had no incentive to implement new practices.

Management of firms has received less attention in economics as compared to business and policy making. Economists have been sceptical of the importance of management due to the emphasis on profit maximisation and cost minimisation (Stigler, 1976). Firms in developing countries may not adopt high quality systems as repairing defects is cheap due to lower labour costs. Therefore, management practices in developing countries may reflect an optimal response to low labour costs. The second reason why management practices have not been emphasized to a great degree in the literature is that it is empirically challenging to measure management (Bloom *et al.*, 2013).

However, in the past few years management practices have been incorporated in literature to study the impact on productivity and profitability. Bloom and Van Reenen (2007) elaborate that there are some management practices that are on average good for the productivity of the firm. Although good management practices contribute positively to the productivity of the firm, managers may not be motivated enough to move away from bad practices to good practices due to the effort involved in changing the style of management. Some examples of good management practices are the lean manufacturing techniques such as just-in-time that were started in Japan and then were adopted by the west as these techniques were recognized to be superior. A second example is the use of a performance tracking system where data on key performers is collected, analysed and communicated within an organization. The absence of any mechanism to collect information on performance will indicate a poor style of management. The third example is the method used to promote employees. Promotions solely based on the tenure of employees and not on individual performance are likely to lead to lower firm performance.

An extensive survey was undertaken by Bloom and Van Reenen (2006) to construct a robust measure of management practices under four areas: operations, monitoring, targets and incentives. The survey uses a practice evaluation tool that describes and provides a score (0 to 5) to eighteen management practices used by industrial firms. A score of 0 denotes worst practice and 5 denotes best practice. The operations section focuses on how process improvements are documented, the use and introduction of lean manufacturing techniques and the reasons for improvements. The targets section focuses on the types of targets used (financial or operational or both), whether targets are achievable, the consistency of targets in the organization and whether targets are simple or complex. The monitoring section looks at how the performance of employees is tracked and reviewed. One of the best practices for performance clarity is that performance measures are clearly defined and communicated to employees and performance is made public to encourage competition. The incentives section focuses on the criterion for promotion such as whether promotions at the organization are based on tenure or are linked to performance, the compensation mechanism, and the protocol to deal with poor performers. The best practice is the one that provides strong rewards to workers who can demonstrate high effort and ability. The scores were then converted into z-scores by normalizing by practice to mean 0 and standard deviation 1. The overall score for the management practices is calculated by taking an average of all z-scores (Bloom and Van Reenen, 2006). After calculating the management scores, there is scope for disagreement over whether these measures really constitute good practices. In order to analyze this, Bloom and Van Reenen (2007) regress firm production on the management scores and found that these scores were positively associated with firm productivity.

Management practices were found to differ among countries. The use of incentives was greater than the use of monitoring and targets in the United States, China and India as compared to the average country. In contrast, the use of monitoring and targets in Japan, Sweden and Germany was seen to be greater than the use of incentives. The wide use of incentives in the United States may be due to the ease of dismissing poor performers and rewarding high performers. The cross-country rankings of management practices show that management practices are an important factor for ranking productivity at the country level. An increase in the management score by one point is associated with a higher labour productivity of 57 percent. There are two ways through which countries can improve the quality of management practices and hence increase average productivity. Firstly, productivity within the average firm can be improved by disseminating better business education. Secondly, reallocation across firms needs to be improved (Bloom and Van Reenen, 2010).

Bloom *et al.* (2009) also find that higher management scores were associated with better performance in hospitals in the United Kingdom. Better management scores were associated with improved survival rates of patients as well as shorter waiting lists. Good management practices were associated with other indicators, such as better facilities for workers for example child care and job flexibility to maintain a better work-life balance (Bloom, Kretschmer and Van Reenen, 2009). Bloom *et al.* (2010) also provide evidence that firms that are well managed also tend to use energy more efficiently.

There is an increasing use of 'innovative' human resource management practices such as problem-solving teams, pay for performance compensation schemes, cross training for multiple jobs and labour management communication procedures. However, establishing the optimal human resource practice is not straightforward as the results of an identical new management practice may vary across similar firms and between worker groups and establishments within firms (Ichniowski and Shaw, 2003).

Boning, Ichniowski and Shaw (2007) explain that the identification of a specific type of production process in steel manufacturing lines provides convincing empirical evidence on the effect of innovative human resource practices i.e. group based incentives and problem-solving teams on the productivity of production lines in the steel industry. They used a fixed effects productivity model which allows for line specific autoregressive errors to provide evidence that group incentives raised productivity in all lines, but the adoption of teams increased productivity of lines which produced more complex products. The measure of productivity on these lines was defined as the ratio of number of tons that meet the quality standard divided by the number of tons that are loaded onto the production line. The production at these lines is divided into 4 production classes according to the complexity of production. Complexity was included in the productivity model in two alternative ways: a continuous index of complexity which is calculated as a weighted total of the production classes and a dummy variable which is zero when the line produces low complexity products and is one when the line produces high complexity goods. Dummy variables were used to denote group incentives and problem-solving teams and several control variables were also included in the productivity model. The control variables included the measures of the lines' technological features, a measure of capital which is denoted by age of the line and its square, worker characteristics such as tenure and age of operators, tenure of the line managers, turnover rate of the workforce and a time trend to control for learning curve effects.

Ichniowski, Shaw and Prennushi (1997) explain that the advantage of focusing on one production process is that it eliminates heterogeneity that is found in aggregate data and heterogeneous samples. They also provide evidence in favour of using a set of complementary human resource practices as this has a higher impact on productivity as compared to making marginal changes in one management practice. Incentive pay plans combined with teams, flexible job assignments, job security and training tend to achieve higher levels of productivity as compared to more traditional management practices with narrow job definitions, strict work rules, incentive pay based on quantity but not quality and limited communication between managers and workers off-line.

Ichniowski, Shaw and Prennushi (1995) suggest that employee participation in the form of ideas to improve productivity should be complemented by a job security policy as employees may feel threatened by productivity enhancement perceiving that this may result in loss of jobs. Complementarities between human resource practices has been mentioned in the past, for example, Baker, Gibbons and Murphy (1994) who suggest that incentive pay plans based on objective performance complement policies such as work teams which required subjective evaluation. When workers perform multiple tasks, increasing an incentive for one task would lead to workers focusing just on that particular task while neglecting the rest. Increasing incentives for all tasks is likely to minimize this problem (Holmstrom and Milgrom, 1994).

The element of trust between workers and managers needs to be present for a new management practice to be effective (Baker, Gibbons and Murphy, 1994). Ichniowski, Shaw and Prennushi (1995) elaborate that new practices such as information sharing, employment security and productivity improvement teams were ineffective in older steel manufacturing lines due to the lack of trust between workers and management. For example, one manager mentioned that workers were skeptical about productivity enhancement teams as they considered it to be another trick to cut jobs and workers perceived the contractual guarantee of job security to be temporary.

The quantity-quality trade off associated with incentive pay plans such as piece rates has been mentioned at various points in the past (Holmstrom and Milgrom, 1991). One other issue associated with piece rates is that workers may be reluctant to share productivity enhancement methods as an overall increase in productivity may decrease piece rates (Roy, 1952; Gibbons, 1987). Milgrom and Roberts (1995) mention the example of a firm that used a bonus for quality in addition to piece rates to avoid this trade-off. Each unit of production was stenciled with the name of the worker and if the unit fails after delivery then the worker loses 10 percent of the bonus. However, apart from the bonus for quality, the firm had a no layoff policy and offered flexible work assignments and skill training for workers. They also had a channel of communication in place between managers and workers to develop the trust needed for the system to work which made productivity-improvement teams more effective.

Ichniowski and Shaw (2009) refer to a research strategy known as insider econometrics which uses micro level data on workers and aims to address questions related to the impact of new management practices on the productivity of firms. Insider Econometrics uses detailed data on a specific production process and uses econometric methods to analyse the impact of a management practice on performance. This performance can be measured for workers or for smaller units within an organisation.

The simplest regression for obtaining estimates of the impact of a management practice on productivity, or any other dependent variable such as the quality of the product, or the downtime of an assembly line will be to include control variables implied by the production function i.e. factor inputs, a dummy variable which equals one when the management practice is present, work specific fixed effects and a common time trend.

II.D. Future Directions for Research on the Economics of Management

Bloom and Van Reenen (2010) pointed out that as there is limited work on the economics of management, and there are several topics that are yet to be explored in this area which can provide interesting results in the future. For example, conducting field experiments by introducing new management practices to find the causal relationship between firm performance and management practices. Bloom *et al.* (2013) tried to establish a causal relationship between firm performance and management practices through randomized control trials in the Indian textile sector. Free management consultancy was provided to randomly chosen textile manufacturers and the adoption of management practices such as improved quality control, performance-based incentives, and improved factory operation were found to increase productivity by 17 percent.

There is a further need to establish links between firm productivity and management practices. More theories regarding the link between management practices and firm performance maybe established as a result of new findings. If information on the same firm is used over time, it will give us further insight into the relationship between management and firm performance. New studies that use panel data to test the causal relationship between management practices and firm productivity would be especially useful. Management practices in areas other than manufacturing also need to be explored (Bloom and Van Reenen, 2010).

II.E. Conclusion

Management of firms has been identified as an important component of firm productivity (Bloom and Van Reenen, 2007; Bloom and Van Reenen, 2010; Bloom et al., 2013). However, there are a limited number of studies on the relationship between management and firm performance due to the lack of availability of high-quality data and the difficulty of measuring management practices. In some cases, direct figures on outputs and inputs are also not available, and researchers often have to make difficult choices (Syverson, 2011). Recently, there is there a trend to analyse innovative management practices on firm performance using a narrowly defined production process (Ichniowski and Shaw, 2009; Ichniowski, Shaw and Prennushi, 1997). Evidence has been provided that innovative management practices are not equally valued in all production environments and the impact of new management practices may vary with the complexity of the production process (Boning, Ichniowski and Shaw, 2007).

This chapter derives its motivation from some of the identified gaps and methodologies mentioned in the literature. This study contributes to the literature in several ways. Firstly, high quality data is available with direct measures of output and inputs. Boning, Ichniowski and Shaw (2007) did not have detailed information on the product mix of lines that is needed to control for cross line differences, while we have information to control for this. Secondly, studies on management and firm performance using panel data are very limited so this study contributes to the literature on the causal effects of management on firm performance. Thirdly, the study contributes to the literature on insider econometrics and analyses whether the complexity of production can explain the heterogeneity in the impact of management practices within groups of the same firm.

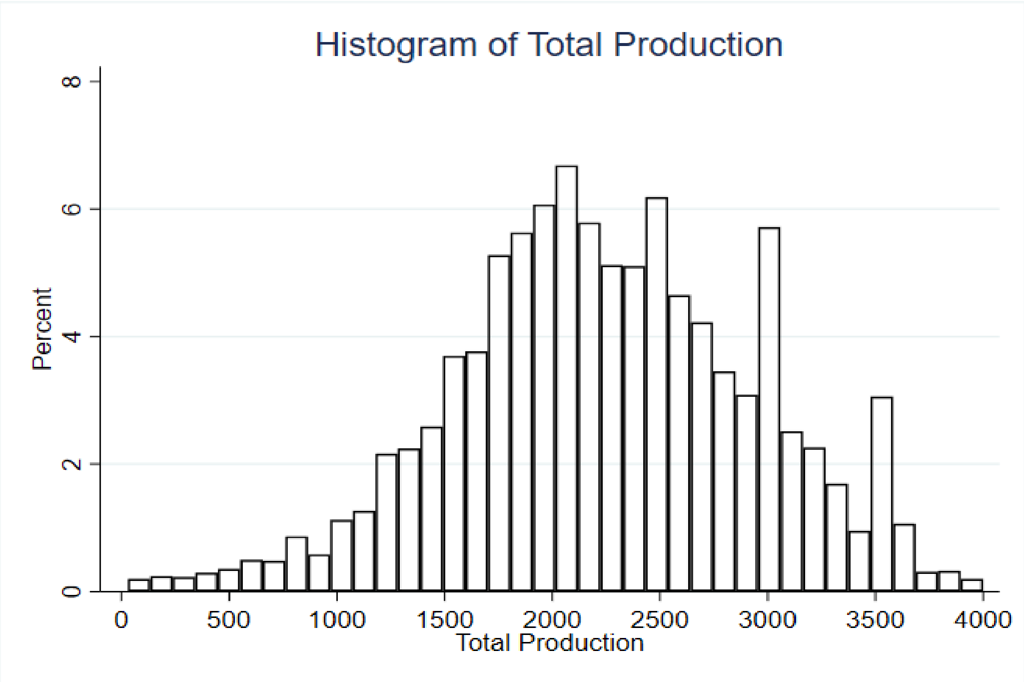
Building on the identified gaps, the aim of this chapter is to test whether the new quality management practice constitutes a good management practice or not. It also tests whether there are any differences in the impact of the new practice across and within assembly lines as the complexity of production can vary both across and within lines.

III. Data and Methodology

III.A. Summary Statistics and Distribution of the Dependent Variable

Daily line level data from the firm was collected before and after the introduction of the new quality management practice. The measure of productivity used in the analysis is the total production at the firm i.e. the number of garments stitched per day per line. Data on other variables includes the number of workers employed per line per day, target per line per day, the standard minute value of the product being produced per line per day which denotes the complexity of the product, and the materials (intermediate inputs) loaded on each line per day. The total sample covers 867 days and 9 assembly lines. However, the study uses an unbalanced panel as some line-day level observations were missing[24] so the total sample contains 7031 line-day level observations.

Figure 4: Histogram of Total Production



The variable for total production (the number of garments produced) is an integer, however given the large number of garments it can be treated as a continuous variable. There are some spikes in the histogram

[24] Some line-day level observations were missing as the line did not operate due to issues at the firm such as delayed input and other technical issues.

generated for total production which may be due to rounding off effects as when production numbers are high the firm rounds off the production figure to the nearest 500.

Table 3.1 : Summary Statistics

	Mean	Standard Deviation	Minimum	Maximum
Total Production	2245.69	701.98	29	4000
Workers	121.23	36.38	19	218
Standard Minute Value	18.46	4.45	4.28	34.99
Target per line	2540.57	495.61	1500	3500
Materials	2433.34	659.41	31	5736
Observations	7031			

Table 3.1 presents the summary statistics of the sample. Total production denotes the total number of garments stitched. The average number of garments stitched per assembly line is 2245.69, while the minimum is 29 and maximum is 4000. The average number of workers present per line is 121.23, while the minimum is 19 and maximum is 218. The huge variation in the number of workers is due to the different styles produced per line and line balancing aspects. Workers are allocated to each task keeping in mind the time it takes to perform a task, hence tasks that take longer may require two or more workers so that the garment is produced within the allocated time, bottlenecks are avoided and targets are achieved. The target represents the desired output per line. The minimum target per line at the firm is 1500 garments and the maximum is 3500 garments. The average target per line is 2540.57 garments per line. Materials denote the intermediate inputs of the firm. The average number of intermediate inputs per line is 2433.34, minimum is 31 and maximum is 5736.

The standard minute value is the time it takes to stitch a garment at the firm. On average, it takes 18.46 minutes to stitch a garment. The minimum standard minute value per line is 4.28 minutes and the maximum is 34.99. The standard minute value is also an indication of the style and complexity of the garment. More tasks are involved while producing a complex garment as compared to a basic garment. For example, more complex denim jeans would have different kinds of rivets or fancier pockets or embroidery.

Table 3.2: Standard Minute Value by Line

Line code	Minimum Standard Minute Value	Maximum Standard Minute Value	Average Standard Minute Value	Type of Production
1A	11.69	21.95	14.95	Basic
1B	4.63	21.95	14.93	Basic
2A	11.54	25.90	16.45	Basic
2B	4.28	25.90	16.38	Basic
3A	11.55	26.68	17.67	Basic
3B	11.54	26.68	17.62	Basic
4	12.88	30.70	21.09	Complex
5	11.26	34.99	25.66	Complex
6	11.68	33.52	21.56	Complex

Personal visits to the firm and interviews with line managers and line supervisors allowed us to identify that there are 6 assembly lines that were operational before and after the new quality management practice was introduced at the firm. The complexity of production varies across lines and the complexity also changes within lines. Three lines operate double shifts, therefore, data for 9 assembly lines is available.

The firm has dedicated different assembly lines for producing basic and complex products, details of which are presented in table 3.2. Some lines were coded with A and B as they operate double shifts. The day shift was coded as A and the night shift as B.

Some lines that produce simple products most of the time are referred to as basic lines and lines that produce more complicated products are termed as complex lines. The complicated products will require a combination of different tasks and will use more sophisticated machinery as compared to basic products although some tasks will be common across all products. Lines 1A, 1B, 2A, 2B, 3A and 3B are all basic lines, while lines 4, 5 and 6 are complex lines. Lines 3A and 3B produce slightly more complicated goods as compared to other basic lines. As expected, the average standard minute value of production lines that mostly produce basic products is lower than the average standard minute value of the lines that produce more complicated products.

The complexity of production also varies within each line. For example, lines that produce basic products most of the time, may occasionally produce products that are more complicated than the ones that are usually produced on the line. On some occasions, basic products are also produced on lines that are designated as complex lines. Interviews with line managers and supervisors revealed that the assembly lines run smoothly when the usual product is produced, but bottlenecks and other problems arise when a more complicated product is run as it takes time for workers to adjust to the requirements of the new product. The organization of production and the procedure for task allocation for workers is the same across all lines.

Table 3.3 shows the average production by assembly line before and after the implementation of the new quality management practice. No significant difference was found before and after the introduction of the practice for line 1A and line 1B. Interestingly, no significant difference was found before and after the implementation of the new quality management practice for line 2A but a significance difference was found for line 2B. The average production for line 2B is significantly higher after the implementation of the practice as compared to before. The average production for both lines 3A and 3B was found to be significantly higher after the implementation of the quality management practice. Line 4, 5 and 6 produce more complicated products and average production was found to be significantly lower after the implementation of the new quality management practice. The magnitude of the decrease in average production is the greatest for line 4.

Table 3.3: Differences in the Mean of Total Production by Line Before and After the Introduction of the Practice

	After	Before	Difference
Line 1A	2062.16	2141.032	-78.87 (40.24)
Line 1B	2220.804	2241.76	20.95 (43.58)
Line 2A	2390.96	2430.30	-39.34 (43.59)
Line 2B	2671.40	2455.86	215.54*** (44.69)
Line 3A	1809.42	1665.10	144.32*** (36.58)
Line 3B	1870.69	1678.67	192.02*** (33.43)
Line 4	2553.19	2925.62	-372.43*** (50.37)
Line 5	1787.65	1937.90	-150.25*** (44.58)
Line 6	2886.72	2701.62	-185.10*** (49.06)

Standard errors in parentheses
* p < 0.10, ** p < 0.05, *** p < 0.01

Table 3.4 presents the mean of key variables by assembly line. The average production and target for line 6 is the highest as compared to the rest of the lines. The average production for line 1B is higher as compared to line 1A although the number of workers is lower, while the standard minute value and target is similar. The standard minute value of line 2A and 2B is similar but the average production for the night shift (2B) is higher than the average production for the day shift (2A), although the average target is similar and the average number of workers present is lower. The average production of 3B is also higher than the average production of 3B, although the average number of workers is lower and other variables such as the standard minute value, target and inputs are similar. The average number of workers present per line is highest for lines 4, 5 and 6 as compared to the rest of the lines that produced simpler products. Complex products require more workers as some complex tasks may require two or more workers in order to balance the line. The lines that produce complex garments have higher average targets as compared to the rest of the lines which is an indication that the order sizes for these styles may be greater than the rest. The firm produces 5 to 10 percent more than the number of garments required by the supplier so that there is a cushion for rejection. A higher percentage is kept as a cushion for complex garments as chances of quality defects are more as compared to basic garments.

Table 3.4: Mean of Variables by Assembly Line

	Line 1A mean	Line 1B mean	Line 2A mean	Line 2B mean	Line 3A mean	Line 3B mean	Line 4 mean	Line 5 mean	Line 6 mean
Total Production	2095.25	2229.24	2406.10	2587.71	1756.30	1800.12	2685.70	1845.18	2815.18
Workers	91.99	84.56	108.28	100.87	105.52	95.00	159.41	179.81	169.03
Standard Minute Value	14.95	14.93	16.45	16.45	17.67	17.66	21.09	25.66	21.56
Target	2383.04	2378.57	2474.88	2476.28	2068.77	2068.13	3168.46	2472.37	3417.62
Input	2430.08	2429.91	2586.61	2579.92	1884.46	1888.93	2827.74	2189.29	3109.98
Observations	746	770	816	801	807	800	742	760	789

III.B. Model

There is a need to understand the reasons why the impact of a certain practice differs among entities within the same firm. Data on a narrowly defined production process makes the identification of specific measures of performance easier. It also helps in isolating the effects of a new management practice on firm performance, minimises concerns about omitted variables, and helps build a true production function (Boning, Ichniowski and Shaw, 2007; Ichniowski and Shaw, 2009; Ichniowski, Shaw and Prennushi, 1997). Management practices are an important component in measuring firm performance has been demonstrated in various research papers (Bloom and Van Reenen, 2007; Bloom and Van Reenen, 2010; Bloom et al. ,2013).

Boning, Ichniowski and Shaw (2007) used a fixed effects specification with line specific autoregressive errors to analyse the impact of an innovative management practice. Cameron and Trivedi (2010) explain that for short panel data sets, it is possible to control for serial correlation in the error term without explicitly stating a model for serial correlation. However, with a long panel data set i.e. when the time dimension is large relative to the cross-sectional dimension, it is necessary to specify a model for serial correlation in the error term to account for any potential autocorrelation. As the cross-sectional dimension is small in a long panel data set, the assumption that the error term is uncorrelated between groups or individuals can be relaxed.

Ignoring the potential correlation of regression disturbances over time will lead to biased standard errors and statistical tests (such as t-test) would lose their validity. Unobserved factors may lead to complex forms of spatial and temporal dependence. Hence the standard errors should be adjusted for the potential dependence in the residuals. Also, it would be more natural to assume that residuals are correlated both within lines and between assembly lines (Hoechle, 2007).

One of the specifications to adjust the standard errors is to allow the error term to follow a line specific autoregressive process of order 1 as was used by Boning, Ichniowski and Shaw (2007). One way to incorporate this into the methodology is to use ordinary least squares with panel corrected standard errors. This allows the error term to be heteroskedastic, autocorrelated of order 1 and correlated over the cross-sectional units (contemporaneous spatial dependence). Another method is to use OLS or fixed effects with standard errors proposed by Driscoll and Kraay (1998) that are assumed to be heteroskedastic and robust to very general forms of spatial and temporal dependence. Hence, these standard errors allow autocorrelation in the error term of a more general form rather than restricting the errors to follow an autoregressive process of order 1. The cross-sectional dependence in the disturbance term arises due to the presence of an unobserved factor, which is common to all cross-sectional units. It follows an autoregressive process so both contemporaneous and lagged spatial dependence is present.

When the lag length for autocorrelation is not specified, Stata uses a rule of thumb to select the lag length for autocorrelation. Stata uses the following formula to calculate the lag length by default:

$$m(T) = floor[4\left(\frac{T}{100}\right)^{\frac{2}{9}}]$$

Where $m(T)$ denotes the lag length up to which the residuals may be auto correlated, T represents time, which is the number of days in our case and floor is a function that rounds the value down to the largest integer.

The following panel data equations will be estimated using fixed effects with Driscoll and Kraay standard errors to investigate the impact of the new quality management practice.

$$lnY_{it} = \beta_0 + \beta_1 P_t + \beta_2 X_{it} + \beta_3 t + \beta_4 t^2 + u_{1i} + \varepsilon_{1it} \quad (1)$$

$$lnY_{it} = \beta_0 + \beta_1 P_t + \beta_2 X_{it} + \beta_3 t + \beta_4 t^2 + \beta_5 (P_t \times Basic_i) + u_{2i} + \varepsilon_{2it} \quad (2)$$

$$lnY_{it} = \beta_0 + \beta_1 P_t + \beta_2 X_{it} + \beta_6 D_{2014} + \beta_7 D_{2015} + \beta_8 D_{2016} + +u_{3i} + \varepsilon_{3it} \quad (3)$$

$$lnY_{it} = \beta_0 + \beta_1 P_t + \beta_2 X_{it} + \beta_5 (P_t \times Basic_i) + \beta_6 D_{2014} + \beta_7 D_{2015} + \beta_8 D_{2016} + + u_{4i} + \varepsilon_{4it} \quad (4)$$

The variables included in the equations are explained below.

Y_{it} represents the production of the firm i.e. the number of garments stitched at line i on day t. Production was also used a measure of firm productivity by Bloom and Van Reenen[25] (2010).

P_t is a dummy variable which equals one when the new management practice (details of the new management practice are given on pages 20-21 in chapter 2) is in place and is zero otherwise. Ichniowski and Shaw (2009) also suggest that the estimates of the impact of a management practice can be obtained by using a dummy variable which equals one when the practice is present and zero otherwise. Bandiera, Barankay and Rasul (2005) also used a dummy variable to analyse the impact of piece rates on worker productivity.

X_{it} is a vector that includes variables such as log of the materials (intermediate inputs) loaded on each line per day, log of the number of workers and log of the target of each line per day. Boning, Ichniowski and Shaw (2007) found that management practices are not equally valued in all production environments and there were differences in the impact of a management practice due to the complexity of production. Therefore, variables that measure the complexity of production across and within lines were included in the equations. The log of the standard minute value is included which is the total time it takes to produce the product at line i on day t. The standard minute value represents the style and complexity of production. A higher standard minute value denotes higher complexity. A measure of the change in style was also included in X_{it}. It is measured as the log of the absolute deviation of the standard minute value from the average standard minute value. Production line supervisors mentioned that productivity decreases initially as the style of production changes, as workers take time to switch from one style to the

[25] As a direct measure of production was not available so deflated sales was used as a proxy for production by Bloom and Van Reenen (2010).

other. An interaction term between the deviation from the average standard minute value and P_t was included to see whether the impact of the implementation of the new quality management practice changes with the deviation from the average standard minute value.

$Basic_i$ is a dummy variable that is one for a basic lines and zero for lines that produce complex garments. This variable is also a proxy for the type of capital employed on the line as some machines will be common among all lines but the lines that produce complex garments will use more sophisticated machines in order to perform complex tasks that will not be performed on basic lines. An interaction term between $Basic_i$ and P_t is also later included to see whether the impact of the new quality management practice varies by the complexity of production.

Time is included to account for learning curve effects and is specified in two different ways for flexibility. A linear time trend with a quadratic time trend is included and then time dummies are included which allow us to see year specific changes. D_{2014} is a dummy variable which equals one when the year is 2014 and equals zero otherwise. D_{2015} is a dummy variable which equals one when the year is 2015 and equals zero otherwise. D_{2016} represents a dummy for the year 2016 which equals one when the year is 2016 and is zero otherwise. u_{1i}, u_{2i}, u_{3i} and u_{4i} are the line fixed effects.

The disturbance terms (ε_{1it}, ε_{2it}, ε_{3it} and ε_{4it}) are explained as follows:

$\varepsilon_{1it} = \lambda_i f_t + \vartheta_{it}$ and $f_t = \sum_{\rho=1}^{10} \delta_1 f_{t-\rho} + \omega_t$ (5)

$\varepsilon_{2it} = \pi_i h_t + \kappa_{it}$ and $h_t = \sum_{\rho=1}^{10} \delta_2 h_{t-\rho} + \varphi_t$ (6)

$\varepsilon_{3it} = \phi_i j_t + \tau_{it}$ and $j_t = \sum_{\rho=1}^{10} \delta_3 j_{t-\rho} + \chi_t$ (7)

$\varepsilon_{4it} = \eta_i m_t + \xi_{it}$ and $m_t = \sum_{\rho=1}^{10} \delta_4 m_{t-\rho} + \iota_t$ (8)

f_t, h_t, j_t and m_t are constructed as common autoregressive processes so δ_1, δ_2, δ_3 and δ_4 are the autocorrelation parameters and $\rho = 1,2 \ldots .10$. ϑ_{it}, κ_{it}, τ_{it} and ξ_{it} are the idiosyncratic forcing terms which are uncorrelated over time and across lines.

The following equations are also fixed effects specifications but are estimated using the least squares dummy approach for convenience. The main difference between the specifications in equations (9) to (10) and the specifications in equations (1) to (4) is that the fixed effects i.e. the line effects are included as dummy variables as we are interested in seeing the effect of the individual lines on productivity directly. The following equations will aim to provide us with the specific impact of the implementation of the new quality management practice on each line and help us analyse a more detailed picture of the impact of the new practice. Hence, the following equations are estimated using Pooled OLS with Driscoll and Kraay standard errors to investigate the impact of the new quality management practice.

$$lnY_{it} = \beta_0 + \beta_1 P_t + \beta_2 X_{it} + \sum_{i=1}^{9} \alpha_i line_i + \sum_{i=1}^{9} \gamma_i (P_t \times line_i) + \beta_3 t + \beta_4 t^2 + \varepsilon_{5it} \quad (9)$$

$$LnY_{it} = \beta_0 + \beta_1 P_t + \beta_2 X_{it} + \sum_{i=1}^{9} \alpha_i line_i + \sum_{i=1}^{9} \gamma_i (P_t \times line_i) + \beta_6 D_{2014} + \beta_7 D_{2015} + \beta_8 D_{2016} + \varepsilon_{6it} \quad (10)$$

The disturbance terms (ε_{5it} and ε_{6it}) are specified as follows:

$$\varepsilon_{5it} = \theta_i g_t + w_{it} \text{ and } g_t = \sum_{\rho=1}^{10} \delta_5 g_{t-\rho} + v_t \quad (11)$$

$$\varepsilon_{6it} = a_i z_t + \varrho_{it} \text{ and } z_t = \sum_{\rho=1}^{10} \delta_{6_{t-\rho}} + \psi_t \quad (12)$$

g_t and z_t are constructed as common autoregressive processes so δ_5 and δ_6 are the autocorrelation parameters and $\rho = 1,2 \ldots .10$. w_{it} and ϱ_{it} are the idiosyncratic forcing terms which are uncorrelated over time and across lines.

$line_i$ is a dummy variable for each line where i=1…9. The line dummies also control for the type of capital used on the line. An interaction term between the new management practice and the line dummy variables is included to analyse the impact of the new quality management practice for each line and whether the productivity of lines changes after the introduction of the practice.

Equations (13) and (14) also control for line fixed effects like equations (9) and (10). However, the main difference between the following equations and equations (9) to (10) is the specification of the autoregressive process for the error term. The specification of equations (13) and (14) is similar to the specification employed by Boning, Ichniowski and Shaw (2007). Equations (9) and (10) allow ρ to vary between 1 to 10 and allow both contemporaneous and lagged spatial dependence. However, equations (13) and (14) restrict the errors to follow an autoregressive process of order 1 i.e. $\rho = 1$ and only allow contemporaneous spatial dependence. The following equation will be estimated using pooled OLS with panel corrected standard errors.

$$lnY_{it} = \beta_0 + \beta_1 P_t + \beta_2 X_{it} + \sum_{i=1}^{9} \alpha_i line_i + \sum_{i=1}^{9} \gamma_i (P_t \times line_i) + \beta_3 t + \beta_4 t^2 + \mu_{it} \quad (13)$$

$$lnY_{it} = \beta_0 + \beta_1 P_t + \beta_2 X_{it} + \sum_{i=1}^{9} \alpha_i line_i + \sum_{i=1}^{9} \gamma_i (P_t \times line_i) + \beta_6 D_{2014} + \beta_7 D_{2015} + \beta_8 D_{2016} + q_{it} \quad (14)$$

Where $\mu_{it} = \sigma_i \mu_{i,t-1} + c_{1it}$ and $q_{it} = o_i q_{i,t-1} + c_{2it}$. c_{1it} and c_{2it} are serially uncorrelated but correlated over i.

IV. Results and Analysis

The following section discusses the results of tables 3.5, 3.6 and 3.7. Table 3.5 illustrates the impact of the implementation of the new quality management practice on total production using the estimates from equations (1) to (4) with slight variations in the specifications as the interaction terms between some variables are also included. For tables 3.5 and 3.6, the auto correlation lag is 1 i.e. ρ in equations (5) to (8) and equations (11) to (12) in section III is specified as 1. The results of tables 3.5 and 3.6 were also estimated by using different lags to see whether the results remain robust to changes in lags. Hoechle (2007) suggests that the default lag chosen by Stata may not be optimal as the chosen lag length does not take into consideration the data set at hand. However, there is no procedure in Stata that would select a lag length by taking into consideration the data set. Also, Stata may select a lag length which might be small. Stata chooses the autocorrelation lag as 6 by default[26] but results were estimated for lags beyond 6 i.e. ρ varies between 1 to 10. Tables 4, 5, 6, 7, 8, 9, 10 and 11 (see appendix B) present the robustness results for columns 1, 2, 3, 4, 5, 6, 7 and 8 of table 3.5 respectively. Tables 12, 13, 14 and 15 (see appendix B) present the robustness results for columns 1, 2, 4 and 5 of table 3.6 while tables 16 and 17 (see appendix B) report the results for columns 3 and 6 of table 3.6.

The analysis has been divided into sections by key results. The following sections will discuss the results for control variables, the impact of the introduction of the new practice on productivity for complex and basic production, impact of the implementation of the practice by individual lines, comparison of the productivity of assembly lines before and after the implementation of the new practice, the impact of change in complexity on productivity and how the impact of the new management practice varies by the change in complexity.

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[26] Using this rule of thumb , $m(T) = floor[4\left(\frac{T}{100}\right)^{\frac{2}{9}}]$ where T=867, the lag length will be 6.46 as the floor function rounds it down to the nearest integer, the lag length is 6.

