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**Abstract**

The author analyzes the strengths and weaknesses of Total Quality Management and Self-Managed Teams, as compared to mass production approaches to service delivery, among customer service and sales workers in a large unionized regional Bell operating company. Participation in self-managed teams was associated with a statistically significant improvement in self-reported service quality and a 9.3% increase in sales per employee. When combined with new technology, teams boosted sales an additional 17.4%. These effects persisted over time. Total Quality Management, by contrast, did not affect performance. This study represents a "strong test" of the efficacy of teams because theory predicts weak outcomes for self-managed teams among service and sales employees in establishments where technology and organizational structure limit opportunities for self-regulation, the nature of work and technology do not require interdependence, and downsizing creates pervasive job insecurity – conditions found at the company studied here.

not a strict focus on unions & productivity

**Keywords**

Total Quality Management, TQM, self-managed teams, teams, production, service delivery, customer service, sales workers, Bell, unionized, quality, sales, technology, downsizing, job security

**Disciplines**

Organizational Behavior and Theory

**Comments**

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# WORK ORGANIZATION, TECHNOLOGY, AND PERFORMANCE IN CUSTOMER SERVICE AND SALES

ROSEMARY BATT*

The author analyzes the strengths and weaknesses of Total Quality Management and Self-Managed Teams, as compared to mass production approaches to service delivery, among customer service and sales workers in a large unionized regional Bell operating company. Participation in self-managed teams was associated with a statistically significant improvement in self-reported service quality and a 9.3% increase in sales per employee. When combined with new technology, teams boosted sales an additional 17.4%. These effects persisted over time. Total Quality Management, by contrast, did not affect performance. This study represents a "strong test" of the efficacy of teams because theory predicts weak outcomes for self-managed teams among service and sales employees in establishments where technology and organizational structure limit opportunities for self-regulation, the nature of work and technology do not require interdependence, and downsizing creates pervasive job insecurity—conditions found at the company studied here.

There is considerable support for the idea that "high involvement" or "high performance" work systems lead to better organizational performance in manufacturing.[1] The argument is that work organized under the logic of mass production to minimize costs alone is no longer compatible with current markets, which demand competitiveness on the basis of quality, cost, innovation, and customization (Piore and Sabel 1984; Appelbaum and Batt 1994). High involvement systems, by contrast, produce better quality and efficiency because work is designed to use a higher-skilled work force with broader dis-

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Copies of data analyses and computer programs used to generate the results presented in this paper are available from the author at the above address.

[1]See, for example, Levine and Tyson (1990); Cutcher-Gershenfeld (1991); Arthur (1992); Snell and Dean (1992); Adler (1993); MacDuffie (1995); Becker and Gerhart (1996); Berg et al. (1996); Kelley (1996); Ichniowski et al. (1995, 1996); Rubenstein (1998); Appelbaum et al. (2000); Pfeffer (1998).

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cretion in operational decision-making; human resource (HR) practices such as training, performance-based pay, and employment security provide complementary incentives for workers to continuously learn and innovate (Lawler 1986; Bailey 1992; Kochan and Osterman 1994; Pfeffer 1998).

At a time when high involvement work systems have gained considerable acceptance in manufacturing, however (for example, Lawler et al. 1995), many service operations are embracing mass production. For example, telemarketers, operators, and customer service and sales representatives in banking, insurance, airlines, telecommunications, and the service centers of manufacturing operations typically work in large call centers. Their work is individualized, repetitive, scripted, and machine-paced by expert systems rather than assembly lines.

In this paper I consider whether the concepts of participation and team work found in high involvement manufacturing systems also produce better performance among production-level workers in call centers—increasingly viewed as the factories of the information economy. Call center work is best conceptualized as "interactive service work" (Leidner 1993). The defining feature is the interaction of a worker with a customer to deliver a service or sell a product. In call centers, however, the interaction is mediated by telephones and computers. In this study, the subjects answer incoming calls for service inquiries (for example, billing, collections) and sales (for example, new orders, transfers, and enhanced features). As in most interactive service work, a tension exists between serving and selling: employees must take enough time with customers to answer their questions fully while simultaneously selling as much as possible and minimizing "call-handling" time. Service and sales appear to involve contradictory demands, and whether they can be "jointly optimized" is a central question in this paper.

Research on interactive service work is important because roughly 42% of the work force is employed in low-productivity service, sales, and clerical occupations (CPS 1996). Call centers have grown dramatically as a result of process reengineering. Heightened global competition in services (McKinsey 1992) and deregulation of national industries (for example, telecommunications, finance, airlines, trucking, and utilities) have led firms to search for higher productivity and quality strategies; and customer service and sales workers increasingly are viewed as critical to competitiveness because they are the face of the company to the customer.

This paper focuses on two questions. First, what is the most effective way to organize work in service and sales operations? Can work be organized to maximize both service quality and sales, or is there an inevitable trade-off? Second, where better performance occurs, what explains it? In addition, I explore what other human resource and industrial relations practices influence individual service and sales performance.

The paper answers these questions through a study of 223 unionized employees in 68 work groups in customer service centers in a large regional Bell operating company organized by the Communications Workers of America (CWA). The telecommunications services industry is an appropriate context for this research because this historically high-skill, high-wage industry achieved annual productivity growth of 6.9% in the three decades prior to 1980, but only 3.4% in the 1980s (Keefe and Boroff 1994). Since 1984, deregulation has led companies to pursue new strategies to cut costs and improve service delivery, and call centers are central to those strategies.

## Previous Research

Management theorists have identified two basic strategies for competing in sales and service delivery. The first focuses on maximizing sales and minimizing costs, and adopts a mass production approach as inspired by Scientific Taylorism (Levitt 1972, 1976). The second seeks to maximize sales by providing good service, and is often referred to as "relationship management" managed teams. I found that compared to mass production, TQM had no statistically significant positive effects on performance; and there were no interactive effects associated with TQM and technology. By contrast, participation in self-managed teams raised objective sales by 9.3%. Time spent in SMT meetings, often a concern of management, had a statistically significant negative effect on sales of .1%, so that the net effect of teams was 9.2%. The interactive effect of team participation and use of new technology raised sales by an additional 17.4%. Participation in teams also significantly raised self-reported service quality. In addition, the effects associated with teams did not erode over time.

Perceptions of job insecurity were associated with decreased service quality and higher sales. A reasonable interpretation is that job insecurity led workers to reduce the time and attention (quality of interactions) they gave to each customer in order to increase the number of calls they handled and, hence, sales volume. They probably did this because their performance evaluations were weighted more heavily toward maximizing sales and minimizing call handling time than toward providing high-quality service.

It is important to interpret these findings in context. The level of decentralized decision-making was minimal compared to the classic model of self-managed teams in the literature. The team model, for example, did not challenge the extensive process standardization in the call centers. The large and statistically significant performance advantages of teams are surprising given the context of this study. Four organizational factors would argue against the successful implementation of teams in this context: the nature of work and technology did not require interdependence; process standardization and organizational structure limited opportunities for self-regulation; setting boundaries around a small team's work in the context of a large office setting (considered critical for group effectiveness) (for example, Cummings and Huse 1989) was not possible; and human resource practices such as group-based pay and job security were not in place.

This raises the question of what dimensions of teams are really important as drivers of better service and sales, and the structural equation analysis points to the importance of group self-regulation, rather than individual discretion or external coordination. What does group "self-regulation" mean, however, in this highly routinized environment?

The results from qualitative field research suggest that the real value of teams centered around group goal-setting, problem-solving, and learning. Workers in teams emphasized that the program "got the supervisor off our backs and allowed us to work together." They said that they established group sales goals, rather than individual ones, and then helped each other with developing sales strategies, handling problem customers, and keeping up with rapid changes in product information, work procedures, and legal regulations. They explicitly noted the contradiction of "going self-managed" in the context of increasingly automated technology, but said that the benefits of teams were even more important in that context. Both the automated technology and management efforts to maximize call volume created a work environment in which social interactions in traditionally supervised groups were minimized. Employees were not supposed to talk to one another because that meant time away from call-handling and sales opportunities. The rapidity of change in both product and legal information and software technology, however, meant that both selling and good service required on-going learning and problem-solving that was more effectively accomplished in groups.

**Conclusion**

One reason the institutional context of this case is important is that the historic HR practices of the Bell System had created a highly skilled work force with tremendous tacit knowledge of the customers, the telecommunications infrastructure, and the use of information systems. In addition, a long history of mature collective bargaining created a climate of trust, and union support for the program provided employees with confidence to fully participate in ways that might otherwise not have occurred. Thus, arguably, the industrial relations system provided the kind of support viewed as necessary for successful implementation of high involvement work systems. The missing incentives were group-based pay and job security, and as indicated earlier, employees viewed self-managed teams as a vehicle to enhance security.

