Teams, Performance-Related Pay, Profit Sharing and Productive Efficiency: Evidence from a Food-Processing Plant

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Abstract

By assembling and analyzing new panel data, we investigate the impact of important changes in HR practices on firm performance for a food-processing plant. Our principal economic data are most unusual – weekly records on efficiency for all four production lines in the plant during 1999-2005. Compared to other insider econometric studies our case experienced an unusual degree of change in HR policies with the introduction of teams, company wide-profit sharing and a group system of performance related pay (PRP) though production technology did not change. We use theory and detailed knowledge of HR policies at the case to develop core hypotheses concerning the specific effects of these particular HR plans. We also consider hypotheses concerning why effects might vary across lines. Evidence that is largely derived from interviews mainly supports our key hypotheses. Our key empirical strategy is to estimate structural change models. In three of four production lines we find, as predicted, that the addition of PRP to teams produces substantial productivity increases ranging from 9 – 20%, while in the remaining line there is no change in productivity. We also provide additional and more qualitative evidence that bears on subsidiary hypotheses, e.g. concerning the impact of PRP and teams on product quality and worker incomes. Our findings thus provide some of the first disaggregated evidence for the importance of complementarities among HR policies. Our findings support those from other studies that have shown the crucial importance of HR plan design and the context surrounding implementation for policies to have economic payoffs.

Keywords: performance related pay; incentives; teams; profit sharing; insider econometrics; personnel economics.

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I Introduction

In many countries including the U.S. and Japan (e.g. Osterman, 2000; Kruse, 1993; Kato, 2000) recent years have witnessed extensive reforms in work organization and payment systems. Unsurprisingly the literature that examines the links between human resource management polices (HRM) and business performance has also grown rapidly as scholars from different fields in labor economics and industrial relations have applied varying approaches to explore new types of evidence and research questions. One prominent approach that is increasingly used is “insider econometrics” (Ichniowski and Shaw, 2003) or econometric case studies (Jones et al., 2006). Most of these studies focus on the effect of a single HRM practice on productivity including Lazear (2000), who investigates the impact of the introduction of PRP and Hamilton et al. (2003), who examine the impact of teams. However, econometric case studies and insider econometric studies are still quite rare.

In this econometric case study we assemble a most unusual panel data set from a plant in a large Finnish food processing firm and use it to investigate the impact of the introduction of teams, company-wide profit sharing and group performance related pay (hereafter PRP) on firm performance. One contribution of our study stems from there being several important changes in the human resource (HR) environment at our case. By investigating the productivity effects of combinations of changes, especially the impact of the introduction of group PRP alongside teams, we provide one of the first econometric studies that uses data that are quite disaggregated to test hypotheses relating to possible complementarities concerning innovative HRM practices. Also, whereas most other insider econometric studies have examined cases in which production technology changed (e.g. Hamilton et al, 2003), in our manufacturing case there were no such changes.

The other main contribution of our study stems from our most unusual data and the empirical methods we use to analyze these data. Our principal data are weekly records on efficiency for all four production lines at the plant during 1999-2005. These data are combined with detailed knowledge concerning crucial characteristics of the main HR policies at the case, and the changing context within which HR changes were introduced. This information was obtained from visits to the plant and the firm's operational headquarters, where we had extensive interviews with managers and employees. By drawing on theory and knowledge gained from visits to the case, our main hypothesis is that while the introduction of either teams or profit sharing alone would not be expected to affect business performance, we predict that the combination of PRP and teams would affect productivity. To examine the impact of these changes in HR policies on business performance, the long time series nature of our data enables us to estimate structural change models to see if the introduction of the HR policies had an impact on the nature of the production series. As such, our empirical approach probably represents one of the first applications of time series econometric methods to the insider econometric literature that examines links between HR policies and business performance. We find strong evidence that there was substantial change in the data generating process after the introduction of PRP and that in two of the lines there were substantial gains in productivity. The plan of the paper is as follows.

We continue by briefly describing aspects of our case study including careful examination of the HR policies. This is followed by a discussion of theory where we review when, how and under what conditions HR policies such as teams might be expected to affect business performance. Next using the institutional knowledge together with lessons derived from theory, we develop our key hypotheses. Also, by examining mainly interview evidence gleaned from plant visits, we provide preliminary evidence concerning our main hypotheses. In the heart of the paper we discuss our data, outline our key empirical strategy, the estimation of structural change models, and then report our principal empirical findings. This is followed by a discussion of subsidiary hypotheses, mainly concerning the impact of HR initiatives on product quality and employee incomes. This is interwoven with other evidence derived, for example, from interviews and annual data for different production lines. In the concluding section we discuss implications of our findings.

II Description of the case

II.1 The firm and its operating environment

The case firm (FP) operates in food-processing and employs around 4,500 employees including 2,600 in Finland. FP is based in Finland where it has five production plants. In this paper we investigate one of these plants which has around 200 employees. Employment in the firm's Finnish plants remained essentially stable during the period of 1999-2005, while the company experienced growth in its overseas operations. The company is one of the top three largest firms in the food-processing industry in Finland and employees are mainly low skill and receive low wages.

Our understanding of the institutional realities of the firm is based on several interviews we have made during 2005. We have interviewed the personnel manager of the company, the plant manager, and other employees at various hierarchical levels. Although the interviews were done towards the end of the period under observation, our discussions covered the entire period 1999 – 2005. Most interviewees worked for FP during the whole period. To reduce the risk of recall bias, we compared the accounts of different interviewees to make sure that there were no inconsistencies. In addition, we discussed our research with another team of researchers who have conducted independent research at the same plant since 2000 and ensured that our understanding of developments at FP was consistent with their findings.[1]

We now turn to describe the changes in the external environment of FP. Until 1995, the Finnish meat markets were largely protected from foreign competition due to import restrictions. The market situation changed overnight following Finland's entry into the EU on January 1st 1995, when Finnish food markets were opened to imports from EU countries. As a result producer meat prices sank by 20 % and consumer prices by 15 %.[2] Naturally, this change did not come as a surprise to meat producers. The industry itself had been under restructuring since the early 1990s, when producers had started to adjust to the new situation. As a result of this, productivity growth in the Finnish food industry during the 1990s has been faster than in other EU-countries, and Finland has risen from one of the countries with relatively low productivity to one that falls in the middle-range (Roponen, 2006).

For FP the 1990s was a decade of considerable trouble. Problems were acute during 1990-1994 when net profit averaged -1.3% annually. In the latter half of the 1990's profitability improved marginally and during 1995-99 it averaged 0.8 %.[3] This was also a time when the industrial relations climate at FP was quite poor, with labor-management relations often resulting in strikes. Consequently, and as we will examine in detail in section four, management at FP began to consider making changes in work organization and the compensation system as possible strategies to improve industrial relations and ultimately to help the financial situation of the firm.

The other area we briefly examine in this section is the process and technology used in the case. The plant we study produces various meat products, the dominant forms of which are frankfurter-type sausages. During our site visits we observed that production at the plant is organized into a series of four production lines namely: Meat reception, sausage spraying, sausage packaging, and a line that manufactured small sausages (and includes both spraying and packaging).

In each of the four lines, the mode of production is that of line production. Work in the packaging lines is mainly automated, as is the small sausage spraying, but the sausage spraying line is characterized by manual work. Also, work in meat reception is organized mainly as individualistic tasks, whereas the norm in other lines is to use teams. Efficient production requires that production be organized so that the various machines are working at optimal speed and that there are no disruptions in production. It is also important that the raw materials that are delivered at each stage are used so that losses from waste are minimized but also to ensure that the final product is of consistent and good quality. Since the plant produces multiple products employees must change their tools when production switches to a new product. Hence to minimize losses caused by production downtime and the set-up costs associated with switching to new products, a key aim of the business has been to produce in batch runs that are as long as possible.