Table 3.5: The Impact of the New Quality Management Practice on Firm Productivity (Driscoll and Kraay Standard Errors)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Log of Workers	0.226***	0.202**	0.216**	0.194**	0.227***	0.203**	0.223**	0.200**
	(0.0868)	(0.0863)	(0.0873)	(0.0865)	(0.0866)	(0.0861)	(0.0876)	(0.0868)
Log of Materials	0.207***	0.199***	0.204***	0.196***	0.207***	0.199***	0.207***	0.200***
	(0.0209)	(0.0207)	(0.0209)	(0.0208)	(0.0209)	(0.0207)	(0.0210)	(0.0208)
Log of Standard Minute Value	-0.0681	-0.0598	-0.0798*	-0.0705*	-0.0688	-0.0604	-0.0671	-0.0594
	(0.0425)	(0.0428)	(0.0423)	(0.0427)	(0.0425)	(0.0427)	(0.0426)	(0.0428)
Log of Target	0.171**	0.236***	0.221**	0.284***	0.170**	0.236***	0.183**	0.243***
	(0.0838)	(0.0871)	(0.0869)	(0.0901)	(0.0838)	(0.0872)	(0.0845)	(0.0876)
Quality Management Practice	-0.0488*	-0.0554***	-0.101***	-0.104***	-0.0494*	-0.0568***	-0.0471*	-0.0518**
	(0.0254)	(0.0209)	(0.0277)	(0.0271)	(0.0253)	(0.0209)	(0.0252)	(0.0209)
Linear Time Trend	0.000766***		0.000814***		0.000746***		0.000792***	
	(0.000163)		(0.000159)		(0.000166)		(0.000171)	
Quadratic Time Trend	-0.000000716***		-0.000000763***		-0.000000695***		-0.000000732***	
	(0.000000157)		(0.000000154)		(0.000000160)		(0.000000163)	
Time Dummy for 2014		0.0906***		0.0923***		0.0889***		0.0924***
		(0.0248)		(0.0248)		(0.0252)		(0.0257)
Time Dummy for 2015		0.211***		0.216***		0.209***		0.212***
		(0.0333)		(0.0329)		(0.0336)		(0.0340)
Time Dummy for 2016		0.117***		0.121***		0.116***		0.120***
		(0.0350)		(0.0348)		(0.0351)		(0.0357)
Basic*Quality Management Practice			0.0744**	0.0710**				
			(0.0311)	(0.0315)				

Table 3.5: The Impact of the New Quality Management Practice on Firm Productivity (Driscoll and Kraay Standard Errors)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Deviation from the Average Standard Minute Value					-0.00541	-0.00463	0.00778	0.00441
					(0.00382)	(0.00379)	(0.00811)	(0.00803)
Deviation from the Average Standard Minute Value*Quality Management Practice							-0.0195^{**}	-0.0135
							(0.00893)	(0.00886)
Constant	3.711^{***}	3.383^{***}	3.418^{***}	3.098^{***}	3.717^{***}	3.389^{***}	3.622^{***}	3.334^{***}
	(0.820)	(0.831)	(0.828)	(0.841)	(0.820)	(0.831)	(0.824)	(0.834)
Observations	7031	7031	7031	7031	7031	7031	7031	7031

All models are estimated using fixed effects with Driscoll and Kraay standard errors.
Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 3.6: The Impact of the New Quality Management Practice on Firm Productivity (Line Specific Effects with Driscoll and Kraay Standard Errors)

	(1)	(2)	(3)	(4)	(5)	(6)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Log of Workers	0.237***	0.237***	0.238***	0.219**	0.219**	0.219**
	(0.0869)	(0.0867)	(0.0871)	(0.0860)	(0.0859)	(0.0861)
Log of Materials	0.206***	0.206***	0.208***	0.199***	0.199***	0.201***
	(0.0206)	(0.0206)	(0.0208)	(0.0205)	(0.0205)	(0.0207)
Log of Standard Minute Value	-0.124***	-0.124***	-0.123***	-0.114**	-0.114**	-0.114**
	(0.0453)	(0.0452)	(0.0454)	(0.0457)	(0.0457)	(0.0458)
Log of Target	0.158*	0.156*	0.164*	0.224**	0.223**	0.226**
	(0.0920)	(0.0919)	(0.0921)	(0.0947)	(0.0946)	(0.0945)
Quality Management Practice	-0.122***	-0.124***	-0.137***	-0.133***	-0.135***	-0.140***
	(0.0375)	(0.0375)	(0.0378)	(0.0356)	(0.0356)	(0.0358)
Line 1B	0.0872***	0.0873***	0.0871***	0.0849***	0.0850***	0.0848***
	(0.0268)	(0.0268)	(0.0268)	(0.0267)	(0.0267)	(0.0267)
Line 2A	0.0637	0.0650	0.0588	0.0622	0.0634	0.0589
	(0.0397)	(0.0396)	(0.0399)	(0.0398)	(0.0397)	(0.0399)
Line 2B	0.101***	0.103***	0.0967***	0.0976***	0.0987***	0.0943***
	(0.0363)	(0.0362)	(0.0361)	(0.0363)	(0.0362)	(0.0362)
Line 3A	-0.257***	-0.253***	-0.269***	-0.251***	-0.248***	-0.261***
	(0.0532)	(0.0534)	(0.0537)	(0.0534)	(0.0537)	(0.0542)
Line 3B	-0.192***	-0.188***	-0.204***	-0.189***	-0.185***	-0.199***
	(0.0464)	(0.0465)	(0.0467)	(0.0460)	(0.0461)	(0.0465)
Line 4	0.141**	0.144**	0.129*	0.110*	0.113*	0.101
	(0.0660)	(0.0661)	(0.0665)	(0.0657)	(0.0659)	(0.0665)

Table 3.6: The Impact of the New Quality Management Practice on Firm Productivity (Line Specific Effects with Driscoll and Kraay Standard Errors)

	(1)	(2)	(3)	(4)	(5)	(6)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Line 5	-0.248***	-0.242***	-0.268***	-0.249***	-0.244***	-0.265***
	(0.0818)	(0.0822)	(0.0836)	(0.0809)	(0.0815)	(0.0830)
Line 6	0.0103	0.0121	0.00190	-0.00354	-0.00181	-0.00913
	(0.0680)	(0.0680)	(0.0683)	(0.0669)	(0.0669)	(0.0672)
Line 1B*Quality Management Practice	-0.00922	-0.00929	-0.00881	-0.00701	-0.00707	-0.00675
	(0.0344)	(0.0344)	(0.0344)	(0.0343)	(0.0343)	(0.0343)
Line 2A*Quality Management Practice	0.0429	0.0454	0.0594	0.0455	0.0478	0.0586
	(0.0416)	(0.0417)	(0.0419)	(0.0417)	(0.0418)	(0.0420)
Line 2B*Quality Management Practice	0.139***	0.142***	0.156***	0.145***	0.147***	0.158***
	(0.0407)	(0.0410)	(0.0410)	(0.0407)	(0.0410)	(0.0410)
Line 3A*Quality Management Practice	0.206***	0.205***	0.230***	0.209***	0.208***	0.228***
	(0.0524)	(0.0524)	(0.0530)	(0.0524)	(0.0524)	(0.0532)
Line 3B*Quality Management Practice	0.208***	0.208***	0.233***	0.213***	0.212***	0.232***
	(0.0481)	(0.0481)	(0.0486)	(0.0475)	(0.0476)	(0.0483)
Line 4*Quality Management Practice	-0.0790*	-0.0773*	-0.0563	-0.0613	-0.0602	-0.0426
	(0.0455)	(0.0455)	(0.0458)	(0.0452)	(0.0452)	(0.0460)
Line 5*Quality Management Practice	0.0277	0.0298	0.0705	0.0329	0.0344	0.0673
	(0.0551)	(0.0549)	(0.0571)	(0.0553)	(0.0551)	(0.0576)
Line 6*Quality Management Practice	0.123***	0.129***	0.149***	0.120**	0.125***	0.141***
	(0.0474)	(0.0475)	(0.0477)	(0.0475)	(0.0475)	(0.0478)
Linear Time Trend	0.000800***	0.000780***	0.000843***			
	(0.000156)	(0.000158)	(0.000162)			
Quadratic Time Trend	-0.000000769***	-0.000000749***	-0.000000798***			
	(0.000000151)	(0.000000153)	(0.000000156)			

Table 3.6: The Impact of the New Quality Management Practice on Firm Productivity (Line Specific Effects with Driscoll and Kraay Standard Errors)

	(1)	(2)	(3)	(4)	(5)	(6)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Deviation from the Average Standard Minute Value		-0.00510 (0.00385)	0.0162* (0.00874)		-0.00451 (0.00382)	0.0121 (0.00881)
Deviation from the Average Standard Minute Value*Quality Management Practice			-0.0317*** (0.00953)			-0.0249*** (0.00959)
Time Dummy for 2014				0.0875*** (0.0246)	0.0858*** (0.0249)	0.0918*** (0.0256)
Time Dummy for 2015				0.208*** (0.0325)	0.205*** (0.0327)	0.211*** (0.0331)
Time Dummy for 2016				0.111*** (0.0344)	0.110*** (0.0345)	0.117*** (0.0351)
Constant	3.960*** (0.844)	3.974*** (0.843)	3.887*** (0.845)	3.593*** (0.854)	3.605*** (0.854)	3.561*** (0.855)
Observations	7031	7031	7031	7031	7031	7031

All models are estimated using pooled OLS with Driscoll and Kraay standard errors.
Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 3.7: The Impact of the New Quality Management Practice on Firm Productivity (Panel Corrected Standard Errors)

	(1)	(2)	(3)	(4)	(5)	(6)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Log of Workers	0.286***	0.286***	0.286***	0.272***	0.272***	0.272***
	(0.0468)	(0.0468)	(0.0467)	(0.0461)	(0.0461)	(0.0461)
Log of Materials	0.0935***	0.0937***	0.0946***	0.0904***	0.0905***	0.0911***
	(0.0111)	(0.0111)	(0.0111)	(0.0110)	(0.0110)	(0.0110)
Log of Standard Minute Value	-0.125***	-0.128***	-0.125***	-0.116***	-0.118***	-0.117***
	(0.0358)	(0.0359)	(0.0359)	(0.0357)	(0.0357)	(0.0357)
Log of Target	0.156**	0.153*	0.158**	0.227***	0.223***	0.226***
	(0.0789)	(0.0789)	(0.0787)	(0.0791)	(0.0791)	(0.0791)
Quality Management Practice	-0.109***	-0.111***	-0.115***	-0.139***	-0.142***	-0.143***
	(0.0420)	(0.0420)	(0.0420)	(0.0387)	(0.0388)	(0.0388)
Line 1B	0.0930***	0.0930***	0.0929***	0.0911***	0.0911***	0.0911***
	(0.0340)	(0.0339)	(0.0339)	(0.0332)	(0.0331)	(0.0332)
Line 2A	0.0724*	0.0743*	0.0721*	0.0689*	0.0707*	0.0696*
	(0.0394)	(0.0394)	(0.0395)	(0.0385)	(0.0385)	(0.0386)
Line 2B	0.114***	0.116***	0.114***	0.108***	0.110***	0.109***
	(0.0374)	(0.0375)	(0.0374)	(0.0363)	(0.0364)	(0.0364)
Line 3A	-0.286***	-0.282***	-0.286***	-0.280***	-0.275***	-0.277***
Line 3B	-0.213***	-0.208***	-0.213***	-0.208***	-0.204***	-0.206***
	(0.0418)	(0.0419)	(0.0420)	(0.0413)	(0.0414)	(0.0415)
Line 4	0.144**	0.148***	0.142**	0.112**	0.117**	0.114**
	(0.0564)	(0.0565)	(0.0563)	(0.0559)	(0.0560)	(0.0560)
Line 5	-0.279***	-0.270***	-0.279***	-0.281***	-0.273***	-0.278***
	(0.0638)	(0.0641)	(0.0641)	(0.0635)	(0.0638)	(0.0639)

Table 3.7: The Impact of the New Quality Management Practice on Firm Productivity (Panel Corrected Standard Errors)

	(1) Log of Production	(2) Log of Production	(3) Log of Production	(4) Log of Production	(5) Log of Production	(6) Log of Production
Line 6	0.0170 (0.0566)	0.0206 (0.0566)	0.0159 (0.0565)	-0.000313 (0.0567)	0.00319 (0.0567)	0.000742 (0.0567)
Line 1B*Quality Management Practice	-0.0109 (0.0438)	-0.0109 (0.0437)	-0.0108 (0.0437)	-0.00826 (0.0427)	-0.00829 (0.0427)	-0.00825 (0.0428)
Line 2A*Quality Management Practice	0.0331 (0.0492)	0.0359 (0.0492)	0.0403 (0.0494)	0.0387 (0.0480)	0.0414 (0.0481)	0.0433 (0.0483)
Line 2B*Quality Management Practice	0.128*** (0.0477)	0.131*** (0.0478)	0.136*** (0.0478)	0.137*** (0.0463)	0.140*** (0.0464)	0.142*** (0.0464)
Line 3A*Quality Management Practice	0.200*** (0.0547)	0.200*** (0.0546)	0.207*** (0.0548)	0.205*** (0.0548)	0.205*** (0.0548)	0.208*** (0.0551)
Line 3B*Quality Management Practice	0.199*** (0.0517)	0.199*** (0.0517)	0.206*** (0.0520)	0.206*** (0.0511)	0.205*** (0.0511)	0.209*** (0.0514)
Line 4*Quality Management Practice	-0.0960* (0.0524)	-0.0940* (0.0524)	-0.0876* (0.0522)	-0.0801 (0.0514)	-0.0789 (0.0515)	-0.0756 (0.0515)
Line 5*Quality Management Practice	0.0130 (0.0663)	0.0152 (0.0664)	0.0276 (0.0667)	0.0180 (0.0663)	0.0198 (0.0664)	0.0256 (0.0668)
Line 6*Quality Management Practice	0.115** (0.0530)	0.121** (0.0531)	0.127** (0.0532)	0.112** (0.0536)	0.118** (0.0537)	0.120** (0.0539)
Linear Time Trend	0.000761*** (0.000170)	0.000735*** (0.000170)	0.000760*** (0.000170)			

Table 3.7: The Impact of the New Quality Management Practice on Firm Productivity (Panel Corrected Standard Errors)

	(1)	(2)	(3)	(4)	(5)	(6)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Quadratic Time Trend	-0.000000731***	-0.000000705***	-0.000000727***			
	(0.000000170)	(0.000000171)	(0.000000170)			
Deviation from the Average Standard Minute Value		-0.00598	0.000416		-0.00547	-0.00252
		(0.00401)	(0.00681)		(0.00398)	(0.00675)
Deviation from the Average Standard Minute Value*Quality Management Practice			-0.00963			-0.00440
			(0.00841)			(0.00835)
Time Dummy for 2014				0.0579**	0.0554**	0.0577**
				(0.0225)	(0.0226)	(0.0226)
Time Dummy for 2015				0.217***	0.214***	0.215***
				(0.0344)	(0.0345)	(0.0344)
Time Dummy for 2016				0.0948***	0.0929**	0.0949***
				(0.0365)	(0.0365)	(0.0365)
Constant	4.623***	4.656***	4.598***	4.196***	4.227***	4.198***
	(0.684)	(0.684)	(0.682)	(0.678)	(0.678)	(0.678)
Observations	7031	7031	7031	7031	7031	7031
Rho						
Line 1A	.298	.298	.296	.286	.285	.285
Line 1B	.273	.270	.274	.252	.250	.254
Line 2A	.388	.389	.390	.371	.372	.373
Line 2B	.356	.356	.354	.325	.326	.324
Line 3A	.381	.381	.379	.388	.388	.387
Line 3B	.420	.420	.417	.416	.416	.414
Line 4	.403	.403	.394	.397	.398	.391
Line 5	.534	.535	.529	.539	.539	.535
Line 6	.501	.500	.498	.517	.516	.515

All models are estimated using OLS with panel corrected standard errors
Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

IV.A Control Variables

The estimated coefficients for workers, materials and target in table 3.5 suggest a positive and significant relationship with production in all specifications. The coefficients for workers and materials are also robust across all lags, while the coefficients for target are not robust across all lags[27]. Most estimates show that the standard minute value has no significant impact on production apart from columns (3) and (4) which show that a one percent increase in the standard minute value is likely to reduce productivity by 0.0798 and 0.0705 percent respectively. However, these results are not very robust to changes in lags as table 6 shows that the coefficient of the standard minute value is only significant up to lag 2 and table 7 shows that the standard minute value is not significant after lag 1. The coefficients for the linear and quadratic time trend indicate that productivity is increasing over time but at a decreasing rate. The time dummies show that firm productivity in years 2014, 2015 and 2016 is higher than the base year which is 2013.

The pattern of the results for workers, materials and target in tables 3.6 and 3.7 is the same as table 3.5, but magnitudes slightly differ from table 3.5. The linear time trend and the quadratic time trend in all specifications in tables 3.6 and 3.7 present the same pattern of results as table 3.5 such that productivity is increasing but at a decreasing rate. The time dummies in tables 3.6 and 3.7 also show that productivity in years 2014, 2015 and 2016 is higher than the productivity in year 2013. The coefficient for the standard minute value was insignificant for most specifications in table 3.5, but the coefficient for the standard minute value in all specifications in tables 3.6 and 3.7 reveals that an increase in the standard minute value is likely to reduce the productivity of the firm. This result is not surprising, given a fixed 480-minute shift; an increase in the time it takes to produce a garment on the line will reduce the number of garments that can be produced during that shift. These

[27] Table 4 shows that the coefficient for target is only significant up to lag 2. In table 6 and 8, the coefficient for target is insignificant after lag 8 and in table 10, it is insignificant after lag 3.

estimates for workers, materials and standard minute value are quite robust to changes in lags while the estimates for target are sensitive to the lag structure.

IV.B. Complex vs. Basic Production

Columns (1) and (2) in table 3.5 suggest that the implementation of the new quality management practice significantly decreases firm productivity. In column (1), the implementation of the new quality management practice significantly reduces firm productivity by 4.8 percent and column (2) indicates that the implementation of the new quality management practice reduces firm productivity by 5.5 percent. However, table 4 shows that the coefficient for the new quality management practice in column (1) is only robust up to lag 2 and table 5 shows that the coefficient for the new management practice in column (2) is significant[28] across all lags.

An interaction term between the dummy variable for basic and the new quality management practice was added in columns (3) and (4). The results in column (3) indicate that the implementation of the new quality management practice differs between basic and complex lines such that the implementation of the new quality management practice reduces the productivity of complex lines by 10.1 percent but reduces the productivity of basic lines by 2.66 percent. The only difference between the specification of column (3) and column (4) is the way in which time was defined as the time trend in column (3) is replaced by time dummies in column (4). The estimates in column (4) suggest that the implementation of the new quality management practice decreases the productivity of complex lines by 10.4 percent while reduces the productivity of basic lines by only 3.3 percent. Tables 6 and 7 show that the coefficient of the new quality management practice[29] is significant across all lags i.e. the implementation of the new quality management practice significantly reduces productivity. However, the significant difference between the

[28] The level of significance changes from 1 percent to 10 percent in table 5.

[29] The level of significance of the coefficient of the new quality management practice changes from 1 percent to 5 percent in tables 6 and 7.

impact of the new management practice for basic and complex lines is only robust[30] up to lag 4 in table 6 and robust up to lag 3 in table 7.

Columns (5) and (6) also show that the implementation of the new quality management practice significantly reduces productivity. However, table 8 shows that the result in column (5) is only significant up to lag 2 but table 9 shows that the result in column (6) is significant across all lags[31].

The estimates of table 3.5 provide us with evidence that the impact of the new quality management practice is contingent upon the complexity of production which is in line with the findings of Boning, Ichniowski and Shaw (2007). Boning, Ichniowski and Shaw (2007) provide evidence that group incentives raised productivity in all lines but the adoption of problem solving teams increased productivity on lines with more complicated processes while we provide evidence that the implementation of the new quality management practice reduces the productivity of both basic and complex lines but the magnitude of the reduction is greater for complex lines.

IV.C. Impact of the New Quality Management Practice by Basic Lines

Columns 1, 2, 4 and 5 of tables 3.6 and 3.7 suggest that within the category of basic lines, the implementation of the new quality management practice significantly reduces the productivity for lines 1A, 1B and 2A but increases the productivity of lines 3A and 3B[32]. Lines 1A and 1B are the most basic lines at the firm with the lowest average standard minute value and produce similar goods. The direction of the impact of the new management practice is the same for both, although

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[30] The linear combination of the new management practice and the interaction term between basic and the new management practice is insignificant, but they remain jointly significant at the 10 percent level up to lag 10.

[31] The level of significance changes to 10 percent at lag 10.

[32] The linear combination of the quality management practice and the interaction term of line 1B and the quality management practice is significant at the 1 percent level in columns 1, 2, 4 and 5 of tables 3.6 and 3.7. The linear combination of the quality management practice and the interaction term of line 2A and the quality management practice is significant at the 10 percent level in columns 1 and 2 of tables 3.6 and 3.7 and significant at the 5 percent level in columns 4 and 5 of tables 3.6 and 3.7.

the magnitude is higher for line 1B. For example, in column (1) of table 3.6, the introduction of the new quality management practice reduces the productivity of line 1A by 12.2 percent and reduces the productivity of line 1B by 13.1 percent. Lines 2A and 2B are also basic lines but with a higher average standard minute value as compared to lines 1A and 1B. Both lines 2A and 2B produce similar goods but the direction of the impact of the management practice differs across specifications. Columns 1, 2, 4 and 5 of tables 3.6 and 3.7 show that the new quality management reduces the productivity of line 2A, but the magnitude of this reduction is smaller as compared to line 1A. However, columns 1, 2, 4 and 5 in table 3.6 and columns 1 and 2 in table 3.7 show that the introduction of the new quality management practice increases the productivity of line 2B. Columns 4 and 5 in table 3.7 do not support this result for line 2B and illustrate that the implementation of the practice reduces the productivity of line 2B although the magnitudes of the coefficients are miniscule.

Lines 3A and 3B are basic lines with a higher average standard minute value as compared to the rest of the basic lines. Both these lines produce similar products and the direction and magnitude of the impact of the new quality management practice is quite similar in most specifications. Columns 1, 2, 4 and 5 of tables 3.6 and 3.7 show that the implementation of the new practice increases the productivity of lines 3A and 3B. For example, in column (1) of table 3.6, the introduction of the practice increases the productivity of line 3A by 8.4 percent and of line 3B by 8.6 percent.

The result that the implementation of the new quality management practice significantly reduces the productivity of line 1A is robust to changes in lag length. However, we observe that the level of significance for line 1A changes from 1 percent to 5 percent after lag 5 in table 12 and after lag 6 in table 13. The result that the implementation of the new quality management practice reduces the productivity of line 1B and the magnitude of the impact of the new practice is greater for line 1B as compared to line 1A is also robust to changes in lags[33]. The results for lines 2B, 3A and 3B are also robust to changes in lag length[34]. The results for line 2A in columns 1 and 4 such that there is a significant difference in the impact of the new quality management practice between line 1A and 2A are only robust up to lag 2 and the results for columns 2 and 5 are only significant up to lag 5. Although, the variable for the new management practice and the interaction term between line 2A remain jointly significant up to lag 10.

IV.D. Impact of the New Quality Management Practice by Complex Lines

Columns 1, 2, 4 and 5 of tables 3.6 and 3.7 show that within the category of complex lines, the implementation of the new quality management practice significantly reduces the productivity[35] of line 4. For example, in column (1) of table 3.6, the implementation of the new quality management practice reduces the productivity of line 4 by 20.5 percent. These results are also robust to changes in lag length[36].

We find mixed results for lines 5 and 6. Columns 1 and 2 of table 3.7 show that there is no significant difference in the impact of the new quality management practice between line 5 and line 1A. The linear combination of the new quality management practice and the interaction term of line 5 and the quality management practice is insignificant in columns 1 and 2 of table 3.7, while the two variables are jointly significant at the 5 percent level. However, the linear combination of the new quality management practice and the interaction term of line 5 and the new quality management is significant at the 5 percent level in columns 1, 2, 4 and 5 of table 3.6 and in columns 4 and 5 in table 3.7. These estimates suggest there is a significant difference between the

[33] The linear combination of the dummy for the new management practice and the interaction term between the quality management practice and line 1B was found to be significant at the 1 percent level up to lag 7 after which it is significant at the 5 percent level in table 12. In table 14, these variables are significant at the 1 percent level up to lag 5 and then at the 5 percent level till lag 10. The linear combination of the new quality management practice and the interaction term between line 1B and the new quality management practice is significant at the 1 percent level up to lag 10 in tables 13 and 15.

[34] The interaction term for line 2B and the new quality management practice is significant at the 5 percent level at lag 9 and 10 in table 12 and at lag 10 in table 13.

[35] The linear combination of the quality management practice and interaction term of line 4 and the new quality management practice is significant at the 1 percent in columns 4 and 5 of tables 3.6 and 3.7.

[36] The linear combination of the dummy for the new management practice and the interaction term between the quality management practice and line 4 was found to be significant at the 1 percent level up to lag 10 in tables 12,13,14 and 15.

impact of the new management practice between line 5 and line 1A. The implementation of the new practice reduces the productivity of line 5 although the magnitude is less than that of line 1A.

The robustness results for columns 1 and 2 of table 3.6 shown in tables 12 and 13 indicate that the result for line 5 remains robust[37] up to lag 4, although the coefficients are jointly significant at the 5 percent level up to lag 10. Tables 14 and 15 show that the result that the implementation of the new quality management practice reduces the productivity of line 5 is robust[38] up to lag 5. Overall, we find that the significant difference between the impact of the new management practice between line 5 and line 1A is not robust across all lags.

Columns 1 and 2 in tables 3.6 and 3.7 show that the new management practice increases the productivity of line 6 but the magnitude is small. However, columns 4 and 5 in tables 3.6 and 3.7 show that the implementation of the practice significantly reduces the productivity of line 6. The results are also robust to changes in lag length[39].

Overall these findings contribute to the literature on insider econometrics (see Ichniowski and Shaw, 2009) which aims to find how management practices impact productivity and identify areas where new practices have smaller or larger effects. These results can also be linked to the study by Bloom and Van Reenen (2007) in which they distinguish between good and bad management practices. Tables 3.6 and 3.7 provide evidence that whether the implementation of the new quality management practice constitutes a good practice or not varies by assembly line. Most of the previous work on management and firm performance has used cross sectional data where management is time invariant. The analysis also highlights the dynamics of managerial change and emphasizes that production complexity is an important

[37] The linear combination of the dummy for the new management practice and the interaction term between the new management practice and line 5 was found to be significant at 10 percent between lags 2 and 4 in tables 12 and 13.

[38] The linear combination of the new quality management practice and the interaction term between the new quality management practice and line 5 is significant at the 10 percent level between lags 2 and 5 in tables 14 and 15. Although the two variables remain jointly significant at the 1 percent up to lag 10.

[39] The significance level of the interaction term between the new quality management practice and line 6 varies with lags.

element in determining the impact of management practices. We find strong evidence that the implementation of the new management practice increases productivity of lines 3A and 3B as this is supported by all specifications. Hence, it has a positive effect on basic lines with the highest complexity (denoted by the highest standard minute value) as compared to the rest of the basic lines. Most specifications show that the implementation of the new quality management practice has a negative impact on lines at the extreme ends of the complexity spectrum as it has a negative effect on very basic lines and on complex lines. Therefore, in these lines, the standard management practices seem to suffice. These findings can also be linked to the evidence provided by Boning, Ichniowski and Shaw (2007) such that the complexity of production is an important determinant of the success of new management practices. There is also some evidence that the impact of the new management practice is different for lines of similar complexity. For example, we observe that some specifications indicate the opposite impact for lines 2A and 2B which produce similar goods but line 2A is operated during the day and line 2B is operated at night. This points out that the production setting also plays a role in determining the impact of the new management practice.

We provide evidence in chapter 2 that the implementation of the new practice increases worker productivity, but the sample only contained 648 workers who were present at the firm for the whole period of data collection. During the production of denim jeans, there are five stages of production: small parts, back, front, assembly 1 and assembly 2. At the first stage small parts are produced to be ready for the back and front section. The front and back of the jeans are stitched individually but then the front and back is assembled during assembly 1 and assembly 2 to complete the garment. As production operations are interdependent, a bottleneck at any stage can reduce the productivity of the line. Hence, even if the productivity of certain workers increases as we have provided evidence in chapter 2, it does not assure that line productivity will also increase as the productivity of the line is dependent on all the stages of the production process. Most specifications provide evidence that the implementation of the new management practice reduces productivity of line 1A, line 2A, line 4, line 5 and few specifications also indicate a negative impact on line 2B and line 6. Hence, for practices to be successful all workers have to trust the management such that all workers be evaluated with fairness. This result can be potentially linked to the suggestion by Baker, Gibbons and Murphy (1994) that the element of trust is important for new practices to be effective. The mistrust between workers and management has also been highlighted by Ichniowski, Shaw and Prennushi (1995) who mention that the lack of trust between workers and management in older steel lines rendered practices such as information sharing, employment security and productivity improvement teams ineffective. They gave various examples of mistrust between management and workers such as productivity enhancement teams were considered by workers as another trick by management to cut jobs and the contractual guarantee of job security was considered to be temporary which will be renegotiated during the negotiations of the next contract.

IV.E. Comparison of Lines Before and After the Implementation of the New Quality Management Practice

The estimates in tables 3.6 and 3.7 both show that within the category of basic lines, line 1B was significantly more productive than line 1A before the implementation of the new practice. The implementation of the new management practice has a dampening effect on line 1B due to which the productivity gap between line 1A and 1B is reduced[40]. For example, the estimates in column (1) of table 3.6 shows that before the introduction of the practice, line 1B was 8.72 percent more productive than line 1A and after the implementation of the new practice, line 1B is only 7.79 percent more productive than line 1A. The estimates for line 1B provided in tables 12 to 17 show that this result is also robust to changes in lag length[41].

[40] The linear combination of the dummy for line 1B and the interaction term between the quality management practice and line 1B was found to be significant at the 1 percent level in all specifications in tables 3.6 and 3.7.

[41] The linear combination of the dummy for line 1B and the interaction term between the quality management practice and line 1B remains significant at the 1 percent level in all specifications in tables 12 to 17.

We find mixed results for line 2A, such that table 3.7 illustrates that line 2A is more productive than line 1A before and after the implementation of the new practice[42]. However, table 3.6 shows that the coefficients for line 2A and the interaction term between the new quality management practice and line 2A are both insignificant. Both these variables were tested for joint significance and were found to be significant at the 1 percent level in all specifications in table 3.6 indicating that line 2A does matter overall but the data does not allow us to cleanly separate the effects for line 2A before and after the implementation of the new quality management practice. We dropped the interaction term between line 2A and the new quality management practice in table 3.6 and observed that the coefficient for line 2A was positive and significant at the 1 percent level in all specifications which indicates that there is no significant difference in the effect of line 2A before and after the implementation of the new quality management practice[43]. All specifications in tables 3.6 and 3.7 show that line 2B was significantly more productive than line 1A before and after the implementation of the practice. These estimates are also robust to changes in lags[44].

The estimates in tables 3.6 and 3.7 illustrate that lines 3A and 3B were significantly less productive than line 1A before the introduction of the practice. All specifications in tables 3.6 and 3.7 show that line 3A still remains less productive than line 1A but the productivity differential between line 1A and line 3A is reduced drastically after the implementation of the new practice. However, all specifications in table 3.6 show that line 3B is significantly more productive than 1A after the new management practice is introduced. This result is also supported by columns (5) and (6) of table 3.7, although the magnitude of the coefficients is small. The rest of the specifications in table 3.7 suggest that line 3B remains less productive than line 1A but the differential reduces by a large magnitude for example, column (1) in table 3.7 shows

[42] The linear combination of the dummy for line 2A and the interaction term between the quality management practice and line 2A was found to be significant at the 1 percent level in all specifications in table 3.7.
[43] These results are shown in table 3.6A in the appendix B.
[44] The level of significance for the dummy for line 2B and the interaction term between line 2B and the new quality management practice switches from the 1 percent level to the 5 percent level in some specifications.

that line 3B was 21.3 percent less productive than 1A but it is only 1.4 percent less productive than line 1A after the practice was introduced. These results are also robust to changes in lags.

The estimates for all specifications in tables 3.6 and 3.7 suggest that line 5 was less productive as compared to line 1A before the implementation of the practice. However, line 5 is still less productive than 1A after the implementation of the new practice but the differential between the productivity of line 5 and 1A has slightly reduced after the introduction of the practice[45]. This result is also robust[46] to changes in lags as shown in tables 12 to 17.

Columns 1 to 6 of tables 3.6 and 3.7 show that there was no significant difference between the productivity of line 6 and line 1A before the implementation of the practice. However, all specifications in tables 3.6 and 3.7 provide evidence that line 6 was more productive than line 1A after the new quality management practice was implemented[47]. The estimates for line 6 in table 3.6 are not very robust to changes in lags. The result in column 1 is only robust[48] up to lag 3 as the linear combination of the dummy variable for line 6 and the interaction term between line 6 and the new practice is significant at the 10 percent level only up to lag 3 in table 12. The result for column 3 is only significant up to lag 4 as shown in table 16. In table 16, the variable for line 6 and the interaction term between line 6 and the new quality management practice remains jointly significant at the 10 percent level between lags 5 and 8 after which the two variables are no longer jointly significant. The results for columns 2 and 5 are significant[49] up to lag 10. The result for column 4 is not significant at lags beyond 1, as the linear combination of the variable for line 6 and the interaction term between line 6 and the new

[45] The linear combination of the dummy for line 5 and the interaction term between the quality management practice and line 5 was found to be significant at the 1 percent level in all specifications in tables 3.6 and 3.7.
[46] The linear combination of the dummy for line 5 and the interaction term between the quality management practice and line 5 remains significant at the 1 percent level in all specifications in tables 12 to 17.
[47] The linear combination of the dummy for line 6 and the interaction term between the quality management practice and line 6 was found to be significant at the 5 percent level in all specifications in table 3.7 except column 4 where it is significant at the 10 percent level. The linear combination of the dummy for line 6 and the interaction term between the quality management practice and line 6 was found to be significant at the 10 percent level in columns 1,4, 5 and 6 and significant at the 5 percent level in columns 1 and 3 of table 3.6.
[48] The two variables are jointly significant at the 10 percent level up to lag 5.
[49] The linear combination of line 6 and the interaction term between line 6 and the new quality management practice remains significant up to lag 10.

quality management practice is insignificant at lag 2 and at further lags. Although the two variables are jointly significant at the 5 percent level at lag 2 and then at the 10 percent level up to lag 4 and then are jointly insignificant at lags beyond 4. The result for column 6 is robust up to lag 2 as the linear combination is only significant up to lag 2 but then the variables are jointly significant at the 5 percent level between lags 3 and 4 and at the 10 percent level between lags 5 and 10. We observe that the dummy for line 6 is insignificant in tables 3.6 and 3.7 but the interaction term between line 6 and the new management practice is significant for all lags. As the linear combination between these two variables is not significant across all lags, so the total effect is insignificant. Hence, the data does not provide very strong evidence for cleanly estimating the productivity differential for line 6 before and after the implementation of the new management practice for all lags.

Columns (1) to (5) in table 3.6 and all columns in table 3.7 show that line 4 was significantly more productive than line 1A before the new quality management practice was implemented. Columns (1) and (2) in table 3.6 and columns (1) to (3) in table 3.7 show that the implementation of the practice has a dampening effect on the productivity of line 4, although it is still more productive than line 1A after the implementation of the practice. Columns (3) to (5) in table 3.6 and columns (3) to (6) in table 3.7 show that line 4 is more productive than line 1A irrespective of the introduction of the new management practice[50]. Column (6) in table 3.6 shows that the coefficients of line 4 and the coefficient for the interaction term between line 4 and the new quality management was insignificant[51]. The coefficient for line 4 was insignificant even after dropping the interaction term between the new quality management practice and line 4, indicating that line 4 has no effect on productivity in this specification. The result of columns (1) and (2) in table 3.6 which indicate that there is a significant difference in the productivity of line 4 before and after the

[50] The linear combination of line 4 and the interaction term between line 4 and the new quality management practice was insignificant in columns 3 to 5 in table 3.6 and columns 3 to 6 in table 3.7. The coefficient for line 4 and the interaction term between the new quality management practice and line 4 were found to be jointly insignificant in columns 3 to 6 in tables 3.6 and 3.7.

[51] These variables are also jointly insignificant.

implementation of the new practice is not robust to changes in lag length, as the interaction term between line 4 and the new quality management practice is insignificant after lag 1 in tables 12 and 13. The linear combination of the dummy for line 4 and the new quality management practice is also insignificant and the two variables are also not jointly significant. However, tables 12 and 13 show that the result that there is a productivity effect of line 4 irrespective of the new quality management practice is significant up to lag 6 and table 16 shows that this result is robust up to lag 3. The results of column 4 and 5 of table 3.6 such that line 4 is more productive than line 1A irrespective of the new quality management practice is not robust to changes in lags. Overall, the results for line 4 are not very robust.

We find strong evidence that lines 3A, 3B and 5 were the worst performing lines at the firm as compared to line 1A before the practice. However, after the implementation of the new practice, there has been a drastic improvement in the productivity for line 3A as compared to line 1A and a few specifications show that line 3B is more productive than line 1A after the introduction of the practice. Line 5 still remains less productive than line 1A but the productivity differential is slightly reduced after the implementation of the new practice.

The motivation behind introducing the new quality management practice was to incentivize workers to reduce quality defects and enhance productivity (workers were paid piece rate throughout). Lower quality defects mean that workers spend less time on re-doing defective pieces, hence this should translate into higher productivity. The result that the implementation of the new quality management practice significantly impacts the productivity of assembly lines whether positively or negatively highlights two alternative theories. The principal-agent theory suggests that an external intervention is expected to improve effort levels of a self-interested agent, as he/she would minimise the possibility of a sanction if caught shirking (Alchian and Demsetz, 1972; Prendergast, 1999; Laffont and Martimort, 2002). However, the crowding out hypothesis derived from social psychology (Frey, 1993) illustrates an alternative view; an external intervention may reduce an agent's self-esteem as the worker may feel that his/her intrinsic motivation is not being appreciated hence would reduce effort. Agents who have high intrinsic motivation may also see external interventions as a sign of distrust. Generally, both the disciplining and crowding effect are active; external interventions may have two opposing effects on the performance of workers. The benefit of the intervention to the principal depends upon the relative magnitudes of both the effects (Frey and Jegen, 2001). The evidence for the performance of lines before and after the implementation of the new quality management practice highlights a point that has not been well emphasized in the previous studies on providing external incentives to workers i.e. the complexity of production also plays a role in determining the benefit of the intervention to the agent.

The decrease in productivity after the implementation of the new quality management practice also complements the theory by Holmstrom and Milgrom (1994) such that when workers perform multiple tasks, increasing an incentive for one task would lead to workers focusing just on that particular task while neglecting the rest. This theory is particularly relevant as the quantity-quality trade off exists while workers are paid piece rates (Paarsch and Shearer, 1999). Higher stitching speed means that workers will skimp on quality. In our case, the incentive for quality changes while the incentives for productivity remains the same. Although we do not have data on line level quality defects[52] so we cannot comment on how quality defects changed but one potential reason for the slowdown in productivity could be that overall lines were trying to produce slowly in order to produce better quality products and minimize quality defects after the incentive for quality was introduced. Increasing incentives for all tasks is likely to minimize this problem and incentives should be complementary in nature. Milgrom and Roberts (1995) suggested that bonuses for quality and piece rates are complementary practices but they also emphasize that these practices should be paired

[52] We used worker level data on quality defects for 648 workers before and after the implementation of the new quality management practice in chapter 1 but data on quality defects per assembly line is not available.

with policies that provide job security as employees may be threatened that productivity enhancement may result in loss of jobs. A proper channel of communication needs to be present between workers and management that enhances the trust needed to make the system work. Ichniowski, Shaw and Prennushi (1997) use results from 17 steel manufacturing lines to illustrate that firms should use a set of human resource management practices as it has a higher impact on productivity as compared to changes in individual practices. Lines with incentive pay plans, teams, flexible job assignments, job security, and training combined tend to achieve higher levels of productivity than lines with more traditional practices such as narrow job definitions, strict work rules and hourly pay with close supervision. Ichniowski, Shaw and Prennushi (1995) also suggest that employee participation in the form of ideas to improve productivity should be complemented by a job security policy as employees may be threatened that productivity enhancement may result in loss of jobs.

