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**Does Industrial Relations Affect Plant
Performance?: The Case of Commercial Aircraft
Manufacturing**

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“unionism per se is neither a plus nor a minus to productivity. What matters is how unions and management interact at the workplace.” (Freeman and Medoff, *What Do Unions Do?*, 1984)

Introduction

To what extent do the industrial relations policies, practices, and interactions of labor leaders with top level managers influence labor productivity? Do total quality management programs that include strong elements of employee involvement affect organizational performance? Does overt conflict or cooperation in labor management negotiations, such as strikes and slowdowns, influence the long term efficiency of an enterprise?

To attempt to answer these questions and address the statement by Freeman and Medoff, we use information gathered from a large U.S. commercial aircraft manufacturing firm during a period when the U.S. dominated world production in this industry. This industry is of particular importance because it has been one of the dominant export sectors of high value added goods in the U.S. economy. In 1995 the U.S. aircraft industry recorded a trade surplus of \$21.3 billion, or about 57% of total commercial export volume (Napier, 1996). The industry is the second largest employer of manufacturing jobs in the U.S. behind only automobile manufacturing. The sector is characterized by huge investments in capital, substantial research and development, and long product development periods sometimes exceeding a decade from the research and development stage to the roll out of the final product. Also, the life of the product cycle is long, frequently exceeding 20 years. The assembly of the final product includes elements of mass production and

of a customized product. Although the assembly process is homogenous, each section of the commercial aircraft has unique elements specific to the final customer. Labor costs as a percentage of total value added is low, but hourly earnings of production workers are about 40% above the average wage in manufacturing and the firm employs a substantial number of scientists and engineers (Kleiner, Nickelsburg, and Pilarski, 1995). During the past decade the industry in the U.S. has faced increasing competition from Europe in the form of Airbus, a multinational organization that has been able to obtain the kind of dynamically increasing returns to be internationally competitive with high value added, capital intensive infrastructure, and a rapidly decreasing learning curve.

One of the main reasons that the U.S. is able to maintain its competitive advantage is because of its high levels of factor market competitiveness that include managerial talent and policies, and the productivity of its production workforce (NRC, 1985). From the perspective of developing production analysis, the industry has been the source of one of the first economic analyses of the learning curve, which was developed with applications to commercial aircraft production and then was modeled more generally for other industries (Asher, 1956 and Arrow, 1962). More recent estimates of the learning curve have shown generally improving learning with some modifications to the trend (Benkard, 1999). Given the oligopolistic structure of the industry, unions have been a major factor in this industry and have succeeded in obtaining high wages and benefits for their members (Karier, 1985).

The economic success in the product market has not necessarily meant peaceful or harmonious industrial relations. Throughout the post World War II period the major firms in the industry have generally had acrimonious labor relations, with strikes, work slowdowns, and

threats of work stoppages as a regular part of the collective bargaining process. Unlike most industries where strikes rarely occur, the firms in this industry endure concerted activities during most contract negotiations. In recent years, in response to greater foreign competition, several attempts have been made by both labor and management to change the focus of industrial relations in the industry from that of confrontation to one of cooperation.

A main goal of this paper is to examine the role of management, labor and their joint policies and practices on the labor productivity of large commercial aircraft. Initially, we examine industrial relations practices within the theoretical context of production efficiency, with a focus on aircraft assembly. We also sketch out theory on matching union and managerial leaders in production. Next, we present the data obtained directly from monthly company files that we employed to investigate these relationships. A major commercial aircraft manufacturer agreed to give us information from the organization's main management information system data base, under the condition that we do not use its name in our publication. We will call the company Big Plane or BP. One advantage of our data relative to information gathered from surveys is that we would expect it to be more accurate than, for example, survey information employed from the Census of Manufacturing LRD file, because the firm has a greater incentive to check the quality of the data since it is gathered at considerable cost to the firm and is used for making policies within the firm. Another unique aspect of our study is the opportunity to examine the impact of industrial relations by reducing unobserved heterogeneity in production, an issue that has plagued other studies. We do this by examining one plant that produces the same standardized product with largely the same workforce, and using virtually the same technology over a relatively long period of time. We follow this discussion with an examination

of the unique institutional and historical events that occurred in the plant during the period of our analysis as well as production-related factors including the learning curve. As part of this discussion we focus on the leaders of both the union and management and their interaction in producing industrial relations events that affected productivity in the plant. Finally, we empirically assess the effects of industrial relations factors on production using both traditional time series regressions as well as a counterfactual simulation that assesses the effect of a total quality management program and other labor management events (Freeman and Kleiner, 1998).

Industrial Relations Events and Productivity

Most previous studies of the economic performance effects of industrial relations variables such as strikes, work to rule, or contracts have used the stock market or firm level profits as the relevant measure of the outcomes of these events even though they often occur at a single plant of a multi-plant facility or within a single business line of a multi-business line organization (Becker and Olson, 1987). Consequently, any impacts of these variables are biased downward, whereas the direct effects of these events are likely much larger if they are directly measured at the level of the establishment. In this section of the paper we examine the effect of highly visible industrial relations conflicts such as strikes and work slowdowns. In addition we explore the effects of top management and labor leaders on the productivity within this large airplane assembly plant. Since labor inputs are a huge cost item in commercial airplane production, we anticipate that changes in the industrial relations climate and organization of work in the assembly line would affect the productivity of the organization. In the context of a production function, changes in the policies and practices that affect the organization of work

would result in changes in productivity.

In the context of a production function labor, L is affected by changing industrial relations events in the following manner where

$$(1) \quad Q = AL^\beta K^\gamma v$$

and K is capital, L is labor, Q is output, and v is a log normal random variable that captures the idiosyncratic random element in production. We assume that

$$(2) \quad L = N \times H \times S,$$

Where N is the number of workers, H is the number of hours, and S is the intensity or the effort of the workers. The industrial relations environment is assumed to influence N , H , and S so that production by substitution of equation two into one yield

$$(3) \quad Q = A(NHS)^\beta K^\gamma v$$

In this case the industrial relations environment will influence the level of output through L by reducing the number or production workers, setting hours of work and the allocation of workers among tasks, and the effort that workers are willing to put forth in production (Kleiner, Nickelsburg, and Pilarski, 1995). This specification explicitly takes into account the role of how labor and industrial relations influences the production function unlike some other studies of manufacturing production (Benkdard, 1999).