The gender patterns between the lines differ in important ways. Only men work in meat reception lines, while most employees in other lines are women. The reason for this is that meat reception requires physical strength, while manual dexterity is a more important characteristic in other lines.

II.2 HRM changes

In response to a weak economic performance and the possibilities of implementing online teams that the line production nature of production at FP offered, FP began to introduce changes in its HR strategy in the autumn of 1999. At first the focus was on teams, and all employees at various plants, including the plant we are focusing on, began to participate in training sessions on teamwork. The introduction of teams actually started during 2000. Subsequently the company embarked on other changes as it searched for a HR system that delivered sustained economic benefits. The other notable changes were the introduction of company-wide profit-sharing in 2001 and the introduction of a new production line performance-related pay (PRP) scheme in 2003 (amended in 2004). In addition, a scheme whereby employees were encouraged to submit suggestions concerning the work environment and production processes was revived in 2000 and a new skill-related base pay system was introduced in 2004. In tandem with these changes there has also been a leveling of managerial hierarchies so that now all supervisors are directly under the control of the plant manager, whereas previously there was one additional managerial layer. All changes in the design of HR policies and organizational structure were initiated from the company level and were also carried out in all domestic plants. We summarize the development of the HR practices in Table 1 below and continue by taking a more detailed look at the key components of the changes in workplace organization and compensation.

Table 1

1999	2000	2001	2002	2003	2004	2005
	Teams Suggestion scheme	Company-wide profit sharing scheme		PRP scheme with hurdle level	Hurdle level removed from the PRP scheme Skill-based pay	

Teams

Prior to the introduction of teams, the workplace was organized in a very hierarchical way with, for example, supervisors being entirely responsible for task assignments for employees. The initiative to introduce teamwork came from management. The central aim of teamwork was to get employees to take more responsibility for their work and to induce them to work "smarter". Training sessions in teamwork started in 1999 and were organized by consultants from outside the firm. All employees were trained for three days in groups of around 20 employees. Also a select group of employees received more thorough training–they were being prepared to act as "team coaches" who would help with the internal functioning and organizing of teams after teams had started and the consultants had left. It is also important to note that union representatives were heavily involved with the process of introducing teams. The local union has been supportive of the team concept and some shop stewards became "team coaches" and, as such, they were the key persons involved in implementing the change with workers. It should also be noted that the Finnish Act on Cooperation within Undertakings requires that employers must consult employees before introducing far-going changes at the workplace such as the introduction of teamwork. In any case, since teamwork requires employee co-operation to succeed, it was necessary for the employers to have extensive co-operation with the union.

The initial aims for teamwork were considerably more ambitious than what was eventually realized. Initially, the goal was to move from a very hierarchical system of workplace relations to autonomous teams where teams would take over the roles of supervisors. Moreover, our interviews revealed that in one training session, a consultant had told supervisors that the number of supervisors would be reduced drastically after the transition to team work has been completed.

However, soon after the introduction of teams, it was realized that most supervisors simply could not be replaced. Instead of teams making supervisors redundant, what has happened is that their job tasks have changed considerably. Now we find that supervisors are the key persons involved in running the team system. Supervisors participate in team meetings, help team leaders prepare for meetings and spend much time on coaching the teams. They also run the suggestion scheme, participate in the development of the PRP scheme, and participate in the setting of operational goals at the plant level. At the same time their current responsibilities involve much less direct supervision of the work of other employees.

Teams can influence the scheduling of production and other work arrangements. An important role for teams is evident from monthly meetings where monthly performance indicators are reviewed and other issues are discussed. These meetings are run by the team members, and the position of team leader rotates among employees. There are also weekly meetings between supervisors and employees where these issues are discussed at the departmental level. The difference between these meetings is that the meetings between teams are set up to be directed by team members, whereas weekly meetings involve more communication from supervisors to employees.

The nature and scope of teams at FP has remained relatively unchanged throughout the period. Initially there was an attempt to keep the teams relatively small, but in 2003 the number of teams in the four lines was reduced from 15 to 10.[4] This change was introduced because it had been observed that teams worked better when all individuals whose jobs were closely connected belonged to the same team. Teams continue to be relatively small, and consist of from 10 to 20 people.

Compensation systems

In the plant that we study, in 1999 all production employees earned fixed wages. Wage levels are quite similar across the lines, but in meat reception they have been 15-20 % higher than in other lines. This is because in meat reception, employees come to work at 4 PM and were entitled to higher night shift rates for 2 hours. Simultaneously with the introduction of teamwork, management started to think of reforming the compensation system. While a joint management – employee committee was formed to prepare for the change in compensation, in fact changes in the compensation system proceeded more slowly than did the reform of work organization (and the introduction of team work.) Changes in the compensation system did not begin until 2001 when a *company*-wide profit sharing scheme was introduced. In this scheme, the payment depended solely on the company reaching a target that was based on operating profit. If the profit goal was met, one third of the amount above target was shared with employees and all employees received equal shares. For example, in 2001 the profit target was 34.3 Million Euros. That target was reached and each employee received 605 euros, or 2% of average annual earnings. For 2002, the profit-sharing targets were made semi-annually and the targets for each half-year were 19.3 million euros, slightly higher than in the previous year. In 2002, the target was reached only in the latter half of the year. This was also the last time during our period of observation when the profit target was met. In 2005, the scheme was modified in important ways. First, instead of using operating profit as the target, it was decided to use profit before exceptional items. Also this criterion was to be restricted to the domestic units (rather than the whole company). Finally the target was set lower.

In the beginning of 2003 a PRP system was introduced, though the profit-sharing scheme still remained in effect. Henceforth, in addition to sharing in profits, this new PRP scheme provided that employees were to be paid according to how well their particular production line was performing.

Importantly, during 2003, a hurdle level for the profit target was set; this hurdle level had to be exceeded in order for production line level bonuses to be paid. In the beginning of 2004 this hurdle level was removed. In other words, after January 2004 employees would be rewarded if their own line outperformed production-line targets, even if company-wide profit targets were not met. Related to this, it was decided that if a production line fully met their targets, each employee in that line would receive a fixed amount (€ 420).[5] Even meeting one criterion is enough in receiving a partial payment. This contrasts with the situation in 2003 when even when a line performed very well and met all its targets, no bonuses were received since company-wide profit targets were not met. However, notwithstanding the formal scheme, it appears that many employees and supervisors were not aware of this hurdle level (Ylikorkala 2006, 58).

While there are some slight differences in the criteria used in the PRP scheme across lines, basically there are three criteria– productivity, quality and capacity utilization. Targets using these three measures are derived from strategic planning at the company level with company management communicating operational targets to plant management. It is the task of the plant management, together with supervisors, to translate plant-level targets into production line-level targets. These preliminary targets are then discussed in team meetings and employees can comment upon them and suggest revisions. The final production line targets are then approved jointly by the plant management, supervisors and employees in team meetings, though it is the plant manager who retains ultimate decision-making power. These goals then form the basis for the production-level PRP plan. The relative weights placed on the three criteria are decided by the plant manager.

PRP is paid out three times a year. The idea is that one third of the potential savings from productivity improvements are allocated to the workers and two-thirds to the company. Since the start of the scheme, employees have received at least some payments. All employees get an equal share of PRP, regardless of their salary.

It is also noteworthy that the system has been continuously adapted. Changes followed after it was observed that the motivating effect of the system might be being undermined because some lines were thought to be operating close to their physical maximum possibilities. In such instances, employees are in danger of losing PRP payments. Consequently the weights placed on the three criteria were adjusted. For example, in one line where employees were frequently at or very close to the maximum potential, it was decided that the weight placed on productivity was to be dramatically reduced. Thus in 2005, the weight placed on productivity in determining PRP was only 10%, while realizing quality-related goals was given a weight of 90 % in determining PRP. Even in this case the norms did not change (see also footnote 12).