IV.F. Change in Complexity

The variable for the deviation from the average standard minute value in columns (5) and (6) in table 3.5 shows that there is no significant impact on productivity due to any deviation from the average standard minute value. However, the linear combination of the deviation from the average standard minute value and the interaction term between the deviation from the average standard minute value and the new quality management practice is significant at the 1 percent level in column (7) of table 3.5. This result indicates that a one percent deviation from the average standard minute value after the implementation of the new quality management practice is likely to reduce productivity by 0.0117. Table 10 also shows that this result remains robust[53] up to lag 10. Column (8) of table 3.5 shows that the deviation from the average

[53] The linear combination of the deviation from the average standard minute value and the interaction term between the average standard minute value and the new management practice remains significant at the 1 percent level.

standard minute value has no significant impact on productivity before and after the implementation of the new practice.

Column (3) of table 3.6 shows that the deviation from the average standard minute increases productivity before the implementation of the new practice but a one percent deviation from the average standard minute value after the implementation of the new quality management practice decreases productivity by 0.0155 percent. However, column (6) shows that a change in the average standard minute value has no significant impact on productivity before the implementation of the new quality management practice, but a one percent deviation from the average standard minute value after the implementation of the practice significantly decreases productivity. Column 6 shows that a one percent deviation from the average standard minute value after the implementation of the new quality management practice decreases productivity by 0.0128 percent[54]. The estimates in table 3.7 show that the deviation from the average standard minute value has no significant impact on productivity before and after the implementation of the new practice.

IV.G. Impact of the New Quality Management Practice Due to the Change in Complexity of Production

Column (7) in table 3.5 provides evidence that the impact of the new management practice varies by the deviation from the average standard minute value. Given that there is no deviation from the average standard minute value, the implementation of the new quality management practice significantly reduces productivity by 4.71 percent. However, a one percent deviation from the average standard minute value is likely to further reduce productivity by 0.0195 percent. Therefore, given a one percent deviation from the average standard minute value, the implementation of the new practice is likely to reduce productivity by 4.73 percent. Column (8) also shows that the impact of the new management

[54] The linear combination of the deviation from the average standard minute value and its interaction with the new management practice is significant at 1 percent in column 6 in table 3.6.

practice[55] varies by the deviation from the average standard minute value. The results in tables 10 and 11 show that the impact of the new management practice which varies by the deviation from the average standard minute value remains significant[56] up to lag 10.

According to the results in column (3) of table 3.6, a one percent deviation from the average standard minute value is likely to reduce productivity. For example, after the implementation of the new quality management practice, a one percent deviation from the average standard minute value is likely to reduce productivity by 13.73 percent for line 1A. There is a significant difference between the impact of the implementation of the new quality management practice given a one percent deviation from the average standard minute value between line 1A and the rest of the lines. The magnitude of this effect is significantly higher for lines 1B and 4 as compared to line 1A[57], such that the productivity for line 1B decreases by 14.6 percent and line 4 decreases by 19.4 percent. The new management practice also has a negative impact on the productivity of lines 2A and 5 but the magnitude is lower[58]. However, the impact of the new quality management practice, given a one percent deviation from the average standard minute value is positive for lines 2B, 3A, 3B and 6. It increases the productivity of line 2B by 1.9 percent, line 3A by 9.3 percent, line 3B by 9.6 percent and line 6 by 1.2 percent. Column (6) also shows a similar pattern of results but magnitudes of the coefficients differ[59] slightly.

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[55] The linear combination of the new management practice and the interaction term of the deviation from the average standard minute value and the new management practice is significant at the 1 percent level.

[56] The linear combination of the new management practice and the interaction term between the deviation from the average standard minute value and the new management practice remains significant at the 1 percent level between lags 3 and 10 in table 10 and across all lags in table 11.

[57] The linear combination of the new quality management practice, the interaction term between line 1B and the new management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice is significant at the 1 percent level. The linear combination of the new quality management practice, the interaction term between line 4 and the new management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice is significant at the 1 percent level.

[58] The linear combination of the new quality management practice, the interaction term between line 5 and the management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice is significant at the 5 percent level. The linear combination of the new quality management practice, the interaction term between line 2A and the management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice is significant at the 5 percent level.

[59] The results for column (6) indicate the implementation of the new practice increases the production of line 6 by only 0.1 percent.

These results for lines 1A, 1B, 2B, 3A, 3B, 4 and 6 are quite robust[60] to changes in lags. However, the results for line 2A[61] in column (3) is only significant up to lag 8. The result for line 5 in column (3) is only significant[62] up to lag 4 and the result in column (6) is significant up to lag 5.

Columns (3) and (6) in table 3.7 show a similar pattern of results for lines 1A[63], 1B[64], 2A[65] and 4. The results for line 2B are different from table 3.6 as the linear combination of the new management practice, the interaction term between line 2B and the new management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice is insignificant indicating that the deviation from the average standard minute value has no effect on the impact of the new management practice for line 2B. For line 2B, the implementation of the practice increases productivity by 2.1 percent in column (3) and decreases it by 0.1 percent in column (6).

The linear combination of the new management practice, the interaction term between line 3A and the new management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice is insignificant. Hence,

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[60] The linear combination of the new quality management practice, the interaction term between line 4 and the new management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice remains significant at the 1 percent level. The linear combination of the new quality management practice, the interaction term between line 1B and the new management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice remains significant at the 1 percent level.

[61] The linear combination of the new quality management practice, the interaction term between line 2A and the new management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice is significant at the 5 percent level at lag 2 and 3 and then significant at the 10 percent level up to lag 8 in tables 16 and 17. These variables are still jointly significant at lag 9 and 10.

[62] The linear combination of the new quality management practice, the interaction term between line 5 and new management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice is significant at the 5 percent level at lag 2 and then significant at the 10 percent level up to lag 4 in column 3 and significant at the 10 percent level up to lag 5 in column 6. These variables remain jointly significant at the 1 percent level up to lag 10 in columns 3 and 6.

[63] The linear combination of the new quality management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice is significant at the 1 percent level in columns 3 and 6 in table 3.7.

[64] The linear combination of the new quality management practice, the interaction term between line 1B and the management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice remains significant at the 1 percent level in columns 3 and 6 in table 3.7. The linear combination of the new quality management practice, the interaction term between line 4 and the management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice remains significant at the 1 percent level in columns 3 and 6 in table 3.7.

[65] The linear combination of the new quality management practice, the interaction term between line 2A and the management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice is significant at the 10 percent level in columns 3 and 6 in table 3.7.

the deviation from the average standard minute value has no effect on the impact of the implementation of the new management practice for line 3A. Columns (3) and (6) show that the implementation of the new practice increases the productivity of line 3A by 9.2 percent and 6.5 percent respectively. The results for line 3B show that the deviation from the average standard minute value after the implementation of the new practice significantly impacts the productivity of line 3B[66]. Hence, even after a one percent deviation from the average standard minute value, the implementation of the new quality management practice increases productivity for line 3B. Lines 5 and 6 show that the deviation from the average standard minute value after the implementation of the new practice has no impact on their productivity[67].

Overall the result that is supported by all specifications is that the implementation of the new quality management practice does vary by the change in complexity for mostly basic lines i.e. lines 1A, 1B, 2A, 3B and one complex line i.e. line 4. Therefore, it is not only the differences in the complexity of production across lines that explains the variation in the impact of the new quality management practice but changes in the complexity of production within a line is also a determinant of the impact of new management practices. These results are in line with the discussions with supervisors who suggested that a change in style usually has a dampening effect on productivity as workers take a while to get used to the new style of production. These results further elaborate the literature on good and bad management practices (Bloom and Van Reenen, 2007; Bloom and Van Reenen, 2010; Bloom et al., 2013) such that the change in the complexity of production within the same working

[66] The linear combination of the new quality management practice, the interaction term between line 3B and the interaction term between the deviation from the average standard minute value and the new quality management practice is significant at the 10 percent level.

[67] The linear combination of the new quality management practice, the interaction term between line 5 and the new management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice is insignificant but these variables are jointly significant at the 5 percent level. The linear combination of the new quality management practice, the interaction term between line 6 and the quality management practice and the interaction term between the deviation from the average standard minute value and the new quality management practice is insignificant but these variables are jointly significant at the 5 percent level.

group is also a determinant of how successful management practices are in enhancing firm performance.

V. Conclusion

This research adds to the literature on management and firm productivity and complements the study by Bloom and Van Reenen (2007). The answer to the question of whether this new management practice turns out to be a good management practice or not is not straight forward as the impact of the new practice varies by assembly line. The results provide evidence in line with Boning, Ichniowski and Shaw (2007) such that the impact of new management practices is contingent upon the complexity of production as there are sizeable differences in the impact of the new quality management practice between complex and basic lines. The implementation of the new practice decreases the productivity of basic lines (1A, 1B and 2A) and complex lines (lines 4 and 5). However, we find mixed results for line 2B (basic line) and line 6 (complex line). All specifications show that the new practice increases the productivity of lines 3A and 3B, which produce relatively more complex products as compared to the rest of the basic lines. Therefore, we suggest that the standard management practices seem to suffice for very basic lines and complex lines, while the new practice is beneficial for lines 3A and 3B.

Significant differences were also found in the impact of the new quality management practice for lines that produce similar products. For example, differences were found between day and night shifts of lines that have a similar average standard minute value. The implementation of the new quality management practice works in the opposite manner for lines 2A and 2B according to some specifications where an increase in productivity is observed for line 2B but a decrease in productivity is observed for line 2A. Line 4 and line 6 have a similar average standard minute value but the greatest reduction in productivity due to the implementation of the new quality management practice is observed for line 4 while some specifications show a positive impact and some show a negative impact for line 6. Line 5 has the highest average standard minute value and the implementation of the new quality management practice reduces the productivity for line 5, although the magnitude is less than that of line 1A.

We also observe that the impact of the new quality management practice also varies by the change in complexity of production denoted by the deviation from the average standard minute value and this effect also differs by assembly line as some specifications show that it further amplifies the negative effect of the new quality management practice while some specifications show that this effect is insignificant.

The limitation of this study is that the data on quality defects per line is not available so we cannot provide empirical evidence on how quality defects per line changed after the implementation of the new practice.

Appendix B

Table 4: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 1 Table 3.5)

	(lag 1)	(lag 2)	(lag 3)	(lag 4)	(lag 5)	(lag 6)	(lag 7)	(lag 8)	(lag 9)	(lag 10)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Log of Workers	0.226***	0.226**	0.226**	0.226**	0.226**	0.226**	0.226**	0.226**	0.226**	0.226**
	(0.0868)	(0.0911)	(0.0936)	(0.0951)	(0.0959)	(0.0966)	(0.0974)	(0.0981)	(0.0987)	(0.0993)
Log of Materials	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***
	(0.0209)	(0.0215)	(0.0221)	(0.0224)	(0.0225)	(0.0226)	(0.0226)	(0.0227)	(0.0229)	(0.0229)
Log of Standard Minute Value	-0.0681	-0.0681	-0.0681	-0.0681	-0.0681	-0.0681	-0.0681	-0.0681	-0.0681	-0.0681
	(0.0425)	(0.0468)	(0.0498)	(0.0520)	(0.0535)	(0.0549)	(0.0560)	(0.0568)	(0.0576)	(0.0583)
Log of Target	0.171**	0.171*	0.171	0.171	0.171	0.171	0.171	0.171	0.171	0.171
	(0.0838)	(0.0960)	(0.105)	(0.111)	(0.116)	(0.120)	(0.123)	(0.125)	(0.127)	(0.128)
Quality Management Practice	-0.0488*	-0.0488*	-0.0488	-0.0488	-0.0488	-0.0488	-0.0488	-0.0488	-0.0488	-0.0488
	(0.0254)	(0.0284)	(0.0310)	(0.0333)	(0.0352)	(0.0369)	(0.0384)	(0.0398)	(0.0411)	(0.0423)
Linear Time Trend	0.000766***	0.000766***	0.000766***	0.000766***	0.000766***	0.000766***	0.000766***	0.000766***	0.000766***	0.000766***
	(0.000163)	(0.000180)	(0.000192)	(0.000203)	(0.000213)	(0.000223)	(0.000231)	(0.000238)	(0.000244)	(0.000249)
Quadratic Time Trend	-0.000000716***	-0.000000716***	-0.000000716***	-0.000000716***	-0.000000716***	-0.000000716***	-0.000000716***	-0.000000716***	-0.000000716***	-0.000000716***
	(0.000000157)	(0.000000174)	(0.000000186)	(0.000000198)	(0.000000208)	(0.000000218)	(0.000000226)	(0.000000233)	(0.000000239)	(0.000000244)
Constant	3.711***	3.711***	3.711***	3.711***	3.711***	3.711***	3.711***	3.711***	3.711***	3.711***
	(0.820)	(0.914)	(0.978)	(1.026)	(1.060)	(1.086)	(1.106)	(1.119)	(1.128)	(1.135)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 5: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 2 Table 3.5)

	(lag 1)	(lag 2)	(lag 3)	(lag 4)	(lag 5)	(lag 6)	(lag 7)	(lag 8)	(lag 9)	(lag 10)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Log of Workers	0.202**	0.202**	0.202**	0.202**	0.202**	0.202**	0.202**	0.202**	0.202**	0.202**
	(0.0863)	(0.0904)	(0.0928)	(0.0941)	(0.0948)	(0.0955)	(0.0962)	(0.0970)	(0.0976)	(0.0981)
Log of Materials	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***
	(0.0207)	(0.0214)	(0.0220)	(0.0223)	(0.0224)	(0.0225)	(0.0225)	(0.0227)	(0.0228)	(0.0229)
Log of Standard Minute Value	-0.0598 (0.0428)	-0.0598 (0.0471)	-0.0598 (0.0502)	-0.0598 (0.0524)	-0.0598 (0.0540)	-0.0598 (0.0554)	-0.0598 (0.0565)	-0.0598 (0.0574)	-0.0598 (0.0581)	-0.0598 (0.0588)
Log of Target	0.236***	0.236**	0.236**	0.236**	0.236*	0.236*	0.236*	0.236*	0.236*	0.236*
	(0.0871)	(0.100)	(0.109)	(0.116)	(0.121)	(0.125)	(0.128)	(0.131)	(0.132)	(0.134)
Quality Management Practice	-0.0554*** (0.0209)	-0.0554** (0.0235)	-0.0554** (0.0256)	-0.0554** (0.0273)	-0.0554* (0.0284)	-0.0554* (0.0293)	-0.0554* (0.0300)	-0.0554* (0.0305)	-0.0554* (0.0309)	-0.0554* (0.0312)
Time Dummy for 2014	0.0906*** (0.0248)	0.0906*** (0.0275)	0.0906*** (0.0296)	0.0906*** (0.0313)	0.0906*** (0.0326)	0.0906*** (0.0338)	0.0906*** (0.0347)	0.0906** (0.0353)	0.0906** (0.0358)	0.0906** (0.0362)
Time Dummy for 2015	0.211*** (0.0333)	0.211*** (0.0372)	0.211*** (0.0402)	0.211*** (0.0425)	0.211*** (0.0442)	0.211*** (0.0457)	0.211*** (0.0468)	0.211*** (0.0475)	0.211*** (0.0480)	0.211*** (0.0484)
Time Dummy for 2016	0.117*** (0.0350)	0.117*** (0.0388)	0.117*** (0.0416)	0.117*** (0.0439)	0.117** (0.0455)	0.117** (0.0467)	0.117** (0.0478)	0.117** (0.0484)	0.117** (0.0489)	0.117** (0.0493)
Constant	3.383***	3.383***	3.383***	3.383***	3.383***	3.383***	3.383***	3.383***	3.383***	3.383***
	(0.831)	(0.928)	(0.995)	(1.044)	(1.078)	(1.103)	(1.123)	(1.136)	(1.144)	(1.151)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses

* *p* < 0.10, ** *p* < 0.05, *** *p* < 0.010

Table 6: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 3 Table 3.5)

	(lag 1)	(lag 2)	(lag 3)	(lag 4)	(lag 5)	(lag 6)	(lag 7)	(lag 8)	(lag 9)	(lag 10)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Log of Workers	0.216**	0.216**	0.216**	0.216**	0.216**	0.216**	0.216**	0.216**	0.216**	0.216**
	(0.0873)	(0.0917)	(0.0944)	(0.0960)	(0.0970)	(0.0979)	(0.0989)	(0.0998)	(0.101)	(0.101)
Log of Materials	0.204***	0.204***	0.204***	0.204***	0.204***	0.204***	0.204***	0.204***	0.204***	0.204***
	(0.0209)	(0.0217)	(0.0223)	(0.0226)	(0.0227)	(0.0228)	(0.0229)	(0.0230)	(0.0232)	(0.0233)
Log of Standard Minute Value	-0.0798*	-0.0798*	-0.0798	-0.0798	-0.0798	-0.0798	-0.0798	-0.0798	-0.0798	-0.0798
	(0.0423)	(0.0465)	(0.0495)	(0.0516)	(0.0531)	(0.0544)	(0.0555)	(0.0563)	(0.0569)	(0.0576)
Log of Target	0.221**	0.221**	0.221**	0.221*	0.221*	0.221*	0.221*	0.221*	0.221	0.221
	(0.0869)	(0.0999)	(0.109)	(0.116)	(0.122)	(0.126)	(0.130)	(0.133)	(0.135)	(0.136)
Quality Management Practice	-0.101***	-0.101***	-0.101***	-0.101***	-0.101**	-0.101**	-0.101**	-0.101**	-0.101**	-0.101**
	(0.0277)	(0.0315)	(0.0346)	(0.0372)	(0.0395)	(0.0416)	(0.0436)	(0.0454)	(0.0472)	(0.0489)
Basic*Quality Management Practice	0.0744**	0.0744**	0.0744*	0.0744*	0.0744	0.0744	0.0744	0.0744	0.0744	0.0744
	(0.0311)	(0.0360)	(0.0400)	(0.0434)	(0.0464)	(0.0491)	(0.0515)	(0.0537)	(0.0557)	(0.0575)
Linear Time Trend	0.000814***	0.000814***	0.000814***	0.000814***	0.000814***	0.000814***	0.000814***	0.000814***	0.000814***	0.000814***
	(0.000159)	(0.000175)	(0.000187)	(0.000198)	(0.000207)	(0.000217)	(0.000225)	(0.000232)	(0.000238)	(0.000243)
Quadratic Time Trend	-0.000000763***	-0.000000763***	-0.000000763***	-0.000000763***	-0.000000763***	-0.000000763***	-0.000000763***	-0.000000763***	-0.000000763***	-0.000000763***
	(0.000000154)	(0.000000170)	(0.000000183)	(0.000000194)	(0.000000204)	(0.000000214)	(0.000000223)	(0.000000230)	(0.000000236)	(0.000000242)
Constant	3.418***	3.418***	3.418***	3.418***	3.418***	3.418***	3.418***	3.418***	3.418***	3.418***
	(0.828)	(0.924)	(0.989)	(1.038)	(1.072)	(1.098)	(1.119)	(1.132)	(1.141)	(1.149)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 7: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 4 Table 3.5)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Log of Workers	0.194**	0.194**	0.194**	0.194**	0.194**	0.194**	0.194**	0.194**	0.194**	0.194*
	(0.0865)	(0.0907)	(0.0932)	(0.0946)	(0.0955)	(0.0962)	(0.0971)	(0.0979)	(0.0986)	(0.0992)
Log of Materials	0.196***	0.196***	0.196***	0.196***	0.196***	0.196***	0.196***	0.196***	0.196***	0.196***
	(0.0208)	(0.0215)	(0.0221)	(0.0225)	(0.0226)	(0.0227)	(0.0228)	(0.0229)	(0.0231)	(0.0232)
Log of Standard Minute Value	-0.0705*	-0.0705	-0.0705	-0.0705	-0.0705	-0.0705	-0.0705	-0.0705	-0.0705	-0.0705
	(0.0427)	(0.0470)	(0.0501)	(0.0523)	(0.0539)	(0.0552)	(0.0563)	(0.0571)	(0.0578)	(0.0585)
Log of Target	0.284***	0.284***	0.284**	0.284**	0.284**	0.284**	0.284**	0.284**	0.284**	0.284**
	(0.0901)	(0.104)	(0.114)	(0.121)	(0.127)	(0.131)	(0.135)	(0.138)	(0.141)	(0.143)
Quality Management Practice	-0.104***	-0.104***	-0.104***	-0.104***	-0.104***	-0.104**	-0.104**	-0.104**	-0.104**	-0.104**
	(0.0271)	(0.0311)	(0.0342)	(0.0367)	(0.0388)	(0.0406)	(0.0423)	(0.0437)	(0.0450)	(0.0462)
Basic*Quality Management Practice	0.0710**	0.0710*	0.0710*	0.0710	0.0710	0.0710	0.0710	0.0710	0.0710	0.0710
	(0.0315)	(0.0364)	(0.0404)	(0.0438)	(0.0468)	(0.0495)	(0.0519)	(0.0541)	(0.0560)	(0.0578)
Time Dummy for 2014	0.0923***	0.0923***	0.0923***	0.0923***	0.0923***	0.0923***	0.0923***	0.0923***	0.0923**	0.0923**
	(0.0248)	(0.0276)	(0.0297)	(0.0314)	(0.0328)	(0.0340)	(0.0350)	(0.0357)	(0.0362)	(0.0366)
Time Dummy for 2015	0.216***	0.216***	0.216***	0.216***	0.216***	0.216***	0.216***	0.216***	0.216***	0.216***
	(0.0329)	(0.0368)	(0.0398)	(0.0422)	(0.0439)	(0.0453)	(0.0464)	(0.0472)	(0.0477)	(0.0482)
Time Dummy for 2016	0.121***	0.121***	0.121***	0.121***	0.121***	0.121***	0.121**	0.121**	0.121**	0.121**
	(0.0348)	(0.0386)	(0.0414)	(0.0437)	(0.0453)	(0.0466)	(0.0477)	(0.0484)	(0.0488)	(0.0493)
Constant	3.098***	3.098***	3.098***	3.098***	3.098***	3.098***	3.098***	3.098***	3.098***	3.098***
	(0.841)	(0.941)	(1.010)	(1.060)	(1.095)	(1.122)	(1.143)	(1.157)	(1.167)	(1.176)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 8: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 5 Table 3.5)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Log of Workers	0.227***	0.227**	0.227**	0.227**	0.227**	0.227**	0.227**	0.227**	0.227**	0.227**
	(0.0866)	(0.0909)	(0.0933)	(0.0947)	(0.0955)	(0.0962)	(0.0969)	(0.0977)	(0.0982)	(0.0988)
Log of Materials	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***
	(0.0209)	(0.0215)	(0.0221)	(0.0224)	(0.0224)	(0.0225)	(0.0226)	(0.0227)	(0.0228)	(0.0229)
Log of Standard Minute Value	-0.0688	-0.0688	-0.0688	-0.0688	-0.0688	-0.0688	-0.0688	-0.0688	-0.0688	-0.0688
	(0.0425)	(0.0467)	(0.0497)	(0.0519)	(0.0534)	(0.0547)	(0.0558)	(0.0567)	(0.0574)	(0.0581)
Log of Target	0.170**	0.170*	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170
	(0.0838)	(0.0960)	(0.105)	(0.111)	(0.116)	(0.120)	(0.123)	(0.125)	(0.127)	(0.129)
Quality Management Practice	-0.0494*	-0.0494*	-0.0494	-0.0494	-0.0494	-0.0494	-0.0494	-0.0494	-0.0494	-0.0494
	(0.0253)	(0.0283)	(0.0310)	(0.0332)	(0.0352)	(0.0368)	(0.0383)	(0.0397)	(0.0410)	(0.0422)
Deviation from the Average Standard Minute Value	-0.00541	-0.00541	-0.00541	-0.00541	-0.00541	-0.00541	-0.00541	-0.00541	-0.00541	-0.00541
	(0.00382)	(0.00397)	(0.00407)	(0.00416)	(0.00425)	(0.00432)	(0.00438)	(0.00441)	(0.00444)	(0.00446)
Linear Time Trend	0.000746***	0.000746***	0.000746***	0.000746***	0.000746***	0.000746***	0.000746***	0.000746***	0.000746***	0.000746***
	(0.000166)	(0.000183)	(0.000196)	(0.000207)	(0.000218)	(0.000227)	(0.000236)	(0.000243)	(0.000249)	(0.000254)
Quadratic Time Trend	-0.000000695***	-0.000000695***	-0.000000695***	-0.000000695***	-0.000000695***	-0.000000695***	-0.000000695***	-0.000000695***	-0.000000695***	-0.000000695***
	(0.000000160)	(0.000000177)	(0.000000190)	(0.000000201)	(0.000000211)	(0.000000221)	(0.000000229)	(0.000000236)	(0.000000242)	(0.000000247)
Constant	3.717***	3.717***	3.717***	3.717***	3.717***	3.717***	3.717***	3.717***	3.717***	3.717***
	(0.820)	(0.913)	(0.978)	(1.025)	(1.060)	(1.086)	(1.106)	(1.118)	(1.128)	(1.135)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 6 Table 3.5)

	(lag 1)	(lag 2)	(lag 3)	(lag 4)	(lag 5)	(lag 6)	(lag 7)	(lag 8)	(lag 9)	(lag 10)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Log of Workers	0.203**	0.203**	0.203**	0.203**	0.203**	0.203**	0.203**	0.203**	0.203**	0.203**
	(0.0861)	(0.0902)	(0.0925)	(0.0938)	(0.0945)	(0.0951)	(0.0959)	(0.0966)	(0.0971)	(0.0976)
Log of Materials	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***
	(0.0207)	(0.0214)	(0.0219)	(0.0223)	(0.0223)	(0.0224)	(0.0225)	(0.0226)	(0.0227)	(0.0229)
Log of Standard Minute Value	-0.0604 (0.0427)	-0.0604 (0.0470)	-0.0604 (0.0501)	-0.0604 (0.0523)	-0.0604 (0.0539)	-0.0604 (0.0552)	-0.0604 (0.0564)	-0.0604 (0.0572)	-0.0604 (0.0579)	-0.0604 (0.0586)
Log of Target	0.236***	0.236**	0.236**	0.236**	0.236*	0.236*	0.236*	0.236*	0.236*	0.236*
	(0.0872)	(0.100)	(0.109)	(0.116)	(0.121)	(0.125)	(0.128)	(0.131)	(0.133)	(0.134)
Quality Management Practice	-0.0568*** (0.0209)	-0.0568** (0.0234)	-0.0568** (0.0255)	-0.0568** (0.0272)	-0.0568** (0.0283)	-0.0568* (0.0292)	-0.0568* (0.0299)	-0.0568* (0.0304)	-0.0568* (0.0307)	-0.0568* (0.0311)
Deviation from the Average Standard Minute Value	-0.00463 (0.00379)	-0.00463 (0.00393)	-0.00463 (0.00403)	-0.00463 (0.00412)	-0.00463 (0.00419)	-0.00463 (0.00426)	-0.00463 (0.00431)	-0.00463 (0.00434)	-0.00463 (0.00436)	-0.00463 (0.00438)
Time Dummy for 2014	0.0889*** (0.0252)	0.0889*** (0.0279)	0.0889*** (0.0300)	0.0889*** (0.0317)	0.0889*** (0.0331)	0.0889*** (0.0343)	0.0889** (0.0352)	0.0889** (0.0359)	0.0889** (0.0363)	0.0889** (0.0367)
Time Dummy for 2015	0.209*** (0.0336)	0.209*** (0.0375)	0.209*** (0.0406)	0.209*** (0.0429)	0.209*** (0.0447)	0.209*** (0.0462)	0.209*** (0.0473)	0.209*** (0.0481)	0.209*** (0.0486)	0.209*** (0.0490)
Time Dummy for 2016	0.116*** (0.0351)	0.116*** (0.0389)	0.116*** (0.0418)	0.116*** (0.0441)	0.116** (0.0457)	0.116** (0.0470)	0.116** (0.0481)	0.116** (0.0488)	0.116** (0.0492)	0.116** (0.0496)
Constant	3.389***	3.389***	3.389***	3.389***	3.389***	3.389***	3.389***	3.389***	3.389***	3.389***
	(0.831)	(0.928)	(0.995)	(1.044)	(1.078)	(1.104)	(1.124)	(1.136)	(1.145)	(1.152)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 10: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 7 Table 3.5)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Log of Workers	0.223**	0.223**	0.223**	0.223**	0.223**	0.223**	0.223**	0.223**	0.223**	0.223**
	(0.0876)	(0.0919)	(0.0944)	(0.0959)	(0.0967)	(0.0974)	(0.0982)	(0.0989)	(0.0996)	(0.100)
Log of Materials	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***	0.207***
	(0.0210)	(0.0216)	(0.0222)	(0.0225)	(0.0226)	(0.0226)	(0.0227)	(0.0228)	(0.0229)	(0.0230)
Log of Standard Minute Value	-0.0671	-0.0671	-0.0671	-0.0671	-0.0671	-0.0671	-0.0671	-0.0671	-0.0671	-0.0671
	(0.0426)	(0.0469)	(0.0500)	(0.0522)	(0.0538)	(0.0551)	(0.0563)	(0.0572)	(0.0580)	(0.0587)
Log of Target	0.183**	0.183*	0.183*	0.183	0.183	0.183	0.183	0.183	0.183	0.183
	(0.0845)	(0.0968)	(0.106)	(0.112)	(0.117)	(0.121)	(0.124)	(0.127)	(0.129)	(0.130)
Quality Management Practice	-0.0471*	-0.0471*	-0.0471	-0.0471	-0.0471	-0.0471	-0.0471	-0.0471	-0.0471	-0.0471
	(0.0252)	(0.0282)	(0.0308)	(0.0331)	(0.0350)	(0.0367)	(0.0382)	(0.0396)	(0.0410)	(0.0422)
Deviation from the Average Standard Minute Value	0.00778	0.00778	0.00778	0.00778	0.00778	0.00778	0.00778	0.00778	0.00778	0.00778
	(0.00811)	(0.00826)	(0.00819)	(0.00816)	(0.00818)	(0.00819)	(0.00817)	(0.00813)	(0.00807)	(0.00801)
Deviation from the Average Standard Minute Value*Quality Management Practice	-0.0195**	-0.0195**	-0.0195**	-0.0195**	-0.0195**	-0.0195**	-0.0195**	-0.0195**	-0.0195**	-0.0195**
	(0.00893)	(0.00915)	(0.00920)	(0.00926)	(0.00931)	(0.00936)	(0.00937)	(0.00936)	(0.00935)	(0.00932)
Linear Time Trend	0.000792***	0.000792***	0.000792***	0.000792***	0.000792***	0.000792***	0.000792***	0.000792***	0.000792***	0.000792***
	(0.000171)	(0.000188)	(0.000201)	(0.000213)	(0.000224)	(0.000234)	(0.000242)	(0.000249)	(0.000255)	(0.000260)
Quadratic Time Trend	-0.000000732***	-0.000000732***	-0.000000732***	-0.000000732***	-0.000000732***	-0.000000732***	-0.000000732***	-0.000000732***	-0.000000732***	-0.000000732***
	(0.000000163)	(0.000000181)	(0.000000194)	(0.000000206)	(0.000000216)	(0.000000226)	(0.000000235)	(0.000000242)	(0.000000247)	(0.000000252)
Constant	3.622***	3.622***	3.622***	3.622***	3.622***	3.622***	3.622***	3.622***	3.622***	3.622***
	(0.824)	(0.918)	(0.984)	(1.033)	(1.068)	(1.094)	(1.116)	(1.130)	(1.140)	(1.148)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 8 Table 3.5)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Log of Workers	0.200**	0.200**	0.200**	0.200**	0.200**	0.200**	0.200**	0.200**	0.200**	0.200**
	(0.0868)	(0.0910)	(0.0933)	(0.0945)	(0.0953)	(0.0959)	(0.0967)	(0.0974)	(0.0980)	(0.0985)
Log of Materials	0.200***	0.200***	0.200***	0.200***	0.200***	0.200***	0.200***	0.200***	0.200***	0.200***
	(0.0208)	(0.0215)	(0.0220)	(0.0224)	(0.0224)	(0.0225)	(0.0226)	(0.0227)	(0.0228)	(0.0229)
Log of Standard Minute Value	-0.0594	-0.0594	-0.0594	-0.0594	-0.0594	-0.0594	-0.0594	-0.0594	-0.0594	-0.0594
	(0.0428)	(0.0472)	(0.0503)	(0.0525)	(0.0542)	(0.0555)	(0.0567)	(0.0575)	(0.0583)	(0.0590)
Log of Target	0.243***	0.243**	0.243**	0.243**	0.243**	0.243*	0.243*	0.243*	0.243*	0.243*
	(0.0876)	(0.101)	(0.110)	(0.117)	(0.122)	(0.126)	(0.129)	(0.132)	(0.134)	(0.135)
Quality Management Practice	-0.0518**	-0.0518**	-0.0518**	-0.0518*	-0.0518*	-0.0518*	-0.0518*	-0.0518*	-0.0518*	-0.0518*
	(0.0209)	(0.0234)	(0.0254)	(0.0270)	(0.0282)	(0.0291)	(0.0299)	(0.0304)	(0.0308)	(0.0312)
Deviation from the Average Standard Minute Value	0.00441	0.00441	0.00441	0.00441	0.00441	0.00441	0.00441	0.00441	0.00441	0.00441
	(0.00803)	(0.00822)	(0.00819)	(0.00817)	(0.00818)	(0.00820)	(0.00819)	(0.00816)	(0.00812)	(0.00808)
Deviation from the Average Standard Minute Value*Quality Management Practice	-0.0135	-0.0135	-0.0135	-0.0135	-0.0135	-0.0135	-0.0135	-0.0135	-0.0135	-0.0135
	(0.00886)	(0.00909)	(0.00917)	(0.00923)	(0.00928)	(0.00932)	(0.00934)	(0.00935)	(0.00935)	(0.00935)
Time Dummy for 2014	0.0924***	0.0924***	0.0924***	0.0924***	0.0924***	0.0924***	0.0924**	0.0924**	0.0924**	0.0924**
	(0.0257)	(0.0285)	(0.0307)	(0.0325)	(0.0339)	(0.0351)	(0.0361)	(0.0367)	(0.0372)	(0.0376)
Time Dummy for 2015	0.212***	0.212***	0.212***	0.212***	0.212***	0.212***	0.212***	0.212***	0.212***	0.212***
	(0.0340)	(0.0380)	(0.0411)	(0.0435)	(0.0453)	(0.0468)	(0.0480)	(0.0488)	(0.0493)	(0.0497)
Time Dummy for 2016	0.120***	0.120***	0.120***	0.120***	0.120***	0.120**	0.120**	0.120**	0.120**	0.120**
	(0.0357)	(0.0396)	(0.0425)	(0.0449)	(0.0465)	(0.0478)	(0.0489)	(0.0496)	(0.0501)	(0.0505)
Constant	3.334***	3.334***	3.334***	3.334***	3.334***	3.334***	3.334***	3.334***	3.334***	3.334***
	(0.834)	(0.932)	(1.000)	(1.050)	(1.084)	(1.110)	(1.131)	(1.144)	(1.154)	(1.162)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 12: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 1 Table 3.6)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Log of Workers	0.237***	0.237***	0.237**	0.237**	0.237**	0.237**	0.237**	0.237**	0.237**	0.237**
	(0.0869)	(0.0915)	(0.0945)	(0.0964)	(0.0976)	(0.0986)	(0.0997)	(0.101)	(0.101)	(0.102)
Log of Materials	0.206***	0.206***	0.206***	0.206***	0.206***	0.206***	0.206***	0.206***	0.206***	0.206***
	(0.0206)	(0.0213)	(0.0218)	(0.0222)	(0.0223)	(0.0224)	(0.0225)	(0.0227)	(0.0228)	(0.0230)
Log of Standard Minute Value	-0.124***	-0.124**	-0.124**	-0.124**	-0.124**	-0.124**	-0.124**	-0.124**	-0.124**	-0.124**
	(0.0453)	(0.0498)	(0.0529)	(0.0551)	(0.0566)	(0.0578)	(0.0587)	(0.0594)	(0.0599)	(0.0605)
Log of Target	0.158*	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158	0.158
	(0.0920)	(0.106)	(0.116)	(0.124)	(0.129)	(0.134)	(0.138)	(0.141)	(0.143)	(0.145)
Quality Management Practice	-0.122***	-0.122***	-0.122***	-0.122***	-0.122***	-0.122**	-0.122**	-0.122**	-0.122**	-0.122**
	(0.0375)	(0.0405)	(0.0429)	(0.0449)	(0.0464)	(0.0477)	(0.0490)	(0.0500)	(0.0509)	(0.0519)
Line 1B	0.0872***	0.0872***	0.0872***	0.0872***	0.0872***	0.0872***	0.0872***	0.0872***	0.0872***	0.0872***
	(0.0268)	(0.0282)	(0.0294)	(0.0304)	(0.0309)	(0.0313)	(0.0318)	(0.0320)	(0.0320)	(0.0323)
Line 2A	0.0637	0.0637	0.0637	0.0637	0.0637	0.0637	0.0637	0.0637	0.0637	0.0637
	(0.0397)	(0.0432)	(0.0457)	(0.0474)	(0.0486)	(0.0495)	(0.0501)	(0.0504)	(0.0507)	(0.0510)
Line 2B	0.101***	0.101**	0.101**	0.101**	0.101**	0.101**	0.101**	0.101**	0.101**	0.101**
	(0.0363)	(0.0393)	(0.0416)	(0.0432)	(0.0442)	(0.0449)	(0.0456)	(0.0463)	(0.0469)	(0.0475)
Line 3A	-0.257***	-0.257***	-0.257***	-0.257***	-0.257***	-0.257***	-0.257***	-0.257***	-0.257***	-0.257***
	(0.0532)	(0.0589)	(0.0631)	(0.0659)	(0.0679)	(0.0692)	(0.0704)	(0.0710)	(0.0715)	(0.0719)
Line 3B	-0.192***	-0.192***	-0.192***	-0.192***	-0.192***	-0.192***	-0.192***	-0.192***	-0.192***	-0.192***
	(0.0464)	(0.0508)	(0.0542)	(0.0571)	(0.0595)	(0.0616)	(0.0635)	(0.0651)	(0.0663)	(0.0674)

