International Differences in Lean Production, Productivity and Employee Attitudes*

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I. **Introduction**

In this paper, we report on a study of US-European productivity differences, conducted at five plants belonging to a single multinational firm. We investigate whether human resource policy changes within a firm in concert with other manufacturing transformations have affected the organization's ability to prosper financially and provide job satisfaction for its employees.

All 5 plants we study make similar products (sensors and actuators for automobiles), using similar processes. We look at the impact of a Value-Added Gainsharing plan (VAG) that was introduced at different times among the plants, in a way that had many features of a natural experiment. Our analysis draws on multiple plant visits over eight years, surveys of almost all of the workforce, and confidential financial data. Our study thus offers an unusual opportunity to examine the internal operations of a low-wage, non-union firm, using data from both management and workers.

A major issue for our firm has been the appropriate method of compensation to complement its other strategic initiatives. In 1987, the firm began a major change in its product market strategy; it now designs its own products (which are complex assemblies of plastic and electronic parts) and modifies them frequently, rather than producing individual electronic components to customer blueprints. It has also vastly increased its quality levels and reduced its inventory. These changes are common in this industry, and result from pressure from the firm's customers, such as Ford and General Motors (though our firm was above average in its response).

As a result of these product-market changes, the firm introduced changes in its human resource policies, changing its methods of compensation, increasing automation, introducing

work in groups and (late in our study) increasing training. In some of the plants, compensation received by production workers has fallen dramatically; in others it has increased slightly. (Wages even at the best-paid US plant is less than 40% of the US manufacturing average.)

We present information on the dates of the introduction of the VAG in Figure 1. The firm has employed a variety of methods of pay (both piece rates and time rates) in plants making similar products in similar ways. It changed these plants over to a plant-wide gain-sharing system at different times. We use these changes as a quasi-experiment, to examine the impact of changes in human resource policies on productivity and worker well-being. We will examine the impact on the plants that changed over early, treating the later adopters as a control group, using a time-series cross-section statistical methodology (Bertrand, Duflo, and Mullainathan, 2002; Athey and Imbens, 2006).

In the next section, we review relevant literature. In Section III, we discuss basic characteristics of the industry and our plants, and the nature and timing of their adoption of the value-added gain-sharing plan and complementary policies such as automation, worker recognition programs, and training. In Section IV, we discuss our methods, both qualitative (multiple visits to each plant, discussions with both management and workers) and quantitative. In Section V we present results, and in Section VI, our conclusions.

We find that the US plants were more productive and profitable than ones in the UK, and that the introduction of VAG enhanced plant level performance across all the plants. Moreover, the transition to VAG influenced employee attitudes toward pay and work by similar amounts in both the US and UK plants.

II. Review of the Literature

Firm Performance

The impact of human resource practices on organizational performance has received considerable attention from academics for more than 20 years. Starting with a Research Volume published by the Industrial Relations Research Association entitled *Human Resources and the Performance of the Firm* (Kleiner, Block, Roomkin, and Salsburg, 1987) many researchers have examined the effects of human-resource policies on the economic performance of the firm.

Two types of policies have been examined extensively: compensation and employee involvement. With respect to compensation, several studies have found that pay based on individual output ("piece-rates") is the best way to maximize firm performance (Ehrenberg, 1990; Conyon and Freeman, 2001) Seiler, 1984, and Lazear, 2000). On the other hand, some studies have suggested that time rate methods of pay allow the enterprise to increase the number of products produced and thereby increase the value-added production of the enterprise (Freeman and Kleiner, 2005, and Helper and Kleiner, 2003). An alternative to piece rates or time rates is value added gainsharing or some form of profit-sharing with employees (Kaufman, Kruse, 1993, Kleiner, Helper, and Ren, 2001, and Helper and Kleiner, 2003).

Although economists see the method and level of compensation as a central factor in developing the correct incentive structures, the results are mixed about compensation's impact on firm performance. This is largely a result of most researchers' inability to control for the way in which the compensation system interacts with the other human resource and production systems in the firm. As we discuss below, the profit-maximizing form of

compensation is contingent on the nature of the product and on which complementary HR policies are adopted.

Another type of policy is participation in running the enterprise. A number of studies have found a positive impact of such employee involvement on productivity and firm performance (See for example Appelbaum and Batt, 1994, Appelbaum, Bailey, Berg, and Kalleberg, 2000, Ichniowski, Kochan, Levine, Strauss, 2000, Black and Lynch, 2004b). Most of these studies, each based in a single industry, find that employee involvement increased the productivity of the firm. However, other studies using a national sample with a diverse set of firms have shown very little impact of employee involvement on firm level productivity, but a larger influence of financial participation (Freeman, Kleiner, and Ostroff, 2000, Cappelli and Neumark, 2001).

An alternative approach to looking just at compensation or just at employee involvement is examining bundles of human resource practices (MacDuffie, 1995; Arthur, 1994; Cutcher-Gershenfeld, 1991; and Ichniowski, Shaw, and Prennushi, 1997). The above papers have found that there is a set of high performance workplace practices (HPWP) that, if all implemented together, result in higher returns than do a set of traditional practices. In contrast other papers (Kleiner, Leonard, and Pilarski, 2002, Jones and Kato, 1995) show mixed results.

Similarly, analyses of nationally representative data have found mixed results regarding the effect of these practices. Black and Lynch (2004a) found in a time-series cross-industry sample that a combination of policies (such as profit-sharing for non-managerial employees and group meetings) led to increased productivity, especially in unionized firms. However, Cappelli and Neumark, 2001 found less positive results. There also is evidence of a

long run equilibrium level of employee involvement that firms move toward with establishments adding and dropping specific types of involvement policies based on their own circumstances (Chi, Freeman, and Kleiner, 2007).

Two factors help to differentiate the studies which have found positive results of employee involvement on productivity and profits: 1) number of industries studied and 2) the extent to which authors are able to distinguish actual implementation of policies from the intent to implement such policies.

One explanation for the difference between the single-industry and multi-industry studies is that the type of employee involvement that matters for productivity varies by industry. (For example, in some industries (e.g. apparel), job rotation and on-line problem-solving may increase productivity, while in others (e.g. steel), off-line problem-solving is most important.) (Appelbaum, et al. 2000).

In addition, many studies simply ask managers what policies they have in place, without looking at extent of implementation. In contrast, it is reasonable to expect that fully adopting a bundle of complementary policies places a premium on management skill, and that not all managers will be equally successful in doing so.

Our study allows us to look especially at this second reason for mixed results. We are able to control for detailed industry, product and process, yet can observe different managerial behavior across our plants. Thus, we extend the traditional analysis of one plant over time to an analysis of similar plants over time, of which some changed and others did not. In addition, we have information from both workers and management about the nature and the extent of these changes; thus we capture not only management's intent to change, but also other views of how effective these changes were.

Impacts on the Establishment's Employees

Employee welfare should be considered as part of any overall calculus of the impact of changes in human resource policies (Appelbaum, Bernhardt, and Murnane, 2003). Moreover, employees' perceived well being is closely correlated with behaviors such as turnover and absenteeism which affect establishment outcomes (Brief, 1998).

A recent survey of American workers in large firms found that U.S. workers want to be employed in establishments where they have a say in running the organization. Over 60 percent of the surveyed workers said they wanted committees in which workers have varying levels of independence from management in deciding work tasks (Freeman and Rogers, 1999). However, these results were for a diverse sample of employees, and there was little attempt to examine the effect of changes in human resource policies, or to examine these changes for a homogeneous group of workers who were all subject to the same policy transformations.

III. Context: The Auto Parts Industry and the Plants We Study

During the 1980s and 1990s, US automakers sharply reduced their degree of vertical integration in three ways: 1) having more components manufactured by outside firms, 2) having the joining of those components ("subassembly") done by outside firms, and 3) having more design work done by outside firms (MacDuffie and Helper, 2006).

