WHAT TYPES OF ORGANIZATIONS BENEFIT FROM TEAM PRODUCTION, AND HOW DO THEY BENEFIT?

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ABSTRACT

Using data from a large cross-section of British establishments, we ask how different firm characteristics are associated with the predicted benefits to organizational performance from using team production. To compute the predicted benefits from using team production, we estimate structural models for financial performance, labor productivity, and product quality, treating the firm's choices of whether or not to use teams and whether or not to grant teams autonomy as endogenous. One of the main results is that many firm characteristics are associated with larger predicted benefits from teams to labor productivity and product quality but smaller predicted benefits to financial performance. For example, this is true for union recognition as measured by the number of recognized unions in an establishment. Similarly, when a particular firm characteristic is associated with lower benefits from teams to labor productivity or product quality, the same characteristic is frequently associated with higher predicted benefits to financial performance. This is true for the degree of financial participation and employee ownership and also for establishment size and a

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number of industries. These results highlight the advantages of analyzing broader measures of organizational performance that are more inclusive of the wide spectrum of benefits and costs associated with teams than the labor productivity measures frequently studied in the teams literature.

1. INTRODUCTION

Arguments suggesting that innovative systems for organizing and managing employees generate improved employee achievement and organizational performance abound. Recent research on workplace practices transferring power to employees, described collectively as "high-performance practices," has identified employee participation as a key element of sustained competitive advantage. Employee participation in the form of team-based work structures, often "self-managed teams" conferred with considerable autonomy, figures prominently as one dimension of high-performance work systems and is the focus of this paper. Specifically, our goal is to shed light on the question of what types of organizations benefit from team production and how they benefit (e.g., through higher financial performance, labor productivity, or product quality).

Much of the vast literature on teams and other high-performance practices focuses on the question of *whether and how* organizations benefit from use of these practices, as opposed to the question of *what types* of organizations benefit. A popular approach is the case study, examining one or a relatively small number of firms, usually over time (e.g., Bartel, 2004; Batt, 1999, 2001, 2004; Hamilton, Nickerson, & Owan, 2003; Batt & Appelbaum, 1995). While the case study approach is useful for answering questions about whether and how organizations benefit from teams, it is somewhat less useful for answering questions about what types of organizations benefit, since by their very nature case studies involve little or no variation in firm characteristics. Introducing variation in firm characteristics usually requires comparisons of different case studies, as in meta analyses.[1] The difficulty with this approach is that studies vary widely in their data, measurement of variables, methodology, sampling period, geographic region of analysis, research questions, and in a variety of other respects. If the goal is to identify how a particular firm characteristic, say firm size, is associated with the predicted benefits to organizational performance from using teams, this question is unlikely to be answered convincingly through comparisons across case studies. Such a task would involve assembling a relatively small number of case studies that vary by the size of the organizations studied; inevitably these organizations will vary in a multitude of dimensions other than the firm size, making it impossible to control for these other factors. Even if it were possible to make controlled comparisons, it would not be clear what weights should be assigned to the individual studies being surveyed.

An alternative to the case study approach, and the one taken in this paper, is the use of broader cross-sections or panels of organizations. Examples of studies taking this approach include Black and Lynch (2001, 2004), DeVaro (2004a, b), Eriksson (2003), Kato and Morishima (2002), Cappelli and Neumark (2001), and Caroli and van Reenen (2001). Like case studies, broader samples of firms can shed light on the question of whether and how organizations benefit from teams. In addition, these data are somewhat more conducive to answering questions about what types of organizations benefit from teams, due to their inherent variation across organizational types. Of course, these broader data sets suffer a number of disadvantages relative to case studies. First, since the samples are more heterogeneous, the definitions of variables (for instance, the meaning of "team production") are not as obviously comparable as they would be across observations in a single case study. Second, significant heterogeneity in these samples increases the threat that unobserved heterogeneity may bias the estimated effect of teams on organizational performance. Other things equal, panel data are always preferable to cross sectional data in that they can accommodate individual effects to mitigate concerns about unobserved heterogeneity. However, exploiting such panel data in studies of team production invariably involves compromising either on the breadth of the sample or on the richness of the information available in the data or both.

Our study uses a large, nationally representative cross section of British establishments in 1998. Our sample has variation not only in whether or not team production is used, but on the type of team production used, in particular whether or not team members are granted autonomy. In addition to detailed firm characteristics for use as controls, the sample also includes multiple measures of organizational performance (financial performance, labor productivity, and product quality). To our knowledge, there are no large, nationally representative panel data sets available that contain information on the types of teams used (autonomous or non-autonomous), firm characteristics, and multiple measures of organizational performance. Our research strategy is therefore to exploit the unique and extensive information contained in our cross-sectional data, while estimating structural models to address concerns about unobserved heterogeneity biases.

There are three main distinguishing features of our work. First, we estimate structural models that treat the choices of team production and whether to grant teams autonomy as endogenous variables, as opposed to the typical approach that treats these variables as exogenous right-hand-side variables in a regression. Second, our models interact the "teams" treatment with all other firm characteristics (both observed and unobserved). Allowing the teams treatment effect to vary with organizational characteristics allows us to make statements about *what types* of organizations are predicted to benefit from team production.

Third, we compare three measures of organizational performance (financial performance, labor productivity, and product quality) in the same analysis, allowing us to make statements about *how* teams benefit organizational performance. Though there are some exceptions, such as DeVaro (2004a) and Huselid (1995), financial performance is rarely seen as the outcome measure in studies of the effects of high-performance practices on organizational performance. This variable is of particular interest as an overall measure of firm performance, since as a measure of profit it is more inclusive than other outcome measures of the wide array of benefits and costs associated with human resource practices.[2]

There are three stages to our empirical analysis. In the first stage, we estimate structural models for our three measures of organizational performance. In the second stage, we use the parameter estimates from the first stage to compute the "predicted benefit to organizational performance from using team production" for each establishment in our sample. In the third stage, we assess how a particular firm characteristic is associated with the predicted benefits to organizational performance from using team production, holding other firm characteristics constant.

A progressive example is useful for motivating our structural approach. Consider the following two regressions, where Y is a continuous measure of firm performance, TEAMS is a dummy variable equaling 1 if the firm uses team production and 0 otherwise, X is a firm characteristic such as firm size, and ε a disturbance term uncorrelated with TEAMS and firm size:

$$Y = \beta_0 + \beta_1 \text{ TEAMS } + \beta_2 X + \varepsilon \tag{1}$$

$$Y = \beta_0 + \beta_1 \text{ TEAMS } + \beta_2 X + \beta_3 (\text{TEAMS} \times X) + \varepsilon \tag{2}$$

(In practice, of course, X would be a vector containing many characteristics other than firm size.) If the goal is to ask what the effect of teams is on firm performance, either regression would be informative. The teams "treatment effect" of interest would be β_1 in Model 1 and $\beta_1 + \beta_3 X$ in Model 2. If, on the other hand, the goal is to ask (as in this paper) whether the benefits from teams are greater in larger firms than in smaller firms or vice versa, only Model 2 is informative. If the estimated β_3 is found to be negative, we would conclude that the benefits to organizational performance from using teams decrease with firm size. In sum, Model 2 provides a simple way of answering our research question of what types of firms (or in this example what size firms) benefit from team production.

Model 2 assumes that the unobserved determinants of firm performance are the same whether team production is used or not. Allowing these unobserved determinants of firm performance to differ by whether or not teams are used, or interacting TEAMS with ε, yields the following generalization of Model 2:

$$\begin{aligned} Y &= \beta_0 + \beta_1 X + \varepsilon_1 \quad \text{if TEAMS} = 1 \\ &= \beta_2 + \beta_3 X + \varepsilon_0 \quad \text{if TEAMS} = 0 \end{aligned} \tag{3}$$

The teams treatment effect in Model 3 is $(\beta_0 - \beta_2) + (\beta_1 - \beta_3)X$. This is computationally identical to the teams treatment effect in Model 2. Models 1–3 can be criticized on the grounds that they assume that the disturbances are uncorrelated with TEAMS, a case that is quite difficult to make. Even if X were to include a detailed set of observable firm characteristics, there would inevitably be some inherently unobservable factors (such as managerial talent or the degree of congeniality and cooperation among the workers) that would influence both firm performance and the tendency of the firm to engage in team production. The consequence is that in all three regressions the estimated teams treatment effect is biased, yielding misleading answers to the question of whether firms benefit from team production and to the question of whether large firms experience different benefits from teams than do small firms.

To address this endogeneity problem, one can specify an additional equation that determines TEAMS. Letting TEAMS* denote a continuous latent index that can be thought of as the firm's propensity to engage in team production, consider the following Model 4:

$$\begin{aligned} Y &= \beta_0 + \beta_1 X + \varepsilon_1 \quad \text{if TEAMS} = 1 \\ &= \beta_2 + \beta_3 X + \varepsilon_0 \quad \text{if TEAMS} = 0 \\ \text{TEAMS}^* &= \alpha_0 + \alpha_1 Z + \varepsilon_2 \\ \text{TEAMS} &= 1 \quad \text{if TEAMS}^* > 0 \\ &= 0 \quad \text{if TEAMS}^* \leq 0 \end{aligned} \tag{4}$$

Assuming multivariate normality of the disturbances, estimation of this model yields consistent estimates of the teams' treatment effect of interest.

Whereas in Model 3 we incorrectly imposed (implicitly) the assumptions $cov(\varepsilon_1, \varepsilon_2) = 0$ and $cov(\varepsilon_0, \varepsilon_2) = 0$, in Model 4 these covariances are unrestricted parameters to be estimated.

The structural models we estimate in this paper are only slightly more complicated than Model 4, the two main differences being that our measures of Y are discrete rather than continuous and that we introduce autonomy into the model and treat it as endogenous in addition to teams. These models were proposed and estimated in a pair of recent related papers (DeVaro, 2004a, b). The first of these considered financial performance (interpreted as profit) as the measure of organizational performance, and the second considered labor productivity and product quality. Both papers addressed the question of whether the team production affects organizational performance but did not consider how these effects differ in different types of firms. In the present paper, we consider all the three measures of organizational performance and ask how the predicted benefits of teams vary with organizational characteristics. We now turn to a discussion of the theoretical background underlying teams research and previous evidence on what types of organizations are most likely to benefit from team structures.

2. PREVIOUS RESEARCH ON FIRM CHARACTERISTICS AND THE BENEFITS OF TEAMS TO ORGANIZATIONAL PERFORMANCE

Theoretical models in the economics literature on the effects of team production on organizational performance involve a comparison of the benefits and costs to team production (Alchian & Demsetz, 1972). Some of the main benefits of team production accrue through productive information sharing among workers, when potential team members have knowledge that is non-duplicative and also relevant to the production process (Lazear, 1995, 1998). The potential costs of team production include costs associated with regular team meetings and training, and shirking and free-riding among team members (Alchian & Demsetz, 1972; Holmstrom, 1982; Rasmusen, 1987; Itoh, 1991, 1992; McAfee & McMillan, 1991; Legros & Matthews, 1993). Kandel and Lazear (1992) argue that teams alleviate costly monitoring of workers in the presence of asymmetric information by relying on monitoring of workers through peer pressure.

In empirical work, team structures are sometimes the central focus of the analysis (e.g., DeVaro, 2004a,b; Hamilton et al., 2003; Boning, Ichniowski, &

Shaw, 2003) and are sometimes one of a number of high performance practices that are analyzed together (e.g., Eriksson, 2003; Black & Lynch, 2001; Ichniowski, Shaw, & Prennushi, 1997). Frequently the teams under study are self-managed or autonomous, reflecting the fact that such teams are used more commonly than closely managed or non-autonomous teams.[3] A common finding in the literature is that autonomous teams have positive effects on firm performance. For example, Eriksson (2003) finds a positive effect of self-managed teams on labor productivity in a cross section of establishments, and Hamilton et al. (2003) finds a 14% increase in labor productivity after the introduction of self-managed teams in a garment manufacturing plant.