Not long after the experimental implementation of total quality and team management, the company let both programs dissolve, and union-management relations deteriorated in the face of on-going downsizing and reengineering. Management reasoning was that small teams are not consistent with reengineering, where the gains from automation and process standardization are significant; and participatory meetings are a waste of time. The company, like others, has moved in the direction of a mass production model of individualized work, faster cycle times, and stricter adherence to schedules. It has created training modules on-line to reduce initial training, and has shifted much of subsequent training to on-line, self-paced modules. Virtually all training and work-related information (work procedures, system capabilities, product information, legal regulations) are on-line; employees receive eight to ten e-mail messages per day advising them of any updates in any of their systems. Employees are discouraged from asking questions or talking with one another because doing so reduces productive work time. The company has also introduced individual sales commissions as an incentive plan. The evidence in this case, however, argues against this type of mass production model, even on the basis of sales efficiency, because effective sales as well as service quality depend on continuous learning, processing of information, and tacit knowledge that group collaboration appears to foster.

## Appendix 1
## Variable Definitions

*Dependent Variables*

**Sales**

Average monthly sales, January 1993 to June 1994
Log of average monthly sales, January 1993 to June 1994

**Work Group Quality**

A scale formed by the following 2 items (a = .56):
- In your opinion, what is the quality of services provided by your work group? (1 = very poor to 5 = excellent)
- How does the current service quality provided by your work group compare to that of 2 years ago? (1 = much worse to 5 = much better)

*Independent Variables*

**Technology**

Have you begun using the regional negotiations system in your daily work? (no = 0, yes = 1)

**Discretion**

A scale formed from the following 4 items (a = .77):
Please tell us how much *personal influence* you have over the following things:
- Deciding what tasks or work assignments you do. (1 = none to 5 = complete)
- Deciding what tools or procedures you use. (1 = none to 5 = complete)
- Controlling the pace or speed at which you work. (1 = none to 5 = complete)

How often is the authority you have adequate to change things to meet customer needs? (1 = never to 5 = almost always)

**TQ Team Participation**

Are you currently participating in a total quality or problem-solving team? (no = 0; yes = 1)

*Continued*

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# HOW UNIONS AFFECT PRODUCTIVITY IN MANUFACTURING PLANTS

BRIAN BEMMELS*

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This study investigates several hypotheses as to how unions may affect productivity. Analysis of data from 46 manufacturing plants for 1982 indicates a negative union impact on productivity. The author finds evidence suggesting that unions reduce the effectiveness of some managerial practices undertaken to increase productivity, and that a poor labor-management relations climate also reduces productivity. These two factors account for almost 50 percent of the negative union impact.

As a recent review symposium in this journal (Burton 1985) demonstrated, different theories offer conflicting predictions about the direction and magnitude of the union impact on productivity. The conventional view of unions is that they will have a negative impact on productivity in two ways. First, resource misallocations result from union-nonunion wage differentials. Second, nonwage-induced inefficiencies are associated with restrictive work rules. The "new" view of unions is that they have two faces: although they may have a negative impact on productivity as proclaimed by the conventional view, they also provide workers with a collective voice in the workplace and may have positive impacts on productivity as well. Thus, the direction of the net impact of unions on productivity is an empirical question.

The conflicting theoretical arguments are matched with conflicting empirical evidence.[1] Recently there has been a flurry of quantitative studies looking at the union impact on productivity. These production function analyses estimate the impact of unions on productivity above and beyond union-induced changes in the physical input mix. To date, the empirical score is about even. For every study that finds a positive impact another finds a negative impact, and clear conclusions on the net impact are wanting at this time. These conflicting empirical results raise a perhaps more important question: precisely *how* do unions affect productivity? Many theoretical explanations have been offered, but few of them have been subjected to empirical investigation. Until this question is answered more completely, it may be impossible to draw any meaningful conclusions on the net impact of unions on productivity.

This study attempts to fill some of the gap in our knowledge on this issue by empirically testing several hypotheses about how unions affect productivity. The empirical analysis is conducted on data for 1982 from a sample of 46 manufacturing plants in the United States.

## Previous Studies

Although there are numerous studies on the net impact of unions on productivity,

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[1] For reviews of the empirical evidence, see Addison (1982) and Freeman and Medoff (1984).

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workers have been organized may have a moderating influence here as well.

The percentage of production workers who receive incentive pay (PAY) is also lower among the unionized plants than among the nonunion plants, but the difference (13.4 percent) is not statistically significant. The lower usage of incentive pay among the unionized plants is not surprising in light of the traditional opposition of unions to incentive systems, but apparently such opposition was not sufficient to produce a significant difference among the plants in the sample. In sum, there is little evidence to support the IOM hypothesis, the only support being the less frequent monitoring of performance at unionized plants.

A further question remains. How much of the union impact on productivity is due to the factors studied here? The results suggest that internal managerial and organizational differences between union and nonunion plants are minimal. The only variable showing a significant difference was APP. Moreover, this variable was insignificant in the production function estimates, and therefore the estimated impact of unions on productivity through changes in performance appraisal and feedback must be very small.

The portion of the union impact due to the altered effectiveness and labor relations climate explanations may be assessed by comparing the estimates from a model (not reported here) with the PART, APP, and PAY with UNION interaction terms and the strikes variables omitted to the estimates from Model 1 in Table 2. The coefficient on UNION in the former model is $-1.32$ ($t = 1.69$), compared to $-.70$ in Model 1, a change of approximately 47 percent. The positive coefficient on UNION SQUARED also decreases from .41 to .34. Therefore, these variables account for at least 47 percent of the negative union impact that is estimated in the model excluding these variables.[19]

By similarly comparing Model 2 with Model 1, it is possible to assess the portion of the negative union impact captured by the strike variables alone. The coefficient estimate on UNION is $-1.14$ in Model 2, compared to $-.70$ in Model 1, a change of approximately 38 percent. The positive coefficient on UNION SQUARED also decreases, from .41 in Model 2 to .34 in Model 1. A comparison of the estimates from a model (not reported) with only the interaction terms omitted to Model 1 shows, however, that the coefficient estimate on UNION changes from $-.1.11$ ($t = -2.02$) to $-.70$, a change of approximately 37 percent, whereas the UNION SQUARED coefficient is unchanged. Therefore, it appears that each of these two competing explanations accounts for about one-half of the 47 percent total change in the union productivity effect. The best estimates are that altered effectiveness accounts for 20–25 percent of the negative union impact, and the strike variables also account for 20–25 percent of the union impact.

## Conclusions

This paper has investigated several issues regarding the mechanisms through which unions affect productivity. The evidence indicates that unions alter the effectiveness of managerial practices and that the labor-management relations climate is also a significant factor in the union impact, but no support was found for the hypothesis that managerial practices and organizational characteristics differ between equivalent union and nonunion operations. The altered effectiveness and climate explanations together account for slightly less than half of the negative union impact found in the production function estimates. This leaves at least half of the union impact unexplained by the mechanisms investigated in the study.

There are several alternative explanations for the unexplained portion of the union productivity effect. The data are for a recessionary period (1982), and the negative union impact could reflect greater

[19] If the union impact operated exclusively through these variables, the coefficients on UNION and UNION SQUARED would go to zero when these variables are included in the production function. Since the estimated union impact is changed toward zero by only 47 percent, we may conclude that they explain approximately that portion of the total union impact. Brown and Medoff (1978) use this same procedure to determine the portion of their estimated union impact that is due to reduced quit rates.

"hoarding" of unnecessary production labor at union plants than at nonunion plants. Or higher absenteeism may have caused the lower productivity at the unionized plants (as mentioned above, however, previous studies have estimated this impact to be very small). Or there may be other managerial practices and organizational characteristics not included in this study that either are changed as a result of unionization or are less effective as a result of unionization, such as the use of overtime and flextime, centralization or other structural changes, job enrichment, strategic and human resource planning, or health and safety programs. Although many aspects of management and organization were included in this study, they certainly are not an exhaustive list of managerial and organizational characteristics that could be affected by unions. Further studies will be needed to investigate the union impact on other factors.

Yet another possible explanation is that dimensions of a poor labor-management relations climate that are not captured by the strike variables in this study have a negative impact on productivity. Given that the plant managers in this study all indicated cooperative relations with their unions, this explanation seems unlikely. Finally, unions may have imposed restrictive work rules not investigated in this study. In sum, although this study has found some evidence of how unions affect the production process, it is clear that many issues remain for further analysis.

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# HOW TO COMPETE: THE IMPACT OF WORKPLACE PRACTICES AND INFORMATION TECHNOLOGY ON PRODUCTIVITY

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*Abstract*—Using data from a unique nationally representative sample of businesses, we examine the impact of workplace practices, information technology, and human capital investments on productivity. We estimate an augmented Cobb-Douglas production function with both cross section and panel data covering the period of 1987–1993, using both within and GMM estimators. We find that it is not whether an employer adopts a particular work practice but rather how that work practice is actually implemented within the establishment that is associated with higher productivity. Unionized establishments that have adopted human resource practices that promote joint decision making coupled with incentive-based compensation have higher productivity than other similar nonunion plants, whereas unionized businesses that maintain more traditional labor management relations have lower productivity. Finally, plant productivity is higher in businesses with more-educated workers or greater computer usage by nonmanagerial employees.

## I. Introduction

HOW do managerial decisions such as whether or not to adopt a Total Quality Management (TQM) system or expand an employee involvement program affect labor productivity? Does the implementation of "high-performance" workplace practices ensure better firm performance? Does the presence of a union hinder or enhance the probability of success associated with implementing these practices? Do computers really help workers be more productive? These questions and others have been raised in recent years as many firms have reorganized or reengineered their work sites from the old Fordist model of work organization to new high-performance work systems that decentralize decision making within a firm. Using data from a unique nationally representative sample of businesses (the Educational Quality of the Workforce National Employers Survey (EQW-NES)), we begin to examine these and other important questions about the determinants of productivity.