These changes created an opportunity for the firm we analyze, which we call SP (for "Small Parts"). SP is a $600 million manufacturer of electrical and electronic products, such as ignition switches and a product that indicates when a car door is ajar, which are sold largely to vehicle manufacturers (automakers and truck manufacturers). The oldest part of

the firm was founded in 1909, and has undergone a number of changes in its markets and products over the years.

SP announced a major change in strategy in 1987 (SP annual report, 1995). The new strategy involved enhancing profitability through product differentiation. SP would increasingly design its own products (instead of building to the automakers' blueprints), do more sub-assembly, produce a wider variety of products, and introduce new products more frequently. These changes would increase overhead, so the firm also began looking to acquire firms that made similar products, as a way of achieving economies of scale and scope. At this time, the firm also began to adopt some Japanese innovations in manufacturing, such as just-in-time inventory and total quality management. (See Helper and Kleiner, 2003 for more detail).

In 1997, SP went public in order to increase its access to capital. At the end of 1998, SP bought another firm that designed and manufactured sensors thereby acquiring a plant in rural Ohio and one in suburban Florida. During the 1990s the firm also acquired some foreign operations (Europe, Mexico, and Brazil). In 1999, the firm ended the contract manufacturing operation that had originally formed the core of its business, and focused entirely on parts that the firm designed itself. Thus the firm exemplifies many of the trends that are common in this industry: it has become an expert in the design and manufacture of its products, become global, and has grown dramatically, mostly through acquisitions, and seen labor costs fall as a percent of total costs. (Direct labor costs at SP average about 8 percent of total costs.)

This new strategy was not consistent with SP's existing pay practices, which involved piece rates for some operators and most assemblers, and time rates for other operators and all

office and engineering staff. As we discuss below, piece rates can lead to excess inventory, difficulty in changing to new products, and problems in encouraging teamwork. However, managers worried that time rates alone would not provide enough incentive to avoid wasteful inventory, prevent defects, or promote incremental improvement. As a result the firm implemented a value-added gain sharing plan (VAG).

Management did not implement VAG in all of its plants at once. We suggest that the implementation process can be thought of as a quasi-natural experiment that can allow us to estimate the impacts of gain-sharing on both productivity and worker satisfaction. Below we describe the implementation process and timing.

Method of Pay and Timing of VAG Introduction

The principle behind the Value-added Gainsharing program was to give workers as a group a stake in their plant's performance. The details of the plan changed over the years; initially the size of the bonus pool was a function only of factors that management felt workers could influence: productivity increases, defect rates, and customer satisfaction. Later material and capital costs were added, and the formula became so complex that "only three people in the company understand how it is calculated", as the controller of the Massachusetts plant (Ms. P) told us. Everyone in the plant (except for a few top managers, who were on a different bonus plan with greater economic incentives) received the same percentage of their pay as a bonus. In practice, the gainsharing bonus varied between zero and 15 percent of pay. (In contrast, the piece rate systems at the Massachusetts and UK plants were widely understood, and offered a 50 to 100 percent increase over base pay.)

We examine the impact of VAG introduction at each of SP's five plants, which all produce similar electronic parts for the automotive industry. The US plants are located in

urban Massachusetts, suburban Massachusetts, rural Ohio, and urban Florida; the UK plant is in a far suburb of London. As we mentioned earlier in Figure 1 we give the timing of the changes in the method of compensation for each of the plants[1].

Interaction of VAG and Other Policies

As mentioned above, management did not implement VAG by itself, but rather as part of a series of changes in overall strategy consist with the system of "Modern Manufacturing" described by Milgrom and Roberts (1990). Our multiple plant visits over 8 years (described in section IV) allowed us to follow this process in real time.

Management's new strategy increased the returns to a group bonus system compared especially to piece rates, but also to time rates. This strategy was most carefully worked out in the Massachusetts plants where it was first implemented. The rationale for VAG and the coordination with supporting policies were much less well understood by management or workers in the plants that SP acquired.

Our fieldwork suggested that there were several factors that affected VAG's impact on productivity and satisfaction: 1) the nature of the changes involved in adopting "modern manufacturing 2) the problems caused by the new system for the existing methods of pay caused for the new system, such as reduced contractibility and return to individual effort, 3) the supporting employee involvement policies introduced by management, 4) impact of the change to VAG on the pay/effort bargain and 5) the degree to which workers in the plant felt they had access to alternative employment. We discuss each of these in turn, starting with the Massachusetts experience and commenting on differences at other plants.

1. Changes in product and process in "modern manufacturing"

At the time of our first visit in 1995, the Massachusetts urban plant was toward the end of a transition begun in the mid-1980s. It had been a low-volume plant where quality requirements were not high, and where designs were generally dictated by the customer and did not change often. The new strategy was to become a "high-volume, precision operation', according to Mr. M, the plant manager in 1995. This transition involved changes in many areas:

Product Strategy. SP hired engineers to design products in-house, and dramatically increased the rate at which new products were introduced (50 in a typical year under the new strategy) and retired. These products became increasingly sophisticated, and many were patented. For example, a sensor based on the Hall Effect (using an electrical current for highly accurate, contact-less sensing) was written up in a technical journal.

Process flow. The older jobs were individually paced, and consisted of a single worker sitting at a machine. She would add one or more pieces to a small assembly and then press a button or foot pedal to fasten the piece via welding or crimping. She would then place the partially-completed product in a box; when the box was full material handlers would move it to workers who would do the next stage. During our 1995 visit we watched several of these piece-rate workers, and were impressed by the workers' speed and intensity of focus.

Management gradually brought in more automated assembly, eliminating individually-paced jobs. Instead, 6-8 workers sat around a circular work cell. Some stations were completely automated; at most stations a worker assisted the machine in assembling the part. When the part was finished, it would be moved (automatically or manually) to the next station. At the last station, the operator would pack the fully-completed part into a box to be

shipped directly to the customer. The cell was paced by the slowest worker. At many of the cells, a lighted overhead sign kept track of the pieces made, and compared it to the pieces that should be made to meet the day's quota. Since there was no buffer between operators, inventory in the cells was dramatically lower (and lead times faster) than under piece rates.

By 2000, these assembly jobs employed the bulk of the work force. There was also a small plastic molding operation, in which workers monitored machines and loaded and unload parts. In the suburban plant there were several cells that were completely automated, and monitored by technicians who had received three months of training and were paid more than the assemblers. Other blue-collar jobs included material handling and shipping and receiving.

Design for manufacturing. The key to the success of the firm, according to the CEO (Mr. P), was the tight integration of product and process. At the time of the survey, the Massachusetts plants employed over 100 design engineers. They tried to design products that were not only sophisticated (many were patented), but easy to make, and whose quality could be checked automatically, rather than relying on manual inspection (which is less accurate, particularly when thousands of parts must be checked each day). Examples of design for manufacturing included molding in small bumps on the piece whose only function was to help locate the part correctly in a machine (they had no function once the part was made), and simple fixtures that tested for the presence of certain parts (and would not let the operator go to the next step unless all parts were there).

In our 1995 visit, we saw several engineers working with operators to design such "mistake-proofing" mechanisms. In several cases, the work seemed hampered by language barriers; we saw a lot of sign language being used, as the operator and engineer struggled to communicate about quality problems. We saw fewer engineers on the shop floor in our later

visits. One reason was that design-for-manufacturing principles had become codified (both by SP and others), so that more of the work could proceed without input from operators. (These principles include ideas such as making sure that parts either are perfectly symmetric, so that orientation doesn't matter, or are obviously asymmetric, so a fixture can be built that would not allow work to proceed on an incorrectly oriented part.) This move toward codification was given additional impetus by the fact that the design engineers in Massachusetts were increasingly called on to design parts for SP's other locations far away (including Europe and Mexico).