Table 12: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 1 Table 3.6)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Line 4	0.141** (0.0660)	0.141* (0.0721)	0.141* (0.0763)	0.141* (0.0797)	0.141* (0.0826)	0.141* (0.0850)	0.141 (0.0869)	0.141 (0.0883)	0.141 (0.0896)	0.141 (0.0908)
Line 5	-0.248*** (0.0818)	-0.248*** (0.0889)	-0.248*** (0.0939)	-0.248** (0.0977)	-0.248** (0.101)	-0.248** (0.103)	-0.248** (0.104)	-0.248** (0.105)	-0.248** (0.106)	-0.248** (0.107)
Line 6	0.0103 (0.0680)	0.0103 (0.0741)	0.0103 (0.0788)	0.0103 (0.0827)	0.0103 (0.0857)	0.0103 (0.0883)	0.0103 (0.0904)	0.0103 (0.0919)	0.0103 (0.0932)	0.0103 (0.0943)
Line 1B*Quality Management Practice	-0.00922 (0.0344)	-0.00922 (0.0365)	-0.00922 (0.0379)	-0.00922 (0.0391)	-0.00922 (0.0399)	-0.00922 (0.0407)	-0.00922 (0.0414)	-0.00922 (0.0418)	-0.00922 (0.0423)	-0.00922 (0.0430)
Line 2A*Quality Management Practice	0.0429 (0.0416)	0.0429 (0.0447)	0.0429 (0.0472)	0.0429 (0.0489)	0.0429 (0.0503)	0.0429 (0.0513)	0.0429 (0.0522)	0.0429 (0.0528)	0.0429 (0.0534)	0.0429 (0.0541)
Line 2B*Quality Management Practice	0.139*** (0.0407)	0.139*** (0.0441)	0.139*** (0.0468)	0.139*** (0.0487)	0.139*** (0.0501)	0.139*** (0.0512)	0.139*** (0.0523)	0.139*** (0.0534)	0.139** (0.0544)	0.139** (0.0554)
Line 3A*Quality Management Practice	0.206*** (0.0524)	0.206*** (0.0581)	0.206*** (0.0621)	0.206*** (0.0650)	0.206*** (0.0670)	0.206*** (0.0684)	0.206*** (0.0696)	0.206*** (0.0704)	0.206*** (0.0711)	0.206*** (0.0717)
Line 3B*Quality Management Practice	0.208*** (0.0481)	0.208*** (0.0524)	0.208*** (0.0557)	0.208*** (0.0584)	0.208*** (0.0606)	0.208*** (0.0625)	0.208*** (0.0642)	0.208*** (0.0655)	0.208*** (0.0666)	0.208*** (0.0677)
Line 4*Quality Management Practice	-0.0790* (0.0455)	-0.0790 (0.0503)	-0.0790 (0.0538)	-0.0790 (0.0569)	-0.0790 (0.0596)	-0.0790 (0.0619)	-0.0790 (0.0640)	-0.0790 (0.0657)	-0.0790 (0.0673)	-0.0790 (0.0687)

Table 12: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 1 Table 3.6)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Line 5*Quality Management Practice	0.0277 (0.0551)	0.0277 (0.0609)	0.0277 (0.0650)	0.0277 (0.0682)	0.0277 (0.0709)	0.0277 (0.0731)	0.0277 (0.0752)	0.0277 (0.0770)	0.0277 (0.0787)	0.0277 (0.0804)
Line 6*Quality Management Practice	0.123*** (0.0474)	0.123** (0.0525)	0.123** (0.0564)	0.123** (0.0596)	0.123** (0.0623)	0.123* (0.0646)	0.123* (0.0666)	0.123* (0.0681)	0.123* (0.0693)	0.123* (0.0702)
Linear Time Trend	0.000800*** (0.000156)	0.000800*** (0.000171)	0.000800*** (0.000182)	0.000800*** (0.000193)	0.000800*** (0.000202)	0.000800*** (0.000211)	0.000800*** (0.000218)	0.000800*** (0.000225)	0.000800*** (0.000230)	0.000800*** (0.000235)
Quadratic Time Trend	-0.000000769*** (0.000000151)	-0.000000769*** (0.000000167)	-0.000000769*** (0.000000179)	-0.000000769*** (0.000000189)	-0.000000769*** (0.000000199)	-0.000000769*** (0.000000209)	-0.000000769*** (0.000000217)	-0.000000769*** (0.000000224)	-0.000000769*** (0.000000230)	-0.000000769*** (0.000000235)
Constant	3.960*** (0.844)	3.960*** (0.947)	3.960*** (1.018)	3.960*** (1.071)	3.960*** (1.110)	3.960*** (1.138)	3.960*** (1.160)	3.960*** (1.174)	3.960*** (1.184)	3.960*** (1.192)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 13: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 2 Table 3.6)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Log of Workers	0.237***	0.237***	0.237**	0.237**	0.237**	0.237**	0.237**	0.237**	0.237**	0.237**
	(0.0867)	(0.0913)	(0.0943)	(0.0962)	(0.0974)	(0.0984)	(0.0994)	(0.100)	(0.101)	(0.102)
Log of Materials	0.206***	0.206***	0.206***	0.206***	0.206***	0.206***	0.206***	0.206***	0.206***	0.206***
	(0.0206)	(0.0213)	(0.0218)	(0.0222)	(0.0223)	(0.0224)	(0.0225)	(0.0226)	(0.0228)	(0.0229)
Log of Standard Minute Value	-0.124***	-0.124**	-0.124**	-0.124**	-0.124**	-0.124**	-0.124**	-0.124**	-0.124**	-0.124**
	(0.0452)	(0.0497)	(0.0528)	(0.0549)	(0.0565)	(0.0577)	(0.0586)	(0.0593)	(0.0598)	(0.0603)
Log of Target	0.156*	0.156	0.156	0.156	0.156	0.156	0.156	0.156	0.156	0.156
	(0.0919)	(0.106)	(0.116)	(0.123)	(0.129)	(0.134)	(0.138)	(0.141)	(0.143)	(0.145)
Quality Management Practice	-0.124***	-0.124***	-0.124***	-0.124***	-0.124***	-0.124***	-0.124**	-0.124**	-0.124**	-0.124**
	(0.0375)	(0.0405)	(0.0429)	(0.0448)	(0.0463)	(0.0476)	(0.0488)	(0.0498)	(0.0507)	(0.0517)
Line 1B	0.0873***	0.0873***	0.0873***	0.0873***	0.0873***	0.0873***	0.0873***	0.0873***	0.0873***	0.0873***
	(0.0268)	(0.0282)	(0.0294)	(0.0303)	(0.0309)	(0.0313)	(0.0318)	(0.0320)	(0.0320)	(0.0322)
Line 2A	0.0650	0.0650	0.0650	0.0650	0.0650	0.0650	0.0650	0.0650	0.0650	0.0650
	(0.0396)	(0.0431)	(0.0456)	(0.0473)	(0.0485)	(0.0494)	(0.0500)	(0.0504)	(0.0507)	(0.0511)
Line 2B	0.103***	0.103***	0.103**	0.103**	0.103**	0.103**	0.103**	0.103**	0.103**	0.103**
	(0.0362)	(0.0392)	(0.0416)	(0.0432)	(0.0442)	(0.0449)	(0.0456)	(0.0463)	(0.0470)	(0.0476)
Line 3A	-0.253***	-0.253***	-0.253***	-0.253***	-0.253***	-0.253***	-0.253***	-0.253***	-0.253***	-0.253***
	(0.0534)	(0.0591)	(0.0634)	(0.0662)	(0.0681)	(0.0695)	(0.0707)	(0.0714)	(0.0719)	(0.0723)

Table 13: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 2 Table 3.6)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Line 3B	-0.188***	-0.188***	-0.188***	-0.188***	-0.188***	-0.188***	-0.188***	-0.188***	-0.188***	-0.188***
	(0.0465)	(0.0508)	(0.0543)	(0.0572)	(0.0596)	(0.0617)	(0.0637)	(0.0652)	(0.0664)	(0.0676)
Line 4	0.144**	0.144**	0.144*	0.144*	0.144*	0.144*	0.144	0.144	0.144	0.144
	(0.0661)	(0.0723)	(0.0766)	(0.0801)	(0.0832)	(0.0856)	(0.0876)	(0.0891)	(0.0905)	(0.0917)
Line 5	-0.242***	-0.242***	-0.242**	-0.242**	-0.242**	-0.242**	-0.242**	-0.242**	-0.242**	-0.242**
	(0.0822)	(0.0895)	(0.0948)	(0.0987)	(0.102)	(0.104)	(0.105)	(0.107)	(0.108)	(0.108)
Line 6	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121	0.0121
	(0.0680)	(0.0741)	(0.0788)	(0.0827)	(0.0857)	(0.0883)	(0.0904)	(0.0920)	(0.0934)	(0.0945)
Line 1B*Quality Management Practice	-0.00929	-0.00929	-0.00929	-0.00929	-0.00929	-0.00929	-0.00929	-0.00929	-0.00929	-0.00929
	(0.0344)	(0.0365)	(0.0379)	(0.0390)	(0.0399)	(0.0407)	(0.0413)	(0.0418)	(0.0422)	(0.0430)
Line 2A*Quality Management Practice	0.0454	0.0454	0.0454	0.0454	0.0454	0.0454	0.0454	0.0454	0.0454	0.0454
	(0.0417)	(0.0449)	(0.0474)	(0.0491)	(0.0505)	(0.0515)	(0.0524)	(0.0531)	(0.0537)	(0.0543)
Line 2B*Quality Management Practice	0.142***	0.142***	0.142***	0.142***	0.142***	0.142***	0.142***	0.142***	0.142***	0.142**
	(0.0410)	(0.0444)	(0.0471)	(0.0491)	(0.0505)	(0.0516)	(0.0527)	(0.0538)	(0.0548)	(0.0558)
Line 3A*Quality Management Practice	0.205***	0.205***	0.205***	0.205***	0.205***	0.205***	0.205***	0.205***	0.205***	0.205***
	(0.0524)	(0.0581)	(0.0622)	(0.0650)	(0.0670)	(0.0685)	(0.0697)	(0.0704)	(0.0711)	(0.0717)
Line 3B*Quality Management Practice	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***
	(0.0481)	(0.0524)	(0.0557)	(0.0583)	(0.0606)	(0.0625)	(0.0641)	(0.0655)	(0.0666)	(0.0677)

Table 13: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 2 Table 3.6)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Line 4*Quality Management Practice	-0.0773* (0.0455)	-0.0773 (0.0502)	-0.0773 (0.0538)	-0.0773 (0.0568)	-0.0773 (0.0595)	-0.0773 (0.0618)	-0.0773 (0.0638)	-0.0773 (0.0656)	-0.0773 (0.0671)	-0.0773 (0.0686)
Line 5*Quality Management Practice	0.0298 (0.0549)	0.0298 (0.0607)	0.0298 (0.0647)	0.0298 (0.0679)	0.0298 (0.0705)	0.0298 (0.0727)	0.0298 (0.0747)	0.0298 (0.0765)	0.0298 (0.0782)	0.0298 (0.0798)
Line 6*Quality Management Practice	0.129*** (0.0475)	0.129** (0.0526)	0.129** (0.0565)	0.129** (0.0597)	0.129** (0.0622)	0.129** (0.0645)	0.129* (0.0665)	0.129* (0.0680)	0.129* (0.0691)	0.129* (0.0700)
Linear Time Trend	0.000780*** (0.000158)	0.000780*** (0.000173)	0.000780*** (0.000185)	0.000780*** (0.000195)	0.000780*** (0.000204)	0.000780*** (0.000213)	0.000780*** (0.000221)	0.000780*** (0.000228)	0.000780*** (0.000233)	0.000780*** (0.000238)
Quadratic Time Trend	-0.000000749*** (0.000000153)	-0.000000749*** (0.000000169)	-0.000000749*** (0.000000180)	-0.000000749*** (0.000000191)	-0.000000749*** (0.000000201)	-0.000000749*** (0.000000210)	-0.000000749*** (0.000000218)	-0.000000749*** (0.000000225)	-0.000000749*** (0.000000231)	-0.000000749*** (0.000000236)
Deviation from the Average Standard Minute Value	-0.00510 (0.00385)	-0.00510 (0.00397)	-0.00510 (0.00407)	-0.00510 (0.00415)	-0.00510 (0.00423)	-0.00510 (0.00431)	-0.00510 (0.00436)	-0.00510 (0.00438)	-0.00510 (0.00440)	-0.00510 (0.00442)
Constant	3.974*** (0.843)	3.974*** (0.946)	3.974*** (1.018)	3.974*** (1.071)	3.974*** (1.109)	3.974*** (1.137)	3.974*** (1.160)	3.974*** (1.174)	3.974*** (1.184)	3.974*** (1.192)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 4 Table 3.6)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Log of Workers	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**
	(0.0860)	(0.0905)	(0.0933)	(0.0950)	(0.0962)	(0.0971)	(0.0980)	(0.0989)	(0.0995)	(0.100)
Log of Materials	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***
	(0.0205)	(0.0212)	(0.0218)	(0.0222)	(0.0223)	(0.0224)	(0.0225)	(0.0227)	(0.0229)	(0.0230)
Log of Standard Minute Value	-0.114**	-0.114**	-0.114**	-0.114**	-0.114**	-0.114*	-0.114*	-0.114*	-0.114*	-0.114*
	(0.0457)	(0.0503)	(0.0536)	(0.0558)	(0.0574)	(0.0587)	(0.0597)	(0.0604)	(0.0609)	(0.0615)
Log of Target	0.224**	0.224**	0.224*	0.224*	0.224*	0.224	0.224	0.224	0.224	0.224
	(0.0947)	(0.109)	(0.120)	(0.127)	(0.133)	(0.138)	(0.142)	(0.145)	(0.147)	(0.149)
Quality Management Practice	-0.133***	-0.133***	-0.133***	-0.133***	-0.133***	-0.133***	-0.133***	-0.133***	-0.133***	-0.133***
	(0.0356)	(0.0384)	(0.0406)	(0.0423)	(0.0433)	(0.0440)	(0.0447)	(0.0451)	(0.0454)	(0.0457)
Line 1B	0.0849***	0.0849***	0.0849***	0.0849***	0.0849***	0.0849***	0.0849***	0.0849***	0.0849***	0.0849***
	(0.0267)	(0.0281)	(0.0293)	(0.0302)	(0.0308)	(0.0312)	(0.0317)	(0.0319)	(0.0319)	(0.0322)
Line 2A	0.0622	0.0622	0.0622	0.0622	0.0622	0.0622	0.0622	0.0622	0.0622	0.0622
	(0.0398)	(0.0433)	(0.0458)	(0.0475)	(0.0488)	(0.0496)	(0.0503)	(0.0506)	(0.0510)	(0.0514)
Line 2B	0.0976***	0.0976**	0.0976**	0.0976**	0.0976**	0.0976**	0.0976**	0.0976**	0.0976**	0.0976**
	(0.0363)	(0.0393)	(0.0416)	(0.0432)	(0.0442)	(0.0449)	(0.0456)	(0.0464)	(0.0470)	(0.0477)
Line 3A	-0.251***	-0.251***	-0.251***	-0.251***	-0.251***	-0.251***	-0.251***	-0.251***	-0.251***	-0.251***
	(0.0534)	(0.0592)	(0.0634)	(0.0662)	(0.0681)	(0.0695)	(0.0706)	(0.0712)	(0.0716)	(0.0719)
Line 3B	-0.189***	-0.189***	-0.189***	-0.189***	-0.189***	-0.189***	-0.189***	-0.189***	-0.189***	-0.189***
	(0.0460)	(0.0502)	(0.0535)	(0.0562)	(0.0584)	(0.0604)	(0.0622)	(0.0635)	(0.0645)	(0.0654)
Line 4	0.110*	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0.110
	(0.0657)	(0.0714)	(0.0752)	(0.0783)	(0.0809)	(0.0829)	(0.0845)	(0.0856)	(0.0866)	(0.0875)

Table 14: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 4 Table 3.6)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Line 5	-0.249***	-0.249***	-0.249***	-0.249***	-0.249**	-0.249**	-0.249**	-0.249**	-0.249**	-0.249**
	(0.0809)	(0.0878)	(0.0925)	(0.0961)	(0.0987)	(0.101)	(0.102)	(0.103)	(0.103)	(0.104)
Line 6	-0.00354	-0.00354	-0.00354	-0.00354	-0.00354	-0.00354	-0.00354	-0.00354	-0.00354	-0.00354
	(0.0669)	(0.0727)	(0.0770)	(0.0806)	(0.0832)	(0.0855)	(0.0872)	(0.0885)	(0.0895)	(0.0903)
Line 1B*Quality Management Practice	-0.00701	-0.00701	-0.00701	-0.00701	-0.00701	-0.00701	-0.00701	-0.00701	-0.00701	-0.00701
	(0.0343)	(0.0364)	(0.0378)	(0.0389)	(0.0398)	(0.0406)	(0.0412)	(0.0417)	(0.0422)	(0.0429)
Line 2A*Quality Management Practice	0.0455	0.0455	0.0455	0.0455	0.0455	0.0455	0.0455	0.0455	0.0455	0.0455
	(0.0417)	(0.0449)	(0.0473)	(0.0490)	(0.0503)	(0.0513)	(0.0522)	(0.0528)	(0.0533)	(0.0540)
Line 2B*Quality Management Practice	0.145***	0.145***	0.145***	0.145***	0.145***	0.145***	0.145***	0.145***	0.145***	0.145***
	(0.0407)	(0.0441)	(0.0467)	(0.0486)	(0.0500)	(0.0510)	(0.0521)	(0.0532)	(0.0542)	(0.0552)
Line 3A*Quality Management Practice	0.209***	0.209***	0.209***	0.209***	0.209***	0.209***	0.209***	0.209***	0.209***	0.209***
	(0.0524)	(0.0580)	(0.0620)	(0.0648)	(0.0667)	(0.0681)	(0.0692)	(0.0698)	(0.0704)	(0.0709)
Line 3B*Quality Management Practice	0.213***	0.213***	0.213***	0.213***	0.213***	0.213***	0.213***	0.213***	0.213***	0.213***
	(0.0475)	(0.0517)	(0.0548)	(0.0573)	(0.0593)	(0.0611)	(0.0626)	(0.0637)	(0.0646)	(0.0655)
Line 4*Quality Management Practice	-0.0613	-0.0613	-0.0613	-0.0613	-0.0613	-0.0613	-0.0613	-0.0613	-0.0613	-0.0613
	(0.0452)	(0.0497)	(0.0531)	(0.0561)	(0.0586)	(0.0608)	(0.0627)	(0.0643)	(0.0657)	(0.0669)
Line 5*Quality Management Practice	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329	0.0329
	(0.0553)	(0.0611)	(0.0652)	(0.0683)	(0.0709)	(0.0731)	(0.0751)	(0.0769)	(0.0785)	(0.0800)

Table 14: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 4 Table 3.6)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Line 6*Quality Management Practice	0.120**	0.120**	0.120**	0.120**	0.120*	0.120*	0.120*	0.120*	0.120*	0.120*
	(0.0475)	(0.0525)	(0.0565)	(0.0597)	(0.0623)	(0.0647)	(0.0667)	(0.0682)	(0.0694)	(0.0703)
Time Dummy for 2014	0.0875***	0.0875***	0.0875***	0.0875***	0.0875***	0.0875***	0.0875**	0.0875**	0.0875**	0.0875**
	(0.0246)	(0.0273)	(0.0293)	(0.0310)	(0.0323)	(0.0335)	(0.0344)	(0.0350)	(0.0354)	(0.0358)
Time Dummy for 2015	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***
	(0.0325)	(0.0363)	(0.0391)	(0.0413)	(0.0429)	(0.0443)	(0.0453)	(0.0460)	(0.0465)	(0.0468)
Time Dummy for 2016	0.111***	0.111***	0.111***	0.111***	0.111**	0.111**	0.111**	0.111**	0.111**	0.111**
	(0.0344)	(0.0381)	(0.0408)	(0.0430)	(0.0445)	(0.0457)	(0.0467)	(0.0473)	(0.0477)	(0.0481)
Constant	3.593***	3.593***	3.593***	3.593***	3.593***	3.593***	3.593***	3.593***	3.593***	3.593***
	(0.854)	(0.962)	(1.035)	(1.088)	(1.127)	(1.155)	(1.178)	(1.192)	(1.203)	(1.211)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 15: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 5 Table 3.6)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Log of Workers	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**
	(0.0859)	(0.0904)	(0.0931)	(0.0948)	(0.0960)	(0.0969)	(0.0978)	(0.0987)	(0.0993)	(0.0999)
Log of Materials	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***	0.199***
	(0.0205)	(0.0212)	(0.0217)	(0.0221)	(0.0222)	(0.0224)	(0.0225)	(0.0226)	(0.0228)	(0.0230)
Log of Standard Minute Value	-0.114**	-0.114**	-0.114**	-0.114**	-0.114**	-0.114*	-0.114*	-0.114*	-0.114*	-0.114*
	(0.0457)	(0.0503)	(0.0535)	(0.0557)	(0.0573)	(0.0586)	(0.0596)	(0.0602)	(0.0608)	(0.0613)
Log of Target	0.223**	0.223**	0.223*	0.223*	0.223*	0.223	0.223	0.223	0.223	0.223
	(0.0946)	(0.109)	(0.119)	(0.127)	(0.133)	(0.138)	(0.142)	(0.145)	(0.147)	(0.149)
Quality Management Practice	-0.135***	-0.135***	-0.135***	-0.135***	-0.135***	-0.135***	-0.135***	-0.135***	-0.135***	-0.135***
	(0.0356)	(0.0384)	(0.0405)	(0.0421)	(0.0431)	(0.0438)	(0.0444)	(0.0448)	(0.0450)	(0.0453)
Line 1B	0.0850***	0.0850***	0.0850***	0.0850***	0.0850***	0.0850***	0.0850***	0.0850***	0.0850***	0.0850***
	(0.0267)	(0.0281)	(0.0293)	(0.0302)	(0.0307)	(0.0312)	(0.0316)	(0.0318)	(0.0319)	(0.0322)
Line 2A	0.0634	0.0634	0.0634	0.0634	0.0634	0.0634	0.0634	0.0634	0.0634	0.0634
	(0.0397)	(0.0432)	(0.0458)	(0.0475)	(0.0487)	(0.0496)	(0.0502)	(0.0506)	(0.0510)	(0.0514)
Line 2B	0.0987***	0.0987**	0.0987**	0.0987**	0.0987**	0.0987**	0.0987**	0.0987**	0.0987**	0.0987**
	(0.0362)	(0.0392)	(0.0415)	(0.0432)	(0.0442)	(0.0449)	(0.0457)	(0.0464)	(0.0471)	(0.0478)
Line 3A	-0.248***	-0.248***	-0.248***	-0.248***	-0.248***	-0.248***	-0.248***	-0.248***	-0.248***	-0.248***
	(0.0537)	(0.0594)	(0.0637)	(0.0665)	(0.0685)	(0.0699)	(0.0710)	(0.0716)	(0.0721)	(0.0723)
Line 3B	-0.185***	-0.185***	-0.185***	-0.185***	-0.185***	-0.185***	-0.185***	-0.185***	-0.185***	-0.185***
	(0.0461)	(0.0504)	(0.0537)	(0.0564)	(0.0586)	(0.0606)	(0.0624)	(0.0637)	(0.0648)	(0.0657)

Table 15: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 5 Table 3.6)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Line 4	0.113*	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113
	(0.0659)	(0.0718)	(0.0757)	(0.0789)	(0.0816)	(0.0837)	(0.0854)	(0.0866)	(0.0877)	(0.0886)
Line 5	-0.244***	-0.244***	-0.244***	-0.244**	-0.244**	-0.244**	-0.244**	-0.244**	-0.244**	-0.244**
	(0.0815)	(0.0885)	(0.0935)	(0.0972)	(0.100)	(0.102)	(0.104)	(0.104)	(0.105)	(0.106)
Line 6	-0.00181	-0.00181	-0.00181	-0.00181	-0.00181	-0.00181	-0.00181	-0.00181	-0.00181	-0.00181
	(0.0669)	(0.0727)	(0.0771)	(0.0807)	(0.0833)	(0.0856)	(0.0874)	(0.0887)	(0.0897)	(0.0906)
Line 1B*Quality Management Practice	-0.00707	-0.00707	-0.00707	-0.00707	-0.00707	-0.00707	-0.00707	-0.00707	-0.00707	-0.00707
	(0.0343)	(0.0364)	(0.0378)	(0.0389)	(0.0398)	(0.0405)	(0.0412)	(0.0417)	(0.0421)	(0.0428)
Line 2A*Quality Management Practice	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478	0.0478
	(0.0418)	(0.0450)	(0.0475)	(0.0492)	(0.0506)	(0.0516)	(0.0524)	(0.0530)	(0.0536)	(0.0543)
Line 2B*Quality Management Practice	0.147***	0.147***	0.147***	0.147***	0.147***	0.147***	0.147***	0.147***	0.147***	0.147***
	(0.0410)	(0.0444)	(0.0471)	(0.0490)	(0.0503)	(0.0514)	(0.0525)	(0.0535)	(0.0546)	(0.0556)
Line 3A*Quality Management Practice	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***
	(0.0524)	(0.0580)	(0.0620)	(0.0648)	(0.0668)	(0.0681)	(0.0692)	(0.0699)	(0.0705)	(0.0709)
Line 3B*Quality Management Practice	0.212***	0.212***	0.212***	0.212***	0.212***	0.212***	0.212***	0.212***	0.212***	0.212***
	(0.0476)	(0.0517)	(0.0548)	(0.0573)	(0.0593)	(0.0611)	(0.0626)	(0.0637)	(0.0647)	(0.0655)
Line 4*Quality Management Practice	-0.0602	-0.0602	-0.0602	-0.0602	-0.0602	-0.0602	-0.0602	-0.0602	-0.0602	-0.0602
	(0.0452)	(0.0497)	(0.0530)	(0.0560)	(0.0585)	(0.0607)	(0.0626)	(0.0642)	(0.0655)	(0.0668)

Table 15: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 5 Table 3.6)

	(lag 1) Log of Production	(lag 2) Log of Production	(lag 3) Log of Production	(lag 4) Log of Production	(lag 5) Log of Production	(lag 6) Log of Production	(lag 7) Log of Production	(lag 8) Log of Production	(lag 9) Log of Production	(lag 10) Log of Production
Line 5*Quality Management Practice	0.0344	0.0344	0.0344	0.0344	0.0344	0.0344	0.0344	0.0344	0.0344	0.0344
	(0.0551)	(0.0608)	(0.0649)	(0.0680)	(0.0706)	(0.0727)	(0.0747)	(0.0765)	(0.0781)	(0.0796)
Line 6*Quality Management Practice	0.125***	0.125**	0.125**	0.125**	0.125**	0.125*	0.125*	0.125*	0.125*	0.125*
	(0.0475)	(0.0525)	(0.0565)	(0.0596)	(0.0622)	(0.0645)	(0.0665)	(0.0680)	(0.0691)	(0.0701)
Time Dummy for 2014	0.0858***	0.0858***	0.0858***	0.0858***	0.0858***	0.0858**	0.0858**	0.0858**	0.0858**	0.0858**
	(0.0249)	(0.0276)	(0.0296)	(0.0314)	(0.0327)	(0.0339)	(0.0348)	(0.0354)	(0.0358)	(0.0362)
Time Dummy for 2015	0.205***	0.205***	0.205***	0.205***	0.205***	0.205***	0.205***	0.205***	0.205***	0.205***
	(0.0327)	(0.0365)	(0.0394)	(0.0416)	(0.0433)	(0.0447)	(0.0458)	(0.0465)	(0.0469)	(0.0473)
Time Dummy for 2016	0.110***	0.110***	0.110***	0.110**	0.110**	0.110**	0.110**	0.110**	0.110**	0.110**
	(0.0345)	(0.0382)	(0.0409)	(0.0431)	(0.0447)	(0.0459)	(0.0470)	(0.0476)	(0.0480)	(0.0484)
Deviation from the Average Standard Minute Value	-0.00451	-0.00451	-0.00451	-0.00451	-0.00451	-0.00451	-0.00451	-0.00451	-0.00451	-0.00451
	(0.00382)	(0.00395)	(0.00405)	(0.00413)	(0.00421)	(0.00428)	(0.00433)	(0.00435)	(0.00437)	(0.00439)
Constant	3.605***	3.605***	3.605***	3.605***	3.605***	3.605***	3.605***	3.605***	3.605***	3.605***
	(0.854)	(0.961)	(1.035)	(1.089)	(1.127)	(1.155)	(1.178)	(1.193)	(1.204)	(1.212)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 16: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 3 Table 3.6)

	(lag 1)	(lag 2)	(lag 3)	(lag 4)	(lag 5)	(lag 6)	(lag 7)	(lag 8)	(lag 9)	(lag 10)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Log of Workers	0.238***	0.238***	0.238**	0.238**	0.238**	0.238**	0.238**	0.238**	0.238**	0.238**
	(0.0871)	(0.0918)	(0.0948)	(0.0967)	(0.0979)	(0.0989)	(0.0999)	(0.101)	(0.102)	(0.102)
Log of Materials	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***	0.208***
	(0.0208)	(0.0215)	(0.0220)	(0.0224)	(0.0225)	(0.0226)	(0.0227)	(0.0229)	(0.0230)	(0.0232)
Log of Standard Minute Value	-0.123***	-0.123**	-0.123**	-0.123**	-0.123**	-0.123**	-0.123**	-0.123**	-0.123**	-0.123**
	(0.0454)	(0.0499)	(0.0531)	(0.0553)	(0.0569)	(0.0582)	(0.0592)	(0.0599)	(0.0605)	(0.0611)
Log of Target	0.164*	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164
	(0.0921)	(0.106)	(0.116)	(0.124)	(0.129)	(0.134)	(0.138)	(0.141)	(0.143)	(0.145)
Quality Management Practice	-0.137***	-0.137***	-0.137***	-0.137***	-0.137***	-0.137***	-0.137***	-0.137***	-0.137***	-0.137***
	(0.0378)	(0.0408)	(0.0433)	(0.0452)	(0.0467)	(0.0480)	(0.0493)	(0.0503)	(0.0512)	(0.0521)
Line 1B	0.0871***	0.0871***	0.0871***	0.0871***	0.0871***	0.0871***	0.0871***	0.0871***	0.0871***	0.0871***
	(0.0268)	(0.0282)	(0.0294)	(0.0303)	(0.0309)	(0.0313)	(0.0318)	(0.0320)	(0.0320)	(0.0322)
Line 2A	0.0588	0.0588	0.0588	0.0588	0.0588	0.0588	0.0588	0.0588	0.0588	0.0588
	(0.0399)	(0.0434)	(0.0460)	(0.0476)	(0.0488)	(0.0496)	(0.0502)	(0.0506)	(0.0509)	(0.0512)

Table 16: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 3 Table 3.6)

	(lag 1)	(lag 2)	(lag 3)	(lag 4)	(lag 5)	(lag 6)	(lag 7)	(lag 8)	(lag 9)	(lag 10)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Line 2B	0.0967***	0.0967**	0.0967**	0.0967**	0.0967**	0.0967**	0.0967**	0.0967**	0.0967**	0.0967**
	(0.0361)	(0.0391)	(0.0415)	(0.0431)	(0.0441)	(0.0447)	(0.0454)	(0.0461)	(0.0468)	(0.0474)
Line 3A	-0.269***	-0.269***	-0.269***	-0.269***	-0.269***	-0.269***	-0.269***	-0.269***	-0.269***	-0.269***
	(0.0537)	(0.0593)	(0.0634)	(0.0661)	(0.0680)	(0.0694)	(0.0704)	(0.0711)	(0.0715)	(0.0718)
Line 3B	-0.204***	-0.204***	-0.204***	-0.204***	-0.204***	-0.204***	-0.204***	-0.204***	-0.204***	-0.204***
	(0.0467)	(0.0510)	(0.0543)	(0.0572)	(0.0595)	(0.0617)	(0.0636)	(0.0652)	(0.0664)	(0.0675)
Line 4	0.129*	0.129*	0.129*	0.129	0.129	0.129	0.129	0.129	0.129	0.129
	(0.0665)	(0.0728)	(0.0772)	(0.0806)	(0.0836)	(0.0860)	(0.0879)	(0.0894)	(0.0907)	(0.0919)
Line 5	-0.268***	-0.268***	-0.268***	-0.268***	-0.268**	-0.268**	-0.268**	-0.268**	-0.268**	-0.268**
	(0.0836)	(0.0912)	(0.0967)	(0.101)	(0.104)	(0.106)	(0.108)	(0.109)	(0.110)	(0.111)
Line 6	0.00190	0.00190	0.00190	0.00190	0.00190	0.00190	0.00190	0.00190	0.00190	0.00190
	(0.0683)	(0.0745)	(0.0793)	(0.0834)	(0.0864)	(0.0890)	(0.0911)	(0.0927)	(0.0940)	(0.0951)
Line 1B*Quality Management Practice	-0.00881 (0.0344)	-0.00881 (0.0365)	-0.00881 (0.0379)	-0.00881 (0.0390)	-0.00881 (0.0399)	-0.00881 (0.0406)	-0.00881 (0.0413)	-0.00881 (0.0417)	-0.00881 (0.0422)	-0.00881 (0.0429)

Table 16: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 3 Table 3.6)

	(lag 1)	(lag 2)	(lag 3)	(lag 4)	(lag 5)	(lag 6)	(lag 7)	(lag 8)	(lag 9)	(lag 10)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Line 2A*Quality Management Practice	0.0594 (0.0419)	0.0594 (0.0452)	0.0594 (0.0477)	0.0594 (0.0495)	0.0594 (0.0509)	0.0594 (0.0519)	0.0594 (0.0529)	0.0594 (0.0535)	0.0594 (0.0542)	0.0594 (0.0550)
Line 2B*Quality Management Practice	0.156*** (0.0410)	0.156*** (0.0444)	0.156*** (0.0472)	0.156*** (0.0491)	0.156*** (0.0505)	0.156*** (0.0516)	0.156*** (0.0528)	0.156*** (0.0540)	0.156*** (0.0551)	0.156*** (0.0562)
Line 3A*Quality Management Practice	0.230*** (0.0530)	0.230*** (0.0586)	0.230*** (0.0624)	0.230*** (0.0652)	0.230*** (0.0671)	0.230*** (0.0685)	0.230*** (0.0697)	0.230*** (0.0705)	0.230*** (0.0711)	0.230*** (0.0717)
Line 3B*Quality Management Practice	0.233*** (0.0486)	0.233*** (0.0528)	0.233*** (0.0559)	0.233*** (0.0586)	0.233*** (0.0608)	0.233*** (0.0627)	0.233*** (0.0644)	0.233*** (0.0658)	0.233*** (0.0669)	0.233*** (0.0680)
Line 4*Quality Management Practice	-0.0563 (0.0458)	-0.0563 (0.0505)	-0.0563 (0.0540)	-0.0563 (0.0570)	-0.0563 (0.0595)	-0.0563 (0.0617)	-0.0563 (0.0637)	-0.0563 (0.0654)	-0.0563 (0.0669)	-0.0563 (0.0683)
Line 5*Quality Management Practice	0.0705 (0.0571)	0.0705 (0.0631)	0.0705 (0.0673)	0.0705 (0.0704)	0.0705 (0.0732)	0.0705 (0.0757)	0.0705 (0.0779)	0.0705 (0.0798)	0.0705 (0.0815)	0.0705 (0.0832)