Although there have been many studies on the impact of capital investments and R&D on firm or establishment productivity, until recently there has been very little direct analysis of the impact of workplace practices on productivity. Some of these studies have been hindered by problems such as low survey response rates, firm-level rather than establishment-level productivity data, limited workplace practice data, and subjective measures of productivity. Moreover, although there is ample micro-based evidence on the impact of human capital accumulation on individuals' wages, much less is known about the direct effect of human capital on the productivity of businesses. Finally, although there has been some research using firm data on the impact of computers on productivity, these studies have not been able to simultaneously control for workplace practices and human capital investments.

Our work builds upon this research by using a large, nationally representative sample of manufacturing businesses. Because of the survey design, we have detailed information on workplace practices (beyond just their incidence), human capital investments, and a measure of the diffusion of computer usage, that can be matched with standard cross-sectional and longitudinal measures of inputs and outputs of the production process. More specifically, the EQW-NES provides information on workplace practices such as TQM systems, benchmarking, the diffusion of computer usage among nonmanagerial employees, recruitment strategies, the use of profit sharing, and the extent of employee participation in decision making. We also have information on the average educational level of the establishment and the numbers of employees trained, along with other characteristics of the business such as whether or not it is unionized, employee turnover, the age of the capital stock, and the demographic composition of the workforce. Finally, one unique design feature of the EQW-NES is that we are able to match it with the Bureau of the Census' Longitudinal Research Database (LRD) so that we can utilize the panel data dimension of the LRD.

We first estimate a standard Cobb-Douglas production function with cross-sectional data that is augmented by our measures of workplace practices, information technology, and human capital investments. We then estimate a standard production function on the LRD panel covering the period from 1987 to 1993 using both within and generalized method of moments (GMM) estimators to address omitted variable and endogeneity bias. The average establishment residual over this period is then used as a measure of the establishment fixed effect and is regressed on our measures of workplace practices, human capital investments, diffusion of computer usage, and other employee and employer characteristics to determine their association with productivity. In this way, we try to see how the information on workplace practices we obtained in our survey is related to

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which businesses did better or worse on average over the period 1988–1993.

We find that workplace practices do matter, no matter how the production function is estimated. However, it is not so much whether or not an employer adopts a particular work practice but rather how that work practice is actually implemented within the establishment that is associated with higher productivity. For example, simply adopting a TQM system has an insignificant or even negative impact on productivity, whereas increasing the proportion of workers meeting regularly to discuss workplace issues or extending profit sharing to production workers has a significant and positive impact on productivity.

We also see important differences across plants on the basis of the type of labor-management relations within the plant. Unionized plants that have adopted new workplace practices such as incentive-based compensation or greater employee participation in decision making have substantially higher productivity than similar nonunion plants or establishments with more traditional labor-management relations. In addition, those plants with more-educated workers also have significantly higher productivity, everything else constant. Finally, the greater the proportion of nonmanagerial workers who use computers, the higher is plant productivity.

## II. Background Discussion

Our paper is not the first to examine the impact of workplace practices on the productivity of businesses, but much of the previous work on this topic has been limited in several ways. Some of the most detailed research on the adoption and nature of new workplace practices has been done on a case study basis. This includes work by Krafcik (1988), Womack, Jones, and Roos (1991), Ichniowski (1992), Berg et al. (1996), and Batt (1995). These studies have provided us with a wealth of information on the chain of events that resulted in the adaptation of new workplace practices, but it is difficult to generalize these results to a broader spectrum of the economy.

One solution to this problem is to conduct a detailed intra-industry study of the adoption of workplace practices to see their impact on a range of industry-specific performance measures. Examples of intra-industry studies include work by Ichniowski, Shaw, and Prennushi (1997), Arthur (1994), Kelley (1994, 1996), Bailey (1993), and Dunlop and Weil (1996). By examining human resource practices associated with one specific production process, it is possible to greatly reduce problems of the underlying heterogeneity of production processes. Most of the intra-industry studies conclude that the adoption of a coherent system of new human resource management practices such as flexible job definitions, cross-training, and work teams, along with extensive reliance on incentive pay, results in substantially higher levels of productivity than more traditional human resource management practices. Although these results represent an important contribution to the literature on workplace practices and productivity, again it is not easy to generalize these findings for a broader segment of the economy.

Another research strategy is to examine a more representative cross-sectional sample of firms to see the impact of workplace practices on broader measures of performance such as productivity or profitability. Examples of this strategy include Bartel (1989), Ichniowski (1990), Huselid (1995), Huselid and Becker (1996), and Delaney and Huselid (1996). These studies have found that there is a correlation between human resource management systems and business performance as measured by labor productivity, Tobin's $q$, or present value gain in cash flow and firm market value. Unfortunately, much of this work has been limited by low survey response rate, high levels of aggregation of human resource management practices and performance measures, and the use of an index of human resource practices. Examining human resource management practices at the firm or business line level may miss the degree of heterogeneity in practices within multiple establishment firms. Therefore, we believe that the preferable level of analysis for the issues we wish to examine is the establishment level. In addition, using an index of workplace practices can lead to ambiguities in the interpretation of the results. Although it probably makes sense to combine subjective responses that are centered on a particular theme into an index, it is not clear why it is necessary to group these responses when there are more detailed data available on factors such as the proportion of workers involved in decision making.

Nevertheless, there is a burgeoning theoretical and empirical debate on the existence of synergies in bundles of human resource management practices. The theoretical work of Milgrom and Roberts (1995) and Kandel and Lazear (1992), along with the empirical studies mentioned above, are important contributions in this area. Milgrom and Roberts argue that the impact of a system of human resource practices will be greater than the sum of its parts because of the synergistic effects of bundling practices together. Kandel and Lazear argue that introducing a profit-sharing plan for all workers in a firm may have little or no impact on productivity unless it is linked with other practices that address the inherent free rider problem associated with corporate-wide profit sharing plans. The empirical evidence on synergies is mixed, with Huselid and Ichniowski arguing that bundles matter more than individual practices and Delaney and Huselid finding no evidence of bundles. Empirically, we have opted to interact a wide range of practices with each other to see if there are interaction effects beyond the own effect of specific HR practices. We believe that this is a less restrictive strategy than arbitrarily grouping our businesses into three or four types of HR practice bundles or using factor analysis to generate an index of HR practices. As Osterman (1994) has shown, in spite of widespread estimation procedure to adjust for endogeneity and omitted fixed-effects biases on these variables. Even though these types of data are unlikely to be produced in the near future, we believe our results shed some light on the impact of workplace practices and information technology on productivity.

## VI. Conclusion

New technologies and changing workplace practices have altered the nature and organization of work. There have been many stories in the popular press about the successes associated with the introduction of high-performance workplace systems and the revolution computers have caused on the job. At the same time, the gains to completing a college degree relative to a high school diploma have doubled over the past fifteen years in response to what many have argued are the skill demands associated with new technologies and changing work organization. We have tried in this paper to get a better understanding of how workplace practices, human capital investments, and information technology are related to establishment productivity. By using a large representative sample of businesses, we have been able to examine these factors on a broader cross section of employers, unlike previous studies that have focused on one particular industry, product, or even firm.

By relying on detailed measures of human resource practices included on their own and interacted with each other, rather than just using summary indices, we have been able to see that what appears to matter most for productivity is how HR systems are implemented. Adopting a TQM system per se does not raise productivity. Rather, allowing greater employee voice in decision making is what seems to matter most for productivity. Instituting a profit-sharing system has a positive effect on productivity, but only when it is extended to nonmanagerial employees. Finally, those unionized establishments that have adopted what have been called new or "transformed" industrial relations practices that promote joint decision making coupled with incentive-based compensation have higher productivity than other similar nonunion plants, and those businesses that are unionized but maintain more traditional labor-management relations have lower productivity.

Although the two-step procedure used in this paper addresses some of the biases that may arise in estimating the impact of workplace practices and characteristics on productivity, it does not address all potential biases. Longitudinal data that enabled us to follow businesses over time to examine changes in performance resulting from implementation of high-performance workplace practices would help provide further evidence on the role of the new workplace in productivity. A long panel on establishments that included repeated information on workplace practices would allow us to use a GMM estimation procedure like we did on capital, materials, and labor to adjust for endogeneity and omitted fixed-effects biases on our estimates of the impact of workplace practices on productivity. Nevertheless, by using this two-step method, this paper has highlighted the importance of measuring the intensity of workplace practices in an establishment and not just the incidence. In addition, it suggests an important role for considering synergies among workplace practices. Understanding what constitutes a productive workplace environment is not limited to whether or not an establishment has TQM, but also how it is implemented including the mechanisms and institutions in place to address incentive compatibility problems that may arise as employers seek greater employee involvement in labor productivity improvements. Other studies have been limited in their ability to identify these important relationships or by the fact that it was not easy to generalize their findings to a broader segment of the economy.