The final change in the compensation system concerns base pay. After the introduction of PRP, the base pay structure was also changed so that base pay became partly dependent on the skills of an individual employee. This is also used in order to encourage employees to participate more in training. This process has been taking place gradually within different lines during 2004-2005. The skill-based component could at maximum be around 2.5% of the base salary.

III Theoretical framework

In this section we discuss ways in which theory suggests that the key HR innovations at FP, namely on-line teams, PRP, and profit sharing might have potential impacts on company performance. Our discussion concentrates on design features of such schemes that are apt to affect the size, channels and the timing of potential effects on productivity. We also examine ways in which the organizational context may help to influence productivity effects. While we concentrate on theoretical issues relating to the expected impact on business performance of *individual* innovative HRM practices such as teams, we also examine theory concerning the potential payoffs to *combinations* of HRMs.

There is a substantial body of theoretical work concerning "team production", and also a related literature on "teams".[6] By "teams" we refer to work practices whereby employees work in groups rather than individually and they also have some discretion over their working methods. “Team production” refers to settings where output can be defined or measured only at the group level instead of individual level.

Teams may have positive effects on productivity through three channels. First, increasing employee discretion allows for more efficient utilization of the private information employees have on production processes (Baron and Kreps 1999). Second, Lazear (1998) has emphasized knowledge transfers in teams. Third, Hamilton et al. (2003) show how heterogeneous teams can facilitate learning effects. However, teamwork involves also costs. First, team work usually involves regular meetings between team members that are not used in productive activities. Second, teams may also increase employee expectations about increased discretion. If these expectations are not fulfilled, it may create frustration and lower work morale (Heller et al. 1998). Third, it has been convincingly argued that the introduction of teams may require time to pay off—there are team learning effects as teams learn how to adapt to a new work organization and the introduction of teams must be viewed as an investment (Levine and Tyson, 1990).

For teams to have positive effects on productivity it is often argued that complementary financial incentives are needed. For example, Ben-Ner and Jones (1995) point out that employee involvement alone may not lead to enhanced business performance, especially in the absence of increasing return rights. The coupling of return rights with teamwork may provide the right incentives for employees to both engage in peer monitoring and to withhold from opportunistic use of increased discretion. Increasing employee discretion without providing incentives for effort may produce detrimental effects. For example, employees within autonomous teams that have wide responsibility for production methods and work pace may use this freedom to work at a more leisurely speed. Next we examine incentives in teams in more detail.

The literature on “team production” is concerned with the provision of incentives in situations where team output can be observed but individual productivity is unobservable. Dividing the output equally between team members leads to well-known free-rider problems. The early literature concluded that the presence of an outside party is necessary for team production to function, either in performing a monitoring function (Alchian and Demsetz, 1972) or acting as a "budget breaker" (Holmström, 1982). Among subsequent works, the most relevant for our purposes is the literature stressing the role of horizontal monitoring.[7] It has been argued that monitoring functions can be performed more efficiently by employees who observe each other's work effort on a continuous basis (Putterman, 1984). Similarly, it has been argued that teams can achieve first best outcomes once they develop norms against shirking (Kandel and Lazear, 1992). Thus the important question to understand is when employees develop norms that protect from shirking and other undesirable side effects of team work. Disciplining of co-workers is likely to inflict psychological costs on employees, and therefore it is not likely that they would engage in it without additional inducements (Blasi et al., 2004).

In FP, teams were first introduced without any incentive schemes. However, after one year a company-wide profit sharing scheme was introduced. There exists fairly consistent evidence that profit sharing schemes have modest but positive performance impacts.[8] However, company-wide schemes may not always work. They are potentially subject to free-riding and "line-of-sight" problems (Vroom, 1995): employees do not perceive that their actions can affect company level indicators and therefore they are not likely to take the desired actions. According to Knez and Simester (2001), company wide schemes may succeed if production units are interdependent, since in this case cooperative high effort equilibrium exists. Baron and Kreps (1999) note that company-wide schemes are more targeted to creating a common bond between the employer and employee and to operating more at a more symbolic level rather than to having a direct impact on how work is done. Weitzman and Kruse (1990) note the fragility of the high effort equilibrium under profit-sharing and emphasize that good labor relations may be essential for positive performance impacts.

When it is feasible to tie pay to group performance below the company level, it may be desirable. This is what FP did when it introduced the group PRP scheme. Performance pay related to team or line performance strengthens the case for mutual monitoring and removes the line-of-sight problem. Other potential advantages of performance-related pay systems are that payments are typically made more frequently than in the case of profit-sharing plans, when the feedback on performance is more direct (e.g. Kauhanen and Piekkola, 2006). There are also other features of PRP schemes, which affect their potential impact on performance. Organizational psychologists have emphasized the need for employees to be involved in designing performance targets in order to foster employee commitment to exceed targets (e.g. Jenkins and Lawler, 1981). Another theme from that literature is that employees have to be aware of the performance targets (e.g. Martin and Lee, 1992). When this is not the case, the system probably appears fairly stochastic to employees and the desired performance effects will not materialize.

Even though group-level PRP schemes have distinct advantages over company-wide profit-sharing schemes, they are not without problems. One problem is that when the company commits itself to pay a fixed amount for reaching specified targets and then experiences a negative shock to its profits, it is still obliged to pay PRP even when profits have turned sour. Thus unlike most profit-sharing schemes, PRP schemes may have adverse liquidity effects. Second, PRP schemes that operate at very low levels of aggregation may cause different divisions to optimize their own performance in ways that hurt the performance of other units and thus possibly produce negative externalities.

PRP schemes with performance targets may be problematic in intertemporal settings. Realized performance affects the choice of effort since employees are able to vary their level of effort over time. The marginal value of effort depends on realized performance, and if employees observe how well they are doing with respect to the performance measure they will use this information to guide their choice of effort. For example, if at some point during the evaluation period employees realize that meeting the targets will be difficult, perhaps due to negative productivity shocks, the marginal benefit of increased effort may be minimal, leading to a choice of a low level of effort. The case for positive shocks is analogous.[9] This was a potential concern at FP because, in 2003, the company-wide profit target formed a hurdle rate for the PRP scheme. Since interim financial reports are public information, employees were able to see how close firm performance was to the profit target. Consequently, this information is expected to have a direct impact on the marginal value of employees' effort, and thus on their effort choice.

Finally, it is often the case that past performance affects current targets, leading to the so-called "ratchet effect" (See Weitzman 1980, and Freixas et al. 1985). Despite incentive pay, employees may not be willing to produce at a level which exceeds the target since they know that exceeding the target will increase the target for the next period. In other words, employees are weighing the benefits of higher current income against more demanding future goals. Of course the firm realizes this and, in equilibrium, the incentive scheme is apt to be quite low-powered. Hence, in the end, the incentive scheme may not be expected to have much of an effect on the effort choice.

We also note that there are various theories concerning how gender can influence the effects of payment systems. Goldin (1986) argues that women prefer immediate (rather than deferred) compensation because of their shorter tenures. An alternative argument (Jirjahn and Stephan 2004) is that women prefer more objective performance measures, since these protect them from gender-based discrimination that may go unchecked when subjective performance evaluation is used instead. These arguments would suggest that women especially should welcome the introduction of production line- based compensation and, by extension, feel more motivated because of such payment systems.