2.1. What Types of Organizations Benefit from Team Production?

While much has been written on the subject of whether and how teams confer benefits to organizational performance, less attention has been devoted to the question of what types of organizations benefit from teams. Our analysis addresses a large number of organizational characteristics, but the following four are of particular interest: union membership, firm size, financial participation and employee ownership, and industry. We now discuss what the previous literature has to say about the relationship between teams and each of these in turn.

2.2. Union Membership

While some argue that the presence of unions at the workplace constrains the ability of management to redesign jobs to incorporate new work systems such as teams, others claim that unions can promote the introduction and continued existence of such systems by facilitating increased dialogue between workers and management. A meta-analysis conducted by Doucouliagos and Laroche (2003) concluded that unions have a negative impact overall on labor productivity in the United Kingdom.[4] Empirical evidence in the previous literature on the relation between the presence of unions and teams has been mixed. Osterman (1994) found that the presence of unions in an organization is not an important determinant of the adoption of high-performance workplace practices, including self-managed teams, whereas McNabb and Whitfield (1997) found that recognized unions facilitate the introduction of teamwork in establishments.

Apart from this issue of adoption of teams, the question of whether the benefits to firm performance from using teams vary with the presence of unions has been addressed by Black and Lynch (2004). That study found that when union membership and self-managed teams are interacted in a cross section regression, the effect on labor productivity is negative, suggesting that unionized establishments that use self-managed teams tend to have lower labor productivity. When union membership and self-managed teams are interacted in a fixed effects regression, the effect on labor productivity is positive. However, neither of these results was statistically significant. McNabb and Whitfield (1997) used cross sectional data from the third wave of the Worker Industrial Relations Survey (the wave previous to the one used in the current paper) to show that the joint effect of union presence and teamwork on relative financial performance is positive. Our findings are closer to Black and Lynch's cross-sectional results in that ours suggest negative relationships between financial performance and both the presence of unions in the establishment and the number of recognized unions in the establishment.

2.3. Firm Size

To our knowledge, there has been no work done on the relationship between firm size and the predicted benefits from team production, though some attention has been devoted to the question of how the adoption of team production varies with firm size. For example, Osterman (1994) used data on 694 manufacturing establishments in the U.S. to find that smaller establishments are more likely to adopt innovative work practices including teams. McNabb and Whitfield (1997), on the other hand, found that the propensity to adopt teamwork programs is positively associated with firm size and being part of a large organization. The question of whether the benefits from team production vary by firm size is of interest if for no other reason than the fact that most labor market measures vary with firm size. One story that could give rise to a firm-size effect concerns the relative costs of alternative means of monitoring workers. It might be that in smaller organizations, internal monitoring by peers in the context of teams is more effective than in larger organizations. An alternative story that would suggest the opposite result is that larger organizations face greater problems of coordination and information sharing than do smaller organizations, so that the benefits from teams would be increasing in the scale of the organization.

2.4. Financial Participation and Employee Ownership

In our study, worker participation in firm decision-making is considered at the group level and is reflected in the granting of autonomy to team members (giving team members the latitude to jointly decide how the work is to be done). Since over half of the teams in our sample are autonomous by this definition, the decision to organize production in teams very often coincides with a decision to increase the degree of worker participation in firm decision making at the group level. Recent research has shown that such employee involvement in decision making is an effective means of enhancing firm performance when implemented along with employee ownership schemes such as profit sharing and share ownership (Kruse et al., 2004; Kruse, 2002; Freeman & Dube, 2000; Kruse & Blasi, 1997; Ichniowski et al., 1997; Ben-Ner & Jones, 1995). Eriksson (2003) argued that new work practices and new pay practices such as teams bonus, individual bonus, stock or stock options, and profit sharing are complementary in the sense that, if a firm that has adopted new work practices introduces performance-related pay schemes, this enhances productivity further, though this complementarity is found to be more on the level of individual compensation schemes, rather than group-based pay incentives. Ben-Ner and Jones (1995) argued that both ownership without participation, and participation without ownership, can actually decrease firm performance by increasing worker–firm conflict. Adams (2003) found the existence of complementarities between the use of profit sharing and the delegation of decision-making power on an individual basis to production line workers.

Other studies have argued that financial participation is conducive to aligning the goals of the employees with the goals of the firm by directly linking the workers' pay to firm performance. However, the goal-alignment process needs to be supported both by financial participation and employee ownership, or what is called "direct participation," and employee involvement in decision making at all levels of the firm hierarchy, or what is called "indirect participation" (Kato & Morishima, 2002). Kruse (2002) has explained the intuition as follows: "Employee ownership may improve firm performance by decreasing labor-management conflict and serving as a collective incentive to improve workplace cooperation, information-sharing, and organizational citizenship behavior. This may be limited by the free-rider problem when rewards are shared with co-workers, direct incentives for better work becomes weak as the number of coworkers expands. To counteract this problem and encourage higher performance, firms may combine employee ownership with employee participation in decision-making and other human resource policies to encourage a sense of ownership, draw more fully on worker skills and information, and create company spirit and work norms." (p. 71). In this paper, we present evidence corroborating this complementarity hypothesis; our analysis shows that establishments whose employees engage in higher levels of financial participation are also more likely to benefit from team production through higher financial performance.

2.5. Industry

According to the cross sectional analysis of McNabb and Whitfield (1997), the presence of teamwork programs is most common in the wholesale and retail sectors, and least likely in production industries and non-metal manufacture, whereas establishments in banking, insurance, and finance are generally more likely to adopt teams. Empirical statements about which industries experience the largest predicted benefits from teams and other workplace practices must be made primarily on the basis of comparisons of different case studies or different industry-specific data sets. The vast majority of past studies have focused on the manufacturing industry. Comparatively less is known about the effects of teams on firm performance in other industries, though there are some results. In services, an example is Batt (1999), which found that the use of self-managed teams among customer service and sales workers yields a statistically significant improvement in self-reported service quality and sales per employee (the measure of labor productivity in sales occupations). When combined with new technology usage, teams boost sales by an even greater magnitude. Batt and Appelbaum (1995) looked at two industries, namely telecommunications (where they considered customer service staff as well as ''network crafts'' occupations such as installation and repair crews) and apparel manufacturing (where they considered sewing machine operators) and found that teams have a significant and positive impact on workers' perceptions of the quality of work done by their work groups.[5] Batt's (2001) empirical results suggest that there are no significant differences in labor productivity and service quality when field technicians work in teams rather than independently.

In manufacturing, the effect of teams and other high-performance work practices has generally been found to be positive. Hamilton et al. (2003) found a 14% increase in labor productivity after a switch to self-managed teams in a garment-manufacturing plant in Northern California. Also in the apparel manufacturing industry, Berg, Appelbaum, Bailey, and Kalleberg (1996) found that team production improved such outcomes as quality, costs, and responsiveness to retailers via better coordination among team members as a result of their ability to self-regulate work, eliminate bottlenecks, resolve conflicts, help one another to solve problems, and make improvements to the production process.

Boning et al. (2003) used data from the steel-manufacturing sector to find that production lines that adopt problem-solving teams experience large gains in productivity. However, this is true only for production lines that undertake complex production processes and products – in less complex environments, there is no benefit to using teams. Ichniowski et al. (1997) studied the effects of high-performance workplace systems in a specific production process in steel manufacturing, namely steel finishing lines. They considered teams (specifically the existence and prevalence of formal work teams for the purposes of problem-solving activities, and worker membership in multiple problem-solving teams) as one of a number of human resource management (HRM) practices used, though their focus was on HRM systems more generally rather than teams specifically. Their results indicate that finishing lines, which utilize a set of innovative work practices have higher levels of worker productivity than lines that use more traditional practices and that there exist complementarities between certain high-performance practices.

Black and Lynch (2001) found that U.S. firms in manufacturing that use high-performance workplace practices, such as regular group meetings, benchmarking, self-managed teams and profit sharing have higher productivity and wages than other firms. Black and Lynch (2004) suggested that the adoption of such innovations was an important factor contributing to the jump in multifactor productivity of the U.S. economy in the second half of the 1990s. On the other hand, Cappelli and Neumark (2001) studied the effects of high-performance work practices including benchmarking, regularly scheduled group meetings to discuss work-related problems, job rotation, self-managed teams, pay for skill and profit sharing in a panel of manufacturing firms. Their results show that these practices may raise productivity, though with little statistical significance, and that the effects on overall labor efficiency are small.

3. DATA: WORKPLACE EMPLOYEE RELATIONS SURVEY (WERS) 1998

The data are from the management questionnaire in the 1998 wave of the British Workplace Employee Relations Survey (WERS) (Department of Trade and Industry and Advisory, 2001), jointly sponsored by the Department of Trade and Industry, ACAS, the Economic and Social Research Council, and the Policy Studies Institute. Distributed via the UK Data Archive, the WERS data are a nationally representative stratified random sample covering British workplaces with at least 10 employees except for those in the following 1992 Standard Industrial Classification (SIC) divisions: agriculture, hunting, and forestry; fishing; mining and quarrying; private households with employed persons; and extra-territorial organizations. Some of the 3,192 workplaces targeted were found to be out of scope, and the final sample size of 2,191 implies a net response rate of 80.4% (Cully, Woodland, O'Reilly, & Dix, 1999) after excluding out-of-scope cases. Data were collected between October 1997 and June 1998 via face-to-face interviews, and the respondent was usually the most senior manager at the workplace with responsibility for employment relations. Table 1 displays the industry composition of the sample, using 12 industry categories in the 1992 SIC.

Table 1. Distribution of Workplaces by Industry and Largest Occupational Group.

	Number of Establishments	Percent of Total
Distribution by industry		
Manufacturing	299	13.7
Electricity, gas, and water	80	3.7
Construction	112	5.1
Wholesale and retail	322	14.7
Hotels and restaurants	127	5.8
Transport and communication	136	6.2
Financial services	101	4.6
Other business services	227	10.4
Public administration	183	8.4
Education	244	11.1
Health	249	11.4
Other community services	111	5.1
Total	2191	100
Distribution by largest occupational group at workplace		
Managers and administrators	15	0.7
Professional occupations	309	14.1
Associate professional and technical occupations	180	8.2
Clerical & secretarial occupations	390	17.8
Craft & related occupations	231	10.5
Personal and protective service occupations	314	14.3
Sales occupations	237	10.8
Plant and machine operatives	278	12.7
Other occupations	237	10.8
Total	2191	100

Our measures of organizational performance are discrete responses to three survey questions concerning the establishment's current financial performance, labor productivity, and quality of product or service, relative to other establishments in the same industry. Responses include: "A lot better than average", "Better than average", "About average for industry", "Below average", "A lot below average", and "No comparison possible". Few establishments report below-average performance for any of the three measures. While this might indicate reporting error in the dependent variables, such errors need not have consequences for our analysis unless a respondent's likelihood of overstating performance is systematically related to the choices of teams and autonomy.[6] Furthermore, an establishment's inclusion in the sample is conditional on its being operational, and length-biased sampling arises when operational establishments are sampled at a point in time. High-performing establishments have long durations of operation and are more likely to be sampled than low-performing establishments with low durations of operation. The pronounced asymmetry in reported performance that is observed in the data is therefore not surprising.[7]

The 1998 wave of the WERS includes a follow-up question asking respondents their interpretation of the term "financial performance". The frequency of responses is as follows:[8]

Interpretation of "financial performance"	Number of Firms	% of Firms
Profit or value added	952	52.9
Sales, fees, budget	374	20.7
Costs or expenditure	389	21.6
Stock market indicators (e.g., share price)	54	3.0
Other specific answer	31	1.7
Total	1,800	100.0

Studies using earlier waves of these data did not have access to this follow-up question and were forced to pool disparate interpretations of the dependent variable in the same analysis (Machin & Stewart, 1990, 1996; McNabb & Whitfield, 1997). As shown in DeVaro (2004a), the estimated effect of teams on financial performance is very sensitive to the interpretation of financial performance. When estimating the model for financial performance, we use only those establishments interpreting financial performance as profit or value added.