The other plants were in the process of making similar moves toward more frequent introduction of more sophisticated products, particularly after they were acquired by SP. Both the Ohio and Florida plants were acquired in 2000 by SP for $370 million. According to Mr. P, the firm had excellent market positioning, but Jack (the paternalistic former owner) had not invested in the business in recent years, and operational effectiveness was slipping. There was growing tension between the Ohio managers and SP top management. In contrast to Mr. P's perception, the Ohioans felt that their company was making a good profit, but being dragged down by accounting charges made to reflect what SP felt were its managers' contribution to the business, and financial problems caused by SP's other plants

The UK plant (actually 3 small plants about a mile apart) was located in a far distant suburb of London, in a gentrifying area. The plant had been unionized, but almost all the workers had left the union by the late 1990s, feeling that they were not getting much for their dues. SP bought the plant in 2002, and replaced a paternalistic managing director (who used to bring the workers fish and chips on Fridays, and did not enforce a fast pace of work). At the

time of our visit, management was just beginning to introduce work cells and just-in-time production techniques.

2. Obstacles to modern manufacturing caused by method of pay

Although economists often regard piece rates as the optimal method of pay because such rates tie together individual effort and reward, operating such a system in practice requires very special circumstances, as we discuss below.

In Massachusetts, management recognized that piece rates were not well suited to their new strategy. First, the new system reduced the return to individual, uncoordinated effort. Under piece rates, individual operators had a strong incentive to figure out how to do their jobs as quickly as possible. This led to a sustained 2-3% annual productivity improvement over the decades, according to Mr. K, an older manager. But piece rates did not promote the teamwork necessary to meet customers' new demands for just-in-time delivery of high-quality products that changed frequently. Increasingly, jobs were automated. The automated work cells increased precision, but frustrated the efforts of those workers who wanted to work faster than others. Also, workers on piece rates wanted a large amount of inventory between stations, so that they were not constrained by someone working more slowly than they were. This practice led to long lead times and low quality, both because of the incentive to work as fast as possible and because the large batches meant that many bad products could be made before they were caught by inspectors.

Second, the problem of establishing contracts for jobs was magnified by the increased rate of new product introduction. Under piece rates new product introduction created big risks for both labor (that the rate of pay per piece would be set too low) and management (that the rate would turn out to be too high, or "loose"). As Ms. P. put it in 200[2], "New product

development became a hurdle with the piecework system. Employees did not want to work on new product [because they would have to learn a new job, with the risk of lower pay while they figured out shortcuts]. We had a lot of turnover in the plant at this time (late 1980s). There were no good standards for new product and there was no way to introduce new products unless we wanted to throw loose rates on them. This restricted us from doing new products."

Both workers and management in the UK reported similar reluctance to work in new products during our visits there in 2003, at the start of that plant's transition away from piece rates.

These problems of uncoordinated individual effort and contractibility were much less in the time rate plants (suburban Massachusetts, Ohio, and Florida). However, management felt that the new higher quality requirements would be better met by having some pay be contingent on group performance.

3. Introduction of employee involvement policies in support of VAG

When we visited the Massachusetts plants again in 1998, it was clear that VAG was the centerpiece of management's strategy to make workers more aware of their impact on plant performance. Management put a lot of effort into figuring out what they considered to be a 'fair' formula (one that would yield a 10-15% payout if things went well). If the payout was too small, workers would be demoralized, if it was too big workers would be getting too much money. Managers also felt the formula needed to change if conditions changed, and so spent a lot of time explaining the changes and justifying them.[3]

Management also set up and continually promoted several mechanisms that provided workers the opportunity to increase the bonus pool for everyone, and recognition for doing so.

Among them were "The Last Chance Club" for workers who had caught a defect just before it went out the door. One example of a response (in 1995) was a flood of volunteers willing to sort through 80,000 parts to find the 5% that were defective in the 90 minutes before the customer's truck came, on their own time. (This action avoided a $1 per part air freight cost.) Members of the Last Chance Club get their names on a plaque in the lunchroom; those so inscribed (including management) seemed genuinely pleased at the honor. The gainsharing also played an important role in changing engineers' incentives; 'it used to be like pulling teeth to get engineers to leave their new products and solve problems on the floor. "We need to leverage our 30% overhead as well as our 5% direct labor," said Mr. P in 1995. However, Mr. P observed in 1999 that the VAG seemed successful in getting on-time delivery, but not quality.

There were several mechanisms for management to communicate to employees. These built on some management communication initiatives started in the 1980s. Union avoidance was the initial motivation for these initiatives, according to Mr. K., a semi-retired manager now in his 80s who had worked at the plant since the 1950s. (There had been several organizing drives in the past, but none since about 1987, a development he attributed to Mr. P's efforts to address problems quickly.) There are quarterly meetings with supervisors, monthly meetings with hourly workers (these are attended by one or two representatives from each department, chosen by management) and quarterly meetings to discuss the gain-sharing results.

Although the VAG formula was complex, almost all shop workers had a basic understanding that low productivity, defects, and delivery mistakes would cost them money. (However, especially in the early months of the program, some of the efforts made by workers

seemed to go far beyond the individual monetary benefit they received (a defective part would cost each worker only about $1).

In 1995, in Boston there were continuous improvement teams in which 10-15% of work force participated. These were not in evidence in later visits. Instead, in 1998, the plants focused on obtaining ISO 9000 quality certification; there was some involvement by workers in writing their own job descriptions. In 2000, the plants undertook a Six Sigma initiative, which was still going on in 2002. This program involves training supervisors and management as "Six Sigma black belts" (or green belts in the case of supervisors); they learn techniques for reducing inventory and lead time, and for analyzing quality data. Operators join with supervisors and engineers to improve line layout, but according to one supervisor I talked with, they contribute very few useful ideas. Overall, the improvement efforts have helped the urban plant to reduce costs by 3% every year since 1986. (Interestingly, this figure is similar to the 2-3% productivity improvement that Mr. K said that operators on piece rates achieved.) At the time of survey, the plants seemed to be placing less emphasis on suggestions to change the process, and more on training to take over supervisory functions, and avoid mistakes. This last is in response to quality problems that have meant the VAG payout in the suburban plant was zero in the year preceding the survey. (The urban plant continued to average 7-10%).

Efforts to set up complementary programs that would allow workers to have an influence on plant performance were much less consistent in the other plants. In Florida, there was an effort to train workers to avoid defects. We attended a company meeting where the emphasis was on the costs to the company of defective parts. The key message was that small numbers of defects can lead to large costs that harm the VAG bonus to production employees.

The emphasis during the meeting was for employees to attempt to catch mistakes, rather than think of innovations to prevent mistakes in the first place.

In Ohio, the main improvement activity at the time of our visits was the "War on Waste" program (WOW). This program was led by an engineer (Mr. S.), who was truly an evangelist for lean production. In 1994 (before SP acquired it), he had gotten the plant enrolled in a program sponsored by the Toyota Supplier Support Program, even though the plant has never had Toyota business. Several Toyota engineers had helped the plant with projects to improve the flow of product through the plant. According to Mr. S's calculations, WOW has saved the plant 2-3% of sales in the two years since its inception. Almost all of the ideas seem to be generated by technicians and engineers. "We don't involve operators enough. We do it hardly at all—this is a failing." Mr. S did what he could to encourage participation, believing that "People want recognition, not more pay. You could increase pay and still have dissatisfied employees." Participation in small ways is rewarded; about 10% (by rough estimate) of operators were wearing a WOW T-shirt or using a WOW pencil on the day we conducted the survey. However, this program was really the brainchild of Mr. S, who called himself "the Wizard of WOW"; he received little reinforcement for his efforts from top management. When SP re-organized the management bonus pool after acquiring the company, Mr. S was no longer included, leading to a significant cut in pay and status for him.