Taken together, the evidence on the effects of PRP and profit-sharing is mixed. As is the case with teams, the expected effects are likely to depend on various contingencies and factors surrounding the implementation of the specific schemes. However, we expect that our earlier remarks concerning the need for and gains from complementary practices to also apply to situations where profit-sharing or performance-pay schemes are introduced in isolation. Without any supportive changes in work organization, we would expect that free-rider effects would dominate. Thus, introducing performance-pay systems in isolation may be just as ineffective as increasing employee control without return rights (Ben-Ner and Jones, 1995; Ichniowski et al., 1997).

IV Core Hypotheses and Preliminary Evidence

Based on the preceding description of HR policies at FP as well our previous review of theory, we develop three core hypotheses concerning the effects of these HR polices. First, we would not expect that the introduction of teams would have any strong initial positive effect on the business—indeed the initial introduction of teams might conceivably damage business performance. This follows in large part because teams were introduced alone, and were not accompanied by any change in the reward system. Moreover, there were important pockets of resistance to the original idea, notably from supervisors and some of the longer tenured workers whose attitudes had been shaped during a period of embittered labor relations.

A second prediction is that the addition of the company-wide profit sharing scheme to teams would not be expected to change the situation markedly. This prediction is based mainly on the observation that the profit sharing scheme was badly flawed in its design. The key conditions for a successful company-wide profit sharing scheme that theorists have identified were not satisfied at FP; hence we would not expect this particular group profit sharing scheme to have delivered any discernible benefits to the plant. For one thing, the plant’s operations are quite independent of the operations at other domestic and international plants. For this reason, as well as the fact that the labor force at this plant constitutes a small fraction of overall employment, it is unlikely that employee behavior could affect company profits in any meaningful way. Also, while managers appeared to realize that for teams to be effective reward systems would also need to change, company-wide profit sharing was chosen mainly because management did not want, ex ante, to commit to put aside a certain amount of cash for PRP payments. Another concern with the PRP scheme was that it could endanger co-operation between the lines. The introduction of profit-sharing was an attempt to introduce some changes in the pay structure but in a situation when there was still no agreement about PRP (Ylikorkala, 2006) and where the hurdle level was set relatively high. However, hardly anyone regarded that as the preferred method of compensation.

The third core prediction is that the addition of PRP to existing team arrangements would be expected to lead to improvements in plant productivity. This follows in large part because we believe that the PRP scheme was well designed and effectively implemented. In addition, by 2003 there had been substantial learning effects accompanying the earlier introduction of teams. For these reasons we expect the economic gains from the addition of PRP to be delivered quite quickly. Moreover, the payoffs to PRP would be expected to be especially strong after the modifications to the early PRP plan and adjustments, such as the removal of the hurdle rate. The changes in the compensation system clearly related to the workplace changes that followed the earlier introduction of teams and offered opportunities for complementarities to be realized between team work and PRP. As a group related performance related pay system, PRP requires mutual monitoring to work, which small teams and regular team meetings facilitate. Also there must be at least interdependencies between the units in which the performance is measured and currently there are no more than a few dozen employees per line and performance can be measured reliably for different lines. The net effect of the changes in compensation is that now there is a very close match between financial rewards and teams. In addition, mutual monitoring is much strengthened by the fact that there are regular team meetings. Once PRP became effective then potentially team meetings provide a useful framework for communicating performance targets and the realized performance to employees. In this sense we can argue that there are indeed complementarities between teams and PRP.

In assembling preliminary evidence that bears on these hypotheses we rely mainly on our extensive interview evidence. Concerning the proposition that teams were not expected to produce significant gains in productivity when introduced alone, our interview evidence strongly suggests that the attitudes of employees towards teamwork were divided. On the one hand, many employees were enthusiastic about the change and the related team training. Also, there is a broad consensus from the interviews that teams improved employee commitment and pride at work. Employees were reported to be more conscientious about the work they are doing which is shown in higher quality and productivity. On the other hand, many seasoned employees were skeptical about the change and preferred the old system with a strong role for supervisors. Supervisors were naturally concerned about their jobs and resisted the change. Also, the available evidence suggests that the process of switching into teams has been a difficult one involving a lot of learning costs. The production process was changed so that employees had to take much more responsibility and show more initiative instead of waiting for orders from the supervisors. This has created enthusiasm among some employees but also resentment. The plant management used lay-offs as a strategy to get rid of some workers that were opposed to teamwork.[10] Consequently, our sense is that the net effect of the introduction of teams at FP did not initially produce significant behavioral changes or changes in business performance.

Turning to the company profit sharing plan, in several interviews we were informed by respondents that they regarded the profit sharing scheme as ineffective. Employees resented not having received disbursements in some years when targets were met, even though the firm has been constantly profitable. Moreover, employees did not think they could influence profits in any meaningful way. Employees were especially aware of this in the early form of the scheme, when the workforce at the case plant constituted less than 5 % of the total work force.

There is also evidence that the combination of teams and PRP began to pay dividends. In part this reflects team learning effects. Our interviews revealed that, over time, employees began to take more initiative in scheduling production, though ultimate decision authority still rested with supervisors. Besides longer batch runs and more discretion in scheduling production, we were informed of other examples of how teams were improving flexibility in production and how employees became more active in solving problems that occurred in production. At the outset, small technical problems might have stopped production as employees called for technical support to solve the problem. But increasingly it was argued that employees had been trained so that they could solve small problems by themselves. Learning effects were revealed in many ways. Initially it appeared that the new team way of working was difficult and many employees felt that team meetings were a waste of time. But subsequently employees indicated that they had learned to use team meetings for their benefit.

Several examples of changes in production that were made by teams were disclosed in our interviews; the bulk of these occurred later on, after 2003. One example is how teams suggested a simple change in the production line: to reduce waste and collect meat that previously had been dropping off from the line, the employees suggested installing a catching device to collect meat that would otherwise have been wasted. Another example concerns how employees responded to a machine break down. Initially employees always took a break when this happened. But after the introduction of the PRP system, employees started to develop alternative plans, moving to another machine when one broke down. In the case of minor technical problems, they also now repair the machines themselves rather than wait for the repairmen. A third example comes from packaging. Initially one process required six workers and employees in that team were asked to think how to improve the process so that only four persons would be required. After consideration and experimentation, employees came up with a process that required input from only two persons, leaving the other four employees to use their time in other productive activities.

Also the addition of PRP meant that employees had financial incentives to make productivity improvements. Our interviews also revealed that the PRP system was not without its critics. The plant manager criticized this system because apparently it was based on the idea that the process could be continuously improved, while some lines were thought to be operating close to their maximum physical possibilities. However, as indicated earlier, the system was quickly responsive to such criticisms, as the weights placed on the three criteria were adjusted.

In sum, our reading of the preceding preliminary evidence is that, on balance, it offers suggestive evidence in support of our core hypotheses. In addition, we cannot find any similar evidence that might lend support for other possible drivers of the predicted jump in productivity that corresponds to the addition of PRP to teams. For example, suggestion schemes were introduced simultaneously with teams. Employees were granted rewards from suggestions that resulted in cost savings. Initially employees were very enthusiastic about the suggestion scheme, filing an average of 350 suggestions per annum (or 1.75 suggestions per head). But by 2004 the number of suggestions dropped to 221 (1.1 suggestions per head). In part the falloff in the volume of suggestions reflects backlogs in reviewing and implementing suggestions that are related to productivity. But in addition most suggestions have been related to ergonomics or work environment and have not directly dealt with production. In sum, there is no support for the view that the suggestion scheme has played a key role in stimulating a sustained increase in productivity.