A skeptic might argue that the three subjective measures of organizational performance are measuring essentially the same thing. If that were the case, we would expect extremely high correlations among the three measures. This is not so, as revealed by the following correlation matrix:

Correlation Matrix for the Measures of Organizational Performance.

	Financial Performance	Labor Productivity	Product Quality
Financial performance	1.000		
Labor productivity	0.507	1.000	
Product quality	0.328	0.352	1.000

The correlations are all positive and statistically significant at the 1% level, but their average value is only 0.40.

For each establishment, the data contain information about the proportion of employees in the largest occupational group that works in formally designated teams. Responses are in the following discrete categories: "All 100%", "Almost all 80–99%", "Most 60–79%", "Around half 40–59%", "Some 20–39%", "Just a few 1–19%", "None 0%". An advantage of this survey question is that it specifically refers to "formally designated" teams. This precise wording of the question directs the respondent's attention to situations of true joint production and should reduce the respondent's likelihood of reporting the use of teamwork simply on the basis of a cooperative or friendly atmosphere of "team spirit" at the workplace. A drawback of the survey question is that it is restricted to the largest occupational group at the establishment. The sample may contain establishments in which team production is heavily used in occupational groups other than the largest, yet the response to this question might be "None 0%". This measurement issue is one limitation of the study.

The survey also contains a measure of team autonomy that corresponds well to the notions of autonomy discussed in the theoretical literatures of economics and organizational behavior (Aghion & Tirole, 1997; Hackman, 1987).[9] For establishments that report the use of formally designated teams in the largest occupational group, the respondent manager is asked to respond "Yes" or "No" to the following statement: "Team members jointly decide how the work is to be done." Since both the team and autonomy variables are defined in terms of the establishment's largest occupational group, we provide the distribution of the sample by largest occupational group in the lower panel of Table 1. All observations in the WERS are coded according to the UK Office of Population, Censuses and Surveys

Standard Occupational Classification (SOC) codes, and we aggregated these to produce nine one-digit categories.

4. METHODOLOGY

There are three stages to our methodology. First, we estimate structural models for each of our three measures of organizational performance (financial performance, labor productivity, and product quality). Second, we use the estimated parameters from the first stage to compute for each establishment in the sample a "predicted benefit to organizational performance from using team production". These first two stages closely follow DeVaro (2004a,b), so our treatment here is brief, and we relegate the technical details to the appendix. Third, we ask how the "predicted benefit" computed in our second stage varies as a function of the firm characteristics in the model. This sheds light on what types of firms are likely to benefit from team production and in what areas (financial performance, labor productivity, and product quality) they are likely to benefit.

4.1. Stage 1: Estimating Structural Models of Teams, Autonomy, and Organizational Performance

The model has the same structure for each measure of organizational performance. Since the three endogenous variables (organizational performance, teams, and autonomy) in each model are observed as discrete responses, the structural model specifies probabilities for all possible outcomes. To make the analysis tractable, some aggregation is needed to reduce the number of outcomes. Since relatively few respondents report below-average performance, we aggregate the lowest three categories for each of the organizational performance measures as follows: 1 = "About average for industry" or below; 2 = "Better than average"; 3 = "A lot better than average". Furthermore, we consider only whether team production is used or not in the largest occupational group, rather than focusing on the fraction of that group that engages in team production. That is, we aggregate the teams variable as follows:

TEAMS	=	1 if positive fraction of workers in the largest occupational group is in teams
	=	0 otherwise

The sequence of the model is as follows. First, the establishment decides whether or not to use teams (TEAMS = 0 or 1). Given that teams are chosen, the establishment then decides whether to grant the teams autonomy (AUTO = 0 or 1). Finally, these choices of teams and autonomy affect organizational performance. Let Y_i^* denote a latent indicator of organizational performance for the ith establishment, relative to the industry average, and let Y_i denote its ordered, discrete realization, taking values of 1, 2, or 3. The four-equation structural model has the following form:

$$
\begin{aligned}
Yi^* &= \alpha \mathrm{AUTO}_i + \boldsymbol{X_{1i}\delta_1} + \varepsilon_{1i} \quad \text{if TEAMS}_i = 1 \\
&= \boldsymbol{X_{1i}\delta_2} + \varepsilon_{0i} \quad \text{if TEAMS}_i = 0 \\
\mathrm{TEAMS}_i{*} &= \boldsymbol{X_{2i}\beta} + \varepsilon_{2i} \\
\mathrm{AUTO}_i{*} &= \boldsymbol{X_{3i}}\gamma + \varepsilon_{3i} \quad \text{if TEAMS}_i = 1 \\
Y_i &= 1 \quad \text{if } Y_i^* < 0 \\
&= 2 \quad \text{if} 0 \leq Y_i^* < c \quad \text{where } c > 0 \\
&= 3 \quad \text{if } Y_i^* \geq c
\end{aligned}
$$

$$
\begin{aligned}
\mathrm{TEAMS}_i &= 1 \quad \text{if TEAMS}_i{*} > 0 \\
&= 0 \quad \text{otherwise} \\
\mathrm{AUTO}_i &= 1 \quad \text{if AUTO}_i{*} > 0 \quad \text{and TEAMS}_i{*} > 0 \\
&= 0 \quad \text{if AUTO}_i{*} \leq 0 \quad \text{and TEAMS}_i{*} > 0
\end{aligned}
$$

We assume multivariate normality of the disturbances, $(\varepsilon_0, \varepsilon_1, \varepsilon_2, \varepsilon_3) \sim N(\mathbf{0}, \mathbf{\Sigma})$, and estimate the four equations jointly by maximum likelihood. The vector of parameters to be estimated, $\boldsymbol{\theta}$, includes α, $\boldsymbol{\delta}_1$, $\boldsymbol{\delta}_2$, c, $\boldsymbol{\beta}$, γ, σ_{02}, σ_{12}, σ_{13}, and σ_{23}, where the notation σ_{ij} means $cov(\varepsilon_i, \varepsilon_j)$.

By treating organizational performance as a switching regression, we allow for a full set of interactions between teams and all observed and unobserved determinants of performance. Autonomy, on the other hand, enters only as a dummy-endogenous variable on the right-hand-side of the organizational performance equation when teams are used. In principle, it would be possible to allow for a full set of interactions of autonomy with the determinants of performance, but that analysis would not be feasible with our sample size.[10]

4.2. Stage 2: Constructing Predicted Benefits of Teams to Organizational Performance

The estimation results from Stage 1 allow us to construct measures of the "predicted benefits from using teams" for each establishment in the sample. Recall that the measures of organizational performance assume values of

1, 2, or 3 according to whether the establishment's recent performance relative to that of others in the industry is average or below, better than average, or a lot better than average. The effect of teams on organizational performance is the change in the probabilities that performance is in each of these three categories when team production is used in the largest occupational group compared to when it is not used. Letting Y_i denote the discrete measure of organizational performance (taking values 1 = "average or below", 2 = "above average", 3 = "a lot above average"), the following three measures give the effect of team production on performance for establishment i:[11]

$$(\mathit{EffectA}1)_i = \mathrm{Prob}(Y_i = 1|\mathrm{TEAMS}_i = 1) - \mathrm{Prob}(Y_i = 1|\mathrm{TEAMS}_i = 0)$$
$$(\mathit{EffectA}2)_i = \mathrm{Prob}(Y_i = 2|\mathrm{TEAMS}_i = 1) - \mathrm{Prob}(Y_i = 2|\mathrm{TEAMS}_i = 0)$$
$$(\mathit{EffectA}3)_i = \mathrm{Prob}(Y_i = 3|\mathrm{TEAMS}_i = 1) - \mathrm{Prob}(Y_i = 3|\mathrm{TEAMS}_i = 0)$$

Since for an individual establishment these three effects must sum to 0, any two of them contain all of the information about the effect of team production on that establishment's performance. We therefore focus on *Effects* *A*1 and *A*3.

4.3. Stage 3: How Do the Predicted Benefits from Teams Vary with Firm Characteristics?

We next ask how the predicted benefit from using team production that we compute in Stage 2 varies as a function of the covariates in the model. That is, we are interested in seeing how the functions *EffectA*3 and *EffectA*1 vary with changes in a particular firm characteristic, holding the other firm characteristics constant. We do this computation slightly differently according to whether the covariate in question is a single dummy variable, one dummy variable from a group of related dummies, or a "continuous" variable.[12] When the covariate of interest is a dummy variable, X, we compute $(\mathit{EffectA}3|X = 1) - (\mathit{EffectA}3|X = 0)$ for each workplace, evaluating each of the other covariates at their actual establishment values. Then we take the average of these differences across all workplaces in the sample to obtain a summary measure of how *EffectA*3 varies with changes in X. We follow the analogous approach for *EffectA*1. If the particular X is one dummy in a group of related dummies the computation is the same as the one just described, except that the other dummies in the same group are evaluated at 0 rather than at their observed values for each workplace. The three groups of dummies that are considered in this way are the industry, occupation, and ownership variables. The reference group for each of these categories is the wholesale and retail industry, clerical and secretarial occupations, and public sector workplaces. Finally, when the covariate of interest is "continuous", the differences we compute are not between $X = 1$ and $X = 0$ but rather between the 0.75 and 0.25 quantile of X, again evaluating all of the other covariates at their individual values for each workplace.

More precisely, consider the following definitions:

x_{ji} $\equiv$ covariate j for establishment i

$x_{k \neq j,i}$ $\equiv$ vector of covariates for establishment i excluding covariate x_{ji}

$x^{*}_{k \neq j,i}$ $\equiv$ vector of covariates for establishment i excluding covariate x_{ji} when x_{ji} is one dummy variable in a multiple-dummy group, setting to 0 all other dummies in the multiple-dummy group to which x_{ji} belongs

x^{q}_{j} $\equiv$ quantile q of covariate x_j

Then the following expressions illustrate how *EffectsA*3 and *A*1 change, on average, with a particular covariate x_j:

Case 1: x_j is binary but not part of a multiple-dummy group

$$\Delta EffectA3 = \left(\frac{1}{N}\right)\sum_{i=1}^{N}\left(EffectA3\left[x_{ji}=1, x_{k \neq j,i}\right] - EffectA3\left[x_{ji}=0, x_{k \neq j,i}\right]\right)$$

$$\Delta EffectA1 = \left(\frac{1}{N}\right)\sum_{i=1}^{N}\left(EffectA1\left[x_{ji}=1, x_{k \neq j,i}\right] - EffectA1\left[x_{ji}=0, x_{k \neq j,i}\right]\right)$$

Case 2: x_j is binary and part of a multiple-dummy group (i.e., industry, occupation, ownership)

$$\Delta EffectA3 = \left(\frac{1}{N}\right)\sum_{i=1}^{N}\left(EffectA3\left[x_{ji}=1, x^{*}_{k \neq j,i}\right] - EffectA3\left[x_{ji}=0, x^{*}_{k \neq j,i}\right]\right)$$

$$\Delta EffectA1 = \left(\frac{1}{N}\right)\sum_{i=1}^{N}\left(EffectA1\left[x_{ji}=1, x^{*}_{k \neq j,i}\right] - EffectA1\left[x_{ji}=0, x^{*}_{k \neq j,i}\right]\right)$$

Case 3: x_j is continuous

$$\Delta EffectA3 = \left(\frac{1}{N}\right)\sum_{i=1}^{N}\left(EffectA3\left[x_{ji} = x_j^{0.75}, x_{k\neq j,i}\right] - EffectA3\left[x_{ji} = x_j^{0.25},\ x_{k\neq j,i}\right]\right)$$

$$\Delta EffectA1 = \left(\frac{1}{N}\right)\sum_{i=1}^{N}\left(EffectA1\left[x_{ji} = x_j^{0.75}, x_{k\neq j,i}\right] - EffectA1\left[x_{ji} = x_j^{0.25},\ x_{k\neq j,i}\right]\right)$$

The preceding definitions refer to the quantiles 0.25 and 0.75. Note, however, that the estimation samples differ for the three measures of organizational performance ($N = 889$ for financial performance, $N = 1,660$ for labor productivity, $N = 1,839$ for product quality) and therefore the quantiles may differ as well. Since most of the covariates are binary, however, the quantiles of interest are frequently identical across the three estimation samples. The only exceptions are establishment size, number of part time workers, financial participation, multi-skilling, and number of recognized unions, and for these variables the quantiles differ only slightly across the three samples. For consistency, we define all quantiles using the largest sample of the three, namely the product quality sample. We also tried estimating all three models on the smallest sample of 889 observations, so that the quantiles exactly coincided for each model, and the results were similar to those we report here. Our preference, however, is to report results based on the largest estimation sample possible for each of the three measures of organizational performance.