In the UK, there was no such effort. (The VAG was not clearly explained, even to the managers who were to implement it. On one of our visits, one month before VAG was implemented; the finance director confided that "I don't understand it at all".)

At the time of our survey in spring 2003, the workers at the UK plant were very unhappy with SP management, which had eased out their "beloved managing director" and

imposed a faster pace of work and more emphasis on cost-cutting. Even though many of the workers found our survey quite challenging, almost a third took the time to write comments, which were quite scathing. Two examples follow:

> "The management could do with more training on how to talk to people and try to understand their personal problems and see that we are human beings and not machines to be switched off and on at will."
>
> "They expect you to send out work [deliver output] when we go days a week without getting any parts. When they get here they are often short mouldings or water damaged. Also nobody takes any notice of anything we say or suggest . They ask for votes but have already made up their minds… Here they treat you as a number not a person. We get little pay for working like a Trojan. Our holidays have been altered now we have to take ours when the children are still at school. .. All we want to do is come to work, earn our money then go home but all we get is meetings and videos that nobody much is interested in.

4. Impact of VAG introduction on levels of pay, and the pay/effort bargain

The change to VAG had a large impact on both levels of pay, and on the pay/effort bargain as perceived by workers. These impacts differed by plant, and the magnitude of the impacts seemed largely unexpected by management.

At the Massachusetts urban plant, getting rid of the piece rate system was not easy. "From 1985 to the early 1990s, we started to educate the employees in a series of round table meetings and business meetings, that the security they felt they had in the incentive system was hurting the company and hurting them and hurting the quality of the business and that we

would have to make changes to the way they made their money." (Ms. P, 2000). But some mistakes were made. "For our original steering committee, we selected [hourly] people who had trust in the plan—we didn't have the natural leaders. We had approached it as a control thing with employees," said Mr. P in 1995.

"The opportunity of expanding to a second plant in 1989 was the first chance of changing the pay system," according to Ms. P. Workers in this plant, located in a suburb, worked in cells, and were paid an hourly wage. This wage was lower than in the urban plant, since the prevailing wage in the suburb was lower. Thus, it was difficult to get people to help with the start-up, so some were given promotions as an incentive. Piece rates also were gradually phased in at the urban plant, between 1992 and 1996.

Some operators we interviewed in focus groups in 2000 remained upset about the change. Almost all operators worked faster than the standard at which the piece rate was set. Management recognized this by setting the base time wage at 132% of the piece-rate base wage. They also introduced a gain-sharing program (described below) which they thought would pay an additional 10-15%. Managers said later that they did not intend to cut pay ('except that there were some people making 200% of the base rate, which is just unrealistic", according to Ms. P in 2002.). However, management was very worried about setting the rates too high and locking themselves into a wage that was "too high."[4] (In one case, "we underestimated the impact of automating the manual O-ring assembly—it almost killed the plan," said Mr. P in 1995). The result was that management erred on the conservative side, and 45% of those who filled out our survey and had worked under piece rates felt that they had suffered a pay cut. According to management, only about 10% of operators quit due to the transition, however.[5] And newer workers, who did not yet figure out shortcuts on their job

(or been assigned to a job with a 'loose' rate) benefited; 27% of survey respondents who had worked under piece rates indicated that they made more money now than before. Workers who had been on piece rates were kept at the same hourly pay for two years. However, the fastest workers saw their hourly pay decline $4-5 per hour (40-50%) over several years. According to management, however, only about 10% of the workers quit during this period.

Wages in 1999 for assemblers were $10.48/hour in the suburban plant and $10.60 per hour in the urban plant (there was no seniority increment). In the urban plant, this was supplemented by a VAG payout of about $1.00 per hour. The VAG was much less (often zero) in the suburban plant, due mostly to quality problems and secondarily to difficulties in accounting for the time of engineers who worked on products for SP's other plants (Ms. P, 2002). This pay rate was far below the US manufacturing average of $14.40 per hour in 1999 ($15.03 for workers in industrial machinery) (Jacobs, 2000). Benefits (which included paid vacation, medical, and dental) were more generous than in the average US factory, but did not come close to offsetting the low pay. In addition, the Massachusetts plants are located in an area with a very high cost of living.

However, the impact on satisfaction of the pay cut for the Massachusetts piece-rate workers was offset in part by a perceived decline in work effort required. There was now no incentive to work fast; instead the goal was to work at the same pace as the team.

At the time rate plants, however, workers perceived that the new management policies (including both VAG and lean production techniques) required a significant increase in effort. Since the VAG payout was generally low in these plants, pay did not increase much to compensate for this effort. The payout was low due to quality problems; it was unclear if

these problems were exogenous, or due to workers' desire to economize on effort given their low pay.

5. Perceived access to alternative employment

The demographics of the workforce in each of SP's plants were quite distinct from each other. But, as we discuss below, the demographics sought out by SP (immigrants, older people, residents of rural areas) were those who had few alternative job possibilities.

In the 1990s, the line workers at the Massachusetts plants were largely immigrants. About one-third of the work force was Vietnamese and one-third Cape Verdean. The rest was a mixture of immigrants from other countries, such as Poland, and US-born workers. About 60% was female. The work force was recruited by word of mouth rather than advertising; many workers were related to each other. There were few blacks though the plant was in a majority-black area. At the urban location, most workers walked or took public transportation to work. Turnover was low; at the time of our survey two-thirds of the workforce had been at SP for at least four years (see table 1).

The Ohio plant was located in a rural part of the state, about 30 minutes from a medium-sized city where most of the managers lived. The company was started in the mid-1960s by a man universally known as Jack, who had innovative ideas for electronics products and a paternalistic management style. Layoffs were done on a voluntary basis, and Jack was often seen on the shop floor until he semi-retired and moved south (where he opened the Florida plant).

At the Ohio plant, everyone seeemed to be native born, and all but a handful were white. The average age was 44, higher than in Massachusetts; about 20% appeared to be over 60. (Management explained that many of them worked to supplement retirement benefits

obtained from working on a previous job.) Although there was a core of experienced workers (see table 1), turnover was very high; 30% of those hired in 2000 had left by the end of the year (quit or were fired). In 2001, the starting wage for an assembler was $6.85 per hour; after one year this increased to $7.80; after 3 years to $8.27. After 12 years, one assembler reported that she made about $9 per hour. This was supplemented with an annual check that was called "profit-sharing". The owner allocated a pool of money (based loosely on the past year's performance) which was divided among the work force based on seniority and wages; the payment was typically equal to about two weeks' wages. In contrast to the VAG, management did not emphasize the role of workers in affecting the payment, and the size of the bonus pool was subjectively determined.

The Florida plant had many similarities to the suburban Boston plant. It was relatively new, about 15 years old, and was capital intensive. Unlike Boston, the workforce has a large number of retirees who moved to Florida, and found that their retirement income and saving were insufficient. Consequently, the age of production employees was higher in Florida than at the other plants.

The plant manager in Florida Mr. Z said that the plant was built to serve as a semi-retirement location for the founder of the company. Consequently, the plant and the major offices for top management were in separate buildings. The manufacturing plant and its offices were plain with Spartan amenities. The main office complex had carpeted workspaces for management with spacious windows, and was generally larger and had modern audio visual equipment. The corporate meeting rooms and cafeteria were in the office complex rather than in the plant.

Although most of the jobs involved watching and adjusting controls on machines and checking for defects, there were many difficult and tedious jobs. These included packing parts, loading trucks; a particularly daunting job involved putting small round sensors into a hole the size of the eye of a needle for eight hours per day.