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# UNIONISM AND PRODUCTIVITY IN WEST VIRGINIA COAL MINING

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This study presents econometric estimates of the effects of unionism on productivity in 83 West Virginia coal mines in the early 1920s. The size, detail, and panel structure of the data set permit investigation of many possible links between unionism and productivity, in contrast to the summary measures reported by most studies. The results show that the union effect was not uniform across mines and cannot be represented by a simple shift parameter. Rather, unionism significantly reduced productivity at small mines but not at large mines. Drawing on historical evidence, the author ascribes this differential effect to systematic differences between small and large operations in the quality of management and union leadership.

UNIONISM can conceivably influence productivity in a variety of ways. From a price-theoretic perspective, possible union effects fall into three classes. First, unions can affect productivity through input prices. Unions may raise the price of labor input relative to other inputs. They may also alter the relative wages of different types of labor, some of which may be substitutes for or complements of nonlabor inputs. For example, a union may raise or lower the wages of workers who use machines relative to the wages of those who do not. Such effects change the average product of labor, but they do not alter the firm's labor demand, cost, and production functions. This class of effects might be called "allocational effects."[1]

Second, unions may restrict the choices among resources available to the firm; that is, they may restrict input proportions, or impose maximum or minimum levels of certain inputs. Such restrictions have often been alleged in discussions of craft unionism in newspapers, railroads, construction, and the maritime trades,[2] but they might

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Data and programs used to generate the results reported in this paper are archived on a tape at the Interuniversity Consortium for Political and Social Research, P.O. Box 1248, Ann Arbor, Michigan 48106. A guide to the tape is available from the Consortium or from the author at the Department of Economics, The Ohio State University, 410 Arps Hall, 1945 High Street, Columbus, Ohio 43210-1172.

[1] Let $x_1$ and $x_2$ denote inputs with prices $w_1$ and $w_2$, respectively. Let the output $y$ be produced with production function $y = f(x_1,x_2)$ and fetch price $p$. The firm's problem is to maximize profits, given by:

$$\text{profits} = py - w_1x_1 - w_2x_2$$

Changes in input prices induce changes in the optimal levels of inputs and therefore changes in the average products of factors: $AP_1 = y/x_1$ and $AP_2 = y/x_2$ without altering the production function $f(x_1,x_2)$ itself. By contrast, "input-restriction effects" add restrictions to the firm's choice of inputs, which might be denoted most generally by:

$$g(x_1,x_2) \leq 0.$$

Finally, "production-function effects" refer to changes in the function $f(x_1,x_2)$ itself, not its arguments.

[2] See Bok and Dunlop (1970:27[illegible]–73) on the

 
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also characterize the demands of some industrial unions for job security. If the restrictions are binding, then the firm is displaced from its cost and labor-demand functions, but not from its production functions.[3] This class of effects might be called "input-restriction effects."

Third, unions may change the parameters of the production function itself. Effects in this class—which might be called "production-function effects"—are the focus of this paper and of most of the existing econometric literature.[4] Results reported by this literature have been mixed. Negative effects on productivity have been reported for turn-of-the-century British coal fields (Pencavel 1977) and for a sample of U.S. manufacturing plants (Bemmels 1987). Positive effects were reported for U.S. manufacturing, however, by Brown and Medoff (1970), who used aggregate data; for a multinational manufacturing firm (Mefford 1986); and, based on both project-level and aggregate data, for U.S. construction (Allen 1984, 1986a, 1986b). Clark (1980a and 1980b) reported small, barely significant positive effects for cement plants. Connerton, Freeman, and Medoff (1979) reported an effect for U.S. coal mining that appeared to change from positive to negative over time, but union effects were not distinguished from mine-specific effects in their methodology. Ehrenberg, Sherman, and Schwarz (1983) reported mixed effects for public libraries.

This literature has several shortcomings. First, those studies reporting the strongest positive effects of unionism have used cross-sectional data. If unions tend to organize the most productive firms or establishments, such studies will suffer from simultaneous-equation bias.[5]

Second, almost all econometric studies to date have used a simple specification of the union effect—a simple intercept shift[6]—and many have used aggregate data. The summary numbers that result, which provide an average union effect, are difficult to interpret. Such simple specifications stand in contrast to the institutional literature, which has long argued that the union effect is complex, varies across industries and establishments, and depends on many factors, including the course of technological change (Hartman 1969) and the quality of management and union leadership (Slichter, Healy, and Livernash 1960). The data are partly to blame for these shortcomings. Simultaneous-equation bias can be overcome with panel data sets (as in Clark 1980a, 1980b), but these are hard to find. More complex specifications for production and the union effect can be estimated, but significant results require larger data sets than those heretofore available to econometricians. It is nevertheless surprising that so few studies have investigated whether unionism affects more than one parameter in the production function.

In this study I attempt to overcome these shortcomings using an unusual data set pertaining to West Virginia coal mines in the 1920s. The panel nature of the data allows union effects to be distinguished from ongoing productivity differences across establishments. The data set is large enough to permit estimation of a flexible production function, with unionism allowed to affect *all* of the input parameters.

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National Diesel Agreement of 1937, and Hartman (1969) on longshoring.

[3] Such an outcome is usually predicted by cooperative bargaining models of unionism in which a Pareto-optimal solution is attained.

[4] Intentions aside, it is a difficult matter empirically to isolate production-function effects completely. When unions influence wages, the possibility of unobserved allocation effects (such as changes in labor quality or managerial effort) can never be confidently ruled out.

[5] This issue has been widely recognized. See the discussion in Brown and Medoff (1978:373–74). Mefford's cross-sectional study appears to have avoided simultaneous-equation bias by using an international sample in which unionism is completely determined by geographic location.

[6] One exception is Mefford (1986), who rejected structural change in the input parameters on the basis of individual t-statistics for his sample of 126 observations. Another exception is Bemmels (1987), who rejected structural change on the basis of likelihood-ratio test statistics for his sample of 46 observations.

various scales of operation are shown in Table 4 and Figure 1 for both the translog specification and the translog with union production constrained to be homogeneous. The sample percentiles refer to values given in the Appendix. The estimates predict a negative effect of unionism for small mines larger in magnitude that the negative effect predicted by the Cobb-Douglas estimates. Point estimates of the union effect at levels above the 25th percentile, however, remain close to zero, in contrast to the Cobb-Douglas prediction. Thus, the translog estimates confirm the negative prediction for small mines found by the Cobb-Douglas specification, but cast doubt on its positive prediction for large mines.

The production function effects of unionism may be further elucidated by predictions that vary the input proportions.[33] Table 5 accordingly predicts the effect of unionism for various combinations of mining machines and other inputs. Predictions for small mines occupy the upper left corner of the table and predictions for large mines occupy the lower right. The diagonal replicates the last column of Table 4. Predictions above the diagonal represent relatively mechanized mines and predictions below the diagonal represent relatively unmechanized mines. Table 5 again demonstrates the negative effect of unionism at small mines, as shown by significant negative predictions in the upper left corner. However, it does not support the hypothesis of a negative effect at mechanized mines. Point predictions of the union effect are large and negative above the diagonal and large and positive below the diagonal, but most of these predictions are not significantly different from zero at conventional levels.

[33] Caution is normally necessary in applying this technique because it risks extrapolation outside the sample. The risk, however, is much smaller here than with, say, aggregate data sets, where inputs typically vary in nearly fixed proportion. In this data set, the number of machines in use varied widely across mines that otherwise operated at the same scale.

## Conclusions

The results of this study may be summarized as follows. First, the production function for coal mines *is* affected by unionism. Second, this effect cannot be reduced to a simple intercept shift, as might be expected if unionism's effect stemmed only from changes in labor quality. The effect of unionism is not uniform—it depends on the level of the inputs. This result does not refute the hypothesis that unionism influenced productivity through changes in labor quality, but demonstrates that other effects must have also been present.

Third, a negative effect of unionism at mechanized mines, as might be expected if the union haggled over the introduction of machines, is not demonstrated. Point estimates of unionism's effect were large and negative at mechanized mines, but standard errors were also large. Fourth, an interaction between unionism and scale, as might be expected on the basis of the differences in labor relations reported at small and large mines, is clearly demonstrated. Estimates for the translog functions show that unionism significantly reduced productivity at small mines. Cobb-Douglas estimates show a lesser effect at small mines, but agree with the qualitative conclusion that scale influenced the unionism effect.