Table 16: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 3 Table 3.6)

	(lag 1)	(lag 2)	(lag 3)	(lag 4)	(lag 5)	(lag 6)	(lag 7)	(lag 8)	(lag 9)	(lag 10)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Line 6*Quality Management Practice	0.149***	0.149***	0.149***	0.149**	0.149**	0.149**	0.149**	0.149**	0.149**	0.149**
	(0.0477)	(0.0527)	(0.0565)	(0.0596)	(0.0622)	(0.0644)	(0.0663)	(0.0677)	(0.0687)	(0.0695)
Linear Time Trend	0.000843***	0.000843***	0.000843***	0.000843***	0.000843***	0.000843***	0.000843***	0.000843***	0.000843***	0.000843***
	(0.000162)	(0.000178)	(0.000190)	(0.000201)	(0.000210)	(0.000220)	(0.000227)	(0.000233)	(0.000239)	(0.000243)
Quadratic Time Trend	-0.000000798***	-0.000000798***	-0.000000798***	-0.000000798***	-0.000000798***	-0.000000798***	-0.000000798***	-0.000000798***	-0.000000798***	-0.000000798***
	(0.000000156)	(0.000000172)	(0.000000184)	(0.000000195)	(0.000000205)	(0.000000214)	(0.000000223)	(0.000000229)	(0.000000235)	(0.000000240)
Deviation from the Average Standard Minute Value	0.0162*	0.0162*	0.0162*	0.0162*	0.0162*	0.0162*	0.0162*	0.0162*	0.0162*	0.0162*
	(0.00874)	(0.00895)	(0.00891)	(0.00892)	(0.00899)	(0.00910)	(0.00914)	(0.00913)	(0.00908)	(0.00902)
Deviation from the Average Standard Minute Value*Quality Management Practice	-0.0317***	-0.0317***	-0.0317***	-0.0317***	-0.0317***	-0.0317***	-0.0317***	-0.0317***	-0.0317***	-0.0317***
	(0.00953)	(0.00977)	(0.00979)	(0.00983)	(0.00990)	(0.0100)	(0.0100)	(0.0100)	(0.00999)	(0.00993)
Constant	3.887***	3.887***	3.887***	3.887***	3.887***	3.887***	3.887***	3.887***	3.887***	3.887***
	(0.845)	(0.949)	(1.021)	(1.073)	(1.112)	(1.140)	(1.163)	(1.178)	(1.188)	(1.196)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 17: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 6 Table 3.6)

	(lag 1)	(lag 2)	(lag 3)	(lag 4)	(lag 5)	(lag 6)	(lag 7)	(lag 8)	(lag 9)	(lag 10)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Log of Workers	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**	0.219**
	(0.0861)	(0.0907)	(0.0935)	(0.0952)	(0.0963)	(0.0973)	(0.0982)	(0.0991)	(0.0997)	(0.100)
Log of Materials	0.201***	0.201***	0.201***	0.201***	0.201***	0.201***	0.201***	0.201***	0.201***	0.201***
	(0.0207)	(0.0214)	(0.0220)	(0.0223)	(0.0225)	(0.0226)	(0.0227)	(0.0229)	(0.0231)	(0.0232)
Log of Standard Minute Value	-0.114**	-0.114**	-0.114**	-0.114**	-0.114**	-0.114*	-0.114*	-0.114*	-0.114*	-0.114*
	(0.0458)	(0.0504)	(0.0537)	(0.0560)	(0.0576)	(0.0589)	(0.0599)	(0.0607)	(0.0613)	(0.0619)
Log of Target	0.226**	0.226**	0.226*	0.226*	0.226*	0.226	0.226	0.226	0.226	0.226
	(0.0945)	(0.109)	(0.119)	(0.127)	(0.133)	(0.138)	(0.142)	(0.145)	(0.147)	(0.149)
Quality Management Practice	-0.140***	-0.140***	-0.140***	-0.140***	-0.140***	-0.140***	-0.140***	-0.140***	-0.140***	-0.140***
	(0.0358)	(0.0386)	(0.0408)	(0.0425)	(0.0435)	(0.0443)	(0.0450)	(0.0454)	(0.0457)	(0.0460)
Line 1B	0.0848***	0.0848***	0.0848***	0.0848***	0.0848***	0.0848***	0.0848***	0.0848***	0.0848***	0.0848***
	(0.0267)	(0.0281)	(0.0293)	(0.0302)	(0.0307)	(0.0312)	(0.0317)	(0.0319)	(0.0319)	(0.0322)
Line 2A	0.0589	0.0589	0.0589	0.0589	0.0589	0.0589	0.0589	0.0589	0.0589	0.0589
	(0.0399)	(0.0435)	(0.0461)	(0.0478)	(0.0490)	(0.0499)	(0.0505)	(0.0509)	(0.0512)	(0.0516)

Table 17: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 6 Table 3.6)

	(lag 1)	(lag 2)	(lag 3)	(lag 4)	(lag 5)	(lag 6)	(lag 7)	(lag 8)	(lag 9)	(lag 10)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Line 2B	0.0943***	0.0943**	0.0943**	0.0943**	0.0943**	0.0943**	0.0943**	0.0943**	0.0943**	0.0943**
	(0.0362)	(0.0392)	(0.0415)	(0.0432)	(0.0442)	(0.0449)	(0.0457)	(0.0464)	(0.0471)	(0.0478)
Line 3A	-0.261***	-0.261***	-0.261***	-0.261***	-0.261***	-0.261***	-0.261***	-0.261***	-0.261***	-0.261***
	(0.0542)	(0.0599)	(0.0640)	(0.0667)	(0.0687)	(0.0700)	(0.0711)	(0.0716)	(0.0720)	(0.0722)
Line 3B	-0.199***	-0.199***	-0.199***	-0.199***	-0.199***	-0.199***	-0.199***	-0.199***	-0.199***	-0.199***
	(0.0465)	(0.0507)	(0.0539)	(0.0567)	(0.0589)	(0.0609)	(0.0626)	(0.0640)	(0.0650)	(0.0659)
Line 4	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101
	(0.0665)	(0.0726)	(0.0767)	(0.0799)	(0.0826)	(0.0847)	(0.0864)	(0.0876)	(0.0887)	(0.0896)
Line 5	-0.265***	-0.265***	-0.265***	-0.265***	-0.265**	-0.265**	-0.265**	-0.265**	-0.265**	-0.265**
	(0.0830)	(0.0904)	(0.0958)	(0.0997)	(0.103)	(0.105)	(0.107)	(0.108)	(0.108)	(0.109)
Line 6	-0.00913	-0.00913	-0.00913	-0.00913	-0.00913	-0.00913	-0.00913	-0.00913	-0.00913	-0.00913
	(0.0672)	(0.0731)	(0.0777)	(0.0814)	(0.0841)	(0.0864)	(0.0882)	(0.0895)	(0.0906)	(0.0914)
Line 1B*Quality Management Practice	-0.00675 (0.0343)	-0.00675 (0.0364)	-0.00675 (0.0378)	-0.00675 (0.0389)	-0.00675 (0.0398)	-0.00675 (0.0405)	-0.00675 (0.0412)	-0.00675 (0.0416)	-0.00675 (0.0421)	-0.00675 (0.0428)

Table 17: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 6 Table 3.6)

	(lag 1)	(lag 2)	(lag 3)	(lag 4)	(lag 5)	(lag 6)	(lag 7)	(lag 8)	(lag 9)	(lag 10)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Line 2A*Quality Management Practice	0.0586 (0.0420)	0.0586 (0.0453)	0.0586 (0.0478)	0.0586 (0.0496)	0.0586 (0.0510)	0.0586 (0.0520)	0.0586 (0.0529)	0.0586 (0.0535)	0.0586 (0.0542)	0.0586 (0.0549)
Line 2B*Quality Management Practice	0.158*** (0.0410)	0.158*** (0.0444)	0.158*** (0.0471)	0.158*** (0.0491)	0.158*** (0.0504)	0.158*** (0.0516)	0.158*** (0.0527)	0.158*** (0.0539)	0.158*** (0.0550)	0.158*** (0.0561)
Line 3A*Quality Management Practice	0.228*** (0.0532)	0.228*** (0.0587)	0.228*** (0.0626)	0.228*** (0.0653)	0.228*** (0.0672)	0.228*** (0.0685)	0.228*** (0.0696)	0.228*** (0.0703)	0.228*** (0.0708)	0.228*** (0.0712)
Line 3B*Quality Management Practice	0.232*** (0.0483)	0.232*** (0.0524)	0.232*** (0.0554)	0.232*** (0.0579)	0.232*** (0.0600)	0.232*** (0.0617)	0.232*** (0.0633)	0.232*** (0.0645)	0.232*** (0.0654)	0.232*** (0.0663)
Line 4*Quality Management Practice	-0.0426 (0.0460)	-0.0426 (0.0506)	-0.0426 (0.0540)	-0.0426 (0.0569)	-0.0426 (0.0595)	-0.0426 (0.0616)	-0.0426 (0.0635)	-0.0426 (0.0651)	-0.0426 (0.0665)	-0.0426 (0.0677)
Line 5*Quality Management Practice	0.0673 (0.0576)	0.0673 (0.0637)	0.0673 (0.0680)	0.0673 (0.0712)	0.0673 (0.0741)	0.0673 (0.0766)	0.0673 (0.0789)	0.0673 (0.0808)	0.0673 (0.0825)	0.0673 (0.0841)
Line 6*Quality Management Practice	0.141*** (0.0478)	0.141*** (0.0529)	0.141** (0.0568)	0.141** (0.0600)	0.141** (0.0625)	0.141** (0.0648)	0.141** (0.0668)	0.141** (0.0682)	0.141** (0.0693)	0.141** (0.0701)

Table 17: The Impact of the New Quality Management Practice on Firm Productivity with Autocorrelation Lag up to 10 (Column 6 Table 3.6)

	(lag 1)	(lag 2)	(lag 3)	(lag 4)	(lag 5)	(lag 6)	(lag 7)	(lag 8)	(lag 9)	(lag 10)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Time Dummy for 2014	0.0918***	0.0918***	0.0918***	0.0918***	0.0918***	0.0918***	0.0918**	0.0918**	0.0918**	0.0918**
	(0.0256)	(0.0284)	(0.0305)	(0.0323)	(0.0336)	(0.0348)	(0.0358)	(0.0364)	(0.0368)	(0.0371)
Time Dummy for 2015	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***	0.211***
	(0.0331)	(0.0369)	(0.0398)	(0.0421)	(0.0438)	(0.0451)	(0.0462)	(0.0469)	(0.0474)	(0.0477)
Time Dummy for 2016	0.117***	0.117***	0.117***	0.117***	0.117***	0.117**	0.117**	0.117**	0.117**	0.117**
	(0.0351)	(0.0389)	(0.0416)	(0.0439)	(0.0454)	(0.0467)	(0.0477)	(0.0484)	(0.0487)	(0.0491)
Deviation from the Average Standard Minute Value	0.0121 (0.00881)	0.0121 (0.00908)	0.0121 (0.00912)	0.0121 (0.00917)	0.0121 (0.00927)	0.0121 (0.00940)	0.0121 (0.00946)	0.0121 (0.00947)	0.0121 (0.00944)	0.0121 (0.00940)
Deviation from the Average Standard Minute Value*Quality Management Practice	-0.0249*** (0.00959)	-0.0249** (0.00988)	-0.0249** (0.00997)	-0.0249** (0.0100)	-0.0249** (0.0102)	-0.0249** (0.0103)	-0.0249** (0.0104)	-0.0249** (0.0104)	-0.0249** (0.0104)	-0.0249** (0.0103)
Constant	3.561***	3.561***	3.561***	3.561***	3.561***	3.561***	3.561***	3.561***	3.561***	3.561***
	(0.855)	(0.962)	(1.036)	(1.089)	(1.128)	(1.156)	(1.179)	(1.194)	(1.204)	(1.213)
Observations	7031	7031	7031	7031	7031	7031	7031	7031	7031	7031

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.6 A: The Impact of the New Quality Management Practice on Firm Productivity (excluding Line 2A*Quality Management Practice)

	(1)	(2)	(3)	(4)	(5)	(6)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Log of Workers	0.236***	0.237***	0.237***	0.218**	0.218**	0.218**
	(0.0868)	(0.0867)	(0.0870)	(0.0860)	(0.0859)	(0.0861)
Log of Materials	0.206***	0.206***	0.207***	0.199***	0.199***	0.200***
	(0.0206)	(0.0206)	(0.0208)	(0.0205)	(0.0205)	(0.0207)
Log of Standard Minute Value	-0.123***	-0.123***	-0.122***	-0.114**	-0.114**	-0.113**
	(0.0453)	(0.0452)	(0.0453)	(0.0457)	(0.0456)	(0.0457)
Log of Target	0.153*	0.151*	0.157*	0.219**	0.217**	0.219**
	(0.0916)	(0.0915)	(0.0915)	(0.0941)	(0.0941)	(0.0940)
Quality Management Practice	-0.100***	-0.101***	-0.107***	-0.109***	-0.111***	-0.110***
	(0.0346)	(0.0346)	(0.0347)	(0.0309)	(0.0308)	(0.0307)
Line 1B	0.0998***	0.101***	0.104***	0.0983***	0.0991***	0.102***
	(0.0263)	(0.0263)	(0.0265)	(0.0264)	(0.0263)	(0.0264)
Line 2A	0.0895***	0.0921***	0.0943***	0.0897***	0.0921***	0.0940***
	(0.0241)	(0.0242)	(0.0244)	(0.0238)	(0.0239)	(0.0241)

Table 3.6 A: The Impact of the New Quality Management Practice on Firm Productivity (Excluding Line 2A*Quality Management Practice)

	(1)	(2)	(3)	(4)	(5)	(6)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Line 2B	0.114***	0.116***	0.115***	0.112***	0.113***	0.112***
	(0.0302)	(0.0302)	(0.0301)	(0.0301)	(0.0301)	(0.0300)
Line 3A	-0.245***	-0.240***	-0.252***	-0.238***	-0.234***	-0.244***
	(0.0509)	(0.0513)	(0.0514)	(0.0512)	(0.0516)	(0.0519)
Line 3B	-0.180***	-0.175***	-0.187***	-0.176***	-0.172***	-0.182***
	(0.0440)	(0.0442)	(0.0444)	(0.0436)	(0.0439)	(0.0442)
Line 4	0.155**	0.159**	0.149**	0.126**	0.129**	0.121*
	(0.0637)	(0.0640)	(0.0641)	(0.0634)	(0.0638)	(0.0641)
Line 5	-0.235***	-0.229***	-0.250***	-0.236***	-0.230***	-0.247***
	(0.0806)	(0.0812)	(0.0824)	(0.0798)	(0.0805)	(0.0818)
Line 6	0.0245	0.0270	0.0215	0.0118	0.0142	0.0106
	(0.0669)	(0.0670)	(0.0672)	(0.0657)	(0.0658)	(0.0660)
Line 1B*Quality Management Practice	-0.0311	-0.0324	-0.0388	-0.0302	-0.0314	-0.0363
	(0.0336)	(0.0334)	(0.0336)	(0.0335)	(0.0334)	(0.0335)

Table 3.6 A: The Impact of the New Quality Management Practice on Firm Productivity(Excluding Line 2A*Quality Management Practice)

	(1)	(2)	(3)	(4)	(5)	(6)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Line 2B*Quality Management Practice	0.117***	0.118***	0.125***	0.121***	0.122***	0.127***
	(0.0309)	(0.0310)	(0.0309)	(0.0308)	(0.0309)	(0.0309)
Line 3A*Quality Management Practice	0.184***	0.182***	0.199***	0.185***	0.184***	0.197***
	(0.0484)	(0.0486)	(0.0491)	(0.0486)	(0.0488)	(0.0494)
Line 3B*Quality Management Practice	0.186***	0.185***	0.202***	0.190***	0.188***	0.201***
	(0.0441)	(0.0442)	(0.0448)	(0.0436)	(0.0437)	(0.0444)
Line 4*Quality Management Practice	-0.101**	-0.100**	-0.0871**	-0.0846**	-0.0846**	-0.0732*
	(0.0420)	(0.0420)	(0.0422)	(0.0419)	(0.0420)	(0.0426)
Line 5*Quality Management Practice	0.00639	0.00717	0.0396	0.0102	0.0106	0.0367
	(0.0536)	(0.0535)	(0.0557)	(0.0540)	(0.0540)	(0.0564)
Line 6*Quality Management Practice	0.102**	0.106**	0.119**	0.0976**	0.101**	0.112**
	(0.0466)	(0.0465)	(0.0467)	(0.0469)	(0.0468)	(0.0471)
Linear Time Trend	0.000795***	0.000776***	0.000836***			
	(0.000156)	(0.000158)	(0.000163)			
Quadratic Time Trend	-0.000000764***	-0.000000744***	-0.000000790***			
	(0.000000151)	(0.000000153)	(0.000000156)			
Deviation from Standard Minute Value		-0.00485	0.0157*		-0.00423	0.0116
		(0.00382)	(0.00875)		(0.00379)	(0.00881)

Table 3.6 A: The Impact of the New Quality Management Practice on Firm Productivity (Excluding Line 2A*Quality Management Practice)

	(1)	(2)	(3)	(4)	(5)	(6)
	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production	Log of Production
Deviation from Standard Minute Value*Quality Management Practice			-0.0304***			-0.0237**
			(0.00956)			(0.00961)
Time Dummy for 2014				0.0871***	0.0855***	0.0911***
				(0.0246)	(0.0249)	(0.0256)
Time Dummy for 2015				0.207***	0.205***	0.209***
				(0.0326)	(0.0328)	(0.0332)
Time Dummy for 2016				0.110***	0.109***	0.116***
				(0.0344)	(0.0345)	(0.0351)
Constant	3.987***	4.002***	3.926***	3.626***	3.638***	3.604***
	(0.842)	(0.842)	(0.844)	(0.852)	(0.852)	(0.853)
Observations	7031	7031	7031	7031	7031	7031

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Chapter 4

I. Introduction

Labour turnover is a prominent subject of labour economics, which has prompted empirical research on the effects of employee tenure on job mobility. This research complements the diverse literature on employee turnover (Jovanovic, 1979; Anderson *et al.*, 1994; Parsons, 1972; Donohue, 1988; Bishop, 1990; Sicherman, 1996).

After analysing the data for chapter 2 to study the impact of the new quality management practice on worker productivity and quality defects, a high attrition rate of workers was noticed over the period of observation i.e. August 2013 to June 2016. The factory has an average of 1400 to 1500 workers on the assembly line each day. However, there were only 648 workers who remained with the firm over the period of observation and new workers joined the firm at various points in time. This motivated us to explore the reasons for such turnover. The aim of chapter 4 is to investigate whether the new quality management practice impacts total turnover (voluntary and involuntary turnover).

The new quality management practice brings in three new features on the factory floor: rewards and recognition according to the performance of the worker, increased monitoring and peer pressure. Shocks at the workplace have been suggested to play a role in the turnover problem (Lee and Mitchell, 1994). A shock has been described as any positive, negative and neutral expected or unexpected event that shakes the employee out of steady state and initiates feelings about leaving the job. Shocks due to negative feedback during informal or formal performance appraisals have been recognised (Allen and Griffeth, 1999) and practices that aim to enhance performance increase the number of quits and dismissals as the enhanced standard may expose individuals who do not match up to the criteria of the new practice (Batt and Colvin, 2011). The research takes motivation from the theory of Lee and Mitchell (1994) to empirically test the impact of a unique quality management practice on employee turnover.

The research also draws its motivation from the job matching theory (Jovanovic, 1979) and aims to test whether the impact of the new management practice is likely to vary with job tenure. Hence, another interesting feature of this research is that it seeks to find whether the impact of the new quality management practice for workers with shorter tenures is different from the impact on workers with relatively longer tenures. There is limited empirical work on the effects of new management practices on turnover; hence, this research will fill in this gap.

A strong relationship between the shirking behaviour of workers and turnover was established in the past (Shapiro and Stiglitz, 1984). This research uses data on productivity, quality defects rate and absenteeism to analyse the impact of shirking. The research also aims to analyse whether the implementation of the new quality management accentuates the relationship between these three variables and turnover. Therefore, the main question that this chapter aims to address is whether greater monitoring and recognition of poor-quality standards people leave? Or do forms of recognition for those with higher quality standards reduce turnover?

Younger workers are known to change jobs frequently (Topel and Ward, 1992), so we also test how the implementation of the new quality management practice may alter this relationship.

The findings of chapter 2 present a strong case for significant gender differentials (potentially due to psychological gender differences and gender differences in attitudes toward competition) in the impact of the new quality management practice on productivity and the number of quality defects made, so it is worthwhile exploring whether there is any significant difference between the turnover of males and females due to the implementation of the new practice. Viscusi (1980) mentions that conclusions drawn from data sets that use a diverse set of job characteristics may not be useful. The data we use can give us useful results about gender differences as all males and females are at the same level in the hierarchy of the firm and we also control for tasks that the workers perform. The Experimental economics literature has suggested that females are more averse to competition but most of these findings have been based on laboratory experiments (Bertrand, 2011). The implementation of the new quality management increases competition at the workplace, therefore this research will further add to the literature on whether gender preferences play any role in labour market outcomes.

Previous studies on gender differentials in job turnover focus on market and non-market reasons for turnover, but there is little empirical work on gender differences in turnover due to shocks caused by the introduction of new management practices.

The study uses survival analysis, which has the advantage of considering both the occurrence and timing of turnover. A piece-wise discrete time survival model has been chosen for the analysis as tenure increments in number of discrete days.

Chapter 4 is organised as follows; Section II presents the literature review, Section III describes the data and methodology, Section IV explains the results, and section V presents the conclusion.

II. Literature Review

Employee turnover is divided into two broad categories: one that is initiated by the employee and the second, which is the decision of the organisation. In many cases, this distinction between voluntary and involuntary separation may not be relevant as turnover often occurs due to the mutual decision of the employee and employer (Bludedorn, 1978).

The literature review has been divided into two sections: one section reviews the economics literature on turnover and the other reviews the management and industrial psychology literature. The following sections go into further detail about the various theories of employee turnover, the relationship between performance and turnover, the link between absenteeism and turnover, the role of shocks in the turnover process, gender and age as determinants of job turnover, relationship of wages, monitoring and turnover and the methodologies used to understand the turnover process.

II.A. Economic Theories of Turnover

Turnover refers to the creation and termination of employee-employer job matches, and can be categorised into three parts: dissolution due to voluntary quits, layoffs or turnover due to a mutual decision (Anderson *et al.*, 1994).

From a worker's perspective, he/she will move to a new job if the gain in utility outweighs the cost of change. The quit function for an individual worker is dependent upon alternative work opportunities, job satisfaction, and monetary and non-monetary costs of quitting. Workers with higher job satisfaction are less likely to quit and workers who are assigned more complex tasks are more likely to quit as compared to workers who are given simpler tasks (Weiss, 1984).

Higher current wages and expectations of higher wages and benefits can reduce voluntary turnover. The use of compensation schemes that pay less than the marginal product early in the career and above the marginal product later in the career are also tools to reduce voluntary turnover (Anderson *et al.*, 1994; Parsons, 1972).

When a contract between an employee and employer is initiated, neither party knows how the match is going to turn out. As the match is experienced and the true productivity of the employee is revealed over time, this may cause either party to become dissatisfied with the terms of the contract. The simple job matching model infers that workers will switch jobs if one job does not seem to be a good match. All job separations are initiated by the worker, however, there is a blurred line between quits and dismissals. In this model, firms do not directly fire workers but may lower wages to an extent that is enough to induce the worker to quit. Workers who end up in good job matches will respond by not changing jobs frequently, hence longer tenures are associated with good job matches. Workers will continue jobs in which their productivity is revealed to be relatively high and will quit jobs in which their productivity is revealed to be low. Also, the probability of separation is likely to be a decreasing function of tenure as a mismatch between a worker and an employer is likely to be detected before much tenure is accrued (Jovanovic, 1979).

According to the sorting model, employers gain knowledge about the agent's type over time and each new observation regarding performance has a diminishing effect on the employer's belief about the employee's ability. The probability of dismissal is less sensitive to the employee's performance as tenure is accumulated. The incentive model suggests that employers can provide incentives in two ways; by increasing the probability of dismissal for a given level of performance or by making the probability of dismissal more sensitive to performance. Learning by doing makes an existing worker more productive as he/she gains skills at the job and becomes more expensive to dismiss over time, hence the employer will decrease the probability of dismissal. Therefore, both models suggest that average probability of dismissal will decline with tenure (Kwon, 2005).

A distinction between models of permanent separation has emerged in literature; jobs are either treated as 'experience goods' or 'pure search goods'. According to the 'experience goods' model the only way to know the quality of a job match is to experience it; new information about the current job match or an alternative job will lead to turnover (Johnson, 1978). According to the 'pure search goods' model of turnover, dissolution of current job matches takes place due to the availability of new information of an alternative match (Lucas and Prescott, 1974; Burdett, 1977).

Another component of turnover consists of the firm's decision to hire and fire workers. The value of a worker varies from one firm to the other as job changes are costlier for workers who have accumulated a substantial amount of firm specific capital (Becker, 1962; Oi, 1962).

A model of static labour demand suggests that firms will hire up to the point where wage equals the marginal revenue product. However, firms do incur adjustment costs such as training costs due to labour turnover which creates a wedge between the marginal product and the current wage. Higher adjustment costs imply lower variability of employment. However, training costs to acquire firm specific human capital may be shared between the employee and employer. Higher investments in firm specific training will provide an incentive to both the worker and firm to form long term attachments. Promoting workers with high productivity and firing workers with low productivity is another way to deal with productivity differentials. Renegotiations of lower wage rates with low productive workers may not be optimal after a certain training has been acquired by a worker (Hashimoto and Yu, 1980).

Voluntary and involuntary turnover are negatively related to an employee's productivity at small and medium non-unionised firms while productivity seems to be negatively related to dismissals at large non-unionised establishments. Productivity appears to be positively related to dismissals and quits at large unionised establishments as Fama (1980) suggested that the most productive workers are among the first to leave at firms that do not have reward structures contingent on performance (Bishop, 1990).

When wage compression is used as a tool to promote cooperation, workers of similar quality sort themselves into the same firm. After learning that their co-workers are relatively less productive, workers will tend to leave and look for employers that have a workforce of a relatively higher quality. To maintain the morale of the workforce, employers will feel the need to fire the least productive workers has been recognised by Lazear (1989) and Akerlof (1982).

According to the efficient turnover literature, formation and dissolution of employment contracts is efficient or jointly optimal, hence the quit-dismissal distinction is irrelevant (see Burdett, 1978; Jovanovic, 1979; Mortensen, 1988; McLaughlin, 1991).

According to the shirking model, the productivity of a worker is positively related to the wage rate, which provides incentives to firms to pay above the market clearing wage. The fear of termination of an employment contract can discourage workers from shirking, hence a higher wage and a higher unemployment rate raises the cost of losing a job. Firms find it optimal to fire shirkers as a wage reduction would induce the worker to shirk again. Monitoring and pay are tools to motivate workers, however, they are considered to be substitutes. When monitoring is difficult, workers have to be well paid to minimise shirking and when monitoring is easy, workers do not have to be highly paid in order to discourage them from shirking (Shapiro and Stiglitz, 1984; Bowles, 1985). Campbell (1994) showed that when local and industry unemployment rates are lower, worker dismissals are higher because presumably shirking is more frequent.

Agell and Lundborg (2003) provide little support for the shirking model and explain that workers who were found shirking were punished with a verbal reprimand. Bewley (1995) also explains that punishment should not be used to obtain cooperation between employees and employers as it impacts the morale of workers. Good morale means that workers are willing to make compromises for the organisation. Therefore, happiness of the workforce is a highly desirable attribute. After discussions with managers and labour leaders, Gintis *et al.* (2005) also suggest that the shirking model does not hold. Employers do not obtain cooperation with workers through the threat of dismissal. The threat of dismissal creates a negative environment and it impairs morale. Employers usually deal with shirking through discussions and warnings and employees are usually fired if the behaviour persists for a long period of time. Employers encourage workers to improve effort by explaining what the employer expects from workers, discussing their strengths and weakness, giving them constructive criticism and making them feel valued within the organisation.

According to the turnover cost model, at the start of a job there is a probability that the worker will be dismissed or will not be satisfied with the job and look for alternative employment opportunities. Hence, quits will be negatively related to the ease of finding another job, which will be difficult if the unemployment rate is high. Also, a higher wage reduces quits and lowers the firm's cost of hiring new workers and training them (Stiglitz, 1974; Salop, 1979).

Monitoring and pay can be substitutes or complements which depends on the source of variation among firms (Allgulin and Ellingsen, 2002; Prendergast, 1999). If the source of variation is the cost of monitoring, then wages and monitoring will act as substitutes as firms will substitute high cost supervision into wages. The two instruments will act as complements if some firms value higher effort levels than others, hence firms that value higher effort levels will use both monitoring and pay to motivate workers.

Campbell (1992) developed a model in which workers select the utility maximising effort and firms choose a profit maximising wage and monitoring intensity. Dismissals are dependent upon a firm's monitoring intensity and worker's effort. Dismissals should have a negative relationship with the cost of supervision as firms are likely to reduce the intensity of monitoring when costs of monitoring increases.

II.B. Gender and Age as Determinants of Job Turnover

Gender differences in labour force attachment that arise as females assume household responsibilities under the traditional division of labour (Azmat and Ferrer, 2017; Angelov, Johansson and Lindahl, 2016; Bertrand, Kamenica and Pan, 2015) were first explained by Mincer and Polachek (1974). It has been argued that women spend more time on household responsibilities and childcare than men do, and are considered as secondary household earners, therefore, women tend to have high turnover rates and are likely to have a more discontinuous pattern of labour force participation.

The human capital acquired by females might depreciate as females take time off from work for childcare. Decisions related to child rearing, may also induce females to delay training until they re-join their workplace. Hence, on average females will receive less training than males. Women tend to accumulate less total work experience, job specific experience and seniority as compared to men (Polacheck, 1981; Barron, Black and Loewenstein, 1993; Corcoran and Duncan, 1979). Firms may also sort women into jobs with lower training requirements due to their higher probability of turnover (Barron, Black and Loewenstein, 1993). Family migration decisions as analysed by Mincer (1978) may also be a determinant of sporadic female labour force attachments (Viscusi, 1980).

Blau and Kahn (1981) used the National Longitudinal Surveys of women and men aged between 14 and 24 and found that the relationship of quitting and current job tenure was similar for men and women after including job and personal characteristics. Viscusi (1980) used the 1976 Michigan Panel Study of Income Dynamics to estimate the quit behaviour of females and males using a logit model. A significant difference between the quit rates of men and women were found during the first year of a job, however, no significant difference was noted after the first year of job tenure.

Building on Viscusi's finding on gender differences in the first year of a job, Meitzen (1986) used the Employment Opportunities Pilot Program Employers' survey of workers with a maximum tenure of 2.5 years.

Gender differences in the job matching process were found as the probability of quitting decreased with tenure for males but increased with tenure for females. This highlights the differences in the way females do on the job learning regarding their work preferences and job discrimination. The relationship between age and the probability of quitting was stronger for females as compared to males. Older females are more likely to be attached to the job market as they may have less family responsibilities as compared to younger females. Although the probability of quitting of older men was lower as compared to younger men, the selection of older male workers into this sample of workers with short job tenures may point out to the idea that they may change jobs frequently (Meitzen, 1986).

Donohue (1988) suggests that the high female hazard rate of quitting the first job after school maybe due to fertility decisions. Sicherman (1996) uses personnel records from a firm to examine gender differences of quitting. A higher percentage of females compared to males quit their jobs due to non-market reasons such as household responsibilities. More women left their jobs due to higher wages elsewhere rather than better opportunities as compared to men. This points to gender differences in terms of career considerations as on the job training and long-term career considerations seem to be more important for men. Interestingly, although the likelihood of turnover increased for both genders in the first two months and then decreased at a decreasing rate, the likelihood of turnover for females was less than that of males after five years of job tenure. Royalty (1998) suggests that the explanation of gender differences of job turnover is incomplete without distinguishing between job-to-job and job-to-no employment transitions as the quit probabilities of educated men and women were found to be similar. Differences in turnover behaviour of men and women can be attributed to the behavioural patterns of low educated women.

Using the role of employee turnover in the efficiency wage theory, Campbell (1997) examined the determinants of turnover (quits, dismissals and layoffs) using data on individual workers. One of the important findings was that workers shirk less when there are fewer job alternatives available, hence unemployment in the local labour market has a negative relationship with dismissals. Males were more likely to be dismissed, and women were found to shirk less, which may be due to the availability of fewer job alternatives for females. This finding is in line with the evidence found by Johansson, Karimi and Nilsson (2014) such that males are more likely to shirk when there is a reduction in monitoring.

Job shopping as termed by Reynolds (1951) is a critical component of the process that leads to stable employment. One of the most consistent relationship between age and labour mobility is that the rate of job changing decreases with age (Mincer and Jovanovic, 1981).

A typical young male worker changes seven jobs during the first ten years of his career. Wage gains due to job changes can be attributed to these weak labour force attachments at the start of the career for young workers (Topel and Ward, 1992). Younger workers tend to change jobs more frequently as transferability of skills is easier for them as they have more general training because firm specific training is accumulated over time (Parsons, 1972). Parnes (1954) suggests that wage comparisons between jobs may not be the deciding factor for manual workers when switching jobs voluntarily. Seniority rules and maturation explain declining turnover with age.

II.C. Absenteeism as a Predictor of Turnover

Labour market conditions, employee values and job perceptions all combine to form intentions of quitting and before quitting employees may engage in other withdrawal patterns such as increased absenteeism (Mobley *et al.*, 1979).

Absenteeism has been divided into two types: avoidable and unavoidable. Examples of unavoidable absences include absences due to sickness and avoidable absences refer to events when workers may not have the motivation to attend work. Hence, observed absence is understood as an interaction between the ability and motivation to attend work (Chadwick-Jones, Brown and Nicholson, 1973). Voluntary absences may also be used for fulfilling aims such as testing the market for other job opportunities (Miller, 1981).

According to one view, absenteeism is perceived as a precursor of employee turnover (Lyons, 1972; Muchinsky, 1977) and a positive relationship between absenteeism and turnover has been suggested (Gupta and Jenkins, 1982). Another view suggests that absenteeism and turnover are substitutes and de-motivated workers are more likely to indulge in this behaviour, but they do not quit (Talacchi, 1960). The third view suggests that absenteeism and turnover are unrelated (March and Simon, 1958).

Withdrawal behaviors such as absenteeism reflect invisible attitudes such as dissatisfaction with the job, low levels of commitment with the organization or the intention to leave. Absenteeism is an expression of negative attachment to the organization (Hanisch and Hulin, 1991). Absence may have a positive impact on dissatisfied employees as it is an opportunity to avoid the negative emotions he/she associates with the job. On the contrary, highly satisfied workers are likely to avoid being absent from work and maintain continued attachment to their job (Blau and Boal, 1987).

Absenteeism has received less attention in economics as compared to other fields such as psychology. One of the first studies in economics that connected job satisfaction with absenteeism as implied by the psychology literature was Flanagan, Strauss and Ulman (1974). As the economy grows, the employee's demands for both monetary and non-monetary rewards will increase. Employees are assumed to be concerned with a combination of these rewards and dissatisfaction with the combination of these rewards will lead to lower productivity and a higher level of turnover and absenteeism.

Economists see absence within the static neo-classical labour supply model. Employees must supply a certain number of hours that are specified in the contract. Employees may gain utility by being absent if the number of specified hours exceed the employee's preferred number of hours. Absences arise due to the difference in the worker's marginal rate of substitution between consumption and leisure and the economic rate of substitution between income and leisure at the level of hours contracted between the employee and employer. Any changes in the marginal rate of substitution will affect the incentives for being absent. The employee's marginal rate of substitution will be relatively high when leisure is highly valued in cases of important events such as weddings and funerals and in cases of illness. According to the labour-leisure choice model, employees choose the level of voluntary absence where the marginal costs of leisure equal the marginal benefits of absence (Allen, 1981b; Allen, 1981a).