In the UK, the base wage had not been raised for several years, and the assembler rate of 4.60 pounds in 2002 (about $7 at then-current exchange rates), was not much above the national minimum of 4.20. The former management saw the low wage as the plant's main source of competitive advantage, according to the new management. The base wage was raised to 4.83 per hour on January 1, 2003, with the possibility of a group bonus ranging from 0-40%, with the average at 14%. (In contrast to the VAG, which is plant-wide, this bonus was based on the efforts of one work cell (a dozen or so people). Management's idea was to transition the work force slowly toward a bonus based on larger number of workers, from an individual bonus (piece-rate) to a group bonus, to the VAG, which was to be implemented in spring 2003. The demographics of the work force was overwhelmingly female ("mostly second earners", according to the HR director), and was about 20% Indian and 5% Chinese with the remainder white British.

IV. Methods

Plant Visits and Surveys

We visited each of the Massachusetts plants three times, in 1995, 1998, and 2000, and the urban plant again in 2002. We visited the Ohio and Florida plants each 3 times in 2002 and the UK plant 3 times in 2003. At each visit, we spoke with managers and toured the plant. As part of the survey process, we conducted focus groups with workers (without management

present), and talked with workers as they filled out the surveys (though we did not look at how they answered the questions; the surveys were anonymous). We also made a presentation of our findings to the management of each plant, and learned from their responses.

Our methodology thus combines standard econometric multivariate approaches with the enhanced knowledge from plant visits that provides insights not gained through statistical estimation. For example, we were able to learn about the product improvements and the "war on waste" policies implemented within the Ohio plant through discussions with the plant manager and employees. General knowledge of the products produced or financial records would not be able to capture these changes in the establishments. Ironically, this close understanding of the policies and practices makes it harder to argue that the policy was implemented identically in each plant—if we had known less, we could have more convincingly argued that we have a true natural experiment.[6]

Estimation Strategy

Our efforts to isolate the impact of the VAG on productivity and satisfaction involve two types of tests. We examine the direct impact of the various plants in the US relative to the UK plant on measures of firm performance to include measures of productivity and profitability. Next we measure the impact of the changes to VAG on employee satisfaction in the US versus the UK plants.

In order to suggest that this was a quasi-natural experiment, we need to show that the plants are similar except for the adoption of VAG. The production processes at all five plants are quite similar, involving assembly of small, complex electronic and plastic-molded parts. These areas of the five plants are remarkably similar. All plants also have in-house

engineering. The level of productivity at the Massachusetts plants is higher than at the others, but this is due largely to the greater productivity of engineers there; these engineers increasingly design products to be produced at SP's other plants as well. Engineers made up a relatively constant 13% of the workforce in Massachusetts, and nonproduction workers ranged from 25-30%. In our estimates, we also control for the level of nonproduction employees in each plant. In addition, the Ohio, Florida, and UK establishments each had plastic molding departments, though Massachusetts did not. Assembly worker jobs and pace of work are remarkably similar across plants, according to the management groups.

Our basic efficiency-based models were of the following form:

(1) $Q=f(VAG, X`, \varepsilon)$, where

Q is productivity as measured by output or value added per worker,

VAG is 0 for each month until the VAG program is introduced in that plant, and 1 afterward,

X` is a set of controls for plant and individual characteristics, and

ε is the standard error term with the usual OLS assumptions on its structure.

V. Results

Worker and Establishment Characteristics

In Table 1 we give the basic financial characteristics of the four plants in our study. For the UK plant, we adjust the values by the exchange rate of the pound for the dollar in each year for which we have data, and give the values in dollars. In all of our measures of productivity or profits, the UK plant is lower. We also show the percentage of nonproduction employees in each of the plants. By this measure, the UK plant ranks second to the Boston area facilities. In the final column, we show the aggregate measures of each factor for the

four facilities for SP. Since there was missing data for some of our measures we also give the range of the number of monthly observations in our sample.

Impact of Value-Added Gain-sharing

In Table 2, we estimate the impact of the plants and the VAG on measures of financial performance at SP. We provide estimates of several specifications of the basic model described in (1). We begin with a basic plant effect with controls for only assets per employee. We then add a time trend measured by the lag of the dependent variable; this captures the impact of other features of the plant's environment. For example, automakers succeeded in preventing suppliers from raising prices (the Producer Price Index for auto parts did not rise 1990-2001), while input prices rose. For the period that VAG is in place, we also control for improvements made due to the VAG in the previous month, imposing a relatively stringent test of the program's efficacy.[7] In the third column of Table 2 we include the percentage of nonproduction employees as a control. In all our specifications, the performance levels of the U.S. plants are significantly higher than those of the UK plant, which is consistent with our descriptive statistics.

Panel A shows the impact of the VAG on gross productivity as measured by sales per employee. In this case, with our fully specified model the VAG increased productivity by 18 percent. Panel B shows a similarly specified set of multivariate models for the log of gross profits per employee, where gross profits equals total revenue minus total variable costs during the month. US plants were more profitable than their UK counterpart across all specifications. Adoption of VAG increased gross profits by a statistically significant 17 percent in the most fully specified model across all the plants.

In panel C of Table 2 we show estimates of the log of value added per employee, where value-added equals sales minus material costs. The results again show that the US plants are more productive than the UK plants. The last column gives the fully specified model that shows that the VAG is associated with a 10 percent increase in value added per employee that is precisely estimated. These estimates are similar to those of Kaufman for his estimates of the effect of gainsharing (1992). The results in Table 3 show that the US plants are more productive and that the introduction of the VAG enhanced the ability of the plants to improve on its productivity and profitability in a highly competitive marketplace.

Thus we find consistently that a) the level of productivity and profits is higher in the US plants than in the UK plants, and that adoption of the VAG is associated with subsequent 10-18% improvements in those measures. (Note that the gross profit figures include the cost of administering the program, so VAG more than paid for itself.) In results not shown, we also find significant differences within the US plants: the Boston plants perform significantly better throughout the period and have significantly greater improvements due to the adoption of VAG.

Table 3 suggests some reasons for the differential effect of VAG across plants—the differences in the levels of adoption of complementary policies, as perceived by workers. In our satisfaction survey, workers were asked to mark each of the statements in table 5 on a scale of 1 ("strongly disagree") to 5 ("strongly agree"). VAG is more effective to the extent that workers understand a)"their roles and responsibilities" b) what actions on their part lead to good performance (they are informed by their supervisors about their performance), c) when certain actions are necessary (eg, they find out when an external customer finds a defect), and d) how to ensure that the problem doesn't happen again (so that VAG leads not

just to a one-time performance gain, but to a new improvement path). Table 3 shows that the US average on each of these measures is significantly greater than the UK average, and that Massachusetts is significantly higher than Florida or Ohio.

As our interviews suggest, the higher US performance is due mostly to managerial policies (the introduction and constant reinforcement of supporting policies). We found little evidence to suggest that the differences were a consequence of country-specific regulations or culture. However, our sample of just a few establishments in only one firm by itself is not sufficient to draw general conclusions about the influence of national policies on either productivity or employee satisfaction.

What Affects Employee Satisfaction?

We find that worker satisfaction varies a great deal by plant. However, the UK plant averages are significantly lower than those for the US. Employees who perceived that they made more money under VAG were more satisfied. Workers who reported working harder under VAG also were more satisfied, although the causality here may be reversed.

The basic survey instrument we used to examine employee satisfaction was the Minnesota Satisfaction Survey (MSS). We then we added questions to examine the impact of the pay systems in each plant. The baseline questions were of a Likert-type 5 point scale. The MSS has been used by industrial psychologists for more than 50 years to gauge employee satisfaction in American industry. We also asked questions of the employees about their tenure with the company, type of job, and pay policies.