The operators had several reasons for wanting to deunionize their mines. They complained of high union relative wages (Mooney 1967:127) and input restriction effects in the form of frequent strikes and excessive union-sanctioned holidays (Bituminous Operators' Special Committee 1923:168–71). This study suggests that production function effects were probably not a reason for deunionization except at small mines. On average, mines in this sample did not suffer adverse production effects due to unionism.[34] Formal tests

[34] Simulation of the log difference in output due to unionism in 1920–21 (when all mines in the sample were unionized) produced a mean difference in log output (over all 83 mines in the sample) of 0.04 using the constrained translog estimates or 0.01 using the translog estimates. These results are

*Table 5.* Predicted Union Effects by Scale and Mechanization.

| *Percentile, Other Inputs* | *Percentile, Mining Machines* | | | | | | |
|---|---|---|---|---|---|---|---|
| | *5th* | *10th* | *25th* | *Median* | *75th* | *90th* | *95th* |
| 5th | −.426** | −.492** | −.606** | −.692* | −.750 | −.775 | −.784 |
| | (.183) | (.196) | (.263) | (.357) | (.459) | (.531) | (.574) |
| 10th | −.306* | −.373** | −.491** | −.581* | −.642 | −.668 | −.678 |
| | (.170) | (.169) | (.224) | (.316) | (.421) | (.495) | (.539) |
| 25th | −.056 | −.134 | −.274* | −.386* | −.468 | −.507 | −.525 |
| | (.185) | (.147) | (.146) | (.229) | (.337) | (.414) | (.460) |
| Median | .217 | .173 | .102 | .059 | .042 | .044 | .049 |
| | (.166) | (.134) | (.084) | (.058) | (.967) | (.094) | (.115) |
| 75th | .273 | .226 | .148 | .098 | .075 | .073 | .076 |
| | (.271) | (.232) | (.167) | (.119) | (.088) | (.087) | (.096) |
| 90th | .212 | .169 | .100 | .059 | .044 | .047 | .053 |
| | (.365) | (.322) | (.247) | (.185) | (.137) | (.118) | (.115) |
| 95th | .192 | .149 | .082 | .042 | .029 | .033 | .040 |
| | (.385) | (.342) | (.267) | (.204) | (.155) | (.132) | (.126) |

*Notes:* Estimates show the predicted difference in the logarithm of output of otherwise identical union and nonunion mines at various levels of inputs. Estimates may be converted to percent differences in levels using the formula $(e^x - 1)100$. For example, with machines and other inputs at sample median values, the log of output is predicted by the constrained translog function to be .059 higher at union mines (6.1% higher in levels). Note that estimates above the diagonal correspond to relatively mechanized mines, and estimates below the diagonal correspond to relatively unmechanized mines. Predictions are based on sample percentiles reported in the Appendix and estimates for the constrained translog production function reported in a supplemental appendix available from the author on request.

* Significantly different from zero at the 10% level; ** at the 5% level.

demonstrate, however, that these effects were not spread evenly across all mines.

Although many other studies of unionism and productivity have appeared recently, the present study is unique with respect to method and data. Most previous research has used the simple Cobb-Douglas functional form because of its ease of interpretation. My analysis of the data for this study, however, led me to reject the Cobb-Douglas in favor of the translog, a flexible functional form containing many more parameters. Interpretation of the parameter estimates was facilitated here by *predicting* the union effect at various levels of inputs.

The data set used in this study is also new, although some previous productivity studies have examined coal mining. Pencavel (1977) found a negative change in the intercept for a sample of British coal fields at the turn of the century. He did not test, however, for changes in the other coefficients—estimation of such subtle effects would be difficult given the aggregate nature of his data and relatively small sample size. Connerton, Freeman, and Medoff (1979) found a decline in the union effect over time for a longitudinal sample in the 1960s and 1970s, which they interpreted as indicating a deterioration in labor relations. The influence of unionism on parameters other than the intercept was not estimated, however, and no mines in their sample changed union status over the sample period. Byrnes, Fare, Grosskopf, and Lovell (1988), using a nonstatistical method to study a sample of surface mines in the Midwest and West during the late 1970s, discovered few differences in efficiency between union and nonunion mines.

It would be extremely interesting to attempt replication of the present study using the same estimation methods on more recent data.[35] I conjecture that the results found here would *not* be repeated

roughly similar to the predictions using median inputs, reported in Table 4 above.

[35] Unfortunately, such a replication is impractical because very few coal mines in the United States have changed union status since 1940.

for more recent data, because they depend crucially on the historical setting. In particular, economies of scale in labor relations are probably less important today than in the 1920s. The recent development of a market for labor-relations services (such as those offered by consultants and lawyers) has meant that a small firm no longer must produce these services internally. Similarly, increased literacy and the advent of telecommunications have given isolated union locals cheap access to the knowledge and experience of the international union.

## Appendix
### Detailed Description of the Data

Data on coal production, employment, capital equipment, and number of days of operation are taken from annual reports of the West Virginia Department of Mines in the early 1920s. (Unfortunately, the data are less complete for the late 1920s. In particular, data on capital equipment were no longer reported at the mine level after 1925.) All inputs were defined by multiplying the number of physical units by the number of days of operation. Sample distributions of output and inputs are given in Table A1.

Data on unionism are also available, although not so neatly collected in one source. No single systematic record of the UMWA's activities in West Virginia has survived. Fortunately, union struggles in the West Virginia coal fields attracted great public attention, and many of the union's victories and defeats were documented in newspapers, magazines, and Congressional testimony. Sources used in this study, in decreasing order of usefulness, included: *Coal Age* (a magazine), the *New York Times*, testimony before various Committees of the United States Senate (in 1921, 1928, and 1932), *Convention Proceedings* of the UMWA and of the West Virginia State Federation of Labor, monographs by Anson (1940) and Corbin (1981), and Freeburg's (1925) article. The history of unionism at a sample of mines was pieced together for this study from these sources.

Unionism is a discrete variable in this data set, determined by whether a mine was operated for the entire observation year under contract to the United Mine Workers of America. The UMWA insisted on a closed shop during this period, so all workers at a unionized mine were union members. Years in which a mine operated for only part of the period under contract were dropped from the sample. No other union succeeded in winning contracts at these mines during this period.

**Table A1. Sample Distributions of Output and Inputs, 83 West Virginia Coal Mines, 1920–25.**

| *Quantile* | *Coal Output (net tons)* | *Miner-Days* | *Other Worker-Days* | *Mining Machine-Days* | *Loco-motive Days* | *Horse & Mule-Days* |
|---|---|---|---|---|---|---|
| Minimum | 1,191 | 0 | 40 | 0 | 0 | 0 |
| 5th percentile | 17,559.5 | 1,675.7 | 1,421.1 | 125.3 | 93.6 | 0 |
| 10th percentile | 25,048.3 | 2,343.6 | 2,018.7 | 180.6 | 137.8 | 0 |
| 25th percentile | 44,554.9 | 4,681.5 | 3,742.25 | 381 | 309 | 0 |
| Median | 102,549 | 12,216.5 | 11,570 | 798 | 790.5 | 919.5 |
| 75th percentile | 188,081 | 24,026.3 | 23,221.8 | 1,615.25 | 2,178 | 2,238.5 |
| 90th percentile | 291,824 | 37,040 | 38,384.2 | 2,532.6 | 3,653.3 | 4,757.6 |
| 95th percentile | 380,664 | 44,851.2 | 46,565.7 | 3,264.94 | 4,242.8 | 6,680.99 |
| Maximum | 614,476 | 59,354.4 | 98,185 | 9,953 | 8,040 | 13,572 |

*Source:* West Virginia Department of Mines.

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# Confirmations and Contradictions

## Unionization and Profitability: Evidence of Spillover Effects

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### I. Introduction

Ruback and Zimmerman's (1984) event study, which showed that formal union-organizing activity significantly lowers a firm's market value, provides compelling evidence that unionization reduces a firm's profitability. Union-organizing activity may also have sizable cross-firm or spillover effects on the performance of neighboring firms. Thus the total impact of union organizing on the wealth of firm owners may be substantially understated by focusing only on the firm in which the union-organizing activity occurs. This paper presents an alternative approach for estimating union spillover effects on profitability using a data set and methodology similar to Ruback and Zimmerman's. We find that the total negative effects of unionization on profits, after cross-firm or spillover effects are included, are nearly three times as large as the own-firm effects reported by Ruback and Zimmerman.

The hypothesis that changes in unionization have spillover effects on nonunion firms is well known. Formal union-organizing activity at one firm may increase the threat of unionization at other firms. Neighboring firms may respond to the greater threat of unionization

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by raising their wages and benefits (Rosen 1969) or by pursuing anti-union policies. To the extent that these actions raise employer costs, union activity at one firm can lower other firms' expected profits. The primary empirical approach has been to estimate spillover effects on wages by measuring the cross-section correlation between union coverage rates and nonunion wages by industry, occupation, or region. The most influential of these studies is Freeman and Medoff (1981), which included measures of industry union coverage in individual wage regressions in manufacturing from the Current Population Survey for 1973–75 and found no significant relationship between nonunion wages and industry unionization rates. More recent studies have found some evidence of union spillover effects on wages, but as Pencavel (1991, p. 174) notes, "the direction and magnitude of this correlation is disturbingly fickle."

The union-organizing process begins with workers petitioning the National Labor Relations Board (NLRB) for a union representation election. The NLRB will order an election held for employees under its jurisdiction when the petition includes the signatures of 30 percent of the workers to be represented by the union. Ruback and Zimmerman's study examined the relationship between the filing date of the union's petition with the NLRB and changes in the firm's market value on the New York Stock Exchange (NYSE). Using a sample of 253 organizing campaigns involving 750 or more employees between February 1962 and September 1980, they found significant declines in market values during the months in which successful petitions were filed with the NLRB. The NLRB representation elections used in our empirical analysis are a subsample of the Ruback and Zimmerman data set, and our analysis of cross-firm effects on market values concentrates on the petition date.

We estimate the impact of petitions for NLRB representation elections at one firm on the share prices of other firms in the same narrowly defined industry. Since unions choose their organizing targets, these estimates do not indicate what would happen if a randomly selected nonunion firm experienced a representation election. Instead, the results quantify the spillover effects of the elections that actually occurred.