V Data and empirical strategy

While the evidence provided in the preceding section provides preliminary support for our core hypotheses, to be more persuasive what is needed is more objective evidence. To this end, the second kind of evidence we collected are quantitative data. Specifically, the data are weekly for all four production lines during the period (weeks) 1/1999 - 52/2005. The key variable is a performance measure that describes how close to the production norm the line is operating. The norms are set by the production manager jointly with line supervisors and the value “100” represents maximum production capacity with given technology, labor input, and production methods[11]. In calculating these norms, there is a fixed amount of uptime or, equivalently, allowances have been made for a fixed time spent on coffee breaks, starting up and turning down the machines. The norms have been fixed in recent years.[12] Similar dependent variables have been used in other recent work, including Hamilton et al. (2003) and Jones and Kato (2004). In Figure 1 we begin our analysis of these quantitative data by showing efficiency scores for each line during the study period.

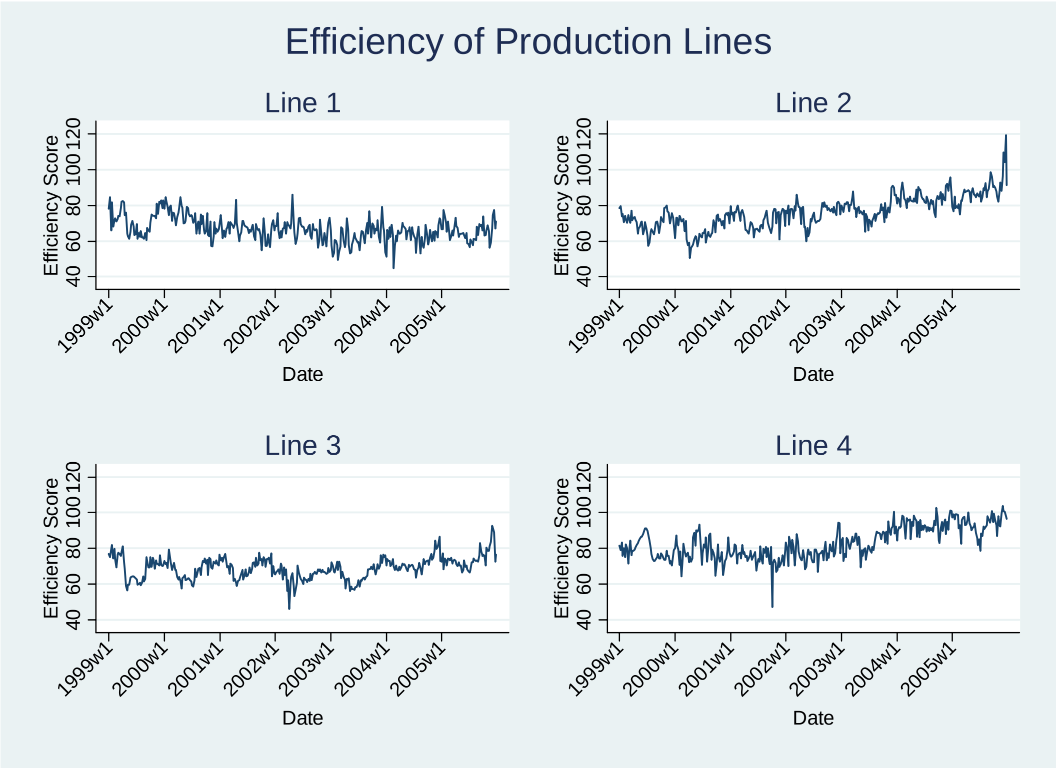

Figure 1

The data displayed for Line 1 exhibit a very stable series around the mean of 66.7. By contrast, efficiency scores for Line 2 appear to be quite cyclical, especially before 2003. The raw data also appear to indicate that the mean of the series is higher in the period after 2003. Line 3 shows the strongest cyclicality for any line. Production managers explain the cyclicality in Lines 2 and 3 as being mainly due to employment of summer workers, who usually arrive around the beginning of April and leave at the end of August. The data reported for Line 4 reveal a picture of relative stability until mid 2003 after which time it appears that efficiency moved to a new and higher level. In 2004, efficiency on this line was close to the maximum; subsequently efficiency remained at this level. As such the data assembled in Figure 1 complement the earlier interview evidence and are suggestive that the introduction of the PRP scheme, and especially changing the rules for that plan, are associated with a positive effect on productive efficiency. Furthermore, and again consistent with the evidence presented in the previous section, neither the introduction of teams alone nor the addition of the company wide profit sharing scheme appear to have affected productive efficiency.

In devising the appropriate empirical strategy to use to analyze these data more thoroughly, the nature of the data and the particular questions that we ask mean that we do not draw too closely on existing empirical work in insider econometrics or econometric case studies. Most importantly, since our data have a long time series dimension and a limited cross sectional dimension, we adopt a time series methodology. By contrast, most other insider econometric studies have used methods which mostly draw on panel data methods based on data that has a short time series dimension. In our application of time series methods it is natural to allow the coefficients to be unconstrained between the lines, and then for us to try to find for each line a model that best describes the data generating process. In other words, by carefully specifying the time series process, we expect that this will help us isolate the effect of changes in the HRM policies.

In this time series context, a natural way to study the impact of the HRM policies is to let the coefficients in the model vary over time, and to test for constancy of the parameters. However this approach requires break dates to be assigned. In turn, one way to assign the dates is to use our knowledge of the timing of the introduction of different HRM practices. However, that method may be criticized on the grounds that break dates are imposed somewhat arbitrarily. An alternative technique is to use a data driven approach where the break dates are estimated. We follow this latter approach and utilize the method developed by Bai and Perron (1998, 2003a) that allows multiple structural breaks and treats the break dates as unknown parameters. Next we describe that method in more detail.

V.1 Model

The model we consider is a multiple linear regression model with m breaks and T data points

$$y_t = z_t'\delta_j + u_t$$

where $t = T_{j-1}+1,...,T_j$; $j = 1,....,m+1$; z_t is $(q \times 1)$ vector of covariates, and u_t is the disturbance. The break dates $(T_1,...T_m)$ are considered unknown, and by convention $T_0 = 0$ and $T_{m+1} = T$. In our application $z_t = \{1, y_{t-1},..., y_{t-p}, S\}$, where S is a seasonal dummy accounting for the summer workers[13]. The coefficient vector is allowed to be different for each of the $m+1$ segments. Bai and Perron (1998) call this the pure structural change model. Stacking the equations we get

$$Y = \overline{Z}\delta + U$$

where $Y = (y_1,....,y_T)'$, $U = (u_1,....,u_T)'$, $\delta = \left(\delta_1', \delta_2',....\delta_{m+1}'\right)$, $\overline{Z} = diag\left(Z_1,...,Z_{m+1}\right)$ with generic element $Z_i = \left(z_{T_{i-1}+1},..., z_{T_i}\right)$. The unknown parameters δ and $(T_1,...T_m)$ can in principle be estimated as follows[14]. Consider the case when the number of breaks, m , is known. The vector δ is found by minimizing the squared residuals

$$\left(Y - \overline{Z}\delta\right)'\left(Y - \overline{Z}\delta\right) = \sum_{i=1}^{m+1}\sum_{t=T_{i-1}}^{T_i}\left[y_t - z_t'\delta_i\right]^2$$

for *each* m-partition $(T_1,...T_m)$. In other words, at this stage the model is estimated for all possible m-partitions and the parameter estimates are saved. Denote the minimizing argument as $\hat{\delta}\left(\{T_j\}\right)$ where $\{T_j\}$ stands for a given m-partition. Substituting these values into the objective function gives

$$\sum_{i=1}^{m+1}\sum_{t=T_{i-1}}^{T_i}\left[y_t - z_t'\hat{\delta}_i(\{T_j\})\right]^2 \equiv SSR_T(T_1,\dots T_m)$$

The estimates for the break dates are the values $\hat{T}_1,...,\hat{T}_m$ such that

$$\left(\hat{T}_1,...,\hat{T}_m\right) = \arg\min SSR_T\left(T_1,...,T_m\right)$$

where the sum of squared residuals is minimized over all m-partitions. In other words, the partition (and corresponding parameter estimates) which achieve the smallest sum of squared residuals is chosen. This minimization gives the estimated break dates and they are the global minimizers of the objective function. The regression parameter estimates are the ones associated with the optimal m-partition, that is, $\hat{\delta}(\{\hat{T}_j\})$. The model of Bai and Perron (1998) accommodates serial correlation and heteroscedasticity of the error terms, lagged dependent variables and different distributions for regressors and errors for each segment (though naturally not all simultaneously). Bai and Perron (1998) also establish the consistency and asymptotic normality of the regression parameters, as well as the consistency of the estimates of the break dates. The limit distribution for the break dates is non-standard, but it can be calculated from statistics obtained from the sample.