In our attempt to examine the determinants of satisfaction, we examine a number of factors in addition to the effects of company policies. From the literature in psychology we know that there are individual differences that affect job satisfaction (Arvey et. al. 1991).

Moreover, the specific question asked of the respondents is also of importance, the central questions about job satisfaction measure different qualities such as attachment to the job, quality of supervision and other attributes. Consequently these factors should be accounted for in any attempt to examine what is under the control of the firm versus other exogenous factors. Even though the overarching policies adopted by the firm were at the plant level, group or team effects are also likely to influence satisfaction with work (Judge, Thorson, Bono, and Patton, 2001).

In Table 4 we show employment characteristics of the more than 1800 employees (90% of the workforce) who responded to the satisfaction survey at the US and UK plants. The UK plant had the highest percentage of assemblers, but the lowest percentage of temporary workers. Except for the Florida plant that was the newest one, tenure with the plant was similar across the plants in our sample.

Table 5 presents an ANOVA multivariate analysis of the role of both individual and plant characteristics in contributing to explaining overall employee satisfaction. We show the role of the plant, individual, or question in explaining overall job satisfaction. The ANOVA shows that the workplace as measured by the plant where you work is important in contributing to overall satisfaction. Although the exact type of satisfaction asked about, and individual worker characteristics are significant, the role of the plant-level environment significantly contributes to the overall level of employee satisfaction, suggesting that where you work matters beyond your personal characteristics.

Internationalization of the American Workplace: The Job Satisfaction of Immigrants

At the inner city Boston and suburban plant we were able to gather more detailed information on the job satisfaction of employees. A high percentage of the employees were

immigrants from Vietnam and Cape Verde, and were not proficient in English. Consequently, we translated our questionnaire into Vietnamese and Portuguese[8]; respondents chose the language in which they wanted to take the survey. Thus, we are able to differentiate individuals in the plant by their degree of assimilation to English. In addition, we compare the degree of satisfaction with work with English-reading and writing individuals within the plant to persons whose main language is Vietnamese and Portuguese. Further we compare their level of satisfaction to persons in the other plants whose main language is English.

The regression results of language on job satisfaction for the Boston facility are presented in Table 6. The estimates show that having worked under piece rates does not have a significant impact on satisfaction. Moreover, we find that the English speakers were the least satisfied, but that language served as a proxy for fewer job opportunities. When we added a variable for the lack of other jobs in the second column, the impact of language was not statistically significant. [9]

Did the Change in HR practices Influence Overall Satisfaction?

As part of the effort to examine the overall effects of the HR practices on employee satisfaction we analyze the change in the method of pay on employee satisfaction. The basic model is of the following form:

2) $\Delta Sat = f(VAG, X`, \varepsilon)$.

Where the change in satisfaction, ΔSat is a function of the change in compensation, and plant controls and characteristics, and the ε error term.

Using the model above,, we examine the relative impacts of working harder and making more money on overall satisfaction. The estimates in Table 7 show the impact of the change in satisfaction or the Boston, Florida and UK facilities after the VAG. We show the

coefficient estimates from equation two where the dependent variable is ΔSat and the independent variables is the response to working harder under the new system and the increase in pay. In all cases, the values for the independent variables for working harder and making more money are statistically significant. Working harder seems to increase job satisfaction, perhaps tied to the strong view about having pride in the company, but having more pay is of greater importance. There seems to have been important impacts of the changes to a VAG system of pay on productivity and employee satisfaction, data from the firm suggest that profitability increased, especially when compared to the industry. SP's profitability increased because of the firm's ability to become a "full service" supplier to auto firms, but also because the move away from policies in plants that were paid by piece rate methods were able to offer more diverse new products that had higher profit margins (Freeman and Kleiner, 1998). In addition, worker's compensation costs at the urban plant were cut in half after the move away from piece rates, for a savings of $200,000 per year (an amount equal to 10% of the direct labor payroll).[10]

VI. Conclusions

Our results show that the UK plant was less productive and profitable relative to the US operations. We also find that changing to VAG increased productivity and gross profits even in the most restrictive specification. We argue that this was due to a) that change from piece rates allowed introduction of new products more quickly, and allowed inventory reduction and b) management undertook a lot of complementary activities to the VAG (explained how the VAG worked, created the Last Chance Club), especially in Massachusetts. The impact of the pay cut from getting rid of piece rates was offset by the reduction in work effort required.

National differences

We find it hard to attribute the differences we found (lower worker satisfaction and lower productivity in the UK plants) to national institutions. We did not hear complaints from managers (many of whom were familiar with conditions in the US) about restrictive work rules, and did not observe any differences in work rules—management in all plants seemed to have complete freedom to assign workers anywhere in the plant. The US plants had made a commitment to workers to avoid layoffs. This was especially true in the two acquired plants; the previous owner made it known that he had a year's worth of salaries in the bank, which he used to cushion downturns. The UK plants had no such commitments.

Instead, we think that the diversity of outcomes is a reflection in large part of sample selection bias. SP choose a low-productivity UK plant to buy, because they believed that their management skills would allow the US firm to turn around the UK firm so that it returned economic value greater than its cost of purchase. (A similar logic was evident in the purchase of the Ohio and Florida plants, which also had lower productivity than Massachusetts.) A variety of sources attested to the low quality of the British management team: SP top executives, workers we interviewed, and our own observation of disorganization, poor communication, and capricious behavior. Pay levels had not kept pace with inflation, and were significantly below the national and regional averages for manufacturing.

We did find one factor that is linked to institutions: access to immigrant labor and other workers with limited alternatives. Across all of our plants, access to alternative employment was negatively correlated with satisfaction. We found this result both directly (satisfaction was negatively correlated with answers to our question about how easy it would be to find an equivalent or better job) and indirectly. In the Massachusetts plants, we translated the survey

into Portuguese and Vietnamese; those who took the survey in these languages were more satisfied than those whose English skills were good enough to take the survey in English. However, the UK plants also had access to immigrants. In England we were unable to distinguish survey responses from immigrants—but we did find that immigrants expressed more satisfaction in our interviews.

The case of SP suggests the following generalizations:

1. Managers often introduce new plans without a) understanding the importance of complementary efforts, or b) thinking through the incentive effects on workers (they are more concerned with making sure they don't pay 'too much', and fall victim to the multi-task problem (they pay too much attention to minimizing costs that can easily be measured, while ignoring costs that are harder to measure, or that would constrain management autonomy if measured, like overhead). These pitfalls affect even highly successful managers, such as those at SP. By most measures, SP has been a financially successful company. Although the second half of 2000 and 2001 were tough years and profits were relatively low, this was true for almost all firms in the auto industry. In other years, the firm's return on equity was between 12 and 20%. SP achieved this performance without being a particularly high-productivity operation; value added per shop worker at the Ohio plant is only $70,000, not far above the median for component producers, according to bench marking data from the Industrial Technology Institute.

Although management bought the Ohio, Florida, and UK plants because it thought they could use their superior administrative tools to turn these plants around, it appears that they did not fully understand the roots of their success in Boston. In Boston, plant management was highly visible, and introduced many complementary policies, including constantly

referring to the importance of the VAG, and the nature of worker actions required to increase it. As a result of their success in Boston, the top two managers there were promoted into corporate offices of an expanding company, where they visited the acquired plants only once a month, pushing VAG on them as a sort of magic bullet.

2. It is possible to introduce a kind of 'lean from above', that mimics some of the Toyota results on inventory and quality by having management do much of the continuous improvement efforts that are done by workers at Toyota. SP has focused on inventory reduction and having engineers design for manufacturing. These efforts have allowed SP to use a relatively unskilled, low-paid work force to produce at low cost. SP has not, on the other hand, placed much emphasis (particularly recently) on broad-based participation where ideas for continuous improvement come from both line workers and engineers.