Absenteeism may not be inefficient because if there is a wedge between the marginal and economic rates of substitution the worker will have an incentive to shirk. The worker is being rational given his/her constraints. The firm faces a choice to enforce fines or threat of dismissal due to such behavior or permit this behavior. The choice will be dependent upon factors such as the nature of the production process, the relationship of the worker with other workers, and the psychology of the available workforce. If the marginal cost of enforcing the contract through penalties or threat of dismissals is greater than the marginal benefit of enforcement, then the firm will choose not to enforce the contract and permit the non-compliant behavior (Brown and Sessions, 1996).

The work discipline models of efficiency wages suggest that workers prefer leisure to work and may take days off from work given that it is difficult for the employer to distinguish between voluntary and involuntary absence. However, absenteeism is associated with a cost generated due to the increased likelihood of dismissal and loss of future income. The employee decides the level of absenteeism by weighing the probability and cost of dismissal against the benefits. The expected utility loss from dismissal rises with an increase in wage, decreases with an increase in income from other sources and adverse working environment, increases as a worker accumulates firm specific capital and with a higher expected unemployment duration (Kenyon and Dawkins, 1989). Drago and Wooden (1992) provides evidence that male, low tenured workers and workers on a higher wage are less likely to be absent while workers with better potential alternative opportunities, workers who receive sick leave pay and those who do shift work are more likely to be absent. They also suggest that the inverse relationship between job satisfaction and absenteeism can be derived from the labour-leisure theory and work discipline models as the relative utility from leisure will be low when job satisfaction is high.

Shapiro and Stiglitz (1984) suggested that the incentive to shirk decreases when unemployment is high as it would be difficult to find an alternative job if the worker is dismissed. A few studies suggested that unemployment at the regional or industry level has an inverse relationship with absenteeism (Leigh, 1985; Askildsen, Bratberg and Nilsen, 2005). Scoppa and Vuri (2014) suggest that worker's absenteeism rate can be a proxy for shirking as workers are usually provided medical insurance by the employer or the government, while the health of the worker cannot be truly observed by the employer, so there will be an incentive to take time off and still get the full salary. They provide evidence that absenteeism rate is negatively related to the unemployment rate at the provincial level and the relationship between unemployment and absenteeism was stronger in smaller firms as compared to larger firms due to the lower protection from dismissal in smaller firms.

II.D. Management and Psychological Theories of Voluntary Turnover

The traditional theories of voluntary turnover in the management literature also emphasize a similar idea as Weiss (1984) such that job satisfaction and the availability of job alternatives are key factors in determining an employee's motivation to withdraw from the organisation. These factors independently determine the decision to quit (March and Simon, 1958). Job dissatisfaction may lead to the evaluation of alternatives before the final decision to quit is made or an individual may evaluate the level of satisfaction with the current job when a job alternative becomes available before finalizing the decision (Jackofsky, 1984).

The intention to quit was also included in turnover models, as the turnover process comprises of various phases that employees go through before withdrawing. Cognitive processes such as the intention to leave, utility of turnover and job search behaviour such as the evaluation of job alternatives both combined lead to turnover (Mobley, 1977).

Price and Mueller (1981) considered organizational commitment as a factor to link job satisfaction and the intention to withdraw. Hom, Griffeth and Sellaro (1984) derived a model from Mobley's (1977) suggestion such that once employees think about leaving the job they make two decisions; employees either look at other job prospects and make a comparison with their current position or immediately resign from their current position.

The investment model suggests that commitment with the current job is defined as a function of job satisfaction i.e. rewards and costs of the job, the kind of alternative employment opportunities available and the magnitude of a worker's investment in the current job. Increase in rewards and reduction in costs increase job satisfaction and hence increase job commitment. Poor quality of alternative job opportunities tends to increase commitment with the current job. Tenure of the current job, retirement programs and acquisition of firm specific skills represent the investment of a worker in the current job and an increase in investment is associated with an increase in job commitment as it increases the cost of leaving the job. Such investments may be material, psychological, intrinsic or extrinsic (Farrell and Rusbult, 1981).

The traditional turnover models focused on job satisfaction and employee commitment however as research on turnover evolved, variables related to organizations and employee's interaction with the work environment were considered relevant to turnover theory (Abelson and Baysinger, 1984; Katz, 1978).

Organisational characteristics such as pay inequality was found to predict turnover of university administrators as institutions with more uniform pay structures were found to have lower turnover rates (Pfeffer and Davis-Blake, 1992).

Apart from variables related to organizational characteristics, emphasis on variables that accounted for employee's relationship with the organisation such as relationships with supervisors, managers and co-workers and the orientation of employee and organisational values were incorporated into turnover theory (O'Reilly, Chatman and Caldwell, 1991; Kristof, 1996; McPherson, Popielarz and Drobnic, 1992).

Lee and Mitchell (1994) introduced a unique theory of voluntary turnover known as the unfolding model. The model suggests that voluntary turnover may not always be a result of job dissatisfaction but the decision to leave maybe initiated by a shock experienced by the employee. A shock has been described as any positive, negative and neutral expected or unexpected event that shakes the employee out of steady state and initiates feelings about leaving the job. Examples of shocks include takeover of a firm by another organisation, change in marital status, negative evaluations, and disagreement with a boss or not getting a promotion that an employee deserved.

People may experience various circumstances when they quit their jobs, however they may follow one of the four behavioural paths while leaving their current job. Path 1 suggests that an employee may act upon a pre-existing script because of a shock. Job satisfaction plays no role in this path and a quit response is done with minimal planning. Path 2 suggests that a shock, which is usually negative, may lead to image violations. Individuals compare the circumstances generated by the shock to their images such as values and goals, hence thoughts of withdrawal emerge if their values and strategies are not aligned with those of the organisation or those reflected in the shock. The employee would leave without searching for job alternatives in this path. In path 3, a worker may seek job alternatives due to the shock and may leave due to the availability of job alternatives. Path 4 suggests that the decision to quit is initiated not because of a shock but as employees reassess their job commitment from time to time and leave as the employee maybe dissatisfied with the job. The employee may leave with or without seeking job alternatives (Lee and Mitchell, 1994; Lee *et al.*, 1996; Lee *et al.*, 1999).

Negative feedback during informal or formal performance evaluations can also act like a shock that may lead to intentions of leaving or immediate quitting (Allen and Griffeth, 1999). Further, Kammeyer-Mueller *et al.* (2005) and Iverson and Pullman (2000) report that critical events also predicted turnover in a manner distinct from the operation of attitudes, which is consistent with the notion of shocks advanced by the unfolding model (Lee and Mitchell, 1994).

When looking at the results from previous studies, it seems that employees who quit due to low job satisfaction are likely to be poor performers, while better performers who quit are more likely to have a higher level of job satisfaction. Hence, if only job satisfaction is considered as a factor in employee turnover, it will be difficult to understand why high performers leave. Therefore, shocks should be incorporated into turnover models as they may offer a better mechanism to predict the turnover of high performers. The psychological process suggested by path 3 according to the unfolding model happens due to a shock but also considers relative dissatisfaction. Therefore, the purpose of including shocks into turnover theory is not to replace existing theory but to enhance it (Holtom *et al.*, 2005).

II.E. Performance and Turnover

Studies show that poor performers are more likely to exit. Examples include mail order house employees (Giese and Ruter, 1949), sewing machine operators (Lefkowitz, 1970), navy enlisted personnel (Rocco, Pugh and Gunderson, 1977), electric company employees in Japan (Marsh and Mannari, 1977), nurses (Seybolt, Pavett and Walker, 1978), bank tellers (Stumpf and Dawley, 1981) and managerial, professional and technical employees (Dreher, 1982).

In contrast, studies on scientists (Allison, 1974), university employed social scientists (Lazarsfeld and Thielens, 1958) and employees of General Electric Missile and Space Division (Bassett, 1967) established a positive relationship between job performance and voluntary turnover. A third opinion on the relationship between job performance and turnover suggests that there is no link between the two variables (Martin, Price and Mueller, 1981; Sheridan and Vredenburgh, 1979).

Job performance has been identified as a significant predictor of both voluntary and involuntary separation (Wanous, Stumpf and Bedrosian, 1979). Practices that aim to enhance performance increase the number of quits and dismissals as the enhanced standard may expose individuals who do not match up to the criteria of the new practice (Batt and Colvin, 2011).

A curvilinear relationship may exist between job performance and turnover. Employees with high job performance are more likely to quit due to the availability of more job alternatives. Relatively lower but adequate performers are more likely to stay due to fewer job alternatives while low performers are dismissed by employers (Jackofsky, 1984; Trevor, Gerhart and Boudreau, 1997). Poor performers have a lower level of job satisfaction as compared to high performers (Judge *et al.*, 2001), have a higher rate of absenteeism (Viswesvaran, 2002) and are more likely to quit (Griffeth, Hom and Gaertner, 2000).

Low performance combined with the threat of dismissal may cause employees to quit on their own (Jackofsky, 1984; Vroom, 1964). To avoid consequences of negative evaluations, employees are sometimes asked to quit which is then recorded as a voluntary decision on official records (Hom and Griffeth, 1995; Kraut, 1975).

Evidence from studies and meta-analyses suggests that low performers are more likely to leave (Williams and Livingstone, 1994; McEvoy and Cascio, 1987; Bycio, Hackett and Alvares, 1990); however, there is a variation in the performance-turnover relationship in the presence of pay contingent on performance. Dreher (1982) proposed that the presence of reward contingencies lead to higher outcomes for high performers and therefore, induce a greater level of job satisfaction and reduce the attractiveness of alternative jobs. For low performers, reward contingencies could reduce satisfaction as the rewards generate fewer intrinsic and extrinsic benefits. The negative-performance turnover relationship is stronger when rewards are linked to performance (Harrison, Virick and William, 1996; Williams and Livingstone, 1994).

II.F. Methodologies for modelling employee turnover

The use of an appropriate methodology is an important concern while modelling employee turnover. The decision of the choice of methodology depends upon the research question and the nature of data.

Survival analysis can model the conditional probability of an event at a particular time, given that it has not happened prior to that time and can handle right censored data (Morita, Lee and Mowday, 1993). The duration of retention of employees is an important factor in understanding turnover. Employee turnover should be studied by analysing information on both the timing and occurrence of the event (Morita, Lee and Mowday, 1989; Morita, Lee and Mowday, 1993; Somers, 1996; Singer and Willett, 1993; Meitzen, 1986; Donohue, 1988). Incorporating the duration of retention of employees is a relevant factor in understanding the turnover problem as questions regarding 'when' and 'why' of employee withdrawal are addressed (Hoverstad, Moncrief and Lucas, 1990).

While using survival analysis, researchers must choose whether time is to be treated as continuous or discrete. The choice of modelling is derived through the nature of available data. If time varying covariates are measured in a continuous manner and an exact measure of the timing of turnover is available, then a continuous model is appropriate. However, if time varying covariates are measured in intervals along a time scale then a discrete time model is preferable (Yamaguchi, 1991; Jenkins, 1995).

II.G. Conclusion

Research in the field of economics and management has suggested that performance is a significant predictor of turnover (Bishop, 1990; Shapiro and Stiglitz, 1984; Williams and Livingstone, 1994; Dreher, 1982;), but shocks or critical events such as negative feedback during appraisals may also play a vital role in the turnover process (Lee and Mitchell, 1994).

Turnover in this study is defined as a worker exiting the firm, it is not disaggregated into voluntary or involuntary turnover. Job performance indicators such as quantity of garments produced and quality defects are used in this chapter to test whether there is a negative relationship between job performance and turnover. The research also draws its motivation from the job matching theory (Jovanovic, 1979) and aims to test whether the impact of the new management practice is likely to vary with job tenure. A strong relationship between the shirking behaviour of workers and turnover has been suggested in the past (Shapiro and Stiglitz, 1984). This research uses productivity, defects rate and absenteeism[68] to analyse the impact of shirking on turnover. The research also aims to analyse whether the implementation of the new quality management changes the relationship between these three variables and turnover. Younger workers are known to change jobs frequently (Topel and Ward, 1992; Frederiksen, 2008; Weiss, 1984), hence we also test how the implementation of the new quality management practice may alter this relationship. These variables have been explained in more detail in the empirical methodology section.

Significant differences in the male-female turnover patterns were observed in the past (Donohue, 1988; Sicherman, 1996; Viscusi, 1980; Meitzen, 1986). This research draws motivation from previous gender differences found in research and tests whether there are gender differences in employee turnover due to shocks at the workplace. A dummy variable was initially used to analyse gender differences but later the sample has been split by gender as explained in section IV.

Job satisfaction and job commitment have also been identified as prominent predictors of turnover (Weiss, 1984; March and Simon, 1958; Farrell and Rusbult, 1981; Price and Mueller, 1981). However, as we do not have data on job satisfaction or job commitment, we are unable to test this relationship.

[68] Scoppa and Vuri (2014) suggest that absenteeism can be a proxy for shirking.

III.Data and Methodology

III.A. Descriptive Statistics and Data Structure

Turnover in this study is defined as a worker exiting the firm, it is not disaggregated into voluntary or involuntary turnover. All workers in the study are paid piece rates and do not have a requirement to serve a notice period before leaving. The sample for this study was generated by a combination of two sampling methods; stock sampling and inflow sampling. Stock sampling is when individuals occupying a state at a certain point in time are selected into the sample and inflow sampling is when some spells start during the observation window. The observation window consists of a total of 852 working days. Data collection started on 1st August 2013 and ended on 1st June 2016. The new quality management practice was introduced on 15th September 2014. The sample contains workers that were employed by the firm on 1st August 2013 and workers who started working at the firm during the observation window. The date of joining of workers who were already employed by the firm at the start of the observation window is also known. There are 648 workers who did not experience turnover by the time data collection ended, hence there are some right-hand censored observations.

Table 4.1: Summary Statistics

	Mean	Standard deviation	Minimum	Maximum
Quantity	1056.97	1045.36	1.00	10000.00
Defects	0.01	0.67	0.00	50.00
Age	27.37	5.68	16.14	55.73
Tenure	4.47	3.70	0.00	21.16
Standard Minute Value	0.43	0.27	0.05	1.25
Absence Rate	0.17	0.06	0.056	0.81
Observations	769491			

Table 4.1 presents the summary statistics of the data analysed in this chapter. An unbalanced data set containing 769,491 worker-day level observations covering 1406 workers and 852 working days has been used for the analysis. The average number of working days in the sample is 378. The mean quantity of pieces of garments produced by workers per day is 1056.97 garments, while the minimum is 1 and maximum is 10000. The standard deviation of the variable quantity is quite large indicating that the number of garments produced by workers is spread out over a large range of values. The average of quality defects made by workers per day is 0.096, while the minimum is 0 and maximum is 50. This indicates that the average quality defects made by workers are low as the value is close to zero. The standard deviation of defects is 0.67, which is greater than the mean as the sample contains values which are zero. The mean tenure of workers is 4.471 years. Minimum tenure is 0 and maximum is 21.162 years; the range of tenure is quite spread out. The mean tenure of workers is 4.471 which is low given that the maximum tenure in the sample is 21.162 years. The mean age is 27.376 years, the minimum age is 16.142 years and maximum is 55.732 years. The range of age indicates a mix of young and older workers in the sample. The standard minute value that represents the time it takes to perform a task by an operative is 0.436 minutes. The minimum standard minute value is 0.053 minutes and maximum is 1.25 minutes. The absence rate is defined as the number of absences of a worker as a percentage of total days worked at the firm. The mean absence rate is 0.171 i.e. 17.1 percent, while the minimum is 5.6 percent and maximum is 80.7 percent.

Table 4.2: Unconditional Differences in the Mean of Key Variables by Gender

	Mean of Females	Mean of Males	Difference
Quantity	993.808	1116.896	123.1***
			(51.22)
Defects	0.075	0.116	0.0406***
			(26.51)
Age	26.674	28.041	1.367***
			(106.48)
Tenure	4.137	4.789	0.652***
			(77.27)
Standard Minute Value	0.439	0.434	-0.00419***
			(-6.84)
Absence Rate	0.167	0.175	0.00886***
			(69.10)
Observations	374575	394916	

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.2 presents the unconditional differences in the mean of key variables by gender. Significant differences were found between sexes. The average daily number of piece of garments produced by males is 1116.89 and the average number produced by females is 993.80. The average number of defects made per day by females is 0.075 and for males is 0.116. Given that the number of garments produced by males is higher as compared to the number of garments produced by females but the average number of quality defects made by females are lower as compared to males is not surprising. The orientation of females towards precise tasks such as sewing is derived from the 'nimble fingers hypothesis' (Elson and Pearson, 1981). In a survey of 150 garment manufacturing firms, Haque (2009) also reports that managers and supervisors often find females to be more disciplined, produce better quality garments but the stitching speed of females is lower than that of males, so productivity of females is lower.

The average age of females is 26.674 years and for males is 28.041 years. The average job tenure of females is 4.137 years and the average tenure for males is 4.789 years. The average standard minute value of tasks performed by females is 0.439, while for males it is 0.434. The average percentage of absence of females over the period of employment is 16.7

percent and for males is 17.5 percent.

III.B. Choice of Model

We use survival analysis for testing our hypothesis. The methodology was motivated by the use of survival analysis to study employee turnover by Donohue (1988) and Meitzen (1986). One of the most important decisions when using survival analysis is to choose whether to consider time as discrete or continuous. Allison (1984) suggests that this choice should depend upon the data generation process and researcher convenience.

An important consideration in this decision is to look at the unit used to measure the timing of the event. If the exact timing of the event is known, a continuous model should be used. Discrete time models will be more appropriate if time is broadly measured for example in intervals such as months or years. However, sometimes time is truly discrete i.e. events can only occur at certain distinct points in time (Yamaguchi, 1991).

A discrete time model is appropriate for this research as we have daily discrete records of tenure and daily performance measures of workers such as quantity produced and quality defects. Also, the data contains gaps as the firm was closed on weekends and for other public holidays, hence turnover can only occur at certain points in time.

III.C. The survivor and hazard function when time is intrinsically discrete

The length of a spell for an individual is a discrete variable T with a cumulative distribution function, F(t), and probability density function, f(t).

F(t) is the failure function and the survivor function is:

$S(T) = 1 - F(T)$ (1)

When survival times are intrinsically discrete, survival time T is a discrete random variable with the probability of failure

$f(j) \equiv fj = \Pr(T = j)$ (2)

Where $j \in \{1,2,3,\dots\}$ the set of positive integers which indexes time periods.

The discrete time survivor function for period j, showing the probability of survival for j periods, is given by:

$S(j) = \Pr(T \geq j) = \sum_{k=j}^{\infty} f(k)$ (3)

The value of the survivor function at *(j-1)*th period is:

$\Pr(T = (j-1)) = 1 - F(j-1) = S(j-1)$ (4)

The probability of the event (turnover in our case) at the *j*th period is

$\Pr(j-1 \leq T \leq j) = F(j) - F(j-1)$ (5)

The discrete time hazard at j, h(j) is the conditional probability of the event at j (with conditioning on survival until *j-1*) is:

$h(j) = \Pr(T = j \mid T \geq j)$ (6)

$$h(j) = \frac{f(j)}{S(j-1)} \qquad (7)$$

$$h(j) = \frac{S(j-1) - S(j)}{S(j-1)} \qquad (8)$$

$$h(j) = 1 - \frac{S(j)}{S(j-1)} \qquad (9)$$

The survivor function for the jth period can also be expressed as

$S(j) = (1-h_1)(1-h_2)(1-h_3) \dots\dots (1-h_{j-1})(1-h_j)$ (10)

$$S(j) = \prod_{k=1}^{j} (1-h_k) \qquad (11)$$

The discrete time failure function for the jth period can be expressed as

$$F(j) = 1 - \prod_{k=1}^{j} (1-h_k) \qquad (12)$$

The probability density function can be written as:

$$f(j) = S(j-1) - S(j) \quad (13)$$

$$f(j) = h_j S_{(j-1)} = \frac{h_j}{h_{(j-1)}} S_j \quad (14)$$

Hence, the discrete density is the probability of survival up to (j-1)th interval, multiplied with the probability of exiting at the jth period.

Table 4.3: Survival by Time Intervals

	Full Sample			Males			Females		
Interval (in days)	Beginning Total	Experienced Turnover (number of workers)	Censored	Beginning Total	Experienced Turnover	Censored	Beginning Total	Experienced Turnover	Censored
0 to 300	1406	81	0	748	67	0	658	14	0
301 to 600	1325	87	0	681	54	0	644	33	0
601 to 900	1238	192	0	627	109	0	611	83	0
901 to 1200	1046	87	195	518	40	94	528	47	101
1201 to 1800	764	114	144	384	46	65	380	68	79
1801 to 2700	506	93	139	273	43	77	233	50	62
2701 to 3300	274	42	40	153	11	24	121	31	16
3301 to 3900	192	35	52	118	15	29	74	20	23
3901 to 7542	105	27	78	74	15	59	31	12	19
Total	6856	758	648	3576	400	348	3280	358	300

The table above illustrates the number of workers who experienced turnover in each interval and the number of workers for whom we have censored data. As shown above, there are 758 workers who experienced turnover during the observation window and there are 648 workers who did not experience turnover during the observation window, hence data is censored. Out of 748 males, 400 experienced turnover during the observation window while there is censored information for 348 males. Out of 658 females, 358 experienced turnover during the observation window and there is censored data for 300 females.

Table 4.4: Hazard Rate of the Full Sample, Males and Females

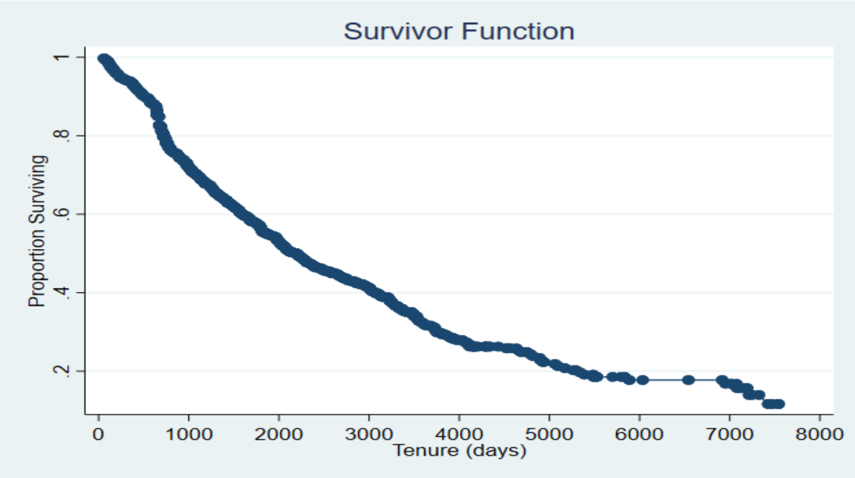
		Full sample			Males			Females		
Dummy Variable	Interval (in days)	Beginning Total	Cumulative Failure	Hazard Rate	Beginning Total	Cumulative Failure	Hazard Rate	Beginning Total	Cumulative Failure	Hazard rate
D1	0 to 300	1406	0.0576	0.000232	748	0.0896	0.00030	658	0.0213	0.00007
D2	301 to 600	1325	0.1195	0.000461	681	0.1618	0.00026	644	0.0714	0.00017
D3	601 to 900	1238	0.256	0.000358	627	0.3075	0.00057	611	0.1976	0.00045
D4	901 to 1200	1046	0.3179	0.000268	518	0.361	0.00026	528	0.269	0.00030
D5	1201 to 1800	764	0.4197	0.000233	384	0.4375	0.00020	380	0.3998	0.00030
D6	1801 to 2700	506	0.5264	0.000207	273	0.5261	0.00018	233	0.5286	0.00024
D7	2701 to 3300	274	0.599	0.000284	153	0.5602	0.00012	121	0.6494	0.00043
D8	3301 to 3900	192	0.6721	0.000297	118	0.6161	0.00021	74	0.7441	0.00045
D9	3901 to 7542	105	0.7564	0.0001	74	0.6939	0.00006	31	0.8432	0.00011

The hazard rate illustrates the risk of turnover during each time interval as shown in table 4.4 and plotted against tenure intervals (working days) in figure 6. The higher the hazard rate, the greater is the risk of exiting the firm.

III.D. Non-Parametric Survival Analysis

Non-parametric analysis was initially performed as it informs us about the pattern of duration dependence (relationship between the hazard function and survival time) and may help us choose an appropriate parametric model. Non-parametric analysis can be done for discrete time data by using the lifetable method. The lifetable provides estimates of survival, failure and hazard functions.

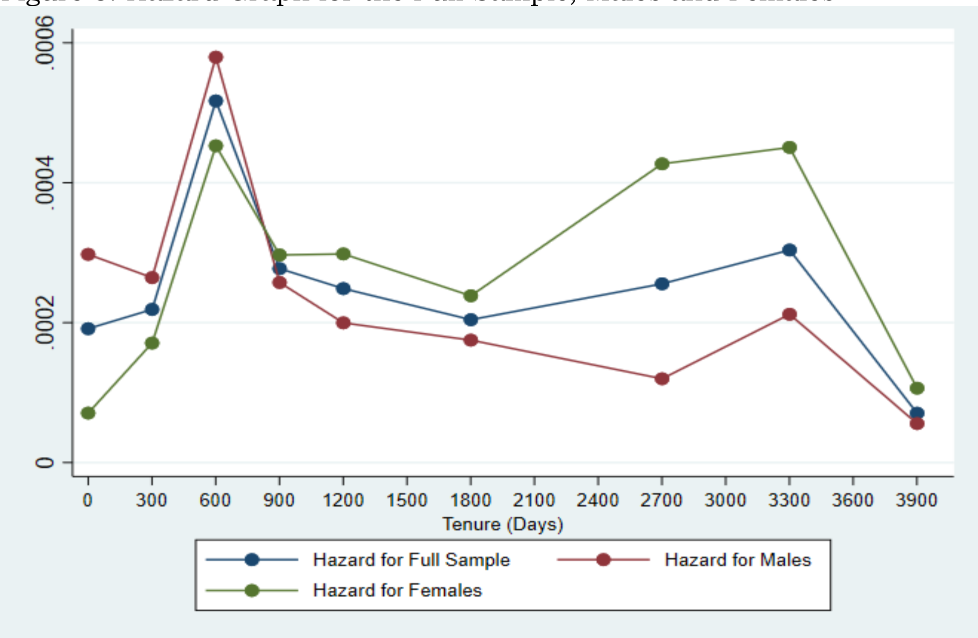
Figure 5: Survivor Function for the Full Sample



The survivor function illustrates the survival probability (proportion of the population that survives at each period) where time is given in number of working days. Figure 5 shows that at the beginning of the study survival probability is 1. However, as time progresses, the survival probability decreases.

The discrete time hazard is the conditional probability that the worker will exit at a certain time interval given that the worker has not exited at the beginning of the time interval. The discrete time hazard rate cannot be estimated for periods when there are no events. For such values, the hazard rate equals to zero. The interpretation of the hazard rate when no event occurs is difficult. One strategy is to suppose that the hazard rate is zero when no event occurs, however, this seems to be implausible as there is no obvious justification for such an assumption. A more plausible strategy is to derive the hazard rate while assuming that the hazard is constant over a broader time interval. The grouping of intervals was redefined (as shown in tables 4.3 and 4.4) so that there are sufficient events per interval to derive the hazard rate. Bergström and Edin (1992) show that whether daily data is aggregated according to weeks, months or quarters in a discrete time semi parametric model, the parameter estimates are stable. Initially, daily tenure data was aggregated into quarterly intervals, where 300 working days[69] represent a quarter. However, while creating the intervals we found that even when daily data is transformed into quarterly data there were some intervals where there were no events or very few events so the hazard rate could not be generated. A more plausible way of dealing with this is to suppose that the hazard rate is constant over a longer interval in some cases (see Jenkins, 2008). The full sample was used for analysis and then the data was split by gender to analyse gender differences. To keep the tenure intervals consistent across the analysis of the full sample and then by gender, we needed to make sure that there are sufficient events to generate the hazard rate in both cases. As shown in tables 4.3 and 4.4, daily data is aggregated into quarters up to 1200 days and then broader intervals are created so that the hazard rate can be interpreted.

Figure 6: Hazard Graph for the Full Sample, Males and Females



[69] Approximately 24 working days in a month as alternative saturdays are working days.

Figure 6 illustrates the hazard rates of the full sample and the relative positions of the hazard rates of males and females[70]. The graph shows two peaks: one at 601 days and the other at 3301 days. The hazard rate increases until 600 days, then decreases until 1800 days, and increases again until 3300 days after which it decreases again.

The hazard rate of males and females increases between 0 and 600 days and then falls between 601 and 900 days. At 901 days, the hazard rate of males becomes lower than the hazard rate of females. The hazard rate of females remains constant between 901 and 1200 days, while the hazard rate of males decreases. The hazard rate of males continues to decrease until 2700 days, while the hazard rate of females decreases between 1201 and 1800 days, and then rises until 2700 days. The hazard rate of males and females increases between 2701 and 3300 days after which the hazard rate for both genders decreases.

The hazard rate is increasing at the beginning, and then decreases after 600 days until 1800 days, this seems to be consistent with the job matching theory (Jovanovic, 1979). Workers will have a higher probability of quitting in the initial years of employment as the arrival of bad information is more likely to take place at the beginning of the employment. Workers will remain in jobs in which they perform well and will leave jobs in which their productivity is found to be low. Workers who end up in good job matches will respond by not changing jobs frequently. Moreover, longer tenures are associated with good job matches. Workers are also less likely to leave after they accumulate firm specific training (Becker, 1962). The human capital theory and job matching theory both predict that the probability of turnover will decline with tenure.

However, the hazard rate rises again after 1800 days until 3300 days, which may reflect the effects of boredom. The relationship between job tenure and job performance may even be slightly negative due to greater

[70] The graph connects hazard rates at the beginning of the interval.

boredom among workers with a long job tenure. The effects of learning by doing exist but boredom is likely to set in eventually. As time passes, there might be a negative effect on productivity, which is called on the job sensory deprivation (Medoff and Abraham, 1980). Workers are unlikely to remain in jobs which they dislike or where they perform poorly (Kanfer et al. 1988; Schneider 1987; Jovanovic 1979). Hutchens (1987) also suggests that piece rate jobs usually involve doing repetitive tasks and are conducive to monitoring and tend not to have job characteristics such as pensions and long job tenures.

III.E. Choice of Functional Form for the Model

After deciding the unit of time, which is discrete in our case, the next important step is to specify how the hazard rate depends upon time and independent variables.

The most popular choice for the discrete time model is the logistic regression function (Cox, 1972; Myers, Hankey and Mantel, 1973; Byar and Mantel, 1975). A time discrete piecewise-constant exponential model will be used to estimate the hazard rate in this chapter. The hazard rate is assumed to be constant within pre-specified time intervals as shown in table 4.4, but the hazard rate may vary between intervals. An advantage of this specification is that it does not impose strong assumptions about the shape of the baseline hazard function in advance (Singer and Willett, 1991; Singer and Willett, 1993). With this specification, one can explore how the hazard rate varies with survival time, and one can later choose one of the parametric specifications in the light of this check.

III.F. Model

The empirical methodology is motivated by the work of Jenkins (1995) on the use of discrete time survival analysis. The following equations were estimated using a random effects logit specification. The unit of analysis in the model is the person-period (Allison, 1982; Singer and Willett, 1991; Singer and Willett, 1993). Each observation or row of the data matrix was a person-day.

Model 1 (base model)

$$logit(turnover_{ij}) = \sum_{k=1}^{9} \alpha_k D_k + \beta_1 Q_{ij} + \beta_2 Y_{ij} + \beta_3 G_i + \beta_4 P_j + \beta_5 A_{ij} + \beta_6 X_i + \beta_7 SMV_i + \varepsilon_{1i} \quad (15)$$

Model 2 (model with interaction terms of tenure and the quality management practice)

$$logit(turnover_{ij}) = \sum_{k=1}^{9} \alpha_k D_k + \beta_1 Q_{ij} + \beta_2 Y_{ij} + \beta_3 G_i + \beta_4 P_j + \beta_5 A_{ij} + \beta_6 X_i + \beta_7 SMV_i + \sum_{k=1}^{9} \alpha_k D_k * P_j + \varepsilon_{2i} \quad (16)$$

Model 3 (model with the interaction between quantity and the quality management practice)

$$logit(turnover_{ij}) = \sum_{k=1}^{9} \alpha_k D_k + \beta_1 Q_{ij} + \beta_2 Y_{ij} + \beta_3 G_i + \beta_4 P_j + \beta_5 A_{ij} + \beta_6 X_i + \beta_7 SMV_i + \sum_{k=1}^{9} \alpha_k D_k * P_j + \gamma P_j Q_{ij} + \varepsilon_{3i} \quad (17)$$

Model 4 (model with the interaction between quality defects and the quality management practice)

$$logit(turnover_{ij}) = \sum_{k=1}^{9} \alpha_k D_k + \beta_1 Q_{ij} + \beta_2 Y_{ij} + \beta_3 G_i + \beta_4 P_j + \beta_5 A_{ij} + \beta_6 X_i + \beta_7 SMV_i + \sum_{k=1}^{9} \alpha_k D_k * P_j + \phi P_j Y_{ij} + \varepsilon_{4i} \quad (18)$$

Model 5 (model with the interaction between absence rate and the quality management practice)

$$logit(turnover_{ij}) = \sum_{k=1}^{9} \alpha_k D_k + \beta_1 Q_{ij} + \beta_2 Y_{ij} + \beta_3 G_i + \beta_4 P_j + \beta_5 A_{ij} + \beta_6 X_i + \beta_7 SMV_i + \sum_{k=1}^{9} \alpha_k D_k * P_j + \theta P_j X_i + \varepsilon_{5i} \quad (19)$$

Model 6 (model with the interaction between age and the quality management practice)

$$logit(turnover_{ij}) = \sum_{k=1}^{9} \alpha_k D_k + \beta_1 Q_{ij} + \beta_2 Y_{ij} + \beta_3 G_i + \beta_4 P_j + \beta_5 A_{ij} + \beta_6 X_i + \beta_7 SMV_i + \sum_{k=1}^{9} \alpha_k D_k * P_j + \delta P_j A_{ij} + \varepsilon_{6i} \quad (20)$$

The variables included in the equations are defined below.

$turnover_{ij}$ defines the probability that individual i as distinguished by his/her predictor values exits the firm at the j^{th} day where j=1……7542, given that he or she survived through all prior periods. The variable j indexes tenure represented in terms of working days. The variable for turnover equals 1 if the worker exits that day otherwise it's 0. However, as the hazard rate cannot be calculated when no event takes places, tenure (working days) was grouped into intervals (as shown in table 4.4) so that there are sufficient events per interval to derive the hazard rate. The variable D_k represents the dummy variables as shown is table 4.4, where k ranges from 1 to 9. No constant term was included, hence all 9 period dummies can be included.

P_j is a dummy variable for the new quality management practice. The dummy variable equals one when the practice is in place and zero otherwise. Utility gains due to incentives (Besley and Ghatak, 2008; Ellingsen and Johannesson, 2007) and reduction in turnover due to gains in utility at the current job (Weiss 1984) were suggested. On the contrary, shocks at the workplace have been linked to higher employee turnover (Lee and Mitchell, 1994) and practices that aim to enhance performance increase the number of quits and dismissals (Batt and Colvin, 2011).

Q_{ij} is the quantity of garments produced by worker i on day j. Y_{ij} is the quality defects made by worker i on day j. Low performers are more likely to have a higher probability of turnover. A negative relationship between performance and voluntary and involuntary turnover has been found (Jackofsky, 1984; McEvoy and Cascio, 1987; Bycio et al., 1990; Williams and Livingstone, 1994; Bishop, 1990; Hashimoto and Yu, 1980). As the true productivity of the employee is revealed over time, firms may fire the least productive workers, while good job matches are likely to survive longer (Jovanovic, 1979). The shirking model also suggests that workers with low performance will be dismissed (Shapiro and Stiglitz, 1984).

A_{ij} is the age of worker i at time j. Younger workers are more likely to quit as compared to older workers (Weiss, 1984; Jovanovic, 1979; Parsons, 1978).

G_i represents gender of the worker. Females are expected to have higher turnover rates. This can be linked to the theory of lower labour force attachments and discontinuous patterns of females due to household responsibilities and child care (Mincer and Polachek, 1974; Anderson et al., 2002; Angelov et al., 2016; Light and Ureta, 1990).