The model seems computationally burdensome, as estimating the model for all m-partitions seems infeasible. However, Bai and Perron (2003a) describe an efficient algorithm to compute the break points and regression parameters. This procedure has two steps. In the first step the sums of squared residuals are obtained for all admissible segments (See Bai and Perron (2003a) 4-5, for discussion on admissible segments). In the second step, a dynamic programming algorithm is used to find the global minimum of the overall sum of squared residuals. In other words, the second step finds the optimal combination of the admissible segments, when optimality is determined by the SSR. The estimations in this paper use the GAUSS program written by Pierre Perron.

V.2 Testing for structural breaks

The previous discussion assumed the number of breaks *m* to be known. However, in practice this is rarely the case. Bai and Perron (1998) suggest several methods to determine the number of structural breaks. Here we describe only the procedure preferred by Bai and Perron (2003a). The procedure consists of two steps. First, we test for the presence of any structural breaks. If these tests reject the null of no structural change, then the number of structural changes can be found using appropriate test statistics sequentially. Below we describe this procedure, starting with the test of no structural change against the alternative of an unknown number of breaks, given some upper bound M for the number of breaks. Bai and Perron (1998) call these tests for the presence of any breaks double maximum tests. The test statistic is

$$UD\max F_T(M,q) = \underset{1\le m\le M}{Max} F_T\left(\hat{\lambda}_1,...,\hat{\lambda}_m;q\right)$$

where $\hat{\lambda}_j = \dfrac{\hat{T}_j}{T}$ $(j=1,...,m)$ are the estimates of the break fractions, based on the estimated break dates obtained by the methods described earlier, and F_T is a conventional F-statistic testing the equality of the parameter vector $\hat{\delta}$ over the different segments for some m-partition. The test statistic can also be constructed so that the marginal p-values are equal across the values of m. Bai and Perron (1998) denote this test as $WD\max F_T(M,q)$. If the tests reject the null of no structural change the next step is to find the number of breaks.

To estimate the number of breaks, a test statistic that tests l versus $l+1$ breaks is used. Bai and Perron (1998) label this as $\sup F_T(l+1\,|\,l)$. This method consists of $l+1$ tests of no break versus a single break. The statistic of no break versus one break is an F-test comparing the sum of squared residuals from the model with no break versus a model with one break, where the break date is the optimal date chosen by the global minimization.

The number of breaks is found using the following procedure. First we start with, say, $l=1$. To both of the segments a parameter constancy test is applied, and if the test rejects the null of no change, then the segment which yields the largest decrease in the SSR is divided into two segments from the estimated break date, giving three segments. This procedure is continued by increasing l until the null of constant parameters can not be rejected for any segment. Bai and Perron (1998, 2003b) have tabulated the critical values for this test. Once the number of breaks is determined by this method, the model can be estimated by the algorithm described above.

V.3 Model specification

Since we estimate AR models where we allow for the autoregressive parameters to change, the models we estimate permit the data to have different distributions over segments. Because our model includes lagged dependent variables, we can not allow the residuals to be autocorrelated, however we allow them to be heterogeneous over segments. These choices mean that the covariance matrix is estimated separately for each segment by OLS.

The limiting distribution of the test statistics described above depends on a trimming parameter, or the minimum admissible length of a segment. Bai and Perron (2003) note that when heterogeneity in errors and distribution of data is allowed, the minimum admissible length of a segment should be long enough, so that asymptotic approximations would be adequately accurate. If the minimum admissible length of a segment is small, the power of the tests used in finding the number of structural breaks is low. Here we have chosen the minimum admissible length to be 15% of the total number of observations, since we allow heterogeneity in errors and data across the segments.[15] The minimum admissible segment length affects also the upper bound for structural breaks, *M*, in the double maximum tests (See Bai and Perron (2003a) 13-14 for details).

Before we can start to estimate the break dates we have to specify a model for the conditional mean of *y*. To start the analysis we examined the autocorrelation and partial autocorrelation functions for the whole data period. They suggest that relatively low order autoregressive (AR) models are appropriate for these data series. To find a tentative lag length we estimated the models with lag lengths ranging from 52 to1 and calculated the Bayesian information criteria (BIC). We include seasonal dummies for all Lines, even though seasonality is most pronounced for Lines 2 and 3. As recommended by Ng and Perron (2005), the sample was fixed, so that the same observations are used to estimate each of the models. In practice this means that the estimation was carried out for the period 2000-2005, since in the first model we allowed for 52 lags. Based on BIC we find that lag lengths of 4, 2, 2, and 4 are appropriate for Lines 1, 2 3, and 4, respectively. We use these lag lengths in the following analysis. These specifications were tested for residual autocorrelation, and only in Line 1 were there any evidence of autocorrelation (after lag 14).

If the parameters of the model change, so does the long-run mean of the series. The long-run mean of the series is given by

$$Ey_j = \frac{\delta_{j\,cons} + \delta_{j\,s}\overline{S_j}}{1 - \sum_{i=1}^{p}\delta_{j\,i}}$$

where $\overline{S_j}$ is the average of *S*, $\delta_{j\,cons}$ is the coefficient of the constant, $\delta_{j\,s}$ is the coefficient of the seasonal dummy, $\delta_{j\,i}$'s are the coefficients on the AR terms, and *j* refers to a segment. The long run mean will be of central interest in the analysis later on.

VI Results

We begin by considering the estimated break dates and the differences in the parameter estimates in the different segments. Table 2 presents the results from the regression models. For Line 1, the double maximum tests indicate that a break in the series is present, as we reject the null of no change at the 5 % level. Additionally, since the sup-F tests are not significant at the 5 % level we conclude that the number of breaks in one. The break occurs quite early on, namely in week 35 of 2000. The confidence interval for the break date is not symmetric, but skewed to the left. This indicates that it is more likely that the break has occurred before 35/2000 than later on. An interesting feature of the parameter change is that seasonality seems to disappear.

For Line 2 the test statistics suggest two breaks, that is, there are three distinct segments. The first break occurs at the end of 2001 and the second occurs at the end of 2003. The confidence interval for the latter change includes 1/2004. For Line 3 a one break model seems to fit best. The estimated break date is 15/2004, but the confidence interval is fairly wide, ranging from 34/2003 to 38/2004. This interval is clearly skewed to the left. For Line 4, the test statistics suggest two structural breaks, which occur at 24/2000, and 31/2003. The first period, that is, 1/1999-24/2000 seems different from the rest of the series, when one looks at Figure 1. To summarize the results so far, in Line 1 there is one break near the beginning of the series. For Line 2, the second break takes place around the time when the rules of the PRP scheme were changed. For Line 3, its single break also occurs around the date of the PRP schemes rule revision, albeit that the date is quite imprecisely estimated. For Line 4, we find a break around the time when teams were introduced, and a second break occurring during the latter half of 2003, that is after the introduction of the PRP scheme.