Our approach differs from earlier analyses of union spillover effects in several respects. First, we analyze the impact of union-organizing elections, which signal a possible change in union coverage, rather than examining cross-section differences in actual union coverage. Second, we measure the cross-firm effects of these petitions on equity values, and not wages or employer costs. It is important to note that significant cross-firm effects on equity values need not imply that there are similar spillover effects on wages. Expected profits may fall in neighboring firms in response to an NLRB petition, without any change in employee compensation, if firms respond to greater union threats with costly anti-union management practices.

An event study utilizes the assumption that the share price of a publicly traded firm reflects all available information about the firm's expected profits. Share prices react quickly to new information about firms' profits, including changes in expected union coverage at any of the firms in the industry. If new information about union threats (i.e., an NLRB petition) is uncorrelated with observable and unobservable variables that influence profitability, then the change in a firm's market value during the petition month can provide a consistent estimate of union spillover effects on profitability.

A limitation of the event study approach is that it is unclear how much of the information about increased union threats was anticipated by the market and capitalized into the value of firms prior to the petition date. Some petition events may have small own-firm and cross-firm effects because much of the information about union-organizing activity was anticipated prior to the petition date. Unobserved heterogeneity in market anticipation of NLRB petitions should induce a positive correlation between own-firm and cross-firm effects across petition events. The magnitude of cross-firm effects may also vary substantially across events, when the size of the own-firm effect is held constant, because of differences in the homogeneity of firms within each four-digit Standard Industrial Classification (SIC) industry group.

## II. Data and Empirical Methodology

The primary goal of our analysis is to estimate the impact of an NLRB petition covering at least 750 of a firm's workers on the market value of other firms in the same narrowly defined industry.[1] We therefore limit our sample to petitions that occurred in four-digit SIC industries in which we observed the share prices of at least two NYSE firms. The resulting sample for our empirical analysis includes 212 NLRB petitions in 122 firms and 82 four-digit SIC industries.[2] In the elections that followed these petitions, unions were successful 51 times and unsuccessful 161 times.

[1] The petitions in our sample cover 1,535 workers, on average. Only 0.8 percent of all NLRB elections during this time period involved at least 750 workers, but 17 percent of workers involved in NLRB elections are covered by these large elections.

[2] The Ruback and Zimmerman sample included all elections covering 750 or more workers in NYSE firms during this time period. Our sample includes all those elections for which we observe at least one other NYSE firm in the same industry. We excluded a few "petitions" that were aggregated by Ruback and Zimmerman from two petitions for different bargaining units in the same firm and month.

cross-firm decline in market value per employee is about \$289, or 65 percent of the own-firm equity loss per employee.[6]

We interpret a petition for an NLRB election at one firm as an increase in the threat of unionization for all firms in the industry. This view of NLRB petitions implies that an innovation in election activity at one firm leads to more elections throughout the industry in future months. We investigated this hypothesis by estimating a simple first-order autoregressive model for the number of NLRB elections per month in a two-digit SIC industry. Using monthly data over the period January 1972 to July 1987, for 56 different two-digit SIC industries, we estimated the following model:[7]

$$\mathrm{ELECT}_{it} = a_i + b_t + \underset{(70.6)}{.568}\,\mathrm{ELECT}_{it-1}, \quad \text{adjusted } R^2 = .759,$$

where $\mathrm{ELECT}_{it}$ is the number of NLRB elections in industry $i$ during month $t$, $a_i$ and $b_t$ are industry and year dummy variables, respectively, and the $t$-statistic is given in parentheses. This simple model suggests that there is considerable persistence in innovations to union-organizing activity within a two-digit SIC industry. Thus it is plausible that an NLRB petition at one firm signals an increase in the threat of union organizing at other firms in the industry, and thereby results in spillover effects on profitability.

## IV. Conclusion

This note presents an alternative method for estimating union spillover effects. We estimate the impact of a petition for a union representation election at one firm on the market value of other firms in a four-digit SIC industry. We find that these cross-firm or spillover effects are quite sizable, averaging \$71.4 million across the 212 petition events in our sample. Nearly two-thirds of the total profitability effect of an NLRB petition is attributable to these spillover effects.

Our event study approach avoids many of the pitfalls of endoge-

[6] For purposes of comparison with Ruback and Zimmerman's study, we also calculate equity losses per worker covered by the NLRB petition. The average own-firm equity loss is about \$24,500 per worker covered in the NLRB election and about \$48,000 per worker covered in organizing elections that the union eventually won. These dollar figures are quite similar to those obtained by Ruback and Zimmerman. As noted in Bronars and Deere (1990), the size of the equity loss due to an election appears unrelated to the size of the bargaining unit, and hence calculations of equity losses per worker in the bargaining unit may be somewhat misleading.

[7] We use monthly election data by two-digit industry beginning in 1972 because election data prior to 1972 are not available from the NLRB in machine-readable form. Monthly NLRB publications report election results on a case by case basis, and annual NLRB reports give total annual (not monthly) elections by industry.

nous unionization that are present in cross-section studies of union spillover effects or of unionization and profits. Although union coverage and profitability are jointly determined, our estimates of union spillover effects are consistent as long as the information about union threats that is revealed during the event month is orthogonal to the observable and unobservable factors that influence a firm's market value.

Our results show that union activity in one firm can have a substantial impact on shareholders and investors in other firms in the economy. It is not clear whether the observed cross-firm decrease in expected profits is accompanied by a corresponding spillover effect on wages. If wage costs increase in neighboring firms by the same amount at which shareholder value falls, union threats represent an efficient transfer of resources from shareholders to workers. It is also quite possible, however, that the spillover effects on equity values represent anticipated costly anti-union policies or inefficient union-firm contracting and work rules.

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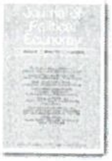

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# Trade Unions in the Production Process

**Charles Brown**, and **James Medoff**



## Abstract

In order to estimate the effects of unions on worker productivity, a Cobb-Douglas production function is modified so that unionization is included as a variable. The resulting functional form is similar to that used to isolate the effect of worker quality in previous studies. Using state by two-digit SIC observations for U.S. manufacturing, unionization is found to have a substantial positive effect on output per worker. However, this result depends on two important assumptions which we cannot verify directly; attempts to relax these assumptions are not conclusive.



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Akcigit

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**Does International Child Sponsorship Work? A Six-Country Study of Impacts on Adult Life Outcomes**
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# THE EFFECT OF UNIONS ON FIRM PERFORMANCE IN JAPANESE MANUFACTURING

GIORGIO BRUNELLO

Using data on a sample of 979 union and nonunion Japanese manufacturing firms selected from the 1987 issue of the *Yearbook of Japanese Unlisted Companies,* the author examines the relationship between union status and firm performance in Japan. The findings suggest that Japanese unions in the sample substantially reduced both productivity and profitability, as well as regular wages net of bonuses and fringes. These three union effects were considerably smaller in small and medium-size firms than in large firms, perhaps because many of the small and medium-size firms were subcontractors that were pressed by the firms contracting them to cut costs and increase productivity.

U ↓ P

THE relationship between unions and firm performance has been the topic of extensive research in the United States and Britain. In a recent survey of the research on this subject, Addison and Hirsch (1989) concluded that unions substantially reduce profitability but their effects on productivity are quite small and just as likely to be positive as negative.

Compared to the enormous amount of evidence accumulated for the United States, little has been done in Japan on this important topic. The dearth of empirical work on Japanese unionism can be explained at least in part by the lack of adequate data. Most Japanese government surveys of workers and establishments do not include questions concerning unions. As a result, the ability to do even a simple cross-section study of union effects on wages and firm performance is limited.

This paper presents evidence on the relationship between unions and firm performance in Japan based on a new data set covering 979 union and nonunion Japanese manufacturers drawn from the 1987 issue of the *Yearbook of Japanese Unlisted Companies* (*Kaisha Soran—Mijojo Kigyo*). This data set has two important advantages: it allows the researcher to explicitly discriminate between union and nonunion firms, and it includes a substantial number of both small and medium-size firms. A disadvantage of the data set is that the sample of firms is not random, so the results cannot be easily generalized to the whole Japanese manufacturing sector.

## Strategy

This study employs fairly standard productivity and profitability equations. As shown by Clark (1984), union effects

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Copies of the computer programs used to generate the results presented in the paper are available from Giorgio Brunello, Department of Economics, University of Venice, Dorsoduro, 30142 Venice, Italy.

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of firms, on the technology they adopt, and on whether unions bargain over employment levels.

The question of why union firms should pay lower wages than nonunion firms in Japan warrants further reflection. Kalleberg and Lincoln (1988) tried to explain their finding that unions reduce wages gross of bonuses by speculating that the Japanese labor market is much more integrated than the U.S. labor market. Hence, they argued, "nonunion companies in Japan may be under stronger competitive pressures to pay at least a union wage, and perhaps more, if they wish to retain a nonunion workforce" (1988:S147). I find Kalleberg and Lincoln's speculation appealing but incomplete, because it fails to account for lower profitability in conjunction with lower wages in Japanese union firms. An alternative speculation, one that avoids the problems discussed by Clark and reported above by reversing the causal ordering of the two variables,[13] is that union firms pay lower wages *because* unions reduce profitability. The link between lower profitability and lower wages can be provided either by recruiting costs or by rent-sharing.