Matching Union and Management Pairs

Given this basic production relationship, we would also expect some effect of the management and union leaders who are primarily responsible for the organization of work within the plant to include the number of workers, effort, and hours of production workers. Although we do not present a formal theory but rather sketch out the basic idea that there are labor/management leadership pairs that are better suited to productivity gains than others. For the union leader the objective is to achieve wage gains and employment security for the membership that are largely derived from the benefits of productivity growth. For the management leader the objective is assumed to be profit maximization with productivity gains a key element in that objective. Bad matches form because of either imperfect information on both sides or the methods of achieving the objectives of both sides are not compatible (Devine and Kiefer, 1991). At any point in time a union leader is matched with a given manager, where each knows the characteristics of the other. Each residual claimant, shareholders or union members, respond by choosing someone who can best attain their goals over the contract period. For our purposes we define a labor/management leadership pair as

$$(4) P_i = f(U_L + M_L) \quad \text{where } 0 < U_L \leq 1 \text{ and } 0 < M_L \leq 1$$

where U is the union leadership and M is the management leadership that forms the characteristics of the matched pair P .¹

The time-invariant productivity of a particular match can be learned over time during negotiations. In addition, leadership can matter during the administration of a contract when the interpretation of provisions is settled, commonly known as fractional bargaining (Kuhn, 1961).

¹Union leadership would also include the union stewards, who in our case were elected by the employees in each section of the plant, but generally reflected the "political party" of the union president. Managers include first line supervisors and middle managers, who serve at the pleasure of upper level management executives in our case example.

Consistent with the economics literature matching of the pair is thus an “experience good.” The learning process is such that a noisy observation on true productivity arrives on each date t .

Furthermore, as t increases and more observations are accumulated the precision of productivity (prod) estimates of the pair will improve. The discontinuation, d , for each P_i , conditioned on the productivity level can be written as

$$(5) \quad d(\text{prod}, t) = \alpha F_t(\text{prod}^F(\text{prod}, t))$$

where $F_t(*)$ denotes the time t estimate for the productivity distribution for the current pair P_i and α denotes the receipt rate of productivity observations. Although productivity is a constant in (5), the learning process implies that the productivity of the match will change over time. A particular match will continue as long as productivity is sufficiently high from management’s perspective to satisfy shareholders, and from the union view, the wage rate and employment security is expected to grow from any productivity gain which then satisfies the membership. Generally the d from the union side would come at a regularly scheduled election, whereas managers can be replaced at any time. In our case example, the firm is a shareholder driven organization that had its headquarters in another city and agency issues may arise regarding the role of the plant relative to other corporate objectives. Furthermore, and the union leadership changed in response to the goals of its members which also varied over time (Freeman and Rogers, 1999). The union was also responsive to national union concerns and during one period operated under the supervision of the national union.

In addition to the duration of any union/management pair there are often questions about the type of managers and union leaders that may lead to optimal productivity. Edward Lazear provides some theoretical insights suggesting that tough managers or “hawks” dealing with one

another may provide the environment for greater productivity relative to putting a tough leader on one side with a weak one (dove) on the other (Lazear, 1995). For example, production employees may reduce their effort if they think that a tough manager will be able to reallocate more of their efforts toward profits and away from wages. The extent to which union and management negotiators are viewed as tough or conciliatory can provide some insights into the productivity effects of alternative matches of labor management negotiators and leaders within an organization. Although we cannot formally or rigorously test for the existence or optimal timing of a particular match of leaders relative to a random draw, we can provide some insights about how particular pairs of union and management leaders may enhance productivity that may be consistent with theoretical insights gained from the literature on matching.

Our Quantitative and Qualitative Data on Production

Estimates of the role of industrial relations on production come from internal company plant level data obtained from one of the largest manufacturers of large commercial aircraft. In Figure 1, panels A through C, we show the annual economic characteristics of the BP firm's commercial operations relative to the other U.S. firms in the industry beginning in 1974, the starting date of our other empirical analysis. The table shows that BP grew about as fast as the other major firms in the industry as measured by commercial revenue, overall employment, and planes delivered for most of the time periods of our study. Further, the Figure shows the cyclical nature of this industry which affected BP and its industrial relations practices. For most of the period of our study, BP accounted for between 25 and 30 percent of total industry output, employment, and revenues and the firm is representative of the changes that occurred in the industry.

BP gave us their monthly productivity data on the production and assembly of its main commercial aircrafts in its principal plant from January 1974 through November 1991 for a total of 215 monthly observations on production. Our key data is for same general model of plane as well as its companion aircraft, which was produced throughout the period in one plant. In 1980 there was a redesign and update of the basic model that caused major changes in productivity. As discussed the plant-level information over this 18-year period was gathered for use by analysts and business economists in the plant as their basis for developing business plans and for managerial accounting data in the organization. Beyond just data gathering, we engaged in several on site interviews with many of the top production related managers and union leaders in the plant who told us about current and past officers in the plant. A unique aspect of our study was our detailed discussion of production-related issues as well as labor-related politics with the leadership of the local union in the plant. We were able to obtain information on the leadership styles and objectives of the relevant union leaders and their attitudes about productivity enhancing policies during their tenure in office. These interviews also focused on their views about cooperation versus confrontation with management in the plant. For example, their positions ranged from adopting total quality management with high levels of employee involvement to seeking a confrontation and calls for crude class warfare with management on most issues in an effort to reallocate plant and company level "rents" toward labor. If cooperation enhances productivity and confrontation reduces it, having measures of union leadership policies and practices as a proxy for members preferences should allow us a measure of the attitudes of the employees toward management and the organization of work during varying periods of production.

Capital per production worker remained constant in the production of this plane and its larger companion version that was produced in the plant. Learning by employees was the only major innovation in the production process. Our measure of productivity is the actual standardized number of person hours per plane as allocated by firm records, and defined by the production quality control persons in the plant. We do, however, have information on what the production managers assumed would be the expected production level or planned production. These planned production values were estimated with known capital and labor available within the firm and projected demand for the planes well in advance of actual outcomes. Since the plant we examined had two major lines of aircraft being assembled, we used the anticipated numbers of hours of the other assembly process as a control for the demand for hours and material resources in the organization and as cross product demand in the production function. The other key variables we used to control for production related factors were span time, which is the average number of days it takes to assemble a plane during the month in question, the number of average weekly parts shortages for the month, and the projected standardized labor hours needed to produce the other major airplane that is produced in the same factory. This detailed data is similar to other firm level analysis obtained in the auto industry (Ruff, 1996). The span time variable measured by the average workdays from start to finish for the assembly of each plane is used to control for either fast or slack periods within the plant that may influence the pace of production. When production was sped up, it affected both learning in production and increased the number of parts shortages. When there are parts shortages, the assembly line was substantially reduced or stopped. As a consequence, learning in production was reduced, and there were obvious delays in the production process. This value was measured by the number of

parts, and we assumed that this variable would have a strong effect on labor productivity for airplane assembly. In order to maintain as long a time-series data series and capture as many labor relations events as possible, we estimated the mean value of the planned production and parts shortage variables, and controlled for any estimated values by including a dummy variable for any estimated results in our regressions (Little and Rubin, 1987).²

Labor and Management Relations in Production

In addition to the production data for BP, we also have monthly data on many of the labor relations aspects of the employment relationship. There were more than 22,000 members of the local union who worked in the plant complex in 1992, and the local had the largest membership of any plant local in the United Automobile Workers (UAW) in the U.S. and Canada. This Big Plane plant experienced a wide array of industrial relations events and conditions during the 1970s through the early 1990s. For example, there were three strikes, and a work to rule slowdown as a substitute for a strike during stalled negotiations. The labor relations events within the plant included a full range of industrial relations situations.