[TABLE 2 AROUND HERE]

The magnitude of the changes can be analyzed by assessing the long-run means of the series for each segment. Table 3 presents these figures and show that, except for Line 1, the long-run means tend to increase over time. Comparing the first period with the last period, the productivity gains are -10%, 26 %, 9 %, and 16% for lines1, 2, 3 and 4, respectively. For the last three lines, the gains are quite large, though of similar magnitude to those reported elsewhere, e.g. Hamilton et al. (2003). If one considers the change after the introduction of the PRP scheme, then the figures are 14%, 9 %, and 20% for lines 2, 3 and 4, respectively, whereas for Line 1 there is no change.

[TABLE 3 AROUND HERE]

The first period for Line 1 is roughly the time before any HRM changes, and productivity is somewhat higher than in the following period. For Line 2, the unconditional mean is increasing all the time. The first period includes the introduction of teams and subsequently the introduction of group-wide profit sharing scheme. The second period, with somewhat higher unconditional mean than in the first period, starts around the beginning of 2002, when the group-wide profit sharing scheme was made semi-annual. However, the largest increase in productivity is seen during the last period, which starts essentially around the time when the hurdle rate of the PRP scheme was abolished. For Line 3, there are only two periods, where the latter has higher productivity than the first. The second period starts after the introduction of the PRP scheme, and the confidence interval includes the date of the abolition of the hurdle rate. It is interesting to note that for Line 4, the introduction of teams seems to occur at the same time as the reduction of productivity. However, the loss is made up after 2003, when the firm simultaneously uses teams, profit sharing, and PRP. This analysis suggests that, for the most part, the productivity gains from teams were not realized before the PRP system was introduced, and that the changes in the rules of the PRP scheme helped to realize even more of the gains.

Based on interview evidence we can rule out other possible explanations for the increases in productivity. First, the plant manager did not identify any substantial changes in the machinery or production methods. Second, we can also be quite confident in that the effect does not crucially depend on employee turnover. Thus, while 14 employees were laid off in September 2004, this is substantially later than our estimated changes in the productivity level.

To further assess the robustness of the results we imposed the break at 1/2003 following our theoretical prediction. The results on the impact on the unconditional mean of the series are very similar and a Chow-test rejects the null of no change in all Lines, except in Line 1.[16]

VII Discussion and Evidence Concerning Subsidiary Hypotheses

In this section we discuss several subsidiary hypotheses concerning the impact of the changes in HRM at FP. In addition we provide what is mainly qualitative evidence that bears on these hypotheses.

Results of the previous section clearly show that the impact of the HRM practices seems to have differed across the lines. Whereas Line 1 has experienced a decrease in productivity, the other lines are characterized by enhanced performance. Also, the gains in Lines 2 and 4 are larger than those recorded in Line 3. In accounting for these differences we note that there are several differences between Line 1 and the other Lines. First, in Line 1 work is more physically demanding than work in other Lines. Furthermore, improving efficiency is more difficult to achieve when output gains are not dependent on machines but are derived from human effort. Second, work at Line 1 is based more on individual tasks, whereas the norm elsewhere is team work. Third, since base wages in Line 1 are higher than in the other lines, the impact of PRP may be smaller[17]. Fourth, Line 1 is male dominated, whereas the other Lines are female are in the majority. This pattern is consistent with the arguments stressing that the reaction to PRP systems may differ by gender. Women may be more motivated by schemes that reward immediate performance and safeguard against discrimination at the workplace. Finally, interview evidence suggests that improvements have been made in other areas which are not captured by our efficiency measure. These gains relate to how long the other Lines have to wait for the raw materials to arrive. Line 1 has made substantial improvements in this respect.

To account for the differences between the Lines where efficiency improved, we note that in Line 3 work is mostly manual, whereas in Lines 2 and 4 the employees operate machinery. Increasing efficiency in manual sausage spraying may be more demanding than operating machinery more efficiently.

One claim that is prominent in the literature is that some of the possible productivity gains that might accompany the introduction of PRP will be possibly offset by quality losses. However, when PRP is accompanied by well-functioning teams, arguably the likelihood of such an outcome is diminished. Also at FP quality indicators have been important criteria for awarding PRP at all lines. In the case of FP we have data on quality only for the period 2003-2004 so we are unable to include quality indicators in a more rigorous analysis. However, the data we have, which are summarized in Table 4, show that there has been a continuous improvement in quality since 2003. Given that seasonality is often strong, it is best to compare the same time periods over the years, e.g. to compare line 1 for the third period of 2003 with data for the same line for the comparable period in 2004. Also interviews confirm that quality has improved since 2000 when teamwork started. Hence we have no reason to suspect that higher efficiency would have been obtained by reducing quality.

[TABLE 4 AROUND HERE]

While our findings from the previous section clearly show that there have been gains in productivity, who has received these benefits? Unfortunately we do not have detailed data to examine whether this has translated into benefits for the employer concerning costs and profits. Yet there is some suggestive evidence. For one thing, if PRP is paid in full, the plan requires that two thirds of the gains accrue to the firm. Thus the current arrangements are such that, if all targets were met, employees would receive 450 euros. This implies that the ex ante-value of improvement in productivity would have been roughly 1350 euros per worker per year. While recent years have not seen all targets being met, in every year since PRP was introduced, at least some targets have been met. This feature of plan design means that when employees have received disbursements under the PRP scheme, then the firm must have has registered economic benefits—hence the firm has gained from the scheme in all years. The second piece of evidence concerns plant costs. Using monthly data from 1998/1-2004/12, analysis of plant level production cost per kilo of output produced is suggestive that the company has realized gains in production costs[18]. Using a similar methodology to that employed before when examining production, we find some evidence that there has been more than a 10 % decrease in the long run mean of the cost process. This is a substantial figure. The break date is estimated very imprecisely (the confidence interval ranges from April 2001 to January 2003), and the algorithm finds the break only at the 10 % significance level. However, it has to be remembered that factors other than productivity may affect production costs. On the other hand, since we know that productivity increased simultaneously, it is plausible to conclude that changes in HRM practices have contributed to the observed decrease in production costs.

We are also interested in seeing whether these gains in productivity have translated into benefits for employees. Again we do not have detailed data to rigorously address this issue. Yet the evidence is strongly suggestive that, at a minimum, employee incomes have not suffered from the changes. For one thing the collective agreement for the food processing industry stipulates minimum guarantees to safeguard employees from income losses under the PRP plan. Furthermore, implementing a PRP plan in Finland that would have resulted in decreases in earnings for employees, most likely would have led to industrial action—and this has not happened. Also we have some aggregate data on wages and wage costs for the lines. In Table 5 we show the median real hourly wage separately for each Line and year. The entries are calculated as the median of monthly wage costs divided by hours worked. The data in Table 5 show that there is some tendency for real wages to increase, although the entries seem to jump around a bit. In sum, our findings on this point, together with earlier findings, suggest overall support for a "mutual gains" view of the distribution of the benefits at FP.

[TABLE 5 AROUND HERE]

VIII. Discussion, Conclusion and Implications

By assembling and analyzing new panel data, we investigate the impact of important changes in HR practices on firm performance for a food-processing plant. Our core economic data are most unusual – weekly records on efficiency for all four production lines in the plant during 1999-2005. During that period HR policies changed with the introduction of teams, company wide-profit sharing and a group system of performance related pay (PRP).

Based on theory and extensive interviews at the firm we develop core hypotheses concerning the expected effects of these particular plans in the case. Our key empirical strategy is to estimate structural change models to see if the HR policies had an impact on the nature of the production series. As predicted we find strong evidence that there were significant changes in the data generating process after the introduction of PRP. Specifically in three of four production lines we find, as predicted, that the addition of PRP to teams produces substantial productivity increases ranging from 9 – 20%, while in the remaining line there is no apparent change in productivity.