X_i represents the absence rate of a worker. It is calculated as the number of absent days divided by the number of working days of the worker. Absenteeism is included as another proxy for shirking (Scoppa and Vuri, 2014). A positive association between absenteeism and turnover is expected as has been found in the past (Lyons, 1972; Muchinsky, 1977; Gupta and Jenkins, 1982).

SMV_i represents the standard minute value of the task performed by the worker. The standard minute value is the time it takes to perform a task on a single garment. The standard minute value has been added as Weiss (1984) suggested that the complexity of the job has a positive association with the propensity to quit. Workers who are assigned more complex tasks are more likely to quit as compared to workers who are given simpler tasks.

Interaction terms between tenure (as shown by the 9 binary dummies for the days worked) and the new quality management practice were included in equations 16 to 20 as the logit hazard function corresponding to the implementation of the new quality management may not be a simple shift of the baseline hazard function. The implementation of the new quality management practice may vary with tenure and may alter the shape of the baseline hazard function. The job matching theory (Jovanovic, 1979) implies that the impact of the new quality management practice may vary by tenure. Workers dissatisfied with the new practice may feel that the current job match is not a good one, hence they may switch jobs.

Four other interaction terms have been included. An interaction term between quantity and the quality management practice, an interaction term between defects and the quality management practice, an interaction term between absenteeism and the quality management practice and an interaction term between age and the quality management practice. The motivation to include these interaction terms is to see whether the impact of these variables changes after the new quality management practice is implemented.

The implementation of the quality management practice also brings in rigorous monitoring of workers with low productivity and high quality defects. Campbell (1997) suggested that an increase in monitoring intensity increases the number of dismissals. Therefore, shirkers are more likely to be dismissed after the new quality management practice is implemented. For low performers, reward contingencies could also reduce satisfaction as the rewards generate fewer intrinsic and extrinsic benefits (Dreher, 1982). The negative-performance turnover relationship should become stronger when rewards are linked to performance. $[\varepsilon_{1i\dots}\,\varepsilon_{6i}]$ represent the random effects.

IV. Results and Analysis

IV.A. Baseline Hazard Rate

Table 4.5 presents the estimates of equations 15 to 20 using a random effects logit model to estimate a discrete time model. The model estimated in column (1) assumes constant proportionality of turnover odds over time. The intercept terms D1 to D9 describe the baseline hazard function in columns (1) to (6). The shape of the baseline hazard in all columns suggest that the hazard rate initially increases until D3 i.e. tenure up to 900 days, decreases between 901 and 1200 days, increases again until 2700 days, and takes a dip again until 3300 days after which it increases again. The hazard rate is the lowest for workers with tenure up to 300 days, after which the hazard rate takes a dip twice but remains higher than the hazard rate for tenure up to 300 days. The finding that the hazard rate for tenure greater than 300 days is always higher than the hazard rate in the initial tenure interval can be linked to various reasons. One of the identified potential reasons is job boredom. Job boredom is the extent to which a worker finds a job uninteresting (Fisherl, 1993). Job boredom may emerge due to prolonged exposure to a monotonous task (Kass, Vodanovich and Callender, 2001) and boredom has been well recognised in industrial settings (Maier, 1973).

The relationship between job tenure and job performance may even be slightly negative due to greater boredom among workers with long job tenure. The effects of learning by doing exist but boredom is likely to set in eventually. As time passes, there might be a negative effect on productivity which is called on the job sensory deprivation (Medoff and Abraham, 1980). Workers with longer tenure may experience a loss in motivation due to the lack of task variety which may also decrease job performance (Frone, 1998; Hackman, 1980). Repetition of well learned tasks may also decrease intrinsic motivation (Stewart, 1999). The loss in job motivation due to boredom may offset the positive human capital gains through learning by doing that are accompanied with a long job tenure (Ng and Feldman, 2013; Dubinsky, Ingram and Fay, 1984).

Table 4.5: The Effect of the Quality Management Practice on Turnover (Full Sample)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
Age	-0.0501***	-0.0502***	-0.0503***	-0.0507***	-0.0521***	-0.0330***
	(0.0101)	(0.0101)	(0.0101)	(0.0101)	(0.0101)	(0.0121)
Quantity	-0.00000687	-0.00000611	0.00000158	-0.00000549	-0.00000742	-0.00000739
	(0.0000494)	(0.0000494)	(0.0000578)	(0.0000493)	(0.0000494)	(0.0000494)
Defects	0.0475	0.0478	0.0479	0.0559*	0.0478	0.0475
	(0.0323)	(0.0323)	(0.0323)	(0.0294)	(0.0322)	(0.0323)
Absence Percentage	9.080***	8.864***	8.869***	8.869***	8.174***	8.860***
	(0.528)	(0.537)	(0.538)	(0.537)	(0.620)	(0.539)
Standard Minute Value	-0.0529	-0.0647	-0.0661	-0.0508	-0.0607	-0.0677
	(0.187)	(0.187)	(0.187)	(0.186)	(0.186)	(0.187)
Female	0.0882	0.0925	0.0921	0.0887	0.0905	0.0914
	(0.0847)	(0.0849)	(0.0850)	(0.0850)	(0.0848)	(0.0849)
Quality Management Practice	-0.520***					
	(0.0875)					
D1	-8.158***	-7.913***	-7.918***	-7.910***	-7.620***	-8.306***
	(0.334)	(0.345)	(0.346)	(0.345)	(0.362)	(0.379)
D2	-7.903***	-7.685***	-7.691***	-7.681***	-7.476***	-8.097***
	(0.316)	(0.325)	(0.326)	(0.325)	(0.335)	(0.364)
D3	-6.897***	-7.118***	-7.125***	-7.115***	-6.925***	-7.532***
	(0.303)	(0.313)	(0.314)	(0.313)	(0.321)	(0.353)

Table 4.5: The Effect of the Quality Management Practice on Turnover (Full Sample)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
D4	-7.427***	-7.557***	-7.564***	-7.554***	-7.372***	-7.984***
	(0.322)	(0.339)	(0.340)	(0.339)	(0.346)	(0.379)
D5	-7.369***	-7.241***	-7.247***	-7.236***	-7.061***	-7.686***
	(0.325)	(0.331)	(0.332)	(0.331)	(0.337)	(0.375)
D6	-6.987***	-6.835***	-6.841***	-6.831***	-6.659***	-7.304***
	(0.336)	(0.343)	(0.344)	(0.343)	(0.349)	(0.389)
D7	-7.205***	-7.071***	-7.079***	-7.066***	-6.877***	-7.583***
	(0.381)	(0.395)	(0.396)	(0.395)	(0.401)	(0.442)
D8	-6.911***	-6.720***	-6.729***	-6.715***	-6.535***	-7.254***
	(0.394)	(0.408)	(0.409)	(0.408)	(0.414)	(0.458)
D9	-6.834***	-6.727***	-6.736***	-6.720***	-6.544***	-7.333***
	(0.432)	(0.457)	(0.458)	(0.457)	(0.461)	(0.515)
D1*Quality Management Practice		-1.474***	-1.455***	-1.448***	-2.229***	-0.306
		(0.440)	(0.447)	(0.440)	(0.541)	(0.669)
D2*Quality Management Practice		-1.028***	-1.007***	-1.003***	-1.654***	0.189
		(0.276)	(0.289)	(0.277)	(0.381)	(0.592)
D3*Quality Management Practice		0.0810	0.102	0.106	-0.497*	1.323**
		(0.161)	(0.183)	(0.162)	(0.291)	(0.559)
D4*Quality Management Practice		-0.0967	-0.0750	-0.0722	-0.652*	1.191**
		(0.240)	(0.255)	(0.240)	(0.334)	(0.605)
D5*Quality Management Practice		-0.766***	-0.743***	-0.739***	-1.287***	0.574
		(0.232)	(0.249)	(0.233)	(0.319)	(0.623)

Table 4.5: The Effect of the Quality Management Practice on Turnover (Full Sample)

	(1)	(2)	(3)	(4)	(5)	(6)
	turnover	turnover	turnover	turnover	turnover	turnover
D6*Quality Management Practice		-0.854***	-0.832***	-0.817***	-1.353***	0.557
		(0.253)	(0.268)	(0.253)	(0.327)	(0.660)
D7*Quality Management Practice		-0.796**	-0.770**	-0.755**	-1.329***	0.751
		(0.375)	(0.389)	(0.375)	(0.436)	(0.766)
D8*Quality Management Practice		-0.982**	-0.954**	-0.947**	-1.482***	0.629
		(0.413)	(0.428)	(0.414)	(0.463)	(0.810)
D9*Quality Management Practice		-0.689*	-0.658	-0.646	-1.180**	1.119
		(0.417)	(0.435)	(0.417)	(0.465)	(0.884)
Quantity*Quality Management Practice			-0.0000218			
			(0.0000876)			
Defects*Quality Management Practice				-0.491*		
				(0.298)		
Absence*Quality Management Practice					2.838**	
					(1.169)	
Age*Quality Management Practice						-0.0505**
						(0.0219)
/						
lnsig2u	-12.37	-12.38	-12.38	-12.38	-13.02	-12.15
	(11.63)	(11.61)	(11.61)	(11.61)	(14.74)	(8.412)
N	769491	769491	769491	769491	769491	769491

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Workers are unlikely to remain in jobs which they dislike or where they perform poorly (Schneider, 1987; Kanfer, Crosby and Brandt, 1988). The job matching theory also predicts that workers are likely to stay in jobs where their productivity is revealed to be high and quit jobs where their productivity is revealed to be low.

The value of a worker varies from one firm to the other as job changes are costlier for workers who have accumulated a substantial amount of firm specific capital (Oi, 1962; Becker, 1962). Jobs with repetitive tasks may require little specific training (Hutchens, 1987). Therefore, the relationship suggested by Hashimoto and Yu (1980) such that high investments in specific training are likely to provide incentives to form long term attachments may not be very strong given that the workers at this firm perform repetitive tasks. Workers at this firm receive training for around 6 weeks and skills are quite transferable between firms for example, a worker who performs a task that attaches front pockets on denim jeans will be able to perform the same task at another firm that produces denim jeans. We interviewed a human resource manager and asked him about the procedure for hiring and training of workers. He replied by saying that most of the workers belong to the villages around the firm. Also, there is no proper institute where the firm can hire trained workers; the firm spends resources on providing in house training but the attachment of workers with the firm is weak.

Lazear (1979) and Lazear (1981) stated that age-earnings profiles should be created that pay the worker less than the value of the marginal product when the worker is young and more than the value of the marginal product when the worker is nearing retirement. The use of delayed payment schemes are also tools to reduce voluntary turnover (Parsons, 1972; Anderson et al., 1994). This may also be a tool to prevent employees from shirking, because if the worker shirks, he/she will be dismissed immediately and will incur a huge cost by losing higher earnings in future. Wages tend to grow with experience, not because senior workers are more productive but because paying senior workers higher wages will produce incentives for junior workers to work harder. Jobs with delayed payment contracts are likely to have characteristics such as long tenure, pension schemes, and mandatory retirement as it is necessary to have a date where the worker is not entitled to receive a wage rate which is more than the marginal product. Such contracts lead to long tenures due to the associated fixed costs (Hutchens, 1986).

The workers at the firm are paid piece rates i.e. pay is dependent upon the quantity of output produced by workers. Hutchens (1987) noted that piece rate jobs usually involve doing repetitive tasks and are conducive to monitoring and tend not to have job characteristics such as pensions, long job tenures, and comparatively higher wages for senior workers. Bjorklund and Akerman (1989) also reveal that workers who are paid piece rates start with a higher wage but receive low tenure premiums.

IV.B. The New Quality Management Practice

The coefficient of the new quality management practice is significant at the 1 percent level and the implementation of the new quality management practice reduces the log odds of turnover by 0.520. This finding can be linked to various elements that define the new practice. The new quality management practice provides recognition to workers according to work standards and promises monetary rewards to workers with outstanding performance. Non-monetary rewards and monetary rewards are associated with utility gains of workers (Besley and Ghatak, 2008; Ellingsen and Johannesson, 2007). From a worker's perspective, he/she will move to a new job if the gain in utility from switching jobs outweighs the cost of change (Weiss, 1984). The finding that the implementation of the new quality management practices reduces turnover is in line with the relationship implied by Weiss (1984) such that an increase in utility at the current job is likely to reduce turnover. The potential increase in job attachment due to the monetary and non-monetary incentives provided by the new quality management practice and the reduction in employee turnover can be linked to the investment model (Farrell and Rusbult, 1981).

The negative relationship between the quality management practice and turnover also provides some evidence in line with the turnover cost model (Stiglitz, 1974) which suggests that firms can reduce the quit rate of workers and save on training costs by offering a higher wage relative to other firms. In our case, the firm does not directly increase the wage rate of workers but provides an opportunity to workers to increase earnings given that they match up to the standards of the new quality management practice. According to this model, quits will also be negatively related to the ease of finding another job, which will be difficult if the unemployment rate is high. The firm operates in a relatively rural area of Pakistan and the nearest garments manufacturer that can provide job opportunities for stitching operators is approximately 50 kilometres away and the next two are around 60 kilometres away. These firms pay a similar piece rate but did not provide the incentives that are provided by the new quality management practice during the data collection period. Hence, the lack of job alternatives combined with the increase in utility due to the recognition and rewards provided by the new quality management practice can be attributed to a reduction in turnover at the firm. The results are also in line with Campbell (1997) such that firms can reduce quits by providing good working conditions and increasing wages. Farrell and Rusbult (1981) also suggest that poor quality of alternative job opportunities also increases job attachment. Cognitive processes such as the intention to leave, utility of turnover and job search behaviour such as the evaluation of job alternatives both combined lead to turnover (Mobley 1977).

Managers and firm owners are concerned about the morale of workers as it affects the turnover at the organisation (Bewley, 1995; Gintis et al., 2005). Disgruntled workers will leave as soon as an alternative job opportunity is available. Incentives may also help improve morale and contribute to internal equity as employees may believe that they are being fairly rewarded for their contributions to the work place (Gintis *et al.*, 2005).

IV.C. Tenure and the New Quality Management Practice

Column (2) shows the estimates of the model that includes the interaction terms of tenure and the new quality management practice. The implementation of the practice has a decreasing effect on the hazard rate of turnover for workers with a tenure up to 300 days, as it reduces the log odds of turnover by 1.474. The magnitude of the impact of the quality management practice is the highest for workers with a tenure up to 300 days, after which the magnitude of the impact is lower or is insignificant. This finding can be linked to the process by which workers accumulate information about the quality of the job match. The job matching theory (Jovanovic, 1979) suggests that at the start of a job, the employee has incomplete information about aspects of the job such as working conditions, tasks and perceptions of a future with the employer. The arrival of information that leads to dissatisfaction may prompt workers to look for alternative work opportunities. Workers will have a higher probability of quitting in the initial years of employment as the arrival of bad information is more likely to take place at the beginning of the employment. Workers who end up in good job matches will respond by not changing jobs frequently; longer tenures are associated with good job matches. The job matching theory, human capital theory, sorting and incentive models all predict that the probability of turnover will decline with tenure (Becker, 1962; Jovanovic, 1979; Kwon, 2005). In our case, the probability of separation does not fall monotonically with tenure, and those who have accumulated less information about the job quality are less likely to quit as the hazard rate for the shortest tenure category (tenure up to 300 days) is the lowest. Workers who have accumulated more information about the job match are more likely to be bored and realise that the job provides low tenure premium and limited specific training.

The magnitude of the impact of the practice is lower for workers with relatively longer tenures and highest for workers who are still in the process of accumulating information about the task requirements of the job. The implementation of the practice may send out positive information and signals about the employer and job to short tenured employees. The gain in utility due to the features of the new quality management practice seems to be stronger for employees with less tenure.

The specifications in columns (2) to (4) suggested that the impact of the new quality management practice for workers with a tenure between 601 and 1200 days is insignificant, while column (5) shows that the impact is only significant at the 10 percent level. However, column (6) suggests that the impact of the practice is only significant for workers who have a tenure between 601 and 1200 days, hence the practice has no impact on workers who have spent shorter durations with the firm and workers with tenure greater than 1200 days. These results are in line with the unfolding model (Lee and Mitchell, 1994) which suggests that shocks and practices that aim to enhance performance (Batt and Colvin, 2011) are likely to increase turnover.

IV.D. Job performance and the New Quality Management Practice

Performance indicators such as quantity and defects were included in all models. Only column (4) shows that an increase in quality defects is significantly associated with higher turnover, while all the other specifications show that both quantity and defects are insignificant factors in determining turnover. The job matching theory suggests that workers will remain in jobs where their performance is high and will quit jobs where their performance is found to be low. Also, given that most of the coefficients for quantity and defects are insignificant, we do not find evidence in line with the shirking model (Shapiro and Stiglitz, 1984) such that the choice of effort levels made by workers are likely to predict dismissals. After discussions with managers and labour leaders, Gintis *et al.* (2005) also suggest that the shirking model does not hold. Employers do not obtain cooperation with workers through the threat of dismissal. The threat of dismissal creates a negative environment and it impairs morale. Employers usually deal with shirking through discussions and warnings and employees are usually fired if the behaviour persists for a long period of time. Employers encourage workers to improve effort by explaining what the employer expects from workers, discussing their strengths and weakness, giving them constructive criticism and making them feel valued within the organisation. Agell and Lundborg (2003) also suggest that shirkers are punished with a verbal reprimand.

An interaction term between quantity and the new quality management practice was added in column (3) and an interaction term between defects and the new quality management practice was included in column (4). The interaction term between quantity and the new quality management practice is insignificant, while the interaction term between defects and the new quality management practice is significant at the 10 percent level. As shown in column (4), before the implementation of the new management practice, workers with higher quality defects were more likely to turnover, but after the implementation of the new practice, workers with higher quality defects are less likely to turnover. A curvilinear relationship between job performance and turnover has been suggested in the past. Employees with high job performance are more likely to quit due to the availability of more job alternatives, relatively lower but adequate performers are more likely to stay due to fewer job alternatives while low performers are dismissed by employers (Jackofsky, 1984; Trevor, Gerhart and Boudreau, 1997). The job matching theory also suggests that low performing workers are more likely to quit. The implementation of the new management practice is offering an opportunity to workers to earn more while it provides non-monetary incentives which are likely to be associated with a higher utility at the current job. Stiglitz (1974) suggested that firms can reduce the quit rate of workers by offering a higher wage relative to other firms, while quit rates will also be negatively related to the ease of finding an alternative job. There are limited job opportunities in the area and the other three nearest firms were not providing the monetary and non-monetary incentives to workers that are provided by the new management practice. It seems like the relationship suggested by Stiglitz (1974) is stronger for employees with a relatively lower performance as they are likely to have fewer job alternatives. Also, according to the job matching theory, workers who are more likely to quit due to a lower job performance are more likely to stay after the implementation of the new practice. Therefore, we do not find evidence in line with Campbell (1997) who suggested that an increase in the intensity of monitoring is likely to increase the number of dismissals as more workers will be caught shirking.

As indicated by Gintis *et al.* (2005), firms may not use dismissals as a tool to prevent shirking as it impairs the morale of workers and creates a hostile environment within the firm. Therefore, even after the implementation of the new practice, the relationship between quantity and turnover remains insignificant.

The coefficients for the interaction terms between tenure and the quality management practice in columns (3) and (4) are similar to the ones estimated in column (2). The coefficients reiterate the notion that the quality management practice has the greatest impact on workers who are in the initial stages of accumulating information about the quality of the job match.

IV.E. Relationship of Absenteeism and Turnover

Column (1) shows that an increase in the absence rate by one percent increases the log odds of turnover by 9.08. The rest of the specifications also show a similar relationship, but the magnitude is slightly lower. A positive association between absenteeism and turnover has also been found in the past (Lyons, 1972; Muchinsky, 1977; Gupta and Jenkins, 1982). Absenteeism is also a proxy for shirking and the threat of dismissal due to absenteeism may act as a worker disciplining device (Shapiro and Stiglitz, 1984; Brown and Sessions, 1996). The result that an increase in absenteeism has a positive relationship with turnover is also in line with Scoppa and Vuri (2014) who suggest that the negative relationship between unemployment and shirking denoted by the absenteeism rate is stronger in smaller firms as compared to larger firms due to lower employee protection from dismissals. Brown and Sessions (1996) suggest that firms face a choice between dismissing employees with higher absences or permitting this behaviour. The decision depends upon the nature of the production process, the relationships between workers and the psychology of the labour force.

Absenteeism is a cause of concern for the firm as production takes place on an assembly line. Absenteeism is a threat to assembly line production as it requires an immediate replacement. The worker who replaces the absent worker has to have the same specialisation otherwise the quality of production is compromised (Mateo, 2008). During factory visits, it was observed that supervisors often change the allocation of workers around the assembly line when workers are absent. Some workers are multi skilled, hence they can perform multiple tasks, but this re-allocation of workers is an extra burden on supervisors and sometimes leads to bottlenecks on the line. Chaudhry and Faran (2015) surveyed 33 line supervisors from six readymade garments factories (including the firm we have collected our data from) and found that two thirds of the supervisors found absenteeism to be a cause of bottlenecks on the line.

Absenteeism is an expression of negative attachment to the organization (Hanisch and Hulin, 1991). Absence may have a positive impact on dissatisfied employees as it is an opportunity to avoid the negative emotions he/she associates with the job. On the contrary, highly satisfied workers are likely to avoid being absent from work and maintain continued attachment to their job (Blau and Boal, 1987).

IV.F. Absenteeism and the New Quality Management Practice

Column (5) includes an interaction term between the absence rate of workers and the new quality management practice, which indicates that after the implementation of the new practice, the relationship between the absence rate and the quality management practice becomes stronger. Before the implementation of the practice, a one percent increase in the absence rate increases the log odds of turnover by 8.174, however after the implementation of the practice, a one percent increase in the absence rate increases the log odds of turnover by 11.012.

Drago and Wooden (1992) suggest that the inverse relationship between job satisfaction and absenteeism can be derived from the labour-leisure theory and work discipline models as the relative utility from leisure will be low when job satisfaction is high. Although we do not have data on the job satisfaction of employees, but as the relationship between the absence rate and turnover becomes stronger after the implementation of the new quality management practice, we can infer that workers who express negative attachment to the firm by being absent from work are more likely to leave due to shocks experienced at the workplace.

The interaction term between the absence rate and the new practice also indicates that after the implementation of the new quality management practice, shirking behaviour such as missing a day at work has a higher impact on turnover. Therefore, we can link this with the idea by Campbell (1997) such that an increase in the monitoring intensity is likely to increase the number of dismissals as more workers will be caught shirking. In our case, shirking is defined by the absence rate of workers and not employee's work effort. We can again link this to the production process at the firm. It seems that as the procedure of managing the line improves with the new quality management practice, shirking behaviour such as absenteeism is considered a greater threat to the management of the line as it is likely to cause disruptions on the line.

Column (5) shows that the coefficients of the interaction terms between the new practice and tenure dummies indicate a similar trend to the previous specifications (columns 1 to 4) such that the impact of the new practice is strongest for workers who are in the shortest tenure category, while the magnitude is lower or insignificant for the rest of the tenure categories. However, the magnitudes are different from the previous specifications. In this specification, the implementation of the practice also significantly reduces the log odds of turnover by 1.180 for workers with a tenure greater than 3900 days.

IV.G. Age and the New Quality Management Practice

An increase in age by one year reduces the log odds of turnover by 0.05 in column (1); similar coefficients were estimated for the specifications in columns (2) to (5). This is consistent with the notion that job shopping is more relevant for younger workers and as a worker ages, the frequency of job switching declines (Parsons, 1978; Topel and Ward, 1992; Mincer and Jovanovic, 1981)[71].

Column (6) indicates that the coefficient for age is significant and indicates that an increase in age by one year reduces the log odds of turnover by 0.0330. However, the impact of age varies with the implementation of the new practice. Younger workers are more mobile between jobs and will be less attached to the current job and firm as compared to older workers. Mincer and Jovanovic (1981) emphasize that as a worker has a finite working life, the likelihood of changing jobs for a better salary decreases with age due to the shorter period to collect returns. An increase in age has a stronger impact on turnover after the implementation of the practice i.e. an increase in age reduces the log odds of turnover by 0.0835. Lee and Mitchell (1994) suggest that employees may seek job alternatives due to the circumstances generated by shocks and may also quit due to the availability of job alternatives. Younger workers have a relatively weaker labour force attachment and are more likely to try and test other options in the labour market. Job shopping is less relevant for older workers and older workers may also be less likely to search for alternatives due to critical events experienced at the workplace. Hence the impact of the new quality management practice is greater for older workers who are less likely to switch jobs as compared to younger workers.

[71] The model specifications were estimated with age-squared as well. Age-squared was found to be insignificant. The results are available in table 19 of Appendix C.

IV.H. Robustness of the Results in Table 4.5 Without Including Absence Percentage

The specifications in table 4.5 were estimated without absence rate due to the possibility of the absence rate being endogenous. The results are available in table 18 of appendix C which show that the impact of the quality managemnet practice given in column (1) in table 4.5 is the same as in table 18, but the magnitude of the coefficient is higher. Also, the relationship between tenure and the new quality management practice suggested in table 4.5 is similar to what is suggsted in table 18, however the cofficients of the interaction term between the new quality management practice and tenure in table 4.5 are different to the ones estimated in table 18. Overall, the results show that the direction of the impact of the new quality management practice suggested in table 4.5 is robust even when absence percentage is excluded.

The coefficient of standard minute value is insignificant in table 4.5, but it is significant in all specifications in table 18, showing that workers who perform tasks with a higher standard minute value are more likely to turnover. This result is line with Weiss (1984) who suggests that workers who perform complex tasks are more likely to turnover. Table 4.5 suggests that the impact of age changes with the implementation of the new quality management practice. However, table 18 shows that the cofficient of age is insignificant when the interaction term between age and the new quality management practice is added, although the interaction term between age and the new quality management practice is significant at the 5 percent level. The coefficient of quantity is significant in table 18 but at 5 percent in column (1) and then at the 10 percent level for the rest of the specifications. Table 4.5 shows that workers with higher quality defects are more likely to turnover, although the coefficient for quality defects and the interaction term between defects and the quality management practice were only significant at the 10 percent level. However, table 18 shows that the interaction term between defects and the new quality management practice is insignificant.

IV.I. Gender Differences in the Baseline Hazard Rate

The gender dummy in table 4.5 shows that gender is an insignificant predictor of turnover. Blau and Kahn (1981) also suggest that males and females have similar quit probabilities after job and personal variables are held constant. However, estimations done after splitting the sample by gender provide some interesting insights into the male-female differences in turnover. The results are summarised in tables 4.6 and 4.7. The results were tested to see whether the coefficients for males and females are significantly different. These results are available in table 20 of appendix C.

The coefficients of the dummy variables D1, D2, D3, D4 and D5 in column (1) of tables 4.6 and 4.7 were found to be significantly different from each other. The hazard rate of females was found to be significantly lower than the hazard rate of males for tenure up to 1800 days. The hazard rate estimates in columns (2) to (4) of tables 4.6 and 4.7 indicate that the hazard rate of females is significantly lower for tenure up to 900 days and tenure between 1201 and 1800 days as compared to males[72]. The estimates in column (5) suggest that the hazard rate of females is significantly lower than that of males for tenure up to 300 days and with tenure between 601 and 900 days and between 1201 and 1800 days. Overall, columns (1) to (5) all provide evidence that there is a significant difference in the hazard rate of males and females in the initial years of employment after which no significant difference was found. Our results complement the finding by Viscusi (1980) who provided evidence that quit behaviour during the first year of employment represents the most important gender difference in turnover. Although his estimates suggest that the quit rate of females was significantly higher than the quit rate of males in the first year of a job but after that no significant difference was found.

[72] The coefficient for the interaction term between tenure of 1201 and 1800 days and gender is only significant at the 10 percent for columns (1) to (5) in table 20 of appendix C.

The initial period on the job reflects a learning process as complete information of the job has not been acquired. The significant difference in the hazard rate of males and females during the initial years of employment highlights gender differences in accumulating information about the quality of the job match. Meitzen (1986) suggests that the probability of quitting declines with tenure for males but increases with tenure for females. This was linked to gender differences in the job matching process as females may do on-the-job learning regarding their work preferences and discrimination differently from males.

Makino (2012) reports that the main reason why women choose to work in the garments industry in Pakistan is financial need. Haque (2009) also reports a similar finding such that supervisors, workers and managers in the garments industry agree that a woman should stay home if the men in the household earn enough. This is also supported by other evidence (Sultana and Malik, 1994; Ahmad and Hafeez, 2007). Makino (2012) also quotes a female manager at a garment factory who explained that unmarried women also work to save money for their dowries. The social fabric of Pakistan restricts mobility of females. Papanek (1971) explains that male family members place restrictions on the mobility of female household members. Travelling is considered to be risky as it may lead to unwanted interactions with the opposite gender and loss of honour. The honour of men is linked with the sexual behaviour of women and female mobility is restricted through the norms of gender segregation and female seclusion (Asian Development Bank, 2000). The mobility of women is controlled through permission, escort and veiling (Sathar and Kazi, 2000). Given that the mobility of females is more restricted as compared to the mobility of males, this may also hinder the way females can actively look for job prospects.

Table 4.6: The Effect of the Quality Management Practice on Turnover (Females)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
Age	-0.0373***	-0.0371***	-0.0371***	-0.0376***	-0.0383***	-0.0363**
	(0.0142)	(0.0142)	(0.0142)	(0.0142)	(0.0142)	(0.0181)
Quantity	0.0000169	0.0000179	0.00000113	0.0000183	0.0000164	0.0000179
	(0.0000688)	(0.0000688)	(0.0000846)	(0.0000687)	(0.0000688)	(0.0000688)
Defects	-0.0465	-0.0467	-0.0469	0.00769	-0.0469	-0.0467
	(0.127)	(0.127)	(0.127)	(0.0902)	(0.127)	(0.127)
Absence Percentage	10.03***	9.947***	9.943***	9.945***	8.791***	9.947***
	(0.939)	(0.943)	(0.943)	(0.943)	(1.165)	(0.943)
Standard Minute Value	-0.0279	-0.0364	-0.0332	-0.0270	-0.0451	-0.0363
	(0.256)	(0.257)	(0.257)	(0.256)	(0.256)	(0.257)
Quality Management Practice	-0.424*** (0.123)					
D1	-9.172***	-8.714***	-8.706***	-8.709***	-8.347***	-8.733***
	(0.515)	(0.535)	(0.535)	(0.535)	(0.569)	(0.596)
D2	-8.505***	-8.241***	-8.229***	-8.237***	-7.957***	-8.261***
	(0.437)	(0.455)	(0.456)	(0.455)	(0.481)	(0.530)
D3	-7.498***	-7.923***	-7.911***	-7.920***	-7.653***	-7.943***
	(0.410)	(0.437)	(0.438)	(0.437)	(0.462)	(0.515)
D4	-7.906***	-7.965***	-7.951***	-7.962***	-7.700***	-7.985***
	(0.428)	(0.448)	(0.450)	(0.448)	(0.471)	(0.525)
D5	-7.841***	-7.787***	-7.773***	-7.784***	-7.536***	-7.808***
	(0.427)	(0.438)	(0.439)	(0.437)	(0.458)	(0.521)
D6	-7.432***	-7.263***	-7.250***	-7.263***	-7.022***	-7.285***
	(0.446)	(0.454)	(0.456)	(0.454)	(0.474)	(0.544)

Table 4.6: The Effect of the Quality Management Practice on Turnover (Females)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
D7	-7.506***	-7.411***	-7.395***	-7.408***	-7.120***	-7.436***
	(0.499)	(0.514)	(0.516)	(0.514)	(0.539)	(0.612)
D8	-7.060***	-7.015***	-6.996***	-7.009***	-6.779***	-7.040***
	(0.524)	(0.550)	(0.553)	(0.551)	(0.567)	(0.649)
D9	-6.847***	-6.627***	-6.609***	-6.619***	-6.391***	-6.657***
	(0.612)	(0.632)	(0.634)	(0.632)	(0.645)	(0.756)
D1*Quality Management		-2.290**	-2.320**	-2.269**	-3.138***	-2.241*
Practice		(1.056)	(1.060)	(1.056)	(1.159)	(1.250)
D2*Quality Management		-1.090***	-1.126***	-1.068**	-1.803***	-1.040
Practice		(0.422)	(0.434)	(0.422)	(0.583)	(0.810)
D3*Quality Management		0.424*	0.387	0.450*	-0.232	0.475
Practice		(0.250)	(0.271)	(0.250)	(0.445)	(0.743)
D4*Quality Management		-0.246	-0.287	-0.220	-0.892*	-0.194
Practice		(0.324)	(0.344)	(0.324)	(0.487)	(0.788)
D5*Quality Management		-0.527*	-0.570*	-0.498*	-1.134**	-0.473
Practice		(0.297)	(0.321)	(0.298)	(0.453)	(0.796)
D6*Quality Management		-0.930**	-0.971**	-0.876**	-1.503***	-0.873
Practice		(0.367)	(0.385)	(0.368)	(0.488)	(0.857)
D7*Quality Management		-0.685	-0.735	-0.632	-1.348**	-0.622
Practice		(0.448)	(0.469)	(0.448)	(0.583)	(0.974)
D8*Quality Management		-0.519	-0.576	-0.471	-1.048*	-0.454
Practice		(0.509)	(0.533)	(0.509)	(0.588)	(1.030)
D9*Quality Management		-1.086	-1.141*	-1.058	-1.616**	-1.008
Practice		(0.667)	(0.684)	(0.667)	(0.730)	(1.263)

Table 4.6: The Impact of the New Quality Management Practice on Turnover (Females)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
Quantity*Quality Management Practice			0.0000424 (0.000119)			
Defects*Quality Management Practice				-1.016 (0.722)		
Absence Rate*Quality Management Practice					3.305* (1.842)	
Age*Quality Management Practice						-0.00206 (0.0282)
/						
lnsig2u	-12.44 (11.61)	-12.46 (11.59)	-12.46 (11.59)	-12.46 (11.59)	-12.46 (11.63)	-12.46 (11.59)
N	374575	374575	374575	374575	374575	374575

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4.7: The Effect of the Quality Management Practice on Turnover (Males)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
Age	-0.0649***	-0.0655***	-0.0657***	-0.0657***	-0.0672***	-0.0341**
	(0.0144)	(0.0144)	(0.0144)	(0.0144)	(0.0144)	(0.0164)
Quantity	-0.0000293	-0.0000279	0.000000847	-0.0000274	-0.0000296	-0.0000322
	(0.0000711)	(0.0000711)	(0.0000808)	(0.0000710)	(0.0000712)	(0.0000712)
Defects	0.0646**	0.0653**	0.0654**	0.0687**	0.0652**	0.0645**
	(0.0317)	(0.0317)	(0.0316)	(0.0305)	(0.0317)	(0.0317)
Absence Percentage	8.241***	8.081***	8.107***	8.089***	7.523***	8.061***
	(0.658)	(0.672)	(0.674)	(0.672)	(0.755)	(0.675)
Standard Minute Value	-0.0191	-0.0317	-0.0355	-0.0176	-0.0192	-0.0378
	(0.272)	(0.272)	(0.272)	(0.272)	(0.272)	(0.272)
Quality Management Practice	-0.586***					
	(0.125)					
D1	-7.342***	-7.189***	-7.213***	-7.193***	-6.943***	-7.894***
	(0.450)	(0.462)	(0.463)	(0.462)	(0.478)	(0.500)
D2	-7.236***	-7.069***	-7.095***	-7.071***	-6.892***	-7.808***
	(0.436)	(0.447)	(0.448)	(0.447)	(0.454)	(0.490)
D3	-6.215***	-6.329***	-6.357***	-6.332***	-6.167***	-7.074***
	(0.420)	(0.428)	(0.430)	(0.428)	(0.434)	(0.474)
D4	-6.850***	-7.091***	-7.118***	-7.094***	-6.937***	-7.876***
	(0.457)	(0.490)	(0.491)	(0.490)	(0.494)	(0.535)
D5	-6.785***	-6.580***	-6.606***	-6.582***	-6.429***	-7.414***
	(0.468)	(0.473)	(0.475)	(0.473)	(0.477)	(0.523)

Table 4.7: The Effect of the Quality Management Practice on Turnover (Males)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
D6	-6.421***	-6.305***	-6.331***	-6.307***	-6.157***	-7.173***
	(0.480)	(0.490)	(0.491)	(0.490)	(0.493)	(0.541)
D7	-7.014***	-6.873***	-6.902***	-6.875***	-6.723***	-7.802***
	(0.577)	(0.609)	(0.610)	(0.609)	(0.612)	(0.654)
D8	-6.599***	-6.272***	-6.302***	-6.273***	-6.114***	-7.246***
	(0.572)	(0.581)	(0.583)	(0.581)	(0.584)	(0.633)
D9	-6.479***	-6.550***	-6.587***	-6.551***	-6.398***	-7.627***
	(0.607)	(0.656)	(0.659)	(0.656)	(0.658)	(0.714)
D1*Quality Management Practice		-1.111**	-1.024**	-1.087**	-1.869***	1.369
		(0.487)	(0.503)	(0.487)	(0.650)	(0.921)
D2*Quality Management Practice		-0.971***	-0.879**	-0.949***	-1.616***	1.605*
		(0.366)	(0.390)	(0.367)	(0.518)	(0.890)
D3*Quality Management Practice		-0.167	-0.0726	-0.145	-0.767*	2.475***
		(0.217)	(0.257)	(0.218)	(0.406)	(0.860)
D4*Quality Management Practice		0.0899	0.180	0.112	-0.480	2.868***
		(0.360)	(0.384)	(0.361)	(0.486)	(0.944)
D5*Quality Management Practice		-1.121***	-1.028**	-1.097***	-1.658***	1.836*
		(0.382)	(0.405)	(0.383)	(0.490)	(1.008)
D6*Quality Management Practice		-0.782**	-0.690*	-0.757**	-1.293***	2.302**
		(0.350)	(0.375)	(0.351)	(0.454)	(1.036)
D7*Quality Management Practice		-0.860	-0.754	-0.830	-1.372*	2.477**
		(0.691)	(0.708)	(0.691)	(0.750)	(1.263)

Table 4.7: The Effect of the Quality Management Practice on Turnover (Males)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
D8*Quality Management Practice		-1.701**	-1.591**	-1.677**	-2.230***	1.783
		(0.769)	(0.786)	(0.770)	(0.827)	(1.348)
D9*Quality Management Practice		-0.298	-0.172	-0.263	-0.805	3.506***
		(0.557)	(0.586)	(0.558)	(0.628)	(1.325)
Quantity*Quality Management Practice			-0.0000881			
			(0.000130)			
Defects*Quality Management Practice				-0.284		
				(0.326)		
Absence Rate*Quality Management Practice					2.869*	
					(1.607)	
Age*Quality Management Practice						-0.109***
						(0.0348)
/ lnsig2u	-12.14	-12.14	-12.14	-12.15	-12.79	-12.14
	(11.54)	(11.52)	(11.52)	(11.52)	(15.83)	(11.47)
N	394916	394916	394916	394916	394916	394916

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Female workers are reluctant to work during evening shifts due to restricted mobility and household responsibilities. In the textile sector, female workers were found in stitching units but mostly males were found in the spinning, weaving and processing units. Females prefer working in stitching units as they attain stitching skills while doing other household work. Choices of economic activities for women are restricted due to the socio-cultural norms. Females face greater difficulties than males to find alternative jobs as females are concentrated in a few sectors. There is a high concentration of females in the agriculture sector and other unskilled occupations (Siegmann, 2005).