5. EMPIRICAL RESULTS

Table 2 displays means and standard deviations of the variables in the model. We present the parameter estimates from the structural models (Stage 1 of our three-stage methodology outlined in the previous section) in Appendix Tables A1–A3. Since the structural models are non-linear, these parameter estimates lack straightforward interpretations. For our purposes, they are useful mainly for computing *EffectsA*3 and *A*1 in Stage 2 for each of the three measures of organizational performance. The difference between *EffectA*3 and *EffectA*1 provides a univariate index of the predicted benefits of team production on organizational performance and facilitates a simple presentation of the distributions of these benefits.[13] Figs. 1–3 display kernel density estimates of ($EffectA3 - EffectA1$) for financial performance, labor productivity, and product quality. These distributions have a slight

Table 2. Means and Standard Deviations.

	Mean	Standard Deviation
Dependent variables		
Financial performance	1.801	0.728
Labor productivity	1.632	0.681
Product quality	1.942	0.701
Teams	0.870	0.337
Autonomy	0.554	0.497
General firm characteristics		
Single-establishment firm	0.217	0.412
Establishment size	294.308	857.423
Fraction of part time workers	0.258	0.280
Temporary workers	0.380	0.486
Fixed term workers under one year	0.439	0.496
Fixed term workers over one year	0.241	0.428
Union workers	0.659	0.474
Financial participation	0.633	0.482
Owner manager	0.096	0.294
Foreign owned	0.104	0.305
Operation over five years	0.890	0.313
Multi-skilling	3.000	1.852
Number of recognized unions	1.538	2.006
Induction training	0.844	0.363
Off-site training	3.941	2.040
Just-in-time production	0.296	0.457
Information	2.729	1.086
Incentive alignment	2.310	0.846
Decisions	3.742	0.980
Work at home	5.369	0.930
Firm ownership		
Private sector franchise	0.011	0.106
Private sector non-franchise	0.372	0.483
Alternative private sector franchise	0.011	0.104
Alternative private Sector non-franchise	0.300	0.458
Public sector	0.309	0.462
Industry		
Manufacturing	0.136	0.343
Electricity, gas, and water	0.037	0.188
Construction	0.051	0.220
Wholesale and retail	0.147	0.354
Hotels and restaurants	0.058	0.234
Transport and communication	0.062	0.241
Financial services	0.046	0.210
Other business services	0.104	0.305

Table 2. (*Continued*)

	Mean	Standard Deviation
Public administration	0.084	0.277
Education	0.111	0.315
Health	0.114	0.317
Other community services	0.051	0.219
Largest occupational group at workplace		
Managers and administrators	0.007	0.082
Professional occupations	0.141	0.348
Associate professional and technical occupations	0.082	0.275
Clerical and secretarial occupations	0.178	0.383
Craft and related occupations	0.105	0.307
Personal and protective service occupations	0.143	0.350
Sales occupations	0.108	0.311
Plant and machine operatives	0.127	0.333
Other occupations	0.108	0.311

Note: Statistics for financial performance are computed using the subsample of 952 establishments for which financial performance is interpreted to mean profit or value added. For all other variables, statistics are based on the full sample.

negative skew for financial performance and labor productivity and a slight positive skew for product quality. As the graphs illustrate, all three distributions peak at a positive number, indicating that the typical establishment is predicted to benefit from team production through higher labor productivity, product quality, and financial performance.[14]

Our main results are from Stage 3 of our analysis, and these are displayed in Tables 3–5 for financial performance, labor productivity, and product quality. The first and second columns of each table illustrate how $EffectsA3$ and $A1$ vary with a particular firm characteristic, holding the other characteristics constant. The third column displays the difference between the first two columns, thus answering the question of how ($EffectA3-EffectA1$) varies with a particular covariate, holding the others constant. Table 6 summarizes the qualitative results from Tables 3–5 by listing firm characteristics along with the sign of their predicted effect on organizational performance (i.e., the sign of $\Delta(EffectA3 - EffectA1)$). Before commenting on the results, we note that a limitation of our analysis is that many of the parameters underlying the predicted benefits of teams are estimated with low precision. As a result, the confidence bands associated with the differences we report in Tables 3–5 would be fairly wide. Our results should therefore be viewed as suggestive, and definitive statements will require corroboration in future work with new data sets.

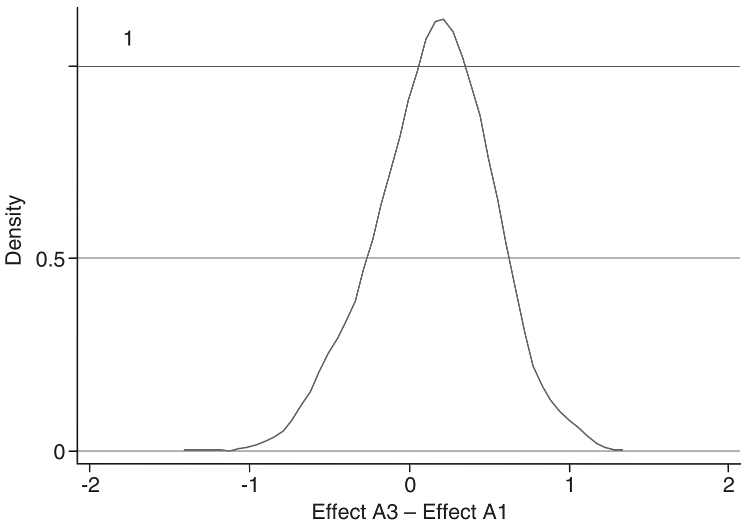

Fig. 1. (*EffectA*3 − *EffectA*1) for the Financial Performance Model. *Note:* (*EffectA*3− *EffectA*1) is a Measure of the Degree to which a Firm Benefits in Terms of Its Financial Performance from Team Production. *EffectA*3 is the Effect of Team Production on the Probability that a Firm's Financial Performance is a Lot Above Industry Average, and *EffectA*1 is the Effect of Team Production on the Probability that a Firm's Financial Performance is Average or Below. The Bandwidth of 0.083 was Chosen to Minimize the Mean-integrated Squared Error if the Data were Gaussian and a Gaussian Kernel were Used.

The results concerning unions, firm size, industry, and financial participation and employee ownership are of particular interest. As seen in Table 6, workplaces at which some employees belong to a union are predicted to lose in all three dimensions from using teams. Having some unionized workers is associated with a decrease of more than 7 percentage points in the probability that labor productivity is a lot above the industry average and more than a 5 percentage point decrease in the probability that product quality is a lot above the industry average. These changes are accompanied by increases in the probability that performance is at or below the industry average of more than 15 percentage points for labor productivity and nearly 7 percentage points for product quality. The predicted benefit of teams to financial performance is also lower in the presence of unionized workers. While the probability that financial performance is a lot above the industry average is actually slightly higher in unionized settings, the probability that financial performance is average or below also increases (and by a greater amount).

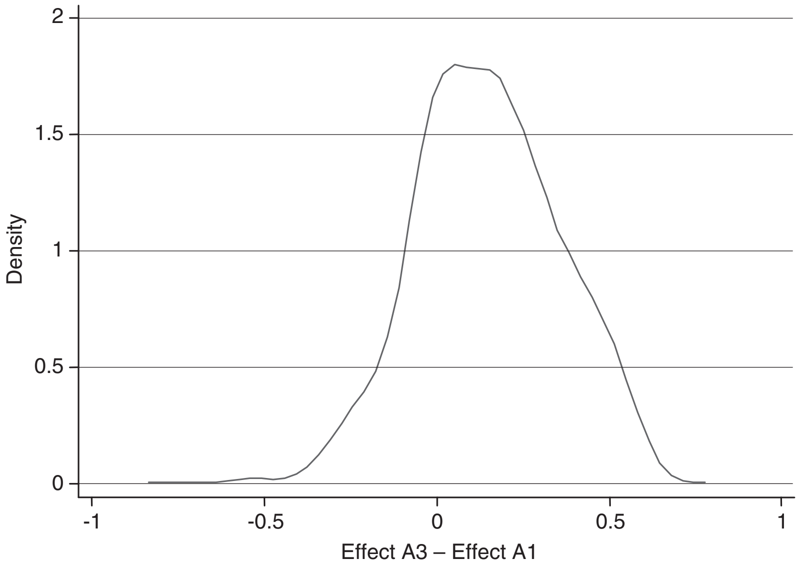

Fig. 2. (*EffectA*3 – *EffectA*1) for the Labor Productivity Model. *Note:* (*EffectA*3– *EffectA*1) is a Measure of the Degree to which a Firm Benefits in Terms of its Labor Productivity from Team Production. *Effect*A3 is the Effect of Team Production on the Probability that a Firm's Labor Productivity is a Lot Above Industry Average, and *EffectA*1 is the Effect of Team Production on the Probability that a Firm's Labor Productivity is Average or Below. The Bandwidth of 0.043 was Chosen to Minimize the Mean-integrated Squared error if the Data were Gaussian and a Gaussian Kernel were Used.

While a greater degree of union recognition (measured by the total number of recognized unions at the workplace) is associated with benefits to labor productivity and product quality from using teams, the reverse is true for financial performance. This result highlights the type of misleading inference that might be drawn by focusing solely on outcome measures, such as labor productivity and product quality (both of which are common in the empirical teams literature) rather than on broader measures such as financial performance that are more inclusive of various benefits and costs. While labor productivity and product quality might indeed be helped by teams in settings with high union recognition, it might be that the costs of organizing team members are prohibitively large and overshadow the benefits.

These results concerning unions, along with the finding from Black and Lynch (2004) that the interaction of union membership and self-managed

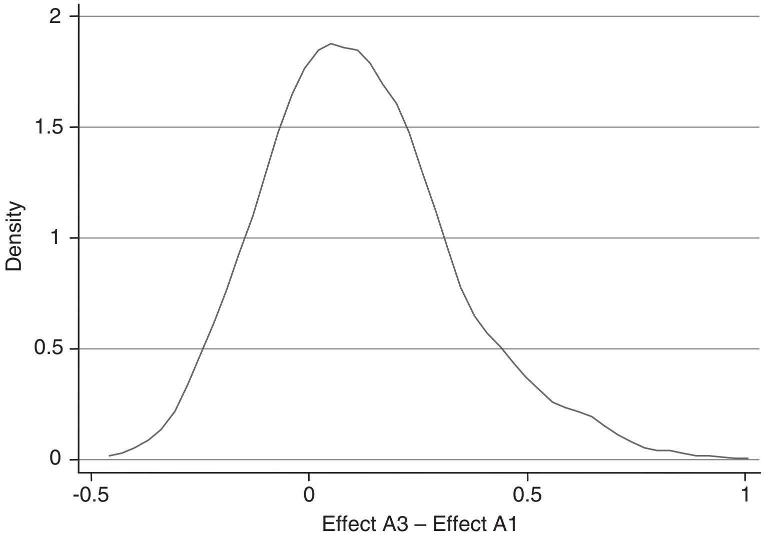

Fig. 3. (*EffectA*3 – *EffectA*1) for the Product Quality Model. *Note:* (*EffectA*3– *EffectA*1) is a Measure of the Degree to which a Firm Benefits in Terms of its Product Quality from Team Production. *EffectA*3 is the Effect of Team Production on the Probability that a Firm's Product Quality is a Lot Above Industry Average, and *EffectA*1 is the Effect of Team Production on the Probability that a Firm's Product Quality is Average or Below. The Bandwidth of 0.042 was Chosen to Minimize the Mean-integrated Squared Error if the data were Gaussian and a Gaussian Kernel were Used.

teams was insignificant in regressions of labor productivity, cast doubt on the hypothesis that team production is more likely to enhance firm performance in unionized settings. On the other hand, McNabb and Whitfield (1997) found that the joint effect of union presence and teamwork on relative financial performance is positive in their analysis of the 1990 Workplace Industrial Relations Survey (WIRS), the predecessor of WERS. While the McNabb and Whitfield result is counter to ours, there are some important differences between the two studies that might account for the discrepancy. First, the studies differ methodologically in that McNabb and Whitfield estimate a binomial logit for financial performance whereas we estimate a structural ordered probit in which teams and autonomy are endogenous. Second, since the questions on teams that we use are new to the 1998 WERS, McNabb and Whitfield used a different measure of teams. Third, we estimate our financial performance model only on those establishments for

Table 3. How the Predicted Benefit of Teams on Financial Performance Varies with Firm Characteristics.