The argument concerning recruiting costs is well summarized by Montgomery (1991:164–65):

> If it is somehow difficult for firms and workers to form a match, and if a firm can increase the probability of filling a vacancy by offering a higher wage, firms for which unfilled vacancies are relatively more expensive will pay higher wages. Thus, highly profitable firms (in which valuable orders would go unfilled if a vacancy persisted) . . . will pay higher wages.

If recruiting costs are about the same in union and nonunion firms and unions reduce profitability (and productivity), union firms will find unfilled vacancies relatively less expensive than nonunion firms, where profitability is higher, and will offer lower wages.

A similar argument is based on the rent-sharing hypothesis. If workers, both in union and in nonunion firms, share the firm's rents with stockholders (see Aoki 1984:104–106) and the workers' share is $\theta R$, where $R$ is rents and $0 \leq \theta \leq 1$, lower profitability in union firms means fewer rents ($R$) to be shared. This could lead to lower wages in union firms even if the bargained $\theta$ is higher.

## Conclusions

My purpose in this paper has been to provide some empirical evidence on the relationship between unions and firm performance in Japan. Given the widespread interest in Japanese industrial relations and the dearth of empirical work on the topic, the emphasis has been on a comparative perspective. There are two main sets of findings.

First, unions in the data set employed in this study substantially reduced both productivity and profitability. They also reduced regular wages, that is, wages exclusive of bonuses and fringe benefits. Only one of these three results—that for profitability—has been found in similar U.S. studies. The U.S. evidence suggests small, possibly positive union effects on productivity, and sizable positive effects of unions on wages. Perhaps the most notable result of this study is the absence of any evidence that the sampled Japanese unions, by cooperating with management and by exerting a positive "collective voice" effect, contributed to the achievement of high productivity standards.

Second, all these effects are substantially smaller in small and medium-size firms than in large firms. One possible explanation of this pattern is that many small and medium-size firms are subcontractors and are under pressure by the firms contracting them to cut costs and increase productivity. This pressure is weaker in larger firms, where stronger unions restrict management's discretion within the firm. Another possible explanation of this pattern of results is that the data set used for the study selects mainly "good" small and medium-size firms and "bad" large firms. In particular, the exclusion from my sample of those large and successful

[13] Clark (1984) investigated whether lower wages lead to higher or lower profitability.

unionized Japanese corporations that are listed in the stock exchanges could be responsible for the observed large negative effect of unions on productivity and profitability in the large firms.

I believe that these results are interesting for at least two reasons. The first is that they do not conform easily to the view that Japanese unions are "company" unions, that is, weak and with a negligible role to play in the firm. Contrary to this common assumption, my findings support the view that unions in Japan, although not effective in raising regular wages, are quite effective in reducing both productivity and profitability. A second noteworthy implication of the study, following from the finding that unions in smaller firms in the sample reduce profitability and productivity less than unions in large firms do, is that industrial relations in small and medium-size Japanese firms are quite different from those in large Japanese firms.

Given the nature of the data set, however, the findings of this study cannot be generalized to the entire manufacturing sector in Japan. In particular, future research should use data that cover large and successful unionized corporations listed in the country's stock exchanges.

## Data Appendix
### Variable Definitions and Sources

Nine variables are all taken from the same source, Nihon Keizai Shinbunsha, Nikkei, *Kaisha Soran—Mijijo Kigyo* (1987): *S* (total sales); *L* (total employment); *YEAR* (number of years since the firm was established); *AGE* (average age of the employees); *FEM* (ratio of female to male employees); *ROI* (ratio of current profits [Keijoh Rieki] to total assets of the firm; *PS* (ratio of current profits to total sales [Uriagedaka Keijoh Riekiritsu]); *D1* (a dummy equal to 1 if the firm has a union and 0 otherwise); and *D2* (a dummy equal to 1 if the enterprise union is affiliated with a union federation and 0 otherwise).

*UM* is the percentage of workers unionized in the industry, by size of firm (fewer than 29 employees, 30 to 99, 100 to 299, 300 to 999, and 1,000 or more employees), defined as the ratio of union members to total employees. The number of union members by two-digit industry and firm size is from the *Labor Union Basic Survey* (*Rodo Kumiai Kihon Chosa*), 1984 and 1985 issues. Following Muramatsu (1983), the number of employees in firms with between 20 and 999 employees is from the Census of Manufacturers—Firm Data (Kogyo Tokei hyo Kigyo hen). The Census does not provide data on firms with fewer than 20 employees. An estimate of the number of employees in the lowest class is obtained by using the Establishment Data (Kogyo Tokei Sangyo hen). This estimate is admittedly approximate, both because the establishment data consider only establishments with more than 4 employees and, obviously, because firms and establishments do not coincide even for very small sizes. Unlike Muramatsu, I cannot use employment in firms with more than 1,000 employees, because this number is lower than union membership in some industries (foodstuffs is a good example). My estimate is the number of employees in firms with more than 1,000 employees provided by the Survey on the Wage Structure (Chingin Census). The definitions of employees in the Survey and in the Census are different especially because the former includes only regular workers. Union density by firm size is computed as the simple average of union density in 1984 and 1985.

*MS* is the market share, defined as sales of the firm over sales in the three-digit industry corresponding to the main product line. Data on sales in an industry (three-digit) are from the Census of Manufacturers, Firm Data. As mentioned above, the Census does not include firms with fewer than 20 employees, so my measure of market share overestimates true market share in all the firms in the sample.

*IW, IVAD, IL,* and *IKL* are, respectively, cash earnings, value added, employment, and the capital-labor ratio by industry and firm size. All variables are from the Census of Manufacturers, Firm Data. The firm size ranges are 20 to 29, 30 to 99, 100 to 299, 300 to 999, and 1,000 or more employees. In some industries the data for firms with 1,000 or more employees are missing. I estimated these values by taking the difference between the total in the industry and the values in the other firm size categories.

*H* is hours worked per year per employee in an industry, partitioned by firm size, from the Monthly Labor Survey (Maitsuki Kinro Rodo Tokei). The firm size categories are 5–29, 30–99, 100–499, and 500 or more employees. The union-nonunion differential in total working hours is based on the estimate of the union-nonunion differential in regular working hours presented by Nakamura et al. (1988). Nakamura reported regular working hours by union status and by firms with 10–29, 30–49, 50–99, and 100–299 employees. I assume that the average union-nonunion differential in firms with 100 to 299 employees is equal to the average union-nonunion differential in firms with more than 299 employees. I also compute the average union-nonunion differential for firms with 30 to 99 employees using the data

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# Unions and Police Productivity: An Econometric Investigation

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## Abstract

We examine the effect of unionization on police productivity in large U.S. metropolitan areas. We define police output in the context of a production function model that draws also on the crime literature. We estimate the resulting model using a data set that includes published and unpublished government statistics as well as our own survey of police departments. Results suggest that the effect of unions on police productivity varies according to categories of police performance. In particular, if performance is stratified according to the severity of crimes, unions seem to have an insignificant effect on police productivity with respect to serious crimes. For minor crimes, unionization alters the parameters of police production function, leading to diminished productivity.

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# THE EFFECT OF UNIONS ON PRODUCTIVITY: U.S. SURFACE MINING OF COAL*

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The purpose of this paper is to compare the abilities of two competing analytical techniques —mathematical programming and statistical regression—to shed light on the union/nonunion productivity differential in U.S. surface coal mining. The programming approach has the virtues of being nonparametric (and thus extremely flexible) and of being able to provide a decomposition of productivity differentials into three components—differences in technical efficiency, differences in scale efficiency, and differences in congestion. Identification of these three components provides an aid to management in its search for the sources of, and remedies for, productivity gaps. The econometric approach, on the other hand, is neither flexible nor does it provide such a decomposition; its chief virtue lies in the fact that, being stochastic, it allows for the presence of noise and measurement error that plagues most if not all empirical data. Thus, the two approaches have complementary virtues.

The two techniques are used to investigate productivity in two samples of U.S. surface coal mines. The programming approach finds a large and significant positive union/nonunion productivity differential. This differential is due primarily to greater congestion occurring in the smaller nonunion mines in one sample, and to scale inefficiency in the smaller nonunion mines in the other sample. The econometric analysis finds nearly the same union/nonunion productivity differential, but sheds no light on the composition of, and thus the cure for, the differential.

(EFFICIENCY; MATHEMATICAL PROGRAMMING; STATISTICAL ESTIMATION; UNIONIZATION)

## 1. Introduction

It has been suggested by Freeman and Medoff (1979) that the neoclassical view of labor unions as using their monopoly power to raise wages, create resource misallocation, and thereby to decrease productivity, is too narrow and may be misleading. They suggest that, through the provision of a collective voice mechanism, unions may reduce turnover, increase labor quality, and have the opposite impact on productivity. The net effect of these two contrary influences being uncertain, empirical testing is called for. Indeed a quantification of the union/nonunion productivity differential would seem to be a necessary first step in the resolution of this important issue; only after the differential has been measured can effort be redirected to a search for its monopoly power/collective voice roots.[1]

The purpose of this paper is twofold. First, we seek to bring new empirical evidence to bear on the union/nonunion productivity issue, by comparing productivity in union and nonunion mines in U.S. surface coal mining. The data base consists of two geologically distinct samples: a 1978 cross-section of 84 midwestern surface mines, and an incomplete panel of 64 western surface mines observed over all or part of the period 1975–1978 that provides a sample of size 113. In both samples we find productivity to be higher in union mines than in nonunion mines, although the composition of the productivity differential is different in the two samples. Thus we are able to document both *direction* and *magnitude* of the productivity differential. In addition, we are able to

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[1] Much of the existing evidence is contradictory; it is surveyed by Freeman and Medoff (1984).