There were two competitive political parties vying for control of the local union. One was generally more cooperative in its stance toward management while the other took a more confrontational approach. Given the highly democratic and competitive nature of the local union there were four changes in union presidencies over the period we examine, which reflected the memberships varying attitudes toward labor's cooperation with managerial policies. For each of these variables, we know the beginning and ending month in which each of the events occurred

²We also estimated the basic models with and without missing values and found consistent results for all the independent variables in our models.

and the general policy directions of the union leader. This institutional knowledge allows us to design a before and after experimental research design as well as more structurally oriented simulations.

Although other studies have attempted to examine the relationship of union leaders to industry productivity, we were unable to find any analysis of this issue at the firm level (Navarro, 1983, and Freeman and Medoff, 1984). The elected union leaders in the plant in our study reflected a diverse set of goals regarding their relationship with management. As background, this union local is perceived to be among the most politically competitive of all UAW locals, with no union president holding office longer than seven years during the past thirty-five years. There are distinct viable political parties among the membership with varying levels of militancy toward management, and virtually all elections are hotly contested. During the early period of our analysis the union leadership reflected traditional adversarial labor management relations. Union leaders' one through three was relatively moderate in their bargaining styles and viewed strikes and other concerted activities as acceptable only as a last resort method in obtaining concessions from management on wages, hours, and other conditions of employment. Union leader four campaigned on a platform of confrontation with management and was the most militant leader out of the six during the period of the study. He led the union and its membership through the longest strike in company history in 1983. He also developed and implemented an in plant slowdown that many in the firm thought reduced the opportunity of the plant to expand employment at its current site, and build a new plant in a more management-friendly state. Relations with the national office of the UAW also were rocky during his term in office. Toward the end of union leader four's leadership the national UAW declared the union to be in

“receivership” because of poor management and loose financial controls and increased its monitoring of the local organization.

Another concern from the national union’s perspective was the tough and usually mean-spirited union campaigns that occurred within the local and their independence from national UAW’s policies and practices. For example, union leader five was supported by the national UAW and had tacit support from management. He was elected during 1987, and took over following highly acrimonious labor relations that included a three-month long strike, an in plant slowdown, and financial troubles with the national UAW and AFL-CIO. Leader five campaigned on a promise to work closely with management and to establish a total quality management (TQM) program that included high levels of employee involvement. Union president five attended several national training sessions on employee involvement, and was committed to having the local union participate in the process. A decline in orders, layoffs, internal union problems, and first-line supervisors opposition to TQM led union leader five to be displaced, although he later won reelection during the mid 1990s.

Union president six was a more militant union leader, who was elected following the “failure” of employee involvement within the plant. He campaigned using a pledge that he would pull union support out of any TQM program, and he followed through on that campaign promise following his election in 1990. He vowed to restore the traditional confrontational tone of negotiations with the company.

There were three strikes during the period of our study that lasted from one to three

months.³ The last one occurred in 1983, and it was the most bitter one. It included threats of the destruction of plant equipment as well as threats from management that the production workers would be replaced if a quick solution to the impasse was not reached. Prior to the last labor agreement in our sample, there was an in- plant slowdown that lasted almost 11 months. It included traditional work to rule procedures, where the production workers strictly followed the letter of the previous contract, and refused non mandated overtime work as well as other job assignments that were not explicitly stated in the labor contract. Given the costly effects of the previous strike at the plant to employees, the unionists thought that they could impose costs, through lower short term productivity, without losing a paycheck.

Managerial Policies' Impact on Plant Performance

The BP company is traded on the New York Stock Exchange and was not involved in any significant mergers or acquisitions during the 1970s through the early 1990s. The industry is highly volatile, cyclical and contains large elements of both civilian and military production. A military production facility operated by BP is located near the civilian aircraft factory. There were four plant managers who were primarily responsible for industrial relations. The major managerial innovation was the implementation of a total quality management program (TQM) within the plant, which was a top-down approach, in an effort to become a "high performance workplace" This policy was supposed to help the plant deal with the threat of new foreign competition (Ichniowski, Shaw, and Prennushi, 1997). As part of this program the company spent about \$53 million in direct training costs over a two-year period and the firm hired a new

³ Four new labor contracts were negotiated during the period of our study that reflected a general movement toward greater benefits as well as enhanced flexibility for management.

vice-president of industrial relations, with considerable experience in "Japanese style management" to implement the program. First line supervisors surmised that their jobs were in jeopardy if total quality management program with teams that had greater autonomy succeeded. As part of the TQM program a major objective of the firm was to drive grievances by employees to zero, with the vice-president receiving a substantial bonus if worker complaints were below a certain level. Further, we obtained the monthly beginning and ending dates of the President of the commercial aircraft manufacturing division, who was a vice president of the company and was directly in charge of industrial relations policy. Division presidents were chosen or remained on the job in large part based on their view of the way work ought to be organized in the plant.

The first production manager's industrial relations policies tended to contribute to the traditional adversarial behavior for this plant. More specially, his policies included tough top down management, and distributive bargaining with the UAW local that was, in part, responsible for the strikes and work slow downs that characterized labor relations in the plant during the post World War II period (Walton and McKersie, 1965). Monitoring of the workforce was relatively rigid with sometimes abusive language and reprimands of the employees in front of other workers. The second manager oversaw a gradual movement to quality circles, the forerunner of employee involvement in the plant, following a long and bitter strike in which management threatened to hire replacement workers. The third manager implemented the Total Quality Management program in large part as a directive from the chief executive officer of the company. A new Vice President of Quality was recruited to come to BP, because of his managerial background at an auto manufacturer with high involvement work teams. Company rules and

regulations were relaxed and negotiations with the union took on a more cooperative tone. The final manager over the time frame we examine was the toughest disciplinarian, and he used policies and practices that were in direct opposition to manager three. He thought that the TQM approach had resulted in a decrease in productivity and an increase in labor costs in the production process. Consequently, manager four engaged in strict monitoring which some in the plant referred to as a "boot camp" type of management. Monitoring was tight and discipline and grievances within the plant increased dramatically. This last manager is the base group for our statistical analysis and he will be used as the comparison grouping.