In interpreting the results it has to be kept in mind that teams were adopted several years before the PRP scheme was introduced. Thus we interpret our findings as capturing the joint effect of teams and PRP on efficiency. These results are consistent with notions of the complementarity effects of teams and PRP and the existence of team learning. Interview evidence provides additional support for the complementarity argument. The established practices of teamwork provided a structure that enabled continuous monitoring of performance. Teams have also helped to maintain peer monitoring to prevent free-riding. Also it appears that there have been other improvements besides productivity, although we are not able to bring econometric evidence to bear on these hypotheses. For example, the amount of second-rate quality production has dropped. Concerning outcomes for employees, we note that there have been wage gains though these have also been moderate.

We note that our findings exhibit both similarities and differences with other insider econometric studies of manufacturing firms, such as Hamilton et al. (2003) and Freeman and Kleiner (2005). The magnitude of the productivity increase is comparable with that reported by Hamilton et al. (2003) on the shift from individual production to team production. However, whereas production technology also changed in the cases studied by Hamilton et al. (2003) and Freeman and Kleiner (2005), in our case only HRM policies change and production technology remains unaltered. Another difference is that we document within plant heterogeneity in productivity effects. Although we do not have clear evidence on the reasons behind the heterogeneous impact, we offer some explanations. In particular we note that differences in results across the lines may be due to diverse physical demands of work, variation in the degree of automation of work, differences in the size of the PRP payments in relation to the base wage, or gender composition. An implication for future research is to further investigate such heterogeneities even within single plants.

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TABLE 2
AR Models of Efficiency by Production Lines

	Line 1	Line 2	Line 3	Line 4
Eff (t-1)	0.499 (0.104)*	0.5889 (0.087)*	0.487 (0.059)*	0.412 (0.118)*
Eff (t-2)	0.377 (0.108)*	0.088 (0.084)	0.224 (0.059)*	0.132 (0.123)
Eff (t-3)	-0.038 (0.106)	-	-	0.0712 (0.122)
Eff (t-4)	-0.059 (0.097)	-	-	-0.124 (0.109)
Sum	-2.057 (0.903)*	-1.868 (0.801)*	-2.067 (0.590)*	5.026 (1.304)*
Constant	16.701 (5.579)*	22.838 (4.885)*	20.090 (3.558)*	38.951 (9.323)*
Eff (t-1)	0.508 (0.060)*	0.222 (0.090)*	0.601 (0.106)*	0.288 (0.077)*
Eff (t-2)	-0.1446 (0.067)*	0.221 (0.086)*	0.055 (0.105)	-0.018 (0.079)
Eff (t-3)	0.028 (0.067)	-	-	0.160(0.079)*
Eff (t-4)	0.132 (0.060)*	-	-	0.103 (0.075)
Sum	-0.209 (0.646)	-3.424 (0.953)*	-2.228 (0.954)*	-1.35 (0.882)
Constant	30.900 (5.114)*	43.285 (7.813)*	26.173 (6.686)*	36.61(7.564)*
Eff (t-1)	-	0.515 (0.101)*	-	0.362 (0.086)*
Eff (t-2)	-	0.196 (0.115)	-	0.204 (0.092)*
Eff (t-3)	-	-	-	-0.164 (0.091)
Eff (t-4)	-	-	-	0.198 (0.084)*
Sum		-0.792 (1.012)		-1.541 (0.869)
Constant	-	25.268 (7.227)*	-	37.505 (8.587)*
		Break dates		
T_1	35/2000	46/2003	15/2004	24/2000
	(13/2000-43/2000)	(38/2003-7/2004)	(34/2003-38/2004)	(50/1999-34/2000)
T_2	-	47/2001	-	31/2003
		(26/2001-5/2002)		(27/2003-39/2003)
		Tests		
UD max	40.479*	26.975*	17.795*	42.515*
WD max	40.479*	31.715*	22.404*	42.899*
Sup $F_T(2\|1)$	13.585	29.567*	12.119	29.933*
Sup $F_T(3\|2)$	13.396	11.2845	6.718	12.746

Notes.
1) Table reports coefficients and standard errors in parenthesis. * denotes significance at 5% level. 2) The Ljung-Box test on the residual does not reject the null of white noise in any of the estimations.

TABLE 3
Long Run Means

	Line 1	Line 2	Line 3	Line 4
Period 1	72.4	69	67.5	79.8
Period 2	64.8	75.9	73.8	77.3
Period 3		86.7		92.9
Change from Period 1 to Period 3	-10 %	26 %	9 %	16 %
Change after the introduction of the PRP scheme	-	14 %	9 %	20 %

TABLE 4
Amount of second rate Quality by Lines

		Line 1	Lines 2 & 3	Line 4
2003	Jan-April	5000	31276	33200
	May-Aug	9090	90793	29990
	Sept-Dec	5148	30811	34138
2004	Jan-April	3779	33937	27927
	May-Aug	6873	61135	21484
	Sept-Dec	4212	24460	18313
2005	Jan-April	3270	28000	19568

Notes.
The entries in the table are kilos of second rate quality, i.e. quantities of products, which can not be sold to consumers (Lines 2-4) or cannot be processed further (Line 1).

TABLE 5
Wages by Year and Line

	Line 1	Line 2	Line 3	Line 4
1999	19.4	na	na	19.1
2000	19.2	na	na	18.5
2001	19.2	15.9	16.6	17.0
2002	24.5	17.1	17.9	18.3
2003	20.2	15.3	16.4	17.3
2004	20.9	16.7	17.5	18.0

Notes.
The entries in the table are median monthly real wages per hours worked. The entries are deflated by consumer price index and for each line 5% from each tail of the wage distribution has been trimmed.

Endnotes

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[1] Their results are reported in Ylikorkala (2006).

[2] This information has been obtained from the Statistical Bulletin of Statistics Finland, 4 / 1996.

[3] We thank Satu Roponen for making these calculations available to us.

[4] In addition there are teams in auxiliary units and management teams for which we do not have the corresponding productivity data.

[5] This is no more than 1.5% of their salary.

[6] Heywood and Jirjahn (2002) also make a similar distinction between teams as an HRM tool and team production, though using slightly different terminology.

[7] For other related literature, see the insightful discussion in Dow (2003, ch. 8.5).

[8] For company level evidence see, e.g. , Wadwhani and Wall (1990), Kruse (1993), Kumbhakar and Dunbar (1993) and Jones and Kato (1995). See also the econometric case study by Knez and Simester (2001).

[9] These issues have been analyzed empirically by Asch (1990) and Oyer (1998).

[10] In Finland lay-offs can be implemented only after presenting a just cause. In the plant in question, the cause was reductions in production that were related to the allocation of production within different plants of the same company. The lay-offs took place only after joint management-employee negotiations on the headcount reductions.

[11] In principle, if workers work unpaid overtime, they can exceed the norm. Usually the reason for exceeding the norm (a very rare event) is that there the number of people working in the line has temporarily differed from the assumption. Curiously, according to the line manager this may happen if there are fewer people working. Then the production targets are moved downwards. However, in some cases fewer people can produce relatively more production than the usual group. However, working undermanned is not desirable since it makes it more difficult for other lines to meet their norms.

[12] In Line 1 the norm was updated in the beginning of 2003 and in Line 2 it was updated in the beginning of 2000. Otherwise the norms have stayed the same.

[13] The seasonal dummy equals unity for weeks i) 16-30 in 1999 and 2005, and ii) 16-31 in 2000-2004. The difference is due to differences in number of weeks in a given month over the years.

[14] The actual estimation procedure is described later on.

[15] If we were to choose the minimum admissible length to be 20%, the results would not change.

[16] These results are available from authors upon request.

[17] The wages in Line 1 are 15-20 % higher than in other lines, as can be calculated from Table 3.

[18] These estimates are available upon request. The production costs include all other costs of production except wages.