	△ *EffectA*3	△ *EffectA*1	△ (*EffectA*3 − *EffectA*1)
Basic firm characteristics			
Single-establishment firm	0.036	−0.073	0.108
Establishment size	0.630	−0.494	1.124
Fraction of part time workers	0.066	−0.126	0.192
Temporary workers	−0.009	0.030	−0.039
Fixed term workers Under one year	0.054	−0.118	0.172
Fixed term workers over one year	0.069	−0.149	0.217
Union workers	0.007	0.017	−0.010
Financial participation	0.053	−0.068	0.121
Owner manager	0.085	−0.148	0.233
Foreign owned	0.004	−0.061	0.065
Operation over five years	−0.053	0.126	−0.179
Multi-skilling	0.029	−0.050	0.080
Number of recognized unions	−0.077	0.114	−0.191
Induction training	0.064	−0.127	0.191
Off-site training	0.014	−0.017	0.032
Just-in-time production	0.049	−0.105	0.154
Information	0.029	−0.038	0.067
Incentive alignment	−0.040	0.059	−0.098
Decisions	0.004	−0.005	0.009
Work at home	−0.010	0.014	−0.024
Firm Ownership			
Private sector franchise	0.136	−0.446	0.582
Private sector non-franchise	0.025	0.013	0.012
Alternative private sector franchise	−0.171	0.334	−0.505
Alternative private sector non-franchise	−0.134	0.285	−0.420
Industry			
Manufacturing	0.038	−0.054	0.091
Electricity, gas, and water	0.128	−0.311	0.439
Construction	0.087	−0.185	0.272
Hotels and restaurants	−0.079	0.124	−0.203
Transport and communication	−0.006	0.024	−0.030

Table 3. (*Continued*)

	△ *EffectA*3	△ *EffectA*1	△ (*EffectA*3 − *EffectA*1)
Financial services	−0.032	0.061	−0.093
Other business services	−0.023	0.047	−0.070
Public administration	0.051	−0.088	0.139
Education	0.114	−0.126	0.240
Health	0.028	−0.031	0.060
Other community services	−0.128	0.162	−0.290
Largest occupational group at workplace			
Managers and administrators	−0.037	0.060	−0.096
Professional occupations	0.086	−0.188	0.274
Associate professional and technical occupations	0.069	−0.273	0.342
Craft and related pccupations	−0.007	0.024	−0.031
Personal and protective service occupations	−0.016	0.037	−0.052
Sales occupations	0.018	−0.006	0.024
Plant and machine operatives	−0.058	0.102	−0.160
Other occupations	−0.022	0.040	−0.062

Note: The omitted categories for firm ownership, industry, and largest occupational group are, respectively, public sector, wholesale and retail, and clerical and secretarial. $(EffectA3)_i$ for establishment i is defined as $(EffectA3)_i = Prob(Y_i = 3|TEAMS_i = 1) - Prob(Y_i = 3|TEAMS_i = 0)$, which is the effect of team production on the probability that establishment i's financial performance is a lot above industry average. Cell entries under "△ Effect A3" indicate how this effect varies, on average, by the firm characteristic indicated by the row title. This is computed slightly differently according to whether the characteristic is a single dummy variable, one dummy variable from a group of related dummies, or a continuous variable. When characteristic X is a single dummy variable, we computed for each establishment $(EffectA3|X_i = 1) - (EffectA3|X_i = 0)$ holding all of the other characteristics at their actual establishment levels. Then we took the average of these differences across all establishments in the sample. When the X in question is one dummy in a group of related dummies, the computation was the same as the one just described, except that the other dummies in the same group were evaluated at 0 rather than at their observed values for each establishment. The three groups of dummies that are considered in this way are the industry, occupation, and ownership variables. When the X in question is continuous, the differences we computed were not between $X = 1$ and $X = 0$ but rather between the 0.75 and the 0.25 quantile of X, again holding all the characteristics of the establishment at their individual values. $(EffectA1)_i$ for establishment i is defined as $(EffectA1)_i = Prob(Y_i = 1|TEAMS_i = 1) - Prob(Y_i = 1|TEAMS_i = 0)$, which is the effect of team production on the probability that establishment i's financial performance is average or below. The "△ *EffectA*1" column was computed analogously. The "$\triangle(EffectA3 - EffectA1)$" column is simply the difference between the first and second columns and is our measure of the degree to which the predicted benefit from teams to financial performance varies with the firm characteristic indicated by the row title. $N = 889$.

Table 4. How the Predicted Benefit of Teams on Labor Productivity Varies with Firm Characteristics.

	△ *EffectA*3	△ *EffectA*1	△ (*EffectA*3 – *EffectA*1)
Basic firm characteristics			
Single-establishment firm	0.006	−0.013	0.019
Establishment size	−0.346	0.808	−1.154
Fraction of part time workers	0.012	−0.025	0.037
Temporary workers	0.003	−0.007	0.010
Fixed term workers under one year	0.005	−0.010	0.015
Fixed term workers over one year	0.071	−0.163	0.234
Union workers	−0.073	0.152	−0.225
Financial participation	−0.039	0.089	−0.129
Owner manager	0.013	−0.024	0.037
Foreign owned	−0.013	0.024	−0.037
Operation over five years	−0.009	0.019	−0.028
Multi-skilling	−0.002	0.006	−0.008
Number of recognized unions	0.020	−0.041	0.061
Induction training	0.027	−0.054	0.081
Off-site training	−0.047	0.095	−0.143
Just-in-time production	−0.006	0.011	−0.017
Information	0.014	−0.027	0.041
Incentive alignment	−0.012	0.025	−0.037
Decisions	0.004	−0.008	0.011
Work at home	−0.004	0.008	−0.012
Firm ownership			
Private sector franchise	0.158	−0.486	0.644
Private sector non-franchise	−0.006	0.024	−0.030
Alternative private sector franchise	−0.049	0.160	−0.209
Alternative private sector non-franchise	−0.078	0.163	−0.242
Industry			
Manufacturing	0.004	−0.008	0.012
Electricity, gas, and water	−0.002	0.006	−0.008
Construction	−0.006	0.014	−0.020
Hotels and restaurants	0.005	−0.010	0.014
Transport and communication	0.027	−0.054	0.080

Table 4. (*Continued*)

	△ *EffectA*3	△ *EffectA*1	△ (*EffectA*3 – *EffectA*1)
Financial services	−0.008	0.018	−0.026
Other business services	−0.010	0.022	−0.033
Public administration	−0.011	0.025	−0.036
Education	0.009	−0.018	0.027
Health	0.000	0.001	−0.001
Other community services	0.001	−0.002	0.003
Largest occupational group at workplace			
Managers and administrators	0.006	−0.012	0.018
Professional occupations	0.019	−0.034	0.053
Associate professional and technical occupations	−0.007	0.015	−0.023
Craft and related occupations	0.013	−0.025	0.037
Personal and protective service occupations	−0.001	0.001	−0.002
Sales occupations	−0.016	0.034	−0.050
Plant and machine operatives	−0.011	0.025	−0.036
Other occupations	−0.010	0.021	−0.031

Note: The omitted categories for firm ownership, industry, and largest occupational group are, respectively, public sector, wholesale and retail, and clerical and secretarial. $(EffectA3)_i$ for establishment i is defined as $(EffectA3)_i = Prob(Y_i = 3|TEAMS_i = 1) - Prob(Y_i = 3|TEAMS_i = 0)$, which is the effect of team production on the probability that establishment i's labor productivity is a lot above industry average. Cell entries under "△ *EffectA*3" indicate how this effect varies, on average, by the firm characteristic indicated by the row title. This is computed slightly differently according to whether the characteristic is a single dummy variable, one dummy variable from a group of related dummies, or a continuous variable. When characteristic X is a single dummy variable, we computed for each establishment $(EffectA3|X_i = 1) - (EffectA3|X_i = 0)$ holding all of the other characteristics at their actual establishment levels. Then we took the average of these differences across all establishments in the sample. When the X in question is one dummy in a group of related dummies, the computation was the same as the one just described, except that the other dummies in the same group were evaluated at 0 rather than at their observed values for each establishment. The three groups of dummies that are considered in this way are the industry, occupation, and ownership variables. When the X in question is continuous, the differences we computed were not between $X = 1$ and $X = 0$ but rather between the 0.75 and the 0.25 quantile of X, again holding all the characteristics of the establishment at their individual values. $(EffectA1)_i$ for establishment i is defined as $(EffectA1)_i = Prob(Y_i = 1|TEAMS_i = 1) - Prob(Y_i = 1|TEAMS_i = 0)$, which is the effect of team production on the probability that establishment i's labor productivity is average or below. The "△ *EffectA*1" column was computed analogously. The "△(*EffectA*3−*EffectA*1)" column is simply the difference between the first and second columns and is our measure of the degree to which the predicted benefit from teams to labor productivity varies with the firm characteristic indicated by the row title. $N = 1,660$.

Table 5. How the Predicted Benefit of Teams on Products Quality Varies with Firm Characteristics.