Estimating the Effect of Industrial Relations on Productivity

Industrial relations in the BP plant have undergone a number of major changes. In Figure 2 we show the timing of the major events during our period of analysis to include major union and management leaders, strikes, slowdowns, contracts, model changes, and the implementation of total quality management that included elements of employee involvement superimposed on production levels measure by standardized hours per plane per month. To assess these changes, we use two different strategies. First, where possible, we use time-series regressions to estimate the effect of the principal changes in labor leaders, managerial leaders, and industrial relations events on the key measure of productivity, the standard number of hours to assemble the large commercial aircraft.⁴ In these OLS regressions, we include a monthly time trend, the lagged log

⁴In addition to the estimates presented in the tables, we also estimated the production function as actual production as a function of planned, and then used the residual of this equation as the dependent variable. Although the signs of our estimates were similar the level of the significance of many of the variables were reduced. Since we do not know what factors are contained in the residual, even including organizational learning and monitoring by management. Therefore, we thought that actual output would be a better measure of productivity for our analysis.

of the dependent variable, and dummy variables for the labor, management, and industrial relations variables in our model. The coefficients and standard errors on these dummy variables provide us with estimates of the effect of each industrial relations factor for the period it was in operation. Because the plant changed many aspects of its operation during the period, lost experienced managers and workers, the analysis cannot isolate *ceteris paribus* the effect of each industrial relations variable on labor productivity.

Our second method of analysis of labor and management practices is more structurally-oriented: we specify a particular counterfactual situation in the plant showing how productivity might have been in 1989 and 1990 had it not had the major managerial innovations of the total quality management program. Here, we use some evidence from the plant that is not readily compatible with a regression framework. We examine what would have occurred had a change not been implemented, but use some of the estimated regression parameters to contrast estimated productivity with actual outputs. In this case we use the estimated outputs from the company's basic forecast, and contrast it with what actually occurred as the organization switched to a TQM program with an employee involvement policy using teams. We then follow the firm to its next industrial relations policy, which was the implementation of a rigid monitoring scheme with lots of discipline and little voice by employees. In addition to these simulations, we also estimate the potential costs of work to rule, and the impact of various labor management pairs.

In the context of our regression format, we use O.L.S. regressions correcting for first order autocorrelation. In Table 1 we show the means and standard deviations of the production-

related factors and industrial relations variables used in our multi-variate models of productivity⁵. Our data is monthly and reflects the average number of hours to assemble the standard commercial plane in the main production line in the plant. As part of the data given to us by BP, we have information that the production economists in the plant say are key factors in the organization's production function. These variables include the estimated number of hours to assemble the plane, and the estimated number of hours to build the other larger plane produced in the plant complex. The production of the complementary plane, which was substantially larger and took about 80 percent more standardized hours to assemble than the plane we employ as the dependent variable in our analysis. We also include the time to build the plane or span time in our examination of this issue. Since parts shortages, measured by the number of units per month, generally result in delays and increases in hours per plane it is included in our analysis. All other variables are dummies reflecting the time period that each factor was in effect during the period of our before and after design.

In Table 2 we present our regression estimates examining the impact of industrial relations factors on productivity. In column one we use only union-focused factors and production-related variables along with a time counter variable. We present results with planned production factors, as developed by the production economists in the firm. We also show the learning curve in production as the cumulative output in the plant from the beginning of the period 1974 to the end 1991 as measured by the logarithm of the summation of the cumulative hours per plane and that value squared. Our results in column two show that at approximately 80

⁵We also estimated models by using moving average smoothing techniques for monthly labor costs and found no qualitative differences in our results. Additional controls for the duration of the labor contract also showed the same qualitative results.

planes learning in production begins to reduce the number of hours per plane, and that there appears to be significant productivity gain over the production cycle as the number of planes assembled grows. This result is in contrast to the study of the Lockheed L-1011 aircraft by Benhard (1999). These contrasting results could be due to the fact that the production numbers for the plane we examined was approximately 1,100 which is more than five times as large as the L-1011 production run, as well as our ability to better account for the factors that influenced labor role in the production of planes.

The results in Table 2 are generally consistent with accepted hypotheses about the role of strikes and work stoppages reducing productivity and firm performance (Becker and Olson, 1987). The third strike was the longest and bitterest one and it had the greatest effect on reducing output and productivity. Although the effect of work to rule was smaller, it lasted more than 10 months, and had a large economic effect on productivity costing the firm almost 5.9 million dollars in lost productivity during the period based on the estimates presented in the table. The early union leaders, one through three, were negatively related to productivity but five and six were more successful at reducing labor costs than union leader four, who was the most militant and longest serving of the union leaders during the period of our study. Union leader six, who also was strident in his approach to management, had the largest effect on increasing productivity, and the coefficient is statistically significant. His leadership followed the TQM movement and he followed a militant tone in negotiations with management. Unlike previous studies that have focused mainly on managerial effects on performance, our results suggest that union leadership also matters, and that not including the changing attitudes of the union membership as largely reflected in their choice of a president may bias upward the role of

executives on firm performance (Leonard, 1990; Murphy, forthcoming).

Column two in Table 2 shows the impact of managerial leaders and their policies on productivity with controls for production-related variables and the time counter. The major industrial relations innovation during the period of our study was the TQM program with teams and efforts at high levels of employee involvement. Our estimates of the effectiveness of the TQM program as implemented by BP, suggest that it did not significantly influence productivity. In contrast, managerial policies that were lax on employee discipline, namely managers two and three, reduced labor productivity. The reference group manager, number four, used the toughest discipline within the firm. He virtually stopped the use and practice of the employee involvement program because he saw no significant initial productivity gains and thought production speed was lacking in filling orders from their customers under these policies for their major U.S. and foreign commercial airlines.

Since both management and labor related factors may influence the efficiency of productivity within an enterprise, we next develop an additional reduced form model that includes both sets of variables. In column three we present a more fully specified model that includes both union-related and managerial leadership on labor productivity⁶. Our results for the major labor events, strikes and slowdowns, are consistent with the results in columns one and two. Labor relations factors such as strikes and slowdowns are significant and of relatively large magnitude. For example, the work to rule slowdown reduced productivity by more than 8 percent for almost an eleven-month period.

⁶In estimating our time series models we varied the timing of the events by one and two months to test for any potential leads or anticipated adjustments as well as lags by the firm to either new managers, union leaders, strikes or slowdowns and found that our basic results were robust in spite of these changes in timing. These results are available from the authors.

The estimates show the diminished significance of union and managerial leadership, when controlling for industrial relations events in the production function. Although this result may be the consequence of overlaps in timing between the labor and management leaders, our estimates for management regimes are not robust in this specification. However, the timing of several of the labor leaders remains statistically significant and large. Consistent with our other results, the major managerial initiative during the period was the introduction of a TQM program, but this variable was imprecisely estimated in our model. The production-related controls are generally consistent and statistically significant across all specifications.