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*decompose* the differential into three sources to be described below. This decomposition represents an important step beyond the usual direction/magnitude finding that characterizes previous empirical studies. The significance of the decomposition lies in its ability to identify distinct components of the productivity differential that may eventually be associated with its monopoly power/collective voice roots that would provide an explanation for the differential.

The second purpose of the paper is to compare the abilities of two very different research strategies to quantify and decompose the union/nonunion productivity differential. The standard approach is to use econometric techniques to estimate a stochastic parametric production function, typically Cobb-Douglas, and to calculate the elasticity of unionization on output per unit of labor. This approach sheds light on the magnitude, but not the composition, of the productivity differential. An alternative approach is to use mathematical programming techniques to bound, or envelop, the data with a nonstochastic nonparametric production frontier. This permits a comparison of the productivity of each establishment and a decomposition of measured productivity into technical, scale, and congestion components.[2] This approach has the distinct advantage of providing a nonparametric representation of production technology, the structure of which is determined by weak regularity conditions and by the data rather than by the investigator's choice of parametric form. Consequently it minimizes the likelihood that any union/nonunion productivity differential will be masked by the effects of specification error. The decomposition of measured productivity also offers the hope of associating observed union/nonunion productivity differentials with important characteristics of production technology, and hence of providing guidance to management searching for ways to enhance productivity in each of the three union contexts. The chief drawback of the nonparametric approach is that it is deterministic, with no allowance being made for noise and measurement error. Note, however, that the strengths of the programming approach are the weaknesses of the econometric approach, and conversely. This makes a comparison of the findings of the two approaches of some interest from a methodological standpoint. From an institutional standpoint, confidence in any union/nonunion productivity differential finding depends on how closely the findings of two such disparate approaches agree.

The paper is organized as follows. In §2 the theoretical underpinnings and the modelling framework of the econometric approach are reviewed. In §3 the programming approach and performance measures are summarized. The coal mining data are described in §4. The empirical findings of both the programming and the econometric approaches are presented and compared in §5. §6 concludes.

## 2. The Econometric Approach

Since the influential work of Brown and Medoff (1978), virtually all econometric tests of the union/nonunion productivity differential have been based on the following model. Let production technology be represented by the parametric production function

$$Q = \phi(K, L_n, L_u) = AK^{\alpha}(L_n + \beta L_u)^{1-\alpha}, \tag{2.1}$$

where $Q$ is output, $K$ is capital, $L_n$ and $L_u$ are nonunion labor and union labor,

[2] The envelopment and productivity measurement stages of this approach have been called "data envelopment analysis" (DEA) by Charnes, Cooper and their associates. See Charnes and Cooper (1985) for a survey and selective bibliography. The decomposition stage of this approach is not typically a part of DEA; it is a logical extension intended to characterize productivity scores in terms of the structure of production technology.

TABLE 8

*Regression Results for Econometric Model*

| Coefficient of* | Interior | West |
|---|---|---|
| Constant | −4.956 | 3.449 |
| | (−3.98) | (2.83) |
| ln $(K/L)$ | 0.031 | 0.108 |
| | (0.26) | (0.86) |
| ln $L$ | 0.091 | −0.562 |
| | (1.37) | (−3.86) |
| ln BEDTHICK | 0.354 | 0.255 |
| | (4.02) | (3.23) |
| ln DEPTH$^{-1}$ | 0.311 | −0.456 |
| | (2.04) | (−5.30) |
| $U1$ | −0.181 | −0.840 |
| | (−0.84) | (−3.84) |
| $U2$ | −0.303 | −0.381 |
| | (−1.74) | (−0.63) |
| $R^2$ | 0.287 | 0.402 |

* Dependent variable is ln $(Q/L)$; $t$-statistics are in parentheses.

displayed in Table 8. The results are not very powerful in terms of goodness-of-fit, but the parameter estimates do show the positive effect of unionization on productivity. In the Interior sample the estimated coefficients of both union dummies are consistent with the findings of the nonparametric analysis summarized in Tables 3 and 6. In the West sample the estimated coefficient of $U1$ is consistent with the nonparametric analysis of Tables 3 and 7, but the estimated coefficient of $U2$ is not.[19]

The conclusion of the parametric analysis is that unionized mines without UMWA affiliation are more productive than unionized mines having UMWA affiliation, which in turn are more productive than non-unionized mines. These findings are broadly consistent with those of the nonparametric analysis in three of four comparisons, despite the fact that they are based on a Cobb-Douglas description of technology that assumes the presence of SDI and the absence of VRS, and that imposes a greater degree of input substitutability than may exist in surface mining. This robustness of findings to variations in assumptions concerning the structure of technology is impressive.

## 6. Concluding Remarks

The purpose of this study has been to compare the abilities of two different analytical techniques to shed light on the union/nonunion productivity differential in U.S. surface coal mining. The industry is of particular interest because of the diversity of union status among mines, some mines having collective bargaining agreements with the UMWA, others with a number of other unions, and still others having no collective bargaining agreement with any union. This diversity of bargaining scenarios enhances the opportunity to identify any union/nonunion productivity differentials that may exist. A comparison of the two analytical techniques is of interest because they are typically viewed as competitors with different and largely complementary strengths.

[19] In the Interior sample the implied degree of homogeneity (1.09) is consistent with the nonparametric results of Tables 3 and 5. In the West sample the implied degree of homogeneity (0.44) is too far below unity to be consistent with the nonparametric results, and the coefficient of the DEPTH$^{-1}$ variable has the wrong sign.

The mathematical programming techniques featured in this study have the virtues of being nonparametric, and thus highly flexible, and of being able to quantify and decompose productivity and its variation by union status. The decomposition property is particularly attractive since it provides guidance in the search for the sources of productivity variation. The econometric techniques employed in this study suffer from an inflexible parametric representation of technology that restricts our ability to decompose productivity differentials, but they have the important advantage of accommodating noise in the economic data being analyzed.

The mathematical programming techniques reveal a large and significant union/nonunion productivity differential. In the Interior sample most of this differential is attributed to scale inefficiency in the smaller nonunion mines. In the West sample the bulk of the differential is attributed to greater congestion occurring in the smaller, more labor-intensive, nonunion mines. These mines are much more likely to experience the lumpiness of the capital variable, and they are also more likely to be pushed into the "uneconomic region" of production by the input requirements of safety and environmental legislation. Even though this legislation is directed at all mines, its impact appears to be most severe in small nonunion mines.[20] In neither sample is the existence or the magnitude of the productivity differential dependent upon different geological conditions that exist in the two types of mines.

The conclusion of the econometric analysis is that non-UMWA union mines are the most productive, followed in order by UMWA mines and nonunion mines. This finding is broadly consistent with the finding of the mathematical programming analysis, and inspires confidence in the general conclusion regarding union/nonunion productivity differentials in U.S. surface coal mining. Despite this broad consistency, however, the econometric approach is incapable of providing a decomposition of the productivity differential into its technical, scale and congestion components without using a more flexible parametric form to represent production technology. This is in our view the main weakness of the econometric approach.

Two additional studies that would be of considerable value are unfortunately ruled out by a lack of appropriate data at the level of the individual mine. The first is a comparison of output per unit of input (or per unit of labor) and wages across the three union status groups. The second is a comparison of costs and/or profits across the three union status groups. Both nonparametric and econometric techniques have been developed for this purpose, but for our two samples the requisite input price data are unavailable.[21]

[20] Our inefficiency scores, and particularly their congestion components, may appear to be implausibly large, but two related findings of Neumann and Nelson (1982) may put our findings in perspective. Neumann and Nelson investigated the effects of the Coal Mine Health and Safety Act of 1969 on a sample of large and small underground mines. They find that compliance with the Act led to a 13% decline in labor productivity, and that the impact was much more severe in small mines than in large mines. In addition, in private correspondence, an environmental impact engineer with Freeman United Coal Company, a subsidiary of General Dynamics, acknowledged that the productivity scores reported here were quite reasonable. He attributes the low scores, and the low congestion scores in particular, to the dramatic effects of environmental and safety regulation. Still further documentation of the deleterious effects of regulation on productivity in coal mining can be found in Harris (1985) and Nelson (1983).

[21] Center for Naval Analyses, Southern Illinois University at Carbondale, and the University of North Carolina at Chapel Hill. Much of the work on this paper was done while the authors were visiting at Vanderbilt University and the University of Pennsylvania. Thanks go to these universities for their hospitality, to the Coal Research Center at SIU-C for its financial support, to John Myers for his assistance, to Ronald Warren for his helpful comments, to the Managing Editor, and to three perceptive referees, one of whose comments clarified and shortened the exposition of §3. All are absolved from responsibility for remaining shortcomings.