	△ *EffectA*3	△ *EffectA*1	△ (*EffectA*3 – *EffectA*1)
Basic firm characteristics			
Single-establishment firm	0.020	−0.024	0.045
Establishment size	−0.230	0.531	−0.761
Fraction of part time workers	−0.014	0.016	−0.030
Temporary workers	0.048	−0.067	0.115
Fixed term workers under one year	−0.059	0.075	−0.133
Fixed term workers over one year	0.036	−0.039	0.075
Union workers	−0.051	0.068	−0.120
Financial participation	−0.019	0.022	−0.040
Owner manager	0.018	−0.005	0.023
Foreign owned	0.107	−0.149	0.256
Operation over five years	−0.089	0.153	−0.242
Multi-skilling	−0.016	0.024	−0.040
Number of recognized unions	0.008	−0.017	0.024
Induction training	−0.012	0.021	−0.033
Off-site training	0.022	−0.023	0.045
Just-in-time production	−0.050	0.070	−0.120
Information	0.025	−0.026	0.051
Incentive alignment	−0.036	0.039	−0.074
Decisions	0.010	−0.011	0.021
Work at home	−0.012	0.013	−0.025
Firm ownership			
Private sector franchise	−0.164	0.207	−0.370
Private sector non-franchise	−0.023	0.073	−0.096
Alternative private sector franchise	−0.026	0.045	−0.071
Alternative private sector non-franchise	−0.042	0.090	−0.132
Industry			
Manufacturing	−0.001	0.019	−0.020
Electricity, gas, and water	−0.110	0.138	−0.248
Construction	−0.045	0.076	−0.120
Hotels and restaurants	0.027	−0.027	0.054
Transport and communication	0.081	−0.138	0.219
Financial services	−0.081	0.117	−0.198

Table 5. (*Continued*)

	$\triangle$ *EffectA*3	$\triangle$ *EffectA*1	$\triangle$ (*EffectA*3 – *EffectA*1)
Other business services	−0.047	0.074	−0.121
Public administration	−0.097	0.134	−0.231
Education	0.011	0.004	0.007
Health	−0.039	0.071	−0.110
Other community services	0.003	−0.006	0.009
Largest occupational group at workplace			
Managers and administrators	−0.022	0.019	−0.041
Professional occupations	0.004	0.018	−0.014
Associate professional and technical occupations	−0.057	0.067	−0.124
Craft and related occupations	0.072	−0.104	0.176
Personal and protective service occupations	0.025	−0.048	0.073
Sales occupations	−0.039	0.048	−0.087
Plant and machine operatives	−0.026	0.020	−0.046
Other occupations	−0.029	0.031	−0.060

Note: The omitted categories for firm ownership, industry, and largest occupational group are, respectively, public sector, wholesale and retail, and clerical and secretarial. $(EffectA3)i$ for establishment i is defined as $(EffectA3)_i = Prob(Y_i = 3|TEAMS_i = 1) - Prob(Y_i = 3|TEAMS_i = 0)$, which is the effect of team production on the probability that establishment i's product quality is a lot above industry average. Cell entries under "$\triangle$ *EffectA*3" indicate how this effect varies, on average, by the firm characteristic indicated by the row title. This is computed slightly differently according to whether the characteristic is a single dummy variable, one dummy variable from a group of related dummies, or a continuous variable. When characteristic X is a single dummy variable, we computed for each establishment $(EffectA3|X_i = 1) - (EffectA3|X_i = 0)$ holding all of the other characteristics at their actual establishment levels. Then we took the average of these differences across all establishments in the sample. When the X in question is one dummy in a group of related dummies, the computation was the same as the one just described, except that the other dummies in the same group were evaluated at 0 rather than at their observed values for each establishment. The three groups of dummies that are considered in this way are the industry, occupation, and ownership variables. When the X in question is continuous, the differences we computed were not between $X = 1$ and $X = 0$ but rather between the 0.75 and the 0.25 quantile of X, again holding all the characteristics of the establishment at their individual values. $(EffectA1)_i$ for establishment i is defined as $(EffectA1)i = Prob(Yi = 1|TEAMSi = 1) - Prob(Yi = 1|TEAMSi = 0)$, which is the effect of team production on the probability that establishment i's product quality is average or below. The "$\triangle$ *EffectA*1" column was computed analogously. The "$\triangle$(*EffectA*3−*EffectA*1)" column is simply the difference between the first and second columns and is our measure of the degree to which the predicted benefit from teams to product quality varies with the firm characteristic indicated by the row title. $N = 1,839$.

Table 6. Firm Characteristics by Sign of Association with "Predicted Benefit of Team Production on Organizational Performance".

	Financial Performance	Labor Productivity	Product Quality
Basic firm characteristics			
Single-establishment firm	+	+	+
Establishment size	+	–	–
Fraction of part time workers	+	+	–
Temporary workers	–	+	+
Fixed Term workers under one year	+	+	–
Fixed term workers over one year	+	+	+
Union workers	–	–	–
Financial participation	+	–	–
Owner manager	+	+	+
Foreign owned	+	–	+
Operation over five years	–	–	–
Multi-skilling	+	–	–
Number of recognized unions	–	+	+
Induction training	+	+	–
Off-site training	+	–	+
Just-in-time production	+	–	–
Information	+	+	+
Incentive alignment	–	–	–
Decisions	+	+	+
Work at home	–	–	–
Firm ownership			
Private sector franchise	+	+	–
Private sector non-franchise	+	–	–
Alternative private sector franchise	–	–	–
Alternative private sector non-franchise	–	–	–
Industry			
Manufacturing	+	+	–
Electricity, gas, and water	+	–	–
Construction	+	–	–
Hotels and restaurants	–	+	+
Transport and communication	–	+	+
Financial services	–	–	–
Other business services	–	–	–

Table 6. (*Continued*)

	Financial Performance	Labor Productivity	Product Quality
Public administration	+	–	–
Education	+	+	+
Health	+	–	–
Other community services	–	+	+
Largest occupational group at workplace			
Managers and administrators	–	+	–
Professional occupations	+	+	–
Associate professional and technical occupations	+	–	–
Craft and related occupations	–	+	+
Personal and protective service occupations	–	–	+
Sales occupations	+	–	–
Plant and machine operatives	–	–	–
Other occupations	–	–	–

Note: +/– represents the signs from Tables 3–5 of $\Delta(EffecA3 - EffectA1)$, which is a measure of the degree to which the predicted benefit, in terms of financial performance, labor productivity or product quality, from teams varies with firm characteristics.

which the respondent interprets the term financial performance as synonymous with profit or value added. This restriction was not possible in the McNabb and Whitfield analysis, since the 1990 WIRS did not ask about the respondent's interpretation of financial performance. This difference is potentially important. For example, DeVaro (2004a) found that the estimated effect of teams on financial performance is quite sensitive to the respondent's interpretation of financial performance.

Regarding firm size, we see that larger establishments experience larger predicted benefits from teams to financial performance. However, smaller establishments experience larger predicted benefits from teams to both labor productivity and product quality. One interpretation of these results is that the nature of the monitoring problem changes with the scale of the organization, such that internal monitoring by peers in the team context is relatively more effective when the organization is small (so that labor productivity is enhanced more by teams in small establishments). But in larger establishments there is greater scope for specialization of tasks and also more diversity in worker information sets, implying that team members' information sets are more likely to be non-duplicative (so that the benefits of teams are higher). Such benefits from teams in large establishments might outweigh the potentially higher costs of monitoring, so that on net the benefits of teams to financial performance are increasing with establishment size. The result concerning establishment size further highlights the dangers of drawing inferences about the benefits of teams based on measures of organizational outcomes that do not capture the full spectrum of benefits and costs from teams.

Our results for financial participation suggest that establishments in which workers receive compensation through various types of variable-pay schemes, including profit-related pay and share ownership schemes, experience higher predicted benefits from teams to financial performance than do establishments with less participation. This result is consistent with the complementarity hypothesis discussed earlier. While financial participation is associated with higher predicted benefits of teams to financial performance, it is also associated with lower predicted benefits of teams to labor productivity and product quality. As was the case for establishment size, this result suggests that standard outcome measures such as labor productivity are not inclusive enough of the various benefits and costs of teams to identify the positive organizational benefits from teams that accrue in firms with a high degree of financial participation.

All of the industry results should be interpreted relative to the reference group of wholesale and retail. Relative to wholesale and retail, the financial services and other business service industries have lower predicted benefits of teams to all three measures of organizational performance, and the education industry has higher predicted benefits across all three measures. Predicted benefits to financial performance and labor productivity in manufacturing are higher than in wholesale in retail, which is consistent with a significant volume of previous work in the manufacturing sector (focusing heavily on measures of labor productivity as an organizational outcome) that is generally supportive of positive effects of team production on firm performance. An interesting result is that for all of the other industries, the sign of the predicted benefits of teams is common for labor productivity and product quality but is the opposite of that for financial performance. For example, industries for which the predicted benefits of teams to labor productivity and product quality are negative but the predicted benefits to financial performance are positive include health, public administration, construction, and electricity, gas, and water. Industries for which the predicted benefits to labor productivity and product quality are positive but the predicted benefits to financial performance are negative include hotels and restaurants, transport and communication, and other community services.

In addition to the results on unions, firm size, financial participation, and industry, some further interesting results emerge concerning the other covariates. We conclude this section by noting a few of these. First, the result concerning the age of the establishment is interesting. The binary variable "operation over five years" is associated with lower predicted benefits of teams to all three measures of organizational performance, suggesting that younger firms experience larger benefits from teams. Second, the results concerning the variables "incentive alignment" (i.e., employees are fully committed to the values of the firm) and "decisions" (i.e., most decisions at this workplace are made without consulting employees) are as we would expect. That is, a greater degree of disagreement with the statement about incentive alignment and a greater degree of agreement with the statement about decisions is associated with lower predicted benefits of teams to all three measures of organizational performance. Third, the results concerning "work at home" are intuitive as well: as the fraction of time spent working at home during normal business hours increases, the predicted benefits of teams to all measures of organizational performance decrease (by over 2, 1, and 2 percentage points for financial performance, labor productivity, and product quality, respectively), which is to be expected since frequent interaction and collaboration with other team members is necessarily reduced when an employee does a significant amount of work from home.

6. CONCLUDING REMARKS

While a significant volume of research addresses the question of how teams and other high-performance work practices affect organizational performance, comparatively little attention has been devoted to the question of what types of organizations benefit from teams. Our paper has aimed to partially address this gap. Although we report results for a large set of firm characteristics, our focus has been on firm size, unions, financial participation, and industry. A distinguishing feature of our approach is the use of structural models in which teams and autonomy are treated as endogenous determinants of organizational performance. This is important because accurate measures of the extent to which the benefits of teams to organizational performance vary with organizational characteristics require accurate measures of the predicted benefits of teams to organizational performance. If the firm's choices of teams and autonomy are treated as exogenous, as is common in the teams literature, then the resulting estimates of the effects of teams and autonomy will be biased as a result of correlations among the unobserved determinants of teams, autonomy, and organizational performance. As shown in DeVaro (2004b) such biases can be quite substantial, particularly in the case of product quality.

An interesting general pattern of results that emerges from our analysis is that while a particular firm characteristic might be associated with large predicted benefits of teams to labor productivity and product quality, the same firm characteristic is often associated with *lower* predicted benefits of teams to financial performance. Similarly, even when a characteristic is associated with lower benefits of teams to labor productivity or product quality, it often is associated with higher benefits to financial performance. This finding is of particular interest since financial performance is much less frequently seen as an outcome variable in this literature than measures like labor productivity or product quality. Since financial performance, as a measure of profit, is more inclusive than these other measures of the full spectrum of benefits and costs induced by teams, our results suggest that studies that focus only on labor productivity and product quality might produce an incomplete picture of the total effect of teams on firm performance.

In future research, it would be interesting to implement our structural approach using other data sets. One possibility is to make use of the fifth wave of the WERS when it is released. We close our discussion with a final recommendation. While our structural models interact the "teams" treatment with all of the firm characteristics, autonomy enters our models only as an intercept shift. In future work with larger data sets, it would be interesting to generalize the model by interacting autonomy with all of the firm characteristics as well. This would allow two separate regressions to be run in Stage 3, one for the "predicted benefits to organizational performance from using autonomous teams" and another for the "predicted benefits to organizational performance from using non-autonomous teams." Then one could discern what types of firms would benefit more from autonomous team production than from closely managed team production, and vice versa.

NOTES

1. It is, of course, possible to obtain variation in characteristics within the context of a single case study if, for example, one exploits variation across multiple establishments in the same firm. Ultimately, however, general inferences cannot be drawn from analysis of only one or a handful of observations from a specialized production setting.

2. A more commonly used outcome variable in this literature is labor productivity (DeVaro, 2004b; Eriksson, 2003; Kato & Morishima, 2002; Black & Lynch, 2001; Ichniowski et al., 1997; Banker, Field, Schroeder, & Sinha, 1996; Ichniowski, 1990). Other outcome variables have also been studied, such as innovation and R&D (Michie & Sheehan, 1999), turnover (Huselid, 1995), worker well-being and wages (Caroli & van Reenen, 2001, Bauer & Bender, 2001), product quality (DeVaro, 2004b; Ichniowski & Shaw, 1999; Ichniowski et al., 1997; Banker et al., 1996), worker satisfaction (Batt, 2004; Batt & Appelbaum, 1995; Godard, 2001), worker absenteeism (Askenazy, Caroli, & Marcus, 2001) and firms' layoff rates (Osterman, 2000). An extensive survey of the empirical literature outside the discipline of economics concerning the effects of team production can be found in Cohen and Bailey (1997).