Since there is overlap between the managers and labor leaders, we next examine the joint effects of union/management leaders and their impact on labor productivity consistent with equations four and five in Table 3. Just as some labor management interpersonal relationships may sour attitudes of employees that later are transformed into poor performance, we anticipated that this may be an important factor within our case example. As the search theory suggests, optimal matches would result in higher performance and that poor matches would result in a “demoralized” labor or management group resulting in one of the leaders losing their position at the bargaining table and in the plant (Devine and Kiefer, 1991). Therefore, we implement our model by developing mutually exclusive union/management pairs over time with the controls used in our previous estimates in Table 3. The omitted group in our analysis is the toughest managerial leader (leader four) with the second toughest labor leader (president 6). We find that the later pairs (manager two and union leader four, manager three and union leader four) were more likely to lower labor productivity than were the union-management pairs who were the toughest. These results are consistent with higher productivity where “hawks” negotiate among

themselves, and is consistent with one of the predictions in the theory section (Lazear, 1995). At any rate, the interaction of labor and management pairs as shown in these results is an important factor consistent with the opening statement in our paper by Freeman and Medoff.

From Traditional Labor-Management Practices to EI and Back Again

Since issues of TQM and employee involvement are such important factors in the managerial literature and have taken on an important role in the policy debate within the Dunlop Commission as a way of enhancing American competitiveness, we develop a more structurally-focused model to examine its impact (Commission on Labor Management Relations, 1995). In our model we use an ARIMA time-series model of production with all planned production in the plant as the independent variables. We use this model to predict what productivity would have been in the absence of the introduction of a TQM program for the 1989 and 1990-period (the time when the firm introduced these policies) relative to what actually happened in the organization. We next simulate the effect of the plant moving from a TQM program in December 1990 to a rigid form of management with strict monitoring of the workforce and little to no employee involvement in plant level labor relations. Figure 3 gives our results for our counterfactual simulation. For the move to employee involvement from traditional labor management relations, our results show that the firm lost money by implementing the TQM program in 1989, but productivity increased during the second year the program was in effect. However, the overall impact was a slight reduction in labor productivity and an increase in production costs to the company for the total time period the policy was in place. This may reflect the way the company implemented the program, but given the large amounts of money and time spent on implementation, it likely was not due to lack of effort or emphasis placed on

the TQM policies. Our discussions with management and labor leaders found that much of the failure of E.I. was a result of top-down management as well as the attempts by first line supervisors to sabotage the TQM program for fear of losing control of production and perhaps losing their jobs under this new program as production employees made more decisions about production and discipline.

Another unique feature of the plant we studied was that the organization switched from strong employee involvement practices to an authoritarian policy. The results in Figure 2 show that productivity increased and labor costs were reduced as a result of this more rigid form of management for a year period. Unfortunately, we do not have estimates of the effects of what might have happened to productivity had the plant managers established a more moderate form, i.e., keeping some elements of employee involvement but increasing the level of direct monitoring and discipline. We are able to establish some symmetry of the impact of moving to "high performance workplaces practices" and returning to more adversarial labor management relationships. Given the labor relations culture in the plant that fostered more traditional adversarial relationships, the move to EI was difficult. Perhaps the plant should have maintained the program, since it was showing results in the second year of the program. Nevertheless, our results provide some evidence for why firms may choose not to adopt "high performance workplaces" in large older establishments when it does not show immediate positive effects on labor productivity.

Further Simulations: Are there long-term impacts of industrial relations events?

In Table 4 we show how long following strikes, slowdowns, and employee involvement programs it took to return to the pre event standardized hours per plane per month. To assess

these changes, we use two different measures of the return to pre event standardized person hours per plane. In columns one and two we estimate how long it took for plant level productivity to return to the average of the three month periods' output ending two months prior to the event. In this way we attempt to control for any anticipated build up or reductions that may have taken place directly before the event. This table shows how many months it took for the plant to return to within one and 5 percent of its pre event productivity levels. For example, in the first row the table shows that for the first strike in our data sample, it took four months for the plant to return to within one percent of its pre-strike productivity, and only two months for the plant to return to within 5 percent of its pre-strike level of output. For the other events that took place at the plant it took about the same time for organizational labor productivity to return to within one and five percent of their pre-event levels of average output. This value ranged from two to four months not considered long by any standard metric.

The most divisive strike, number three, were the longest and most bitter, and it was not surprising to find that it took four months for the plant to return to pre-strike levels of productivity. The work-to rule event lasted almost 11 months and served as a substitute for a strike. However, even with this relatively long process of intentional reductions in productivity, it only took the employees a month to reach about the average of the pre slowdown levels of output. Finally, the TQM approach, with attempts at heavy levels of employee involvement, resulted in reduced productivity in the short run. However, after the two-year long program ended, the plant was able to achieve pre-TQM levels of output within one month after the program ended. Overall, it appears that for this plant the impacts of strikes, work to rule slowdowns, and employee involvement programs have short-lived effects. Although industrial

relations events are dramatic and inspire lots of emotional outpourings from both labor and management during and shortly after the event, the long-run effects are fairly minor as measured by labor hours per plane.

Although we show that concerted activities, like strikes and slowdowns, have no long term impact on productivity, they are certain to have strong effects on short term profits. The union in this case did impose significant costs on the plant managers and shareholders in the short run. However, after the strike or slowdown the production employees did not "forget" what they knew about manufacturing, and were able to return to previous levels of production after a relatively short period.

Conclusions

The purpose of our analysis has been to examine the impact of major industrial relations factors on productivity for a major firm that is an oligopolistic industry which is the largest manufacturing exporter, and second largest manufacturing employer in the U.S. We use a before and after research design, over a 18-year period with monthly data, as well as information from the participants in industrial relations. This analysis provides a unique opportunity to examine the impact of industrial relations by minimizing unobserved heterogeneity in production through examining one plant that produces a standardized product. Our results show that labor and industrial relations factors do matter a great deal on labor productivity both in terms of statistical significance, relative magnitude, and costs. Strikes, slowdowns, and union leaders influenced the productivity of this plant by large percentages and absolute dollar amounts. Our findings are unique in showing that omitting factors such as union leadership and related labor relations events may result in a misspecified equation when analyzing firm performance. The major managerial innovation, TQM, did little to increase productivity over the short time that it was in

place, and it resulted in a slight reduction in labor productivity and increased labor costs. However, the practice was showing a positive effect when it was abandoned in the second year it was in effect. Another unique part of our study was the ability to show the movement from traditional management to employee involvement and back again. The movement to an authoritarian mode of management from TQM showed positive productivity effects in the short run. We hope to gather more data for this plant to examine the longer run effects of greater discipline and closer monitoring of the production workforce as the organization moved further away from TQM practices. Finally, our results show that major industrial relations events like strikes, slowdowns and the TQM program did not have long term productivity effects, and that the firm we studied was able to return to pre-event levels of production within one to three months.

An implication of our analysis for the firm performance literature is that studies which omit the role of union leadership, when labor organizations are present, may overstate the role of executives. Furthermore, our results show the positive effects of movement to higher involvement human resource policies may also be upwardly biased because they fail to account for the impact of firms who try, but do not succeed, in implementing "high performance" workplace practices. Our example of one plant does not fully address all the issues of the role of union and management policies and practices, and may in part reflect the unique characteristics and corporate culture of this establishment. We nevertheless encourage this type of detailed examination of plants in sufficient depth so that the role of industrial relations policies and practices on organizational efficiency can be rigorously examined in a more thorough fashion.