What are the benefits of SP for workers? The factors affecting satisfaction appear quite similar in the US and UK. One way to characterize them is that "workers at SP do fairly well compared to their alternatives". An optimist would emphasize the "do well " part, pointing out that SP's wages are high by world standards, and that SP's worker satisfaction levels similar to national averages, and that many SP workers stay there for a long time. From the perspective of SP employees, it seems there are several reasons why many stay. First, the firm pays good benefits, including health care, pension, and paid vacation. (Pay and benefits were low in the UK plant, but so were effort requirements until new management came in). The extra pay provided by the VAG is important. In the Massachusetts suburban plant applications for openings fell dramatically after the VAG pay out fell from almost 7% to zero. Second, the firm has found work forces that perceive themselves as having few labor market options. The firm hired many immigrants in Massachusetts and the UK, retirees and other

rural workers in Ohio, and older workers and retirees in Florida. Third, in the Massachusetts plants the sense of community provided by working with others of the same ethnic group, and sometimes the same family, in a plant that is perceived as well managed provides many first generation Americans a sense of economic and cultural security.

A pessimist would also agree that "workers at SP do fairly well compared to their alternatives"—but would focus on how bad the alternatives are. In this view, the worker satisfaction measures capture mostly that workers do not feel they can do much better. From this point of view the impact of the changes in product and HR strategies is to give managers and stockholders more new products without paying a higher wage (and in the case of the urban plant, paying a lower wage). Workers report that they work harder, and now that they work for a public company rather than a paternalistic owner, they are subject to layoffs. However, at least the firm survives, offering a fairly high probability of continued employment with health and pension benefits.

Endnotes

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[1] In the urban Massachusetts plant, workers on individually-paced jobs were paid piece rates from the 1960s until early 1996. The VAG was phased in gradually (by department) between 1993 and 1995. The suburban Massachusetts facility was established in 1989, and was populated in part by workers from the urban plant. Both managers and workers were moved back and forth between the two plants; our data do not allow us to separate these plants.

The Florida and Ohio facilities were acquired by SP in late 1998. At the Florida facility the production employees were paid a time rate. On January 1, 2001, the plant shifted to a value added gain sharing method of pay. Workers also were paid an hourly rate at the Ohio facility. This facility did not switch to VAG until January 1, 2002.

The UK plant was acquired by SP in March 1999. The workers had been paid a piece rate for many years. At the time of our first visit in January 2003, most of the workers had been transferred from individual piece rates to a time rate plus a bonus based on their work group's performance, and some had been told that they would be paid a time rate plus VAG (a bonus based on plant-wide performance) starting in March 2003.

[2] This is a quote from a very useful document, "Progression of Pay for Performance", that Ms. P wrote for us in February 2000.

[3] The magnitude of management's effort to design and maintain the gainsharing effort perhaps both explains its success, and why relatively few firms are able to achieve such success. See Helper and Kleiner (2003) for more details.

[4] It seemed that "too high" meant wages more than 15% above the average for unskilled manufacturing workers in the area. (For example, Mr. P said in 1995 that if gain-sharing exceeded 15%, then it was time to cut prices to

customers (rather than continue to increase compensation to workers). It is not clear how the 15% figure was arrived at.

[5] Note that the figure of 45% of workers receiving a pay cut does not include any of the 10% who left the plant.

[6] Thanks to Fredrik Andersson for this point.

[7] On the other hand to the extent that errors in measuring output are serially correlated, this method overstates the impact of VAG on performance.

[8] The Cape Verdeans spoke several dialects of Portugese.

[9] In the Appendix we estimate the same model but give the satisfaction measure as a Rasch index rather than for overall satisfaction, and find similar results

[10] According to data provided by the company, workers' compensation expenses incurred averaged $203,000 per year from 1996-99 (after the transition to gain-sharing was completed), and $413,000 from 1989-1995. (These figures are uncorrected for inflation, or the growth in hours worked over this period, similar-sized adjustments that move in opposite directions.)

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Appendix Table A: Impact of Working on Piece Rates on Job Satisfaction of Production Employees in the Massachusetts Establishments*- Rasch Index Measures of Job Satisfaction

	Rasch Measure of Job Satisfaction	Rasch Measure of Job Satisfaction
	(1)	(2)
Piece Rate	0.09	0.11
	(0.20)	(0.20)
Vietnamese	0.33**	0.19
	(0.14)	(0.14)
Cape Verde	-0.04	-0.04
	(0.14)	(0.14)
Tenure Less Than 1 Year	0.27	0.36**
	(0.18)	(0.18)
Tenure Between 1 and 6	0.28**	0.28**
Years	(0.12)	(0.12)
		0.23***
Lack of Other Jobs		(0.04)
Adj. R^2	0.03	0.11
N	376	358

*Standard errors are in parenthesis.

Table 1: Descriptive Financial and Nonproduction Employee Statistics

Variable	Boston Mean (S.D.)	Florida Mean (S.D.)	Ohio Mean (S.D.)	UK Mean (S.D.)	All Plants Mean (S.D.)
Assets per Employee	106.90 (8.55)	148.12 (112.11)	133.16 (110.80)	41.78 (3.26)	102.01 (71.86)
Sales per Employee	14.04 (3.73)	8.07 (1.02)	9.42 (1.39)	6.48 (1.36)	10.51 (4.18)
Gross Profits per Employee	4.37 (1.15)	1.68 (0.47)	3.47 (0.67)	1.08 (0.37)	3.01 (1.65)
Operating Profits per Employee	2.77 (1.03)	1.07 (0.51)	2.71 (0.66)	0.36 (0.26)	2.00 (1.29)
Value Added per Employee	8.31 (1.34)	5.68 (0.71)	5.98 (0.90)	4.14 (0.79)	6.45 (2.01)
Percentage Non-production Employees	28.94 (1.52)	19.42 (0.64)	17.64 (1.28)	21.71 (1.44)	24.26 (4.89)
Sample Size	98 – 111	37 – 39	37 – 39	44 – 58	224 – 245

Notes:

All financial figures are in tens of thousands of dollars

Value Added = Net Sales – Material Cost

Boston monthly data from December, 1989 to April, 2000

Florida monthly data from January, 1999 to March, 2002

Ohio monthly data from January, 1999 to March, 2002

UK monthly data from March, 1999 to December, 2003

Table 2: Estimates of the Impact of VAG on Measures of Firm Performance in US Plants relative to the UK Plant

Panel A

Dependent Variable: Log Sales per Employee						
% Non-production Employees	---	---	-0.08*** (0.01)	-0.03*** (0.01)	-0.03** (0.01)	-0.02 (0.01)
Lagged Log Sales per Employee	---	0.59*** (0.05)	---	0.51*** (0.06)	---	0.38*** (0.06)
Log Assets per Employee	0.00 (0.03)	0.01 (0.02)	-0.07** (0.03)	-0.03 (0.02)	-0.10*** (0.03)	-0.05** (0.02)
Boston	0.75*** (0.05)	0.31*** (0.06)	1.36*** (0.09)	0.64*** (0.11)	0.88*** (0.10)	0.55*** (0.10)
Florida	0.23*** (0.05)	0.09** (0.04)	0.13** (0.05)	0.06 (0.04)	0.15*** (0.05)	0.09** (0.04)
Ohio	0.39*** (0.05)	0.15*** (0.04)	0.13** (0.06)	0.07 (0.05)	0.36*** (0.06)	0.21*** (0.06)
VAG	---	---	---	---	0.32*** (0.04)	0.18*** (0.04)
Adjusted R^2	0.66	0.81	0.72	0.82	0.78	0.83
N	239	229	239	229	239	229

Table 2 (continued)