3. However, recent evidence from a large, nationally representative sample of British establishments suggests that both types of teams confer benefits of similar magnitude to financial performance, labor productivity, and product quality (DeVaro, 2004a,b).

4. This result does not necessarily generalize across countries. For example, Doucouliagos and Laroche (2003) show in their meta-analysis that there is a positive association between unions and labor productivity in the United States.

5. Batt and Appelbaum (2003) also looked at employee job satisfaction and organizational commitment as dependent variables. They found that for workers in the network crafts and sewing machine operators' occupations, teams significantly improve job satisfaction and organizational commitment. On the other hand, for workers in customer service occupations, this is not the case.

6. This kind of misreporting could arise if managers who adopt innovative work practices want to believe that their organizations are doing better, thereby rationalizing their decision to employ those practices.

7. Consistent with this line of argument, Machin and Stewart have shown the subjective financial performance measure in the WIRS to be a good predictor of workplace closure.

8. The responses sum to 1,800 instead of the full 2,191 because some respondents reported that no comparison was possible or that the relevant data were not available.

9. See DeVaro (2004a) for a discussion of the theoretical rationale for granting teams autonomy.

10. The statistical model requires some standard identifying restrictions on the disturbance covariance matrix. All of its diagonal elements are normalized to one. Furthermore, both the disturbance covariances σ_{01} and σ_{03} are assumed to be 0. The restrictions on the covariance matrix are weaker than those that are imposed in the simpler "non-structural" approaches common to the teams' literature. These approaches also impose (implicitly) $\sigma_{01} = 0$ and $\sigma_{03} = 0$. In addition, however, they impose the restrictions $\sigma_{02} = 0$, $\sigma_{12} = 0$, $\sigma_{13} = 0$, and $\sigma_{23} = 0$, whereas our models treat these as unrestricted parameters to be estimated. This issue is not discussed in the teams literature, because with the standard approach of using a single equation for organizational performance (with only one disturbance term in the model), treating teams and/or autonomy as exogenous variables on the right-hand-side, all of these assumptions are implicit rather than explicit as they are in our models. Apart from the non-linearities introduced by the distributional assumptions, identification of the model is facilitated by a set of exclusion restrictions on the covariates in each equation. The specification for each equation is detailed in the appendix. More

discussion of the exclusion restrictions and their justification on the basis of theory, previous empirical work, and independent tests confirming that the variables appear unimportant in the equations from which they are excluded, can be found in DeVaro (2004a,b).

11. In the appendix, we state the formulae for computing these three effects. The notation for these *Effects* "*A*1", "*A*2", and "*A*3" was introduced in DeVaro (2004a,b). In those studies, the role of the "A" in the notation was to distinguish the effects from the analogous "predicted benefits from using autonomous teams" (*Effects* *B*1, *B*2, and *B*3) and the "predicted benefits from using non-autonomous teams" (*Effects* *C*1, *C*2, and *C*3). We do not discuss the "*B*" and "*C*" effects in the present paper, because here we are interested in the relationships of the firm characteristics to the predicted benefits from teams. In principle, we could analyze either the "*B*" effects or the "*C*" effects like we do the "*A*" effects, though this would yield no insights beyond those we present in the paper. The reason is that while the structural model interacts the "teams treatment" with all of the covariates, the "autonomy treatment" simply shifts the intercept. Hence, any relationships between the covariates and the "*B*" or "*C*" effects arises because of interactions of the covariates with "teams" rather than with "autonomy".

12. The only covariates in the model that are "continuous", in the usual sense, are establishment size and the fraction of employees who work part time. However, the model also includes several variables recorded in the survey as ordered discrete categories. These include information, incentive alignment, and decisions (5 categories each); work at home (6 categories); multi-skilling and off-site training (7 categories each); and number of recognized unions (11 categories). To economize on the number of parameters to be estimated, we treat each of these variables as continuous indexes rather than creating multiple dummies for each category. In unreported sensitivity checks, we found the same qualitative results in models that include these variables as multiple dummies rather than as "continuous" indexes.

13. While a univariate measure of the predicted benefits from teams eases the presentation of results, collapsing *EffectA*3 and *A*1 into (*EffectA*3−*EffectA*1) necessarily involves some loss of information, since neither *EffectA*3 nor *EffectA*1 can be inferred from their difference. For example, suppose that one workplace has *EffectA*3 = 0.10 and *EffectA*1 = −0.07, whereas another has *EffectA*3 = 0.07 and *EffectA*1 = −0.10. Both are ranked the same by the criterion *EffectA*3 − *EffectA*1. However, this lost information is not particularly useful for our purposes. To see why, consider an alternative to (*EffectA*3 − *EffectA*1) that assigns greater weight to increases in *EffectA*3 than to decreases in *EffectA*1, or vice versa. Using such an alternative criterion, one of the two workplaces in the example could clearly be ranked above the other in terms of predicted benefits from teams. Absent any information about the establishments' loss functions, however, there is no clear basis for weighting increases in *EffectA*3 differently from decreases in *EffectA*1.

14. More detailed information on the overall effects of teams (as opposed to the interactions we focus on in this paper) can be found in DeVaro, 2004a, b. Those analyses report magnitudes at the 0.25, 0.50, and 0.75 quantiles of (*EffectA*3 − *EffectA*1) as well as the analogous information for autonomous teams and non-autonomous teams (as opposed to teams in general). Those studies also report all of these results from models that treat teams and autonomy as exogenous, to determine the nature of the bias that arises when the endogeneity of teams and autonomy is ignored.

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APPENDIX

The statistical model specifies probabilities for each of the nine possible outcomes that a workplace might realize. Letting i index workplaces, these potential outcomes and their probabilities are as follows:

Probability	$Y_i =$	$\text{TEAMS}_i =$	$\text{AUTO}_i =$
$P_{1i}(\boldsymbol{\theta})$	1	1	1
$P_{2i}(\boldsymbol{\theta})$	1	1	0
$P_{3i}(\boldsymbol{\theta})$	2	1	1
$P_{4i}(\boldsymbol{\theta})$	2	1	0
$P_{5i}(\boldsymbol{\theta})$	3	1	1
$P_{6i}(\boldsymbol{\theta})$	3	1	0
$P_{7i}(\boldsymbol{\theta})$	1	0	Unobserved
$P_{8i}(\boldsymbol{\theta})$	2	0	Unobserved
$P_{9i}(\boldsymbol{\theta})$	3	0	Unobserved

$$\begin{aligned} \textit{Let } Z_{ij} &= 1 \quad \text{if Workplace } i \text{ experiences the } j\text{th outcome} \\ &= 0 \quad \text{otherwise, for } i = 1,\ 2, \ldots, N \text{ and } j = 1,\ 2, \ldots, 9 \end{aligned}$$

Then the likelihood function, L^*, is

$$L^* = \prod_{i=1}^{N} \prod_{j=1}^{9} P_{ji}^{Z_{ji}}$$

and the log-likelihood function, L, is

$$L = \sum_{i=1}^{N} \sum_{j=1}^{9} Z_{ji} \log\ P_{ji}$$

Since each of the endogenous variables is observed only discretely, each probability of the form $P_{ji}(\boldsymbol{\theta})$ is a multiple integral of the joint density $f(\varepsilon_{0i}, \varepsilon_{1i}, \varepsilon_{2i}, \varepsilon_{3i})$. Suppressing all subscripts i, the expression for $P_1(\boldsymbol{\theta})$ is as follows:

$$P_1(\theta) = \int_{-\infty}^{-(\alpha+X_1\delta_1)} \int_{-X_2\beta}^{\infty} \int_{-X_3\gamma}^{\infty} f(\varepsilon_1, \varepsilon_2, \varepsilon_3)\, \mathrm{d}\varepsilon_3 \mathrm{d}\varepsilon_2 \mathrm{d}\varepsilon_1$$

Probabilities $P_2(\boldsymbol{\theta})$ to $P_9(\boldsymbol{\theta})$ are similarly defined.

Formulae for Computing Effects A1, A2, A3

Each effect is a function of the $P_j(\boldsymbol{\theta})$ and is computed as follows, evaluating the expressions for P_j at the estimated values of $\boldsymbol{\theta}$:

$$(Effect A1)_i = \frac{P_{1i}+P_{2i}}{\sum_{j=1}^{6} P_{ji}} - \frac{P_{7i}}{\sum_{j=7}^{9} P_{ji}}$$

$$(Effect A2)_i = \frac{P_{3i}+P_{4i}}{\sum_{j=1}^{6} P_{ji}} - \frac{P_{8i}}{\sum_{j=7}^{9} P_{ji}}$$

$$(Effect A3)_i = \frac{P_{5i}+P_{6i}}{\sum_{j=1}^{6} P_{ji}} - \frac{P_{9i}}{\sum_{j=7}^{9} P_{ji}}$$

Control Variables

We include the following common set of control variables in each of $\mathbf{X}_1$, $\mathbf{X}_2$, and $\mathbf{X}_3$.

Single-establishment firm: dummy variable that equals 1 if the establishment is either a single independent establishment not belonging to another body, or the sole UK establishment of a foreign organization and equals 0 if the establishment is one of a number of different establishments within a larger organization.
Establishment size: total number of full time, part time, and temporary workers at the establishment.
Fraction of part time workers: number of part time workers at the establishment as a fraction of establishment size.
Temporary workers: dummy variable that equals 1 if there are temporary agency employees working at the establishment at the time of the survey and equals 0 otherwise.
Fixed term workers under one year: dummy variable that equals 1 if there are employees who are working on a temporary basis or have fixed-term contracts for less than one year and equals 0 otherwise.
Fixed term workers over one year: dummy variable that equals 1 if there are employees who have fixed term contracts for one year or more and equals 0 otherwise.
Union workers: dummy variable that equals 1 if any of the workers at the establishment belong to a union and equals 0 otherwise.
Private sector franchise: dummy variable that equals 1 if the establishment is a private sector company and a franchise and equals 0 otherwise.
Private sector non-franchise: dummy variable that equals 1 if the establishment is a private sector company but not a franchise and equals 0 otherwise.

Alternative private sector franchise: dummy variable that equals 1 if the establishment is an alternative private sector firm and a franchise and equals 0 otherwise.
Alternative private sector non-franchise: dummy variable that equals 1 if the establishment is an alternative private sector firm but not a franchise and equals 0 otherwise.

The following additional control variables were included in the financial performance equation in DeVaro (2004a), and we include them in our labor productivity and product quality models as well so that our specification is identical across the three measures of organizational performance. A number of these additional variables have been found to be significantly associated with financial performance in earlier analyses of the WIRS/WERS data, for example, union activity, (Bryson & Wilkinson, 2002); training (Collier et al., 2004); and financial participation (McNabb & Whitfield, 1998).

Financial participation: dummy variable that equals 1 if any employees at the workplace receive payments or dividends from any of the following variable pay schemes (profit-related payments or bonuses, deferred profit sharing schemes, employee share ownership schemes, individual or group performance-related schemes, other cash bonus). This variable was included in the financial performance equation in McNabb and Whitfield (1998) and found to be significant; their study used data from an earlier wave of the survey, so their definition of this variable differed slightly from ours.
Owner manager: dummy variable that equals 1 if any of the controlling owners of the workplace are actively involved in day-to-day management on a full-time basis, and 0 otherwise. This question was only asked of private sector workplaces for which a single individual or family has controlling interest (meaning at least 50% ownership) over the company.
Foreign owned: dummy variable that equals 1 if workplace reports that either of the following two statements best describes the ownership of the workplace (predominantly foreign owned, meaning 51% or more; foreign owned/controlled) and 0 if any of the following three statements is chosen (UK owned/controlled, predominantly UK owned, meaning 51% or more; UK and foreign owned). This question was asked only of private sector workplaces.
Operation over five years: dummy variable that equals 1 if the workplace has been operating at its present address for five years or more, and 0 otherwise
Multi-skilling: degree of multi-skilling at the workplace in the largest occupational group. Question asks what fraction of these employees are formally trained to be able to do jobs other than their own. Responses are: "None 0%" (1); "Just a few 1–19%" (2); "Some 20–39%" (3); "Around half 40–59%" (4); "Most 60–79%" (5); "Almost all 80–99%" (6); "All 100%" (7).