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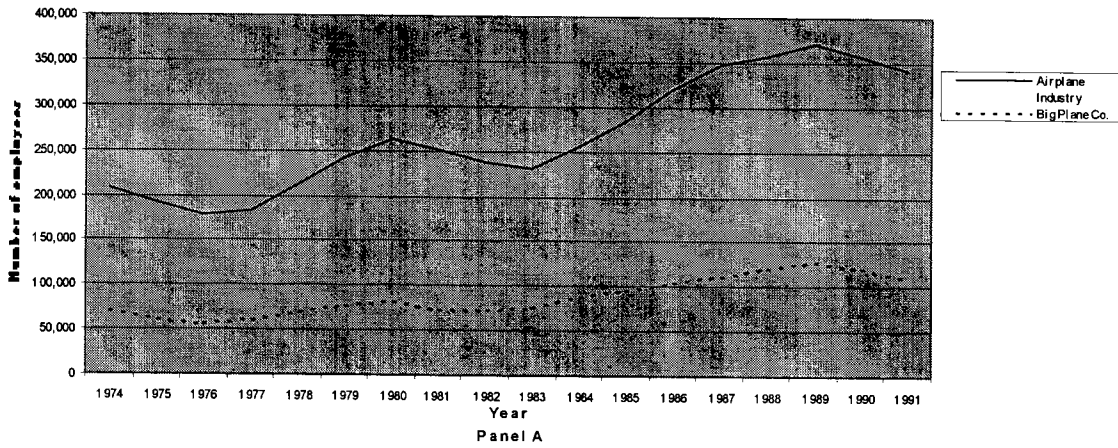
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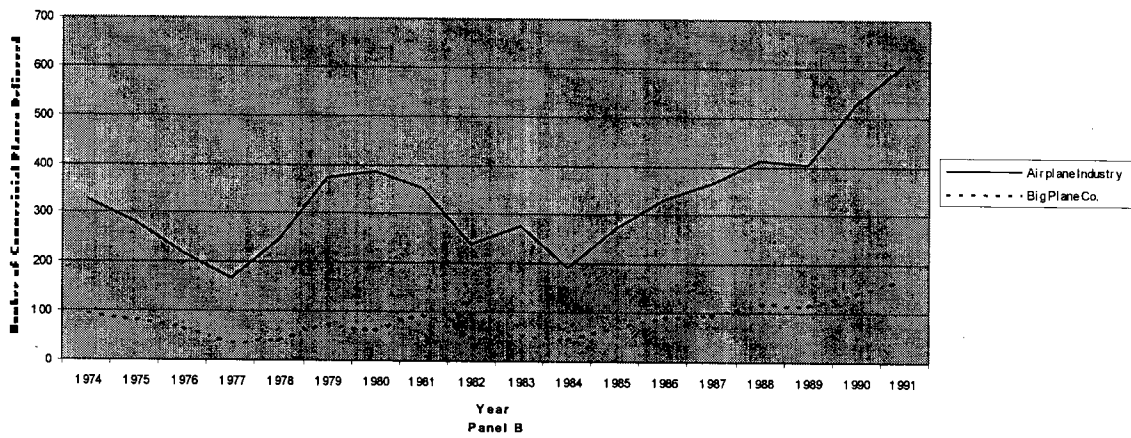
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Figure 1

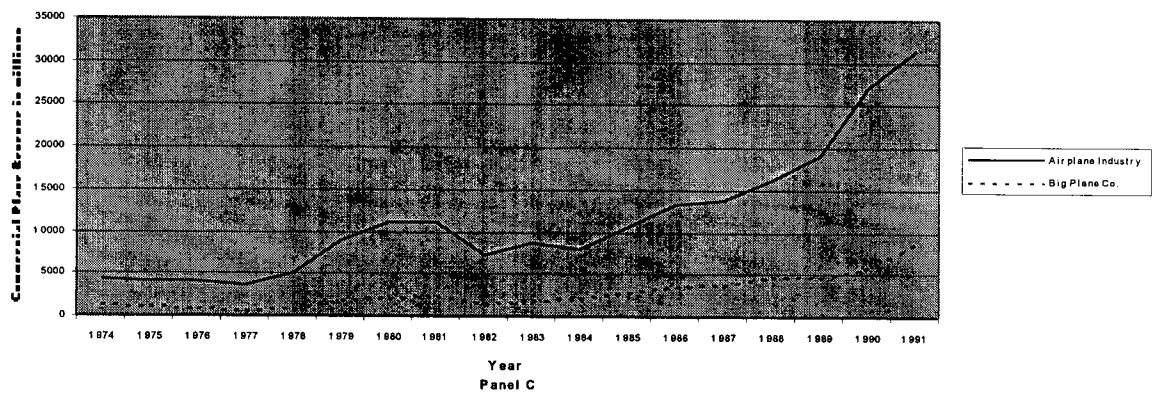
Comparison of Employment in Big Plane Co. and the Commercial Airplane Industry



Comparison of Commercial Planes Delivered by Big Plane Co. and Commercial Airplane Industry