Financial hardship combined with fewer job alternatives may suggest that the utility loss from quitting or being dismissed for females maybe greater as compared to males. As there are more barriers for females in terms of job opportunities, therefore once females are in employment they may not have the same opportunities as males to actively seek alternatives and therefore switch jobs.

Females and males are known to have different psychological attributes which may also play a role in explaining the gender difference in turnover. Females are also found to be more conscientious than males (Mueller and Plug, 2006; Goldin, Katz and Kuziemko, 2006). Haque (2009) reveals that a survey of managers in 150 garment manufacturing firms in Pakistan indicates that managers think that females provide better quality work, are more honest, disciplined and responsible than their male counterparts. Managers have indicated a preference for female workers as they produce better quality products and have better work ethics, however the stitching speed of females is lower as compared to males. Managers would prefer hiring more females if firms can fetch orders for medium to high quality products so that the profit margin is high enough to compensate for the lower stitching speed of females.

The justification for hiring female workers is also derived from the 'nimble fingers' hypothesis, where the orientation of women towards precise tasks that are required in garment production emerges from their traditional designation at home and performing tasks like sewing. Females are naturally more compliant, less likely to join trade unions and accept tougher work discipline as compared to males (Elson and Pearson, 1981). Managers and supervisors at the firm[73] also agree that female stitching operators at the firm are more disciplined as compared to male operators. These differences also highlight the potential reasons for the lower turnover rate of females in the initial period of employment.

IV.J. Gender Differences in the Impact of the New Quality Management Practice

Overall, we find that few specifications show significant gender differences in the impact of the new quality management practice. Columns (2) and (4) show that the implementation of the new quality management practice increases the log odds of turnover for females with a tenure between 601 and 900 days while the introduction of the practice has no significant impact on the turnover of males[74]. Column (6) also illustrates that there are significant gender differences in the impact of the new quality managemenet practice. The implementation of the new quality management practice decreases the log odds of turnover for females with tenure up to 300 days but has no impact on the turnover of males. However, the implementation of the new quality management practice increases the log odds of turnover for males with a tenure between 301 and 3300 days and tenure greater than 3900 days but there is no impact on the turnover of females.

The relationship that the new quality management practice increases turnover is in line with the unfolding model (Lee and Mitchell, 1994) such that shocks at the workplace can increase turnover. Batt and Colvin (2011) also suggest that productivity enhancing practices may increase quits and dismissals as they expose individuals who can't keep up with the expectations of the practice. The process of turnover described by the unfolding model suggests that a shock, which is usually negative, may

[73] During the interviews with managers and supervisors when the data was collected, managers and supervisors were asked whether they observed any gender differences within the stitching operators in terms of performance and work ethics at the firm.
[74] This result is only significant at the 10 percent level.

lead to image violations. Individuals compare the circumstances generated by the shock to their images such as values and goals, hence thoughts of withdrawal emerge if their values and strategies are not aligned with those of the organisation or those reflected in the shock. A worker may seek job alternatives due to the shock and may leave due to the availability of job alternatives.

IV.K. Gender Differences in the Impact of Age

Column (6) includes an interaction term between age and the new quality management practice. An increase in age reduces the log odds of turnover by 0.0341 before the implementation of the practice for males and by 0.0363 for females. An interesting finding is that although there is no significant gender difference in the impact of age, but the impact of the new quality management practice is different for older males as compared to older females. After the implementation of the practice, an increase in age by one year reduces the log odds of turnover by 0.1431 for males. However, the relationship between age and turnover does not change for females after the implementation of the practice as the interaction term between age and the new quality management practice is insignificant in table 4.6. Various gender differences in labour market outcomes have been found in the past for example females are found to be more averse to competition as compared to males, tend to be more altruistic and are less concerned about financial outcomes as compared to males and are also likely to opt for fixed pay schemes as compared to variable pay schemes (Bertrand, 2011).

V. Conclusion

The research uses discrete time survival analysis to provide evidence of the impact of a new quality management practice on employee turnover. The new quality management practice provides monetary and non-monetary incentives to workers, increases monitoring of workers with low performance, and increases peer pressure at the work place. Gains in utility of workers due to rewards and recognition has been established in the past. This research provides results in line with the relationship suggested by Weiss (1984), such that a higher expected utility at the current job is likely to decrease turnover. The lack of job alternatives combined with the potential increase in job attachment due to the recognition and rewards provided by the new management practice can explain the reduction in turnover at the firm.

In our case, workers with longer tenures who have accumulated substantial information about the job are more likely to turnover due to various reasons discussed in the analysis, such as boredom due to repetitive tasks, low amount of firm specific training, and low tenure premium.

One of the most important findings is that the impact of the new quality management practice varies by job tenure. The magnitude of the impact of the new practice is higher for short tenured workers as compared to workers with longer tenures. The new quality management practice may send positive signals about the job to workers who have only been with the firm for a short period of time. Therefore, a larger reduction in turnover has been observed for workers who are in the initial stages of the job and are in the process of accumulating information about the quality of the job match as compared to those workers who have accumulated substantial information about the quality of the job match and other aspects of the job.

Most model specifications suggest that worker effort denoted by productivity and quality defects is not a significant predictor of turnover before the implementation of the new practice. This may be explained by the notion that firms may not extensively use the threat of dismissal as it may impair the morale of the workforce. Instead of using the threat of dismissal, shirking behaviour may be dealt through discussions and verbal warnings. Interestingly, one specification suggests that before the implementation of the new management practice, workers with higher quality defects are more likely to turnover, however, after the implementation of the new quality management practice, workers with higher quality defects are less likely to turnover.

An interesting finding is that absenteeism is a significant determinant of turnover, as an increase in absenteeism increases the likelihood of turnover. After the implementation of the new quality management practice, shirking behaviour such as absenteeism has a higher impact on turnover, hence shirkers are more likley to be dismissed or the withdrawal process of absenteeism that leads to turnover becomes stronger. Another finding is that older workers are less likely to turnover and this relationship becomes stronger after the implementation of the new quality management practice.

In one of the model specifications we find that the implementation of the new practice increases the likelihood of turnover, which supports the unfolding model (Lee and Mitchell, 1994), but overall we do not find evidence in line with this.

Initially, a gender dummy was included in the logit estimation for the full sample, but no significant difference between the turnover of males and females was found. However, the sample was split by gender and a logit model including all predictors that were used for the full sample was estimated. The hazard rate of females were found to be significantly lower than the hazard rate of males in the initial years of employment, after which no significant difference was found. This result also highlights significant gender differences in the job matching process. Financial hardship and fewer job alternatives due to restrictions on the mobility of females may also be potential reasons for the lower turnover rate of females. The implementation of the new quality management practice reduces turnover for older males but has no impact on older females.

The results provide empirical evidence that the use of motivational tools which provide a combination of monetary and non-monetary incentives, monitoring and peer pressure may reduce the training and hiring costs incurred by firms due to high employee turnover.

The limitation of this research is that we are not able to distinguish between voluntary and involuntary turnover. Although it has been suggested that there is a blurred line between voluntary and involuntary turnover as these decisions are mutual. However, this distinction could provide us with further insights into the importance of the predictors used in this research for each type of turnover.

Appendix C

Table 18: The Effect of the New Quality Management Practice on Turnover (full sample without absence percentage)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover
Age	-0.0336***	-0.0345***	-0.0345***	-0.0349***	-0.0160
	(0.0102)	(0.0102)	(0.0102)	(0.0102)	(0.0121)
Quantity	-0.000103**	-0.0000987*	-0.000102*	-0.0000982*	-0.000101*
	(0.0000518)	(0.0000516)	(0.0000610)	(0.0000515)	(0.0000517)
Defects	0.0486	0.0493	0.0493	0.0564**	0.0489
	(0.0307)	(0.0307)	(0.0307)	(0.0282)	(0.0307)
Female	-0.0749	-0.0650	-0.0649	-0.0684	-0.0659
	(0.0829)	(0.0831)	(0.0831)	(0.0831)	(0.0830)
Standard Minute Value	-0.387**	-0.387**	-0.387**	-0.374**	-0.390**
	(0.186)	(0.186)	(0.186)	(0.186)	(0.186)
Quality Management Practice	-0.690***				
	(0.0861)				
D1	-5.735***	-5.385***	-5.383***	-5.382***	-5.811***
	(0.295)	(0.298)	(0.299)	(0.298)	(0.336)
D2	-6.055***	-5.883***	-5.881***	-5.880***	-6.325***
	(0.298)	(0.307)	(0.308)	(0.307)	(0.347)
D3	-5.199***	-5.477***	-5.475***	-5.474***	-5.922***
	(0.288)	(0.299)	(0.300)	(0.299)	(0.340)

Table 18: The Effect of the New Quality Management Practice on Turnover (full sample without absence percentage)

	(1)	(2)	(3)	(4)	(5)
	turnover	turnover	turnover	turnover	turnover
D4	-5.799***	-5.982***	-5.980***	-5.979***	-6.436***
	(0.308)	(0.327)	(0.328)	(0.327)	(0.366)
D5	-5.826***	-5.751***	-5.748***	-5.747***	-6.223***
	(0.313)	(0.320)	(0.321)	(0.320)	(0.362)
D6	-5.521***	-5.424***	-5.421***	-5.420***	-5.929***
	(0.331)	(0.338)	(0.339)	(0.338)	(0.383)
D7	-5.706***	-5.602***	-5.600***	-5.598***	-6.155***
	(0.377)	(0.391)	(0.392)	(0.390)	(0.438)
D8	-5.544***	-5.395***	-5.392***	-5.390***	-5.973***
	(0.393)	(0.407)	(0.408)	(0.406)	(0.456)
D9	-5.614***	-5.575***	-5.572***	-5.569***	-6.236***
	(0.437)	(0.461)	(0.463)	(0.461)	(0.519)
D1*Quality Management Practice		-2.200***	-2.208***	-2.178***	-0.894
		(0.434)	(0.442)	(0.434)	(0.676)
D2*Quality Management Practice		-1.182***	-1.190***	-1.160***	0.177
		(0.276)	(0.290)	(0.276)	(0.605)
D3*Quality Management Practice		-0.0326	-0.0410	-0.00890	1.351**
		(0.161)	(0.184)	(0.161)	(0.572)
D4*Quality Management Practice		-0.211	-0.219	-0.186	1.214**
		(0.240)	(0.256)	(0.240)	(0.614)
D5*Quality Management Practice		-0.871***	-0.880***	-0.843***	0.609
		(0.232)	(0.250)	(0.233)	(0.632)
D6*Quality Management Practice		-0.945***	-0.953***	-0.910***	0.635
		(0.253)	(0.269)	(0.253)	(0.677)

Table 18: The Effect of the New Quality Management Practice on Turnover (full sample without absence percentage)

	(1)	(2)	(3)	(4)	(5)
	turnover	turnover	turnover	turnover	turnover
D7*Quality Management Practice		-0.958**	-0.968**	-0.921**	0.777
		(0.375)	(0.390)	(0.375)	(0.785)
D8*Quality Management Practice		-1.102***	-1.113***	-1.070***	0.708
		(0.413)	(0.428)	(0.413)	(0.830)
D9*Quality Management Practice		-0.724*	-0.736*	-0.688*	1.325
		(0.417)	(0.436)	(0.417)	(0.914)
Quantity*Quality Management Practice			0.00000868		
			(0.0000920)		
Defects*Quality Management Practice				-0.473	
				(0.298)	
Age*Quality Management Practice					-0.0563**
					(0.0224)
/ lnsig2u	-11.66	-12.60	-12.60	-3.120	12.61
	(7.320)	(9.022)	(9.022)	(3.564)	(9.015)
Observations	769491	769491	769491	769491	769491

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 19: The Impact of the Quality Management Practice on Turnover with Age-Squared (Full Sample)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
Age	-0.102*	-0.112*	-0.112**	-0.113**	-0.105*	-0.0581
	(0.0576)	(0.0573)	(0.0573)	(0.0574)	(0.0575)	(0.0715)
Age-squared	0.000853	0.00103	0.00103	0.00103	0.000868	0.000417
	(0.000932)	(0.000926)	(0.000926)	(0.000926)	(0.000929)	(0.00117)
Quantity	-0.00000576	-0.00000479	0.00000337	-0.00000416	-0.00000631	-0.00000642
	(0.0000494)	(0.0000494)	(0.0000579)	(0.0000493)	(0.0000495)	(0.0000495)
Defects	0.0475	0.0477	0.0478	0.0559*	0.0478	0.0473
	(0.0323)	(0.0323)	(0.0323)	(0.0294)	(0.0322)	(0.0324)
Absence Percentage	9.079***	8.862***	8.867***	8.867***	8.190***	8.846***
	(0.528)	(0.537)	(0.537)	(0.537)	(0.620)	(0.539)
Female	0.0853	0.0888	0.0884	0.0851	0.0875	0.0880
	(0.0847)	(0.0850)	(0.0850)	(0.0850)	(0.0849)	(0.0849)
Standard Minute Value	-0.0464	-0.0572	-0.0587	-0.0432	-0.0542	-0.0586
	(0.187)	(0.187)	(0.187)	(0.186)	(0.186)	(0.187)
Quality Management Practice	-0.516***					
	(0.0876)					
D1	-7.440***	-7.049***	-7.051***	-7.046***	-6.895***	-7.955***
	(0.861)	(0.863)	(0.863)	(0.863)	(0.864)	(1.053)
D2	-7.176***	-6.810***	-6.813***	-6.806***	-6.740***	-7.743***
	(0.863)	(0.865)	(0.865)	(0.865)	(0.864)	(1.061)

Table 19: The Impact of the Quality Management Practice on Turnover with Age-Squared (Full Sample)

	(1)	(2)	(3)	(4)	(5)	(6)
	turnover	turnover	turnover	turnover	turnover	turnover
D3	-6.167***	-6.241***	-6.245***	-6.237***	-6.186***	-7.178***
	(0.862)	(0.862)	(0.862)	(0.862)	(0.862)	(1.059)
D4	-6.693***	-6.675***	-6.679***	-6.670***	-6.628***	-7.628***
	(0.873)	(0.877)	(0.877)	(0.877)	(0.876)	(1.072)
D5	-6.624***	-6.344***	-6.349***	-6.340***	-6.305***	-7.325***
	(0.885)	(0.885)	(0.885)	(0.885)	(0.885)	(1.084)
D6	-6.232***	-5.925***	-5.929***	-5.920***	-5.891***	-6.938***
	(0.901)	(0.902)	(0.902)	(0.902)	(0.902)	(1.104)
D7	-6.444***	-6.151***	-6.156***	-6.144***	-6.101***	-7.212***
	(0.926)	(0.933)	(0.933)	(0.933)	(0.933)	(1.134)
D8	-6.150***	-5.800***	-5.806***	-5.794***	-5.759***	-6.885***
	(0.931)	(0.939)	(0.939)	(0.939)	(0.938)	(1.139)
D9	-6.108***	-5.845***	-5.852***	-5.837***	-5.800***	-6.982***
	(0.914)	(0.931)	(0.931)	(0.931)	(0.931)	(1.121)
D1*Quality Management Practice		-1.468***	-1.448***	-1.443***	-2.201***	1.614
		(0.440)	(0.447)	(0.441)	(0.541)	(1.779)
D2*Quality Management Practice		-1.024***	-1.002***	-0.999***	-1.632***	2.133
		(0.276)	(0.289)	(0.277)	(0.381)	(1.773)
D3*Quality Management Practice		0.0900	0.113	0.115	-0.472	3.291*
		(0.162)	(0.183)	(0.162)	(0.291)	(1.775)
D4*Quality Management Practice		-0.0875	-0.0645	-0.0630	-0.629*	3.177*
		(0.240)	(0.256)	(0.241)	(0.335)	(1.802)
D5*Quality Management Practice		-0.759***	-0.736***	-0.733***	-1.268***	2.587
		(0.232)	(0.249)	(0.233)	(0.319)	(1.832)

Table 19: The Impact of the Quality Management Practice on Turnover with Age-Squared (Full Sample)

	(1)	(2)	(3)	(4)	(5)	(6)
	turnover	turnover	turnover	turnover	turnover	turnover
D6*Quality Management Practice		-0.850***	-0.827***	-0.813***	-1.335***	2.599
		(0.253)	(0.268)	(0.253)	(0.327)	(1.872)
D7*Quality Management Practice		-0.800**	-0.773**	-0.760**	-1.316***	2.801
		(0.375)	(0.389)	(0.375)	(0.436)	(1.927)
D8*Quality Management Practice		-0.988**	-0.958**	-0.953**	-1.472***	2.678
		(0.413)	(0.428)	(0.414)	(0.463)	(1.945)
D9*Quality Management Practice		-0.704*	-0.671	-0.661	-1.175**	3.080
		(0.417)	(0.435)	(0.418)	(0.464)	(1.909)
Quantity*Quality Management Practice			-0.0000231			
			(0.0000877)			
Defects*Quality Management Practice				-0.491*		
				(0.298)		
Absence Percentage*Quality Management Practice					2.753**	
					(1.169)	
Age*Quality Management Practice						-0.187
						(0.119)
Age-squared*Quality Management Practice						0.00224
						(0.00189)
/ lnsig2u	-12.36	-12.38	-12.38	-12.38	-13.03	-12.15
	(11.64)	(11.62)	(11.62)	(11.62)	(13.53)	(8.41)
Observations	769491	769491	769491	769491	769491	769491

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Table 20: The Impact of the New Quality Management Practice on Turnover (Gender Interaction Model)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
Age	-0.0649***	-0.0655***	-0.0657***	-0.0657***	-0.0672***	-0.0341**
	(0.0144)	(0.0144)	(0.0144)	(0.0144)	(0.0144)	(0.0164)
Quantity	-0.0000293	-0.0000279	0.000000845	-0.0000274	-0.0000296	-0.0000322
	(0.0000711)	(0.0000711)	(0.0000808)	(0.0000710)	(0.0000712)	(0.0000712)
Defects	0.0646**	0.0653**	0.0654**	0.0687**	0.0652**	0.0645**
	(0.0317)	(0.0317)	(0.0316)	(0.0305)	(0.0317)	(0.0317)
Absence Percentage	8.241***	8.081***	8.107***	8.089***	7.523***	8.061***
	(0.658)	(0.672)	(0.674)	(0.672)	(0.755)	(0.675)
Standard Minute Value	-0.0192	-0.0317	-0.0355	-0.0176	-0.0191	-0.0379
	(0.272)	(0.272)	(0.272)	(0.272)	(0.272)	(0.272)
Quality Management Practice	-0.586***					
	(0.125)					
D1	-7.342***	-7.190***	-7.213***	-7.193***	-6.943***	-7.895***
	(0.450)	(0.462)	(0.463)	(0.462)	(0.478)	(0.500)
D2	-7.236***	-7.069***	-7.096***	-7.072***	-6.892***	-7.808***
	(0.436)	(0.447)	(0.448)	(0.447)	(0.454)	(0.490)
D3	-6.215***	-6.330***	-6.357***	-6.332***	-6.167***	-7.074***
	(0.420)	(0.428)	(0.430)	(0.428)	(0.434)	(0.474)

Table 20: The Impact of the New Quality Management Practice on Turnover (Gender Interaction Model)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
D4	-6.850***	-7.091***	-7.118***	-7.094***	-6.937***	-7.876***
	(0.457)	(0.490)	(0.491)	(0.490)	(0.494)	(0.535)
D5	-6.785***	-6.580***	-6.606***	-6.582***	-6.428***	-7.414***
	(0.468)	(0.473)	(0.475)	(0.473)	(0.477)	(0.523)
D6	-6.421***	-6.305***	-6.331***	-6.307***	-6.157***	-7.173***
	(0.481)	(0.490)	(0.491)	(0.490)	(0.493)	(0.541)
D7	-7.015***	-6.873***	-6.902***	-6.875***	-6.722***	-7.802***
	(0.577)	(0.609)	(0.610)	(0.609)	(0.612)	(0.654)
D8	-6.599***	-6.272***	-6.302***	-6.273***	-6.114***	-7.246***
	(0.572)	(0.581)	(0.583)	(0.581)	(0.584)	(0.633)
D9	-6.479***	-6.550***	-6.587***	-6.551***	-6.398***	-7.627***
	(0.607)	(0.656)	(0.659)	(0.656)	(0.658)	(0.714)
Age*Gender	0.0276	0.0283	0.0286	0.0281	0.0289	-0.00220
	(0.0202)	(0.0203)	(0.0203)	(0.0203)	(0.0202)	(0.0244)
Quantity*Gender	0.0000462	0.0000458	0.000000289	0.0000457	0.0000459	0.0000501
	(0.0000990)	(0.0000989)	(0.000117)	(0.0000988)	(0.0000990)	(0.0000990)
Defect*Gender	-0.111	-0.112	-0.112	-0.0610	-0.112	-0.111
	(0.131)	(0.131)	(0.131)	(0.0952)	(0.131)	(0.131)
Absence Percentage*Gender	1.791	1.865	1.835	1.855	1.268	1.885
	(1.147)	(1.158)	(1.159)	(1.158)	(1.388)	(1.160)
Standard Minute Value*Gender	-0.00874	-0.00469	0.00230	-0.00945	-0.0259	0.00156
	(0.374)	(0.374)	(0.374)	(0.374)	(0.374)	(0.374)

Table 20: The Impact of the New Quality Management Practice on Turnover (Gender Interaction Model)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
Quality Management Practice*Gender	0.162					
	(0.176)					
D1*Gender	-1.830***	-1.524**	-1.493**	-1.516**	-1.404*	-0.839
	(0.684)	(0.707)	(0.708)	(0.707)	(0.743)	(0.777)
D2*Gender	-1.269**	-1.173*	-1.134*	-1.165*	-1.066	-0.453
	(0.617)	(0.637)	(0.640)	(0.637)	(0.662)	(0.722)
D3*Gender	-1.283**	-1.594***	-1.554**	-1.588***	-1.485**	-0.870
	(0.587)	(0.612)	(0.614)	(0.612)	(0.634)	(0.699)
D4*Gender	-1.055*	-0.873	-0.832	-0.868	-0.762	-0.109
	(0.626)	(0.664)	(0.666)	(0.664)	(0.682)	(0.750)
D5*Gender	-1.055*	-1.208*	-1.167*	-1.202*	-1.107*	-0.395
	(0.633)	(0.645)	(0.647)	(0.645)	(0.662)	(0.738)
D6*Gender	-1.011	-0.958	-0.919	-0.956	-0.865	-0.112
	(0.656)	(0.668)	(0.670)	(0.668)	(0.684)	(0.767)
D7*Gender	-0.492	-0.538	-0.492	-0.533	-0.397	0.367
	(0.763)	(0.797)	(0.799)	(0.797)	(0.815)	(0.896)
D8*Gender	-0.461	-0.742	-0.693	-0.736	-0.664	0.206
	(0.775)	(0.800)	(0.803)	(0.800)	(0.814)	(0.906)
D9*Gender	-0.368	-0.0765	-0.0219	-0.0686	0.00659	0.970
	(0.862)	(0.911)	(0.914)	(0.911)	(0.922)	(1.039)

Table 20: The Impact of the New Quality Management Practice on Turnover (Gender Interaction Model)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
D1*Quality Management Practice		-1.111**	-1.023**	-1.087**	-1.869***	1.370
		(0.487)	(0.503)	(0.488)	(0.650)	(0.921)
D2*Quality Management Practice		-0.971***	-0.879**	-0.949***	-1.616***	1.605*
		(0.366)	(0.390)	(0.367)	(0.518)	(0.890)
D3*Quality Management Practice		-0.167	-0.0726	-0.144	-0.767*	2.475***
		(0.217)	(0.257)	(0.218)	(0.406)	(0.860)
D4*Quality Management Practice		0.0899	0.180	0.112	-0.480	2.868***
		(0.360)	(0.384)	(0.361)	(0.486)	(0.944)
D5*Quality Management Practice		-1.121***	-1.028**	-1.097***	-1.658***	1.836*
		(0.382)	(0.405)	(0.383)	(0.490)	(1.008)
D6*Quality Management Practice		-0.782**	-0.690*	-0.757**	-1.293***	2.302**
		(0.350)	(0.375)	(0.351)	(0.454)	(1.036)
D7*Quality Management Practice		-0.860	-0.754	-0.830	-1.372*	2.477**
		(0.691)	(0.708)	(0.691)	(0.750)	(1.263)
D8*Quality Management Practice		-1.701**	-1.591**	-1.677**	-2.230***	1.783
		(0.769)	(0.786)	(0.770)	(0.826)	(1.348)
D9*Quality Management Practice		-0.298	-0.172	-0.263	-0.805	3.506***
		(0.557)	(0.586)	(0.558)	(0.628)	(1.325)
D1*Quality Management Practice*Gender		-1.179	-1.297	-1.182	-1.269	-3.611**
		(1.163)	(1.173)	(1.163)	(1.328)	(1.552)
D2*Quality Management Practice*Gender		-0.119	-0.247	-0.119	-0.187	-2.645**
		(0.559)	(0.583)	(0.559)	(0.780)	(1.203)

Table 20: The Impact of the New Quality Management Practice on Turnover (Gender Interaction Model)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
D3*Quality Management Practice*Gender		0.591* (0.331)	0.459 (0.373)	0.595* (0.332)	0.535 (0.602)	-1.999* (1.137)
D4*Quality Management Practice*Gender		-0.336 (0.485)	-0.467 (0.515)	-0.333 (0.485)	-0.412 (0.688)	-3.061** (1.230)
D5*Quality Management Practice*Gender		0.593 (0.484)	0.458 (0.517)	0.599 (0.485)	0.524 (0.667)	-2.310* (1.284)
D6*Quality Management Practice*Gender		-0.148 (0.507)	-0.281 (0.538)	-0.119 (0.508)	-0.210 (0.666)	-3.175** (1.345)
D7*Quality Management Practice*Gender		0.175 (0.823)	0.0190 (0.849)	0.197 (0.824)	0.0237 (0.949)	-3.100* (1.595)
D8*Quality Management Practice*Gender		1.182 (0.922)	1.015 (0.949)	1.206 (0.923)	1.182 (1.014)	-2.237 (1.696)
D9*Quality Management Practice*Gender		-0.788 (0.869)	-0.968 (0.901)	-0.795 (0.870)	-0.811 (0.963)	-4.514** (1.831)
Quantity*Quality Management Practice			-0.0000881 (0.000130)			
Quantity*Quality Management Practice*Gender			0.000130 (0.000176)			
Defects*Quality Management Practice				-0.284 (0.326)		

Table 20: The Impact of the New Quality Management Practice on Turnover (Gender Interaction Model)

	(1) turnover	(2) turnover	(3) turnover	(4) turnover	(5) turnover	(6) turnover
Defect*Quality Management Practice*Gender				-0.731 (0.792)		
Absence Percentage*Quality Management Practice					2.869* (1.607)	
Absence Percentage*Quality Management Practice*Gender					0.436 (2.444)	
Age*Quality Management Practice						-0.109*** (0.0348)
Age*Quality Management Practice*Gender						0.107** (0.0448)
/						
lnsig2u	-12.38 (-1.07)	-12.17 (-1.44)	-12.16 (-1.44)	-12.16 (-1.45)	-13.52 (-0.80)	-12.16 (-1.45)
Observations	769491	769491	769491	769491	769491	769491

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

Chapter 5

Conclusion of the Thesis

The research provides evidence of the impact of a new quality management practice on various measures of worker level and firm level performance by using a unique data set from a large-scale garments manufacturer in Pakistan.

It has often been mentioned that piece rates lead to a misallocation of tasks as workers concentrate on quantity rather than quality. Data on 648 workers was used when analysing the impact of the new management practice on the productivity and quality defects of individual workers, which shows that the quality defects made by all workers were significantly reduced and the productivity of workers was significantly increased after the implementation of the new quality management practice.

The results also complement the literature on good and bad management practices and firm productivity (see Bloom and Van Reenen, 2007; Bloom and Van Reenen, 2010). After we analysed the impact of the new quality management practice on the production of the firm by assembly lines, we found that whether this new management practice turns out to be a good management practice or not is not straight forward as the impact of the new practice varies by assembly line. The impact of the new management practice is contingent upon the complexity of production which is in line with Boning, Ichniowski and Shaw (2007) and we find sizeable differences in the impact of the new quality management practice between complex and basic lines. The implementation of the new practice decreases the productivity of basic lines (1A, 1B and 2A) and complex lines (lines 4 and 5). However, we find mixed results for line 2B (basic line) and line 6 (complex line). All specifications show that the new practice increases the productivity of lines 3A and 3B, which produce relatively more complex products as compared to the rest of the basic lines. Therefore, we suggest that the standard management practices seem to suffice for very basic lines and complex lines, while the new practice is beneficial for lines 3A and 3B.

We also observe that the impact of the new quality management practice also varies by the change in complexity of production denoted by the deviation from the average standard minute value and this effect also differs by assembly line as some specifications show that changes in complexity within a line after the implementation of the new quality management practice has a dampening effect on productivity while some specifications show that this effect is insignificant.

Worker turnover at the firm was reduced after the implementation of the new quality management practice. Gains in utility of workers due to rewards and recognition has been established in the past. This research provides results in line with the relationship suggested by Weiss (1984), such that a higher expected utility at the current job is likely to decrease turnover. The lack of job alternatives combined with the potential increase in job attachment due to the recognition and rewards provided by the new management practice may explain the reduction in turnover at the firm.

One of the most important findings is that the impact of the new quality management practice varies by job tenure. The magnitude of the impact of the new practice is higher for short tenured workers as compared to workers with longer tenures. The new quality management practice may send positive signals about the job to workers who have only been with the firm for a shorter period of time. Therefore, a larger reduction in turnover has been observed for workers who are in the initial stages of the job and are in the process of accumulating information about the quality of the job match as compared to those workers who have accumulated substantial information about the quality of the job match and other aspects of the job.

Most model specifications suggest that worker effort denoted by productivity and quality defects is not a significant predictor of turnover before the implementation of the new practice. This may be explained by the notion that firms may not extensively use the threat of dismissal as it may impair the morale of the workforce. Instead of using the threat of dismissal, shirking behaviour may be dealt through discussions and verbal warnings. Interestingly, one specification suggests that before the implementation of the new management practice, workers with higher quality defects are more likely to turnover, however, after the implementation of the new quality management practice, workers with higher quality defects are less likely to turnover. Hence, the implementation of the new management practice tends to reduce turnover of workers with a relatively lower level of performance.

However, absenteeism is a significant determinant of turnover, as an increase in absenteeism increases the likelihood of turnover. Absenteeism seems to be a cause of concern as it is a threat to assembly line production. Supervisors need to find a replacement when a worker is absent and the replacement workers needs to have the same specialisation as the absent worker, otherwise the quality of production is compromised. After the implementation of the new quality management practice, shirking behaviour such as absenteeism has a higher impact on turnover, hence shirkers are more likley to be dismissed or the withdrawal process of absenteeism that leads to turnover becomes stronger.

Gender differentials were found in the impact of the new quality management practice. Before the implementation of the new practice, females were less productive as compared to males and also earned less than their male counterparts. The implementation of the new quality management practice increased the productivity and earnings of females by a greater magnitude as compared to males. Hence, the implementation of the practice reduces the male-female productivity and pay gap. Before the implementation of the new practice, females made significantly fewer quality defects as compared to males. Although, the implementation of the new quality management practice reduces the number of quality defects made by both males and females but females make significantly more quality defects as compared to males after the implementation of the new practice. The quality management practice seems to target and minimise the shirking behaviour of workers as it has a greater impact on reducing the quality defects made by males who were making more quality defects before the intervention as compared to females, while the impact of the practice is of a smaller magnitude on the relatively more careful and quality conscious females.

Females were less likely to turnover as compared to their male counterparts in the initial years of employment, after which no significant difference was found. This result highlights significant gender differences in the job matching process, which is line with Viscusi (1980). Financial hardship and fewer job alternatives due to restrictions on the mobility of females may also be potential reasons for the lower turnover rate of females.

As the data in this research is limited to one specific firm, the findings from this study cannot be generalised for the labour market or the manufacturing industry but such findings contribute to a growing body of firm level studies (for example Bloom and Van Reenen, 2007; Bloom and Van Reenen, 2010; Bloom et al., 2013; Lazear, 2000; Boning, Ichniowski and Shaw, 2007; Ichniowski, Shaw and Prennushi, 1997; Bandiera, Barankay and Rasul, 2005) which may later on provide general conclusions about various aspects of worker and firm performance. However, the findings of this research will be useful to other firms in the ready-made garments industry who want to introduce new management practices to improve firm and worker performance.

One of the limitations of the study is that there is no control group. However, throughout the period of observation, the technology used by the operators, other management practices at the firm, number of hours worked, compensation mechanisms remained the same, hence our estimates are reliable. There are some other data limitations, for example, when analysing the impact of the new quality management practice on turnover, data does not allow us to distinguish between voluntary and involuntary turnover. We also do not have data on the quality defects per assembly line so while we analysed the impact of the new quality management practice on the productivity per line in chapter 3, we are unable to comment on the quality defects per line.

An avenue for future research could be to analyse a shorter time frame around the change in the management practice to run a robustness check that whether the change in the practice is driving the results found in the current research rather than something else. Another idea is to analyse the impact of the new quality management practice on absenteeism at the firm.

Practice/Management

One of the important implications of the study for the firm is that although this study provides evidence that linking rewards for reducing quality defects while keeping piece rates intact does improve worker productivity while reducing quality defects, however this result should be used with caution as the overall performance of lines after the implementation of the new practice shows a different picture. The firm should further investigate reasons for the decrease in the productivity for all lines apart from lines 3A and 3B in order to keep the new quality management practice in place in the long run.

The study provides empirical evidence that the use of such motivational tools which provide a combination of monetary and non-monetary incentives, monitoring and peer pressure may reduce the training and hiring costs incurred by the firm due to employee turnover. Also, as the results indicate that females have a lower likelihood of turnover in the initial period on the job, the firm may be able to benefit from further increasing the proportion of females as stitching operators. The firm should calculate the costs saved by reduced turnover and see if there are any significant effects on profitability.

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