Panel B

Dependent Variable: Log Gross Profits per Employee						
% Non-production Employees	---	---	-0.07*** (0.02)	-0.04** (0.02)	-0.03 (0.02)	-0.02 (0.02)
Lagged Log Gross Profits per Employee	---	0.24*** (0.07)	---	0.21*** (0.07)	---	0.19*** (0.07)
Log Assets per Employee	-0.08* (0.05)	-0.05 (0.04)	-0.15*** (0.05)	-0.10** (0.05)	-0.17*** (0.05)	-0.12** (0.05)
Boston	1.52*** (0.07)	1.18*** (0.12)	2.03*** (0.15)	1.54*** (0.20)	1.64*** (0.18)	1.34*** (0.21)
Florida	0.56*** (0.08)	0.42*** (0.09)	0.47*** (0.09)	0.38*** (0.09)	0.49*** (0.08)	0.41*** (0.09)
Ohio	1.30*** (0.08)	0.98*** (0.11)	1.08*** (0.10)	0.88*** (0.12)	1.26*** (0.11)	1.03*** (0.13)
VAG	---	---	---	---	0.26*** (0.07)	0.17** (0.07)
Adjusted R^2	0.76	0.80	0.77	0.80	0.78	0.81
N	236	225	236	225	236	225

Table 2 (continued)
Panel C

Dependent Variable: Log Value Added per Employee						
% Non-production Employees	---	---	-0.04*** (0.01)	-0.03*** (0.01)	-0.02** (0.01)	-0.02** (0.01)
Lagged Log Value Added per Employee	---	0.33*** (0.06)	---	0.26*** (0.06)	---	0.21*** (0.07)
Log Assets per Employee	0.02 (0.02)	0.02 (0.02)	-0.02 (0.02)	-0.01 (0.02)	-0.03 (0.02)	-0.03 (0.02)
Boston	0.68*** (0.03)	0.45*** (0.05)	1.00*** (0.07)	0.75*** (0.10)	0.80*** (0.08)	0.65*** (0.10)
Florida	0.30*** (0.04)	0.20*** (0.04)	0.25*** (0.04)	0.18*** (0.04)	0.26*** (0.04)	0.20*** (0.04)
Ohio	0.37*** (0.04)	0.24*** (0.04)	0.23*** (0.05)	0.16*** (0.05)	0.32*** (0.05)	0.24*** (0.05)
VAG	---	---	---	---	0.13*** (0.03)	0.10*** (0.03)
Adjusted R^2	0.74	0.77	0.77	0.78	0.78	0.79
N	232	229	232	229	232	229

Table 2 Notes:

*p<0.10 **p<0.05 ***p<0.01

Standard errors in parenthesis

Value Added = Net Sales – Material Cost

Boston monthly data from December, 1989 to April, 2000

Florida monthly data from January, 1999 to March, 2002

(Table 2 Notes, continued)

Ohio monthly data from January, 1999 to March, 2002

UK monthly data from March, 1999 to December, 2003

Boston introduced VAG in January, 1996

Florida introduced VAG in January, 2001

Table 3. Measures of Complementary policies to improve productivity

	Boston	**Florida**	**Ohio**	**UK**
	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)
In my work unit, people have a clear understanding of their roles and responsibilities	3.66 (1.12)	3.37*** (1.18)	3.42*** (1.15)	3.14*** (1.17)
I regularly get communication from my supervisor (or group leader) about my performance	3.26 (1.34)	2.91*** (1.24)	2.89*** (1.28)	2.58*** (1.26)
When an external customer (like Ford or Chrysler) finds a problem, I learn about it	3.62 (1.15)	3.28*** (1.24)	3.13*** (1.23)	3.08*** (1.17)
When a problem is found in my work unit, we change our procedures to make sure the problem does not happen again	3.97 (1.06)	3.55*** (1.12)	3.43*** (1.09)	3.31*** (1.20)

Table 4: Employee Characteristics at SP

	Boston (all)	Boston (urban)	Boston (suburban)	Florida	Ohio	UK
Sample size	518	233	285	482	634	199
Assemblers	67.71%	63.29%	71.35%	44.33%	53.55%	73.51%
Part-time workers	---	---	---	1.07%	0.59%	---
Temporary workers	14.49%	16.53%	12.96%	---	---	5.37%
Worked on piece rate	66.02%	67.38%	64.91%	---	---	76.88%
Worked on hourly rate	74.13%	70.82%	76.84%	---	---	68.84%
Tenure: less than 1 year	12.17%	12.02%	12.30%	16.51%	3.74%	12.95%
Tenure: 1 to 4 years	30.00%	26.92%	32.54%	37.39%	34.47%	25.91%
Tenure: 4 to 6 years	20.65%	13.94%	26.19%	17.66%	16.91%	15.03%
Tenure: 6 to 10 years	12.39%	11.54%	13.10%	21.79%	19.84%	12.44%
Tenure: more than 10 years	24.78%	35.58%	15.87%	6.65%	25.04%	33.68%

Table 5. ANOVA Analysis of the Impact of Working in the Establishment on Employee Satisfaction

	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1356	18131.48	13.37	14.93	<.0001
Person	1337	13476.77	10.08	11.26	<.0001
Question	15	3963.00	264.20	295.04	<.0001
Place	4	691.70	172.92	193.11	<.0001
Error	20051	17954.86	0.90		
Corrected Total	21407	36086.34			
R^2	0.50				

Note: The ANOVA sample include employee satisfaction data from two plants in

Massachusetts, Florida, UK and Ohio Plant.

Table 6: Impact of Working on Piece Rates on Job Satisfaction of Production Employees in the Massachusetts Establishments*

	Job Satisfaction	Job Satisfaction
	(1)	(2)
Piece Rate	0.24	0.24
	(0.24)	(0.24)
Vietnamese	0.38	0.26
	(0.16)*	(0.16)
Cape Verde	0.11	0.02
	(0.17)	(0.17)
Tenure Less Than 1 Year	0.05	0.13
	(0.21)	(0.22)
Tenure Between 1 and 6	0.26	0.23
Years	(0.14)	(0.14)
Lack of Other Jobs		0.22
		(0.05)**
Adj. R^2	0.02	0.07
N	361	361

*Standard errors are in parenthesis.

Table 7: Impact of Changes in Satisfaction after moving to VAG

From Piece Rate to VAG MASS.	Change in Job Satisfaction after VAG	Change in Job Satisfaction after VAG
Working Harder Under VAG	0.20**	
	(0.08)	
Making more money Under VAG		0.55***
		(0.08)
Making Suggestions	-0.02	0.01
	(0.07)	(0.06)
Vietnamese	0.76***	0.29
	(0.28)	(0.26)
Cape Verde	0.23	-0.23
	(0.29)	(0.27)
Adj. R^2	0.07	0.29
N	131	127

From Time Rate to VAG FLORIDA	Change in Job Satisfaction after VAG	Change in Job Satisfaction after VAG
Working Harder Under VAG	0.47***	
	(0.07)	
Making More Money		0.49***
		(0.07)
Making Suggestions	0.03	0.09*
	(0.05)	(0.05)
Adj. R^2	0.22	0.25
N	158	161

*Standard errors are in parenthesis

From Piece Rate to VAG UK	Change in Job Satisfaction after VAG	Change in Job Satisfaction after VAG
Working Harder Under VAG	0.53***	
	(0.08)	
Making More Money		0.58***
		(0.07)
Making Suggestions	-0.05	-0.05
	(0.06)	(0.06)
Adj. R^2	0.30	0.36
N	110	110

Chapter 8: Susan Helper and Morris Kleiner

Figure 1: Timeline for the Implementation of the VAG at Small Parts

Figure 1: Timeline for the Implementation of the VAG at Small Parts