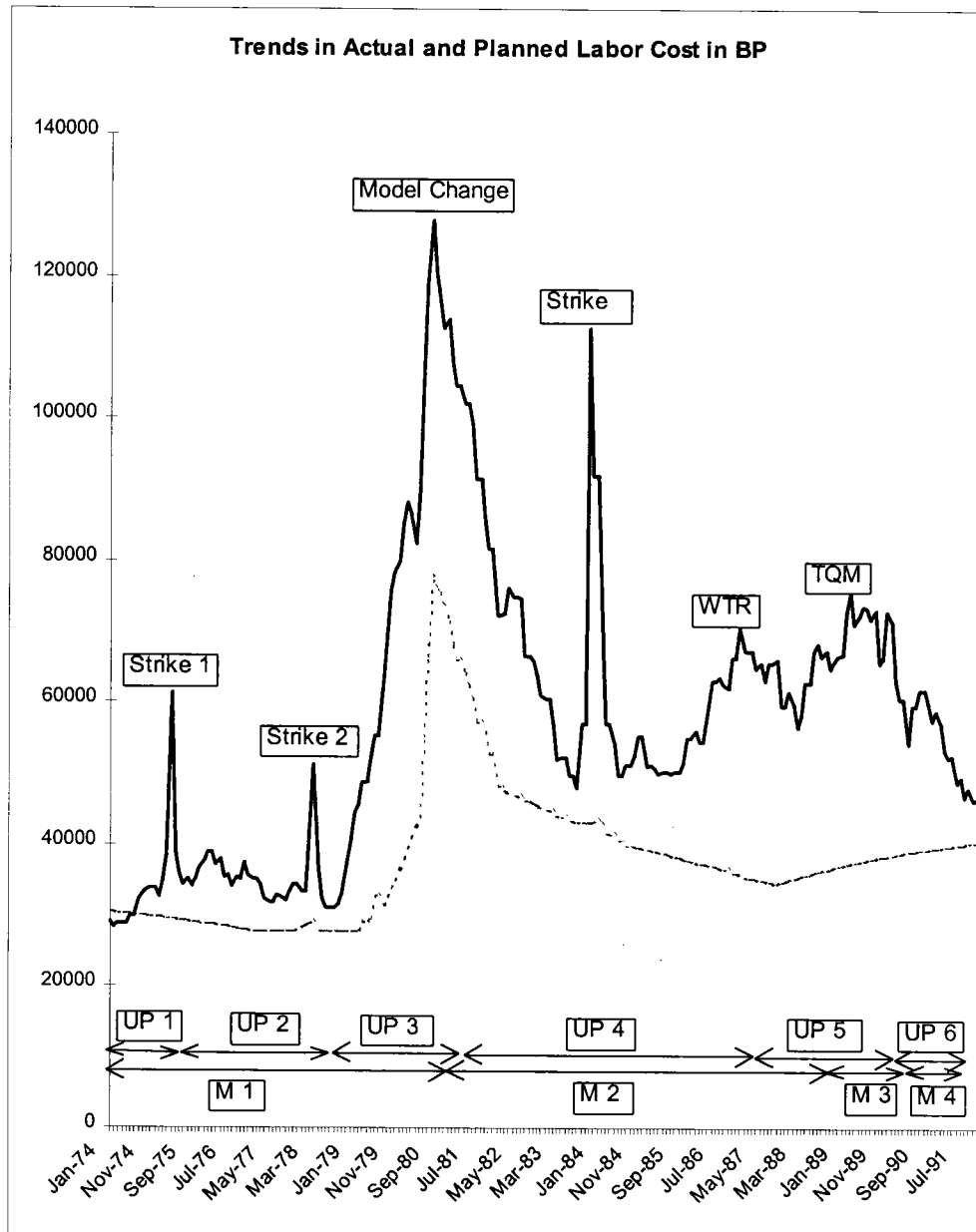


Comparison of Commercial Plane Revenue in Big Plane Co. and the Commercial Airplane Industry



Source: Annual Reports

Figure 2



Note:

1. Dotted line is planned labor cost. Solid line is actual labor cost.
2. Strike 1: Feb-May, 1975. Strike 2: Dec. 1977-Mar. 1978. Strike 3: Sept. 83-Feb. 1984.
3. Model Change: Jan. 1980-Dec. 1982.
4. Union President 1: Jan. 1974-April. 75. Union President 2: May, 1975-April. 1978.
Union President 3: May, 1978-April, 1981. Union President 4: May, 1981-April, 1987.
Union President 5: May, 1987-April, 1990. Union President 6: May, 1990-Nov. 1991.
5. Manager 1: Jan. 1974-Feb. 1981. Manager 2: Mar. 1981-Dec. 1988.
Manager 3: Jan. 1989-Aug. 1990. Manager 4: Sept. 1990-Nov. 1991.
6. TQM: Feb. 1989-Nov. 1990. Work to rule: Dec. 1986-Sept, 1987.

Figure 3. Estimated Counterfactual of the Impact of the movement to and from Total Quality Management (TQM) on Hours and Dollars per Plane in BP Relative to No TQM.

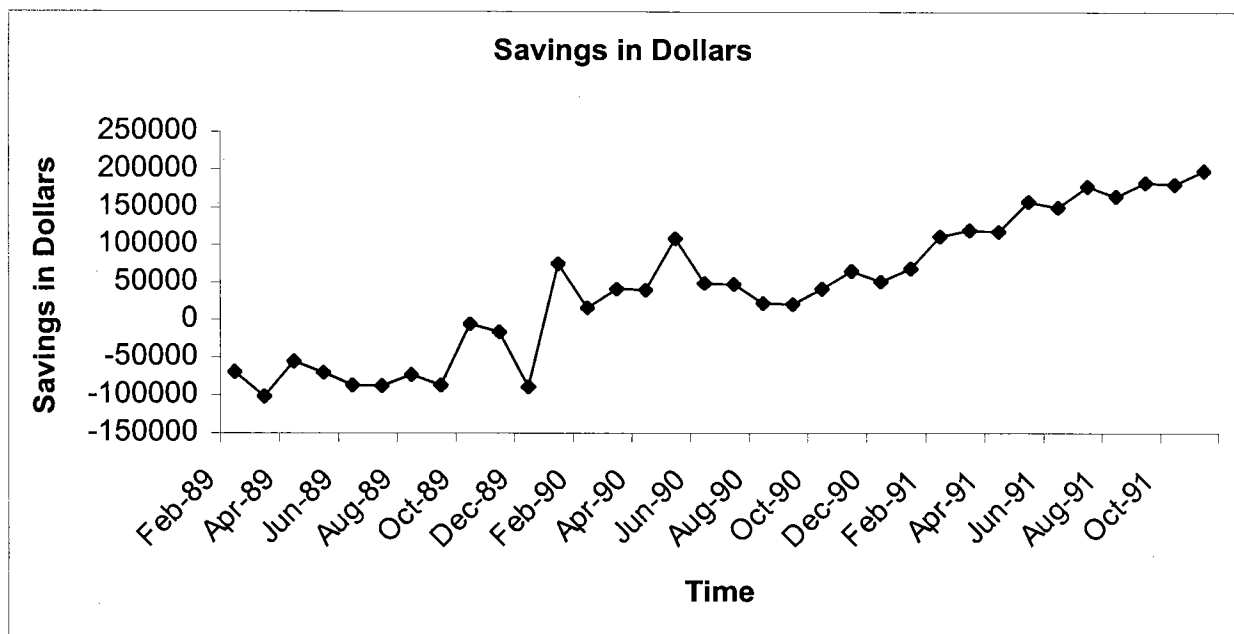
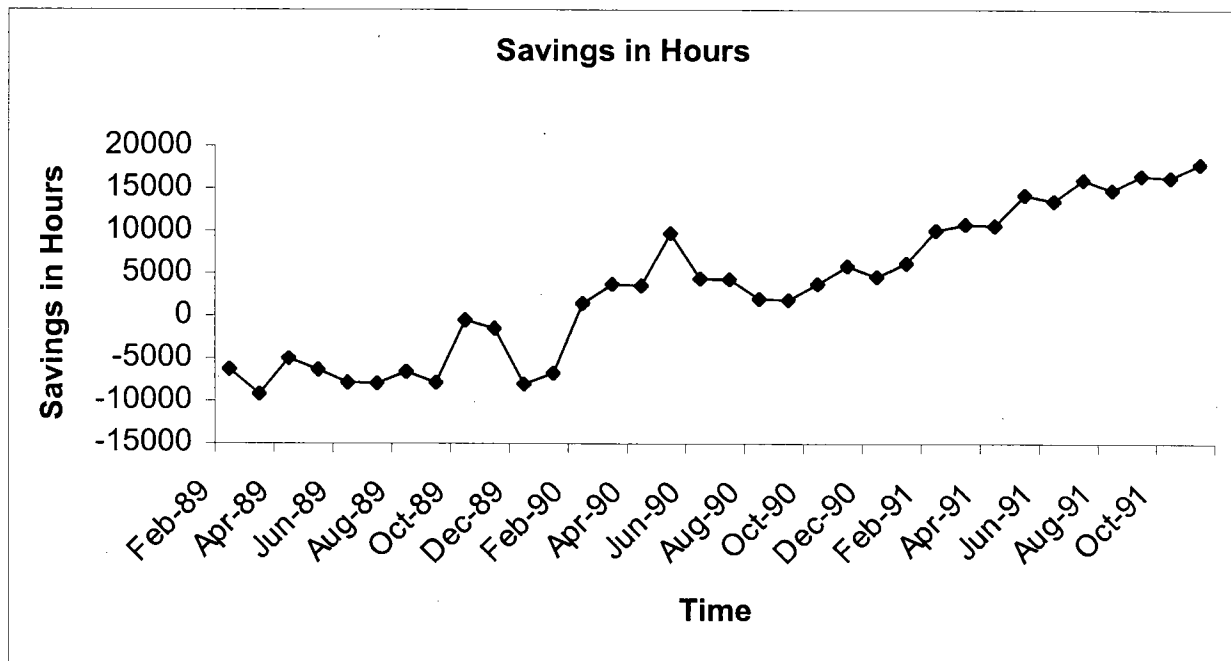


Table 1

Means and Standard Deviations of Key Variables for the Big Plane (BP) Company

	Mean	Standard Deviation
Average Standardized Hours Per Plane	58,051.97	20,964.08
Company's Estimated Hours Per Plane	38,308.35	9,934.98
Company's Estimated Hours Per Second Plane Assembled in the Plant	106,811.56	10,855.00
Spantime-Days per Plane	133.43	48.77
Parts Shortage (number of plane parts per month)	1,360.20	2,487.69
Manager 1 (Dummy)	0.40	0.49
Manager 2 (Dummy)	0.44	0.50
Manager 3 (Dummy)	0.09	0.29
Manager 4 (Dummy)	0.07	0.26
Union President 1 (Dummy)	0.07	0.26
Union President 2 (Dummy)	0.17	0.37
Union President 3 (Dummy)	0.17	0.37
Union President 4 (Dummy)	0.33	0.47
Union President 5 (Dummy)	0.17	0.37
Union President 6 (Dummy)	0.09	0.28
Strike 1 (Dummy)	0.02	0.14
Strike 2 (Dummy)	0.01	0.12
Strike 3 (Dummy)	0.02	0.15
Work to Rule (Dummy)	0.05	0.21
Total Quality Management Program (Dummy)	0.10	0.30

Table 2

Impact of the Overall Industrial Relations(IR) Environment on Log of Hours per Plane in BP*

	Union-related factors (1)	Managerial factors (2)	Overall IR factors (3)
Constant	57.84*(15.82)	65.35*(13.16)	65.93*(16.79)
Strike 1	.11*(.05)		.11*(.05)
Strike 2	.14*(.06)		.14*(.06)
Strike3	.17*(.06)		.17*(.06)
Work to Rule	.07*(.03)		.08*(.04)
Union President 1	.30*(.10)		.26*(.10)
Union President 2	.18*(.07)		.14*(.08)
Union President 3	.18*(.05)		.13*(.07)
Union President 5	-.01(.04)		-.00(.04)
Union President 6	-.12*(.06)		-.10(.06)
Total Quality Management Program		.02 (.05)	-.01(.04)
Manager 1		.32*(.07)	.10(.08)
Manager 2		.15*(.05)	.00(.06)
Manager 3		.11*(.05)	.02(.05)
Spantime	-.00(.00)	-.00(.00)	-.00(.00)
Log(Parts Shortage)	.02*(.01)	.00(.01)	.02*(.01)
Time Trend	-.01*(.00)	-.00(.00)	-.01*(.00)
Log Learning Curve	.65(.67)	1.40*(.71)	.41(.76)
Log Learning Curve Squared	-.02(.03)	-.06*(.03)	-.01(.03)
Lag of the Dependent Variable	.58*(.07)	.68*(.06)	.56*(.08)
Log(Planned Hours Per Plane)	.02(.08)	.01(.08)	.00(.08)
Log(Planned Hours Per Second Plane)	-4.98*(1.38)	-6.03*(1.18)	-5.52*(1.44)
Model Change	.07*(.03)	.03(.03)	.07*(.03)
R ²	.96	.95	.96

* Standard errors are in parenthesis with corrections for first order autocorrelation, and an asterisk indicates significance at the 95% confidence level

Table 3

Impact of the Union/Management Leadership Pairs on Log of Hours per Plane in the BP Plant*

	Log Hours Per Plane
Constant	65.84*(16.80)
Strike 1	.11*(.05)
Strike 2	.14*(.06)
Strike 3	.17*(.06)
Work to Rule	.08*(.04)
Manager 1- Union President 1	.46*(.11)
Manager 1- Union President 2	.34*(.09)
Manager 1- Union President 3	.33*(.08)
Manager 2- Union President 3	.23*(.09)
Manager 2- Union President 4	.10(.07)
Manager 2- Union President 5	.09*(.06)
Manager 3- Union President 5	.11*(.06)
Manager 3- Union President 6	.02(.05)
Total Quality Management Program	.01(.04)
Spantime	-.00(.00)
Log(Parts Shortage)	.02*(.01)
Time Trend	-.01*(.00)
Log Learning Curve	.41(.76)
Log Learning Curve Squared	-.01(.03)
Lag of the Dependent Variable	.56*(.07)
Log(Planned Hours Per Plane)	.00(.08)
Log(Planned Hours Per Second Plane)	-5.52*(1.44)
Model Change	.07*(.03)
R ²	.96

* Standard errors are in parenthesis with corrections for first order autocorrelation, and an asterisk indicates significance at the 95% confidence level

Table 4

Number of Months for Productivity Levels to Return to Pre- Industrial Relations Event Values.

Industrial Relation Events	Months to Return to within	Months to Return to within
	1% of pre-event productivity	5% of pre-event productivity
Strike 1	4	2
Strike 2	2	2
Strike 3	4	4
Work to Rule	1	1
TQM	1	1

Note: a. The productivity level prior to the industrial relations events is the average productivity of the three month productivity levels two months before the event.

b. 1% and 5% refer to within 1% and 5% of the prior productivity levels.