Number of recognized unions: total number of recognized unions at the workplace.
Induction training: dummy variable that equals 1 if there is a standard induction program designed to introduce new employees (in the largest occupational group) to the workplace, and 0 otherwise.
Off-site training: discrete variable measuring the proportion of experienced employees (in the largest occupational group) that have had formal off-the-job training (away from the normal place of work, but either on or off the premises) over the last 12 months. Responses are: "None 0%" (1); "Just a few 1–19%" (2); "Some 20–39%" (3); "Around half 40–59%" (4); "Most 60–79%" (5); "Almost all 80–99%" (6); "All 100%" (7).

In the TEAMS equation, we include a dummy variable indicating whether a just-in-time system is in operation at the establishment. Specifically, the employer is asked "Does this workplace operate a system designed to minimize inventories, supplies or work-in progress? This is sometimes known as Just-in-Time." Responses are coded as 1 for yes and 0 for no.

In the autonomy equation, we include a set of four proxies for the organizational and informational structure of the establishment, the alignment of incentives between workers and owners, and the importance to the firm of monitoring inputs. The first three of these are qualitative measures of managerial opinion. The respondent manager is asked to comment on each of a list of statements, responding with "Strongly agree" (1), "Agree" (2), "Neither agree nor disagree" (3), "Disagree" (4), or "Strongly disagree" (5). The questions of interest as determinants of team autonomy are as follows:

Information: "Those at the top are best placed to make decisions about this workplace."
Incentive alignment: "Employees here are fully committed to the values of this organization."
Decisions: "Most decisions at this workplace are made without consulting employees."

In addition to these managerial opinion variables, as a proxy for the importance the employer places on monitoring worker inputs, we include a discrete variable measuring the proportion of workers at the establishment that ever work from home during normal working hours. Responses include: "Half or more 50% + ", "A quarter up to a half 25–49%", "Up to a quarter 10–24%", "A small proportion 5–9%", "Hardly any (less than 5%)", or "None 0%".

The full specification of the exogenous variables in $\mathbf{X_1}$, $\mathbf{X_2}$, and $\mathbf{X_3}$ is summarized in the following tables.

Exogenous Variables Included in Structural Models.

	$FINPER_i$ **X_1**	$LABPROD_i$ **X_1**	$QUALITY_i$ **X_1**	$TEAMS_i$ **X_2**	$AUTO_i$ **X_3**
Single-establishment firm	Yes	Yes	Yes	Yes	Yes
Establishment size	Yes	Yes	Yes	Yes	Yes
Fraction of part time workers	Yes	Yes	Yes	Yes	Yes
Temporary workers	Yes	Yes	Yes	Yes	Yes
Fixed term workers under one year	Yes	Yes	Yes	Yes	Yes
Fixed term workers over one year	Yes	Yes	Yes	Yes	Yes
Union workers	Yes	Yes	Yes	Yes	Yes
Private sector franchise	Yes	Yes	Yes	Yes	Yes
Private sector non-franchise	Yes	Yes	Yes	Yes	Yes
Alternative private sector franchise	Yes	Yes	Yes	Yes	Yes
Alternative private sector non-franchise	Yes	Yes	Yes	Yes	Yes
Financial participation	Yes	Yes	Yes		
Owner manager	Yes	Yes	Yes		
Foreign owned	Yes	Yes	Yes		
Operation over five years	Yes	Yes	Yes		
Multi-skilling	Yes	Yes	Yes		
Number of recognized unions	Yes	Yes	Yes		
Induction training	Yes	Yes	Yes		
Off-site training	Yes	Yes	Yes		
Just-in-time production				Yes	
Information					Yes
Incentive alignment					Yes
Decisions					Yes
Work at home					Yes
Industry controls (12)				Yes	Yes
Occupation controls (10)				Yes	Yes

Table A1. Estimates from the Structural Model for Financial Performance.

	FINPER* (TEAMS = 1)	FINPER* (TEAMS = 0)	TEAMS*	AUTO*
AUTO	1.103**			
	(0.205)			
Single-establishment	0.122	−0.337	−0.349**	−0.261**
firm	(0.107)	(0.253)	(0.160)	(0.119)
Establishment size	0.006	0.047	0.028	−0.009
	(0.010)	(0.059)	(0.028)	(0.010)
Fraction of part	0.231	−0.136	0.479	−0.248
time workers	(0.152)	(0.405)	(0.329)	(0.229)
Temporary workers	0.165*	0.244	0.251*	−0.291**
	(0.095)	(0.181)	(0.129)	(0.132)
Fixed term workers	0.016	−0.123	0.164	−0.017
under one year	(0.073)	(0.261)	(0.135)	(0.104)
Fixed term workers	−0.052	−0.172	0.126	0.232
over one year	(0.119)	(0.371)	(0.256)	(0.167)
Union workers	0.103	0.203	0.078	0.057
	(0.122)	(0.267)	(0.137)	(0.117)
Financial	0.207**	0.068		
participation	(0.084)	(0.235)		
Owner manager	0.126	−0.176		
	(0.108)	(0.296)		
Foreign owned	−0.166**	−0.286		
	(0.099)	(0.346)		
Operation over five	−0.013	0.238		
years	(0.103)	(0.285)		
Multi-skilling	0.023	−0.027		
	(0.019)	(0.047)		
Number of	−0.090**	0.027		
recognized unions	(0.033)	(0.112)		
Induction training	−0.088	−0.334		
	(0.109)	(0.232)		
Off-site training	0.013	0.004		
	(0.015)	(0.034)		
Private sector	0.384	−2.743**	0.644	−0.247
franchise	(0.364)	(0.007)	(1.663)	(0.508)

Table A1. **(***Continued***)**

	FINPER* (TEAMS = 1)	FINPER* (TEAMS = 0)	TEAMS*	AUTO*
Private sector non-franchise	0.070	0.293	0.180	0.235
	(0.145)	(0.369)	(0.254)	(0.243)
Alternative private sector franchise	0.100	0.742	0.147	−0.222
	(0.380)	(1.648)	(1.091)	(0.573)
Alternative private sector non-franchise	−0.263*	0.660*	0.260	0.514**
	(0.148)	(0.357)	(0.260)	(0.261)
Just-in-time			0.350**	
			(0.135)	
Information				0.092**
				(0.042)
Incentive alignment				−0.261**
				(0.071)
Decisions				0.023
				(0.048)
Work at home				−0.065
				(0.060)
Constant	−0.746**	1.050*	0.691*	0.559
	(0.265)	(0.553)	(0.410)	(0.526)
c	0.916			
	(0.081)			
σ_{02}	0.843			
	(17.149)			
σ_{12}	0.618			
	(5.656)			
σ_{13}	−0.804**			
	(0.001)			
σ_{23}	−0.533**			
	(0.038)			

Note: Standard errors from the parametric bootstrap are in parentheses and are based on 75 bootstrap replications. The omitted firm ownership category is public sector. $N = 889$.
*Indicates significance at the 10% level.
**Indicates significance at the 5% level.

Table A2. Estimates from the Structural Model for Labor Productivity.

	LABPROD* (TEAMS = 1)	LABPROD* (TEAMS = 0)	TEAMS*	AUTO*
AUTO	0.768** (0.267)			
Single-establishment firm	0.054 (0.091)	−0.026 (0.298)	−0.140 (0.122)	−0.190* (0.107)
Establishment size	−0.003 (0.005)	−0.039 (0.073)	0.052** (0.024)	−0.004 (0.004)
Fraction of part time workers	0.277** (0.127)	0.237 (0.328)	−0.301* (0.219)	0.040 (0.181)
Temporary workers	−0.043 (0.073)	−0.190 (0.288)	0.110 (0.219)	−0.277** (0.075)
Fixed term workers under one year	0.010 (0.081)	−0.059 (0.217)	0.220** (0.103)	−0.043 (0.080)
Fixed term workers over one year	0.066 (0.082)	−0.420 (0.384)	0.251 (0.163)	0.004 (0.093)
Union workers	−0.020 (0.079)	0.388* (0.233)	0.146 (0.103)	−0.051 (0.087)
Financial participation	0.098 (0.065)	0.378* (0.223)		
Owner manager	0.089 (0.117)	0.039 (0.322)		
Foreign owned	0.079 (0.102)	0.165 (0.300)		
Operation over five years	0.050 (0.098)	0.118 (0.298)		
Multi-skilling	0.044** (0.015)	0.062* (0.040)		

Table A2. **(***Continued***)**

	LABPROD* (TEAMS = 1)	LABPROD* (TEAMS = 0)	TEAMS*	AUTO*
Number of recognized unions	−0.009 (0.022)	−0.069 (0.123)		
Induction training	0.047 (0.070)	−0.099 (0.248)		
Off-site training	0.022 (0.016)	0.097* (0.054)		
Private sector franchise	0.557** (0.278)	−2.751** (0.454)	0.670 (1.379)	−0.596** (0.287)
Private sector non-franchise	0.144 (0.099)	0.217 (0.347)	−0.069 (0.175)	−0.094 (0.137)
Alternative private sector franchise	−0.557 (0.373)	−0.282 (1.980)	−0.152 (0.414)	−0.274 (0.373)
Alternative private sector non-franchise	−0.052 (0.106)	0.457 (0.431)	−0.170 (0.183)	0.103 (0.131)
Just-in-time			0.289** (0.118)	
Information				0.105** (0.032)
Incentive alignment				−0.190** (0.041)
Decisions				0.059 (0.037)
Work at home				−0.060 (0.046)
Constant	−0.944** (0.239)	−1.278* (0.769)	0.762** (0.284)	0.685 (0.436)
c	1.168 (0.064)			

Table A2. **(***Continued***)**

	LABPROD* (TEAMS = 1)	LABPROD* (TEAMS = 0)	TEAMS*	AUTO*
σ_{02}	−0.046			
	(0.361)			
σ_{12}	0.386			
	(1.415)			
σ_{13}	−0.496**			
	(0.018)			
σ_{23}	−0.693**			
	(0.009)			

Note: Standard errors from the parametric bootstrap are in parentheses (75 bootstrap replications). Dummies for industry and largest occupational group are also included in the TEAMS* and AUTO* equations. The omitted firm ownership category is public sector. Sample size is 1,660.
*Indicates significance at the 10% level.
**Indicates significance at the 5% level.

Table A3. Estimates from the Structural Model for Quality of Product or Service.

	QUALITY* (TEAMS = 1)	QUALITY* (TEAMS = 0)	TEAMS*	AUTO*
AUTO	1.234**			
	(0.123)			
Single-establishment firm	0.181*	0.144	−0.183	−0.155
	(0.090)	(0.173)	(0.123)	(0.105)
Establishment size	0.002	−0.080*	0.048**	−0.004
	(0.003)	(0.047)	(0.020)	(0.005)
Fraction of part time workers	0.043	0.246	−0.204	0.001
	(0.103)	(0.243)	(0.189)	(0.161)
Temporary workers	0.075	−0.224	0.067	−0.208**
	(0.073)	(0.162)	(0.095)	(0.081)
Fixed term workers under one year	−0.092	−0.030	0.205**	−0.021
	(0.057)	(0.171)	(0.091)	(0.064)

***Table A3.* (*Continued*)**

	QUALITY* (TEAMS = 1)	QUALITY* (TEAMS = 0)	TEAMS*	AUTO*
Fixed term workers over one year	−0.014	−0.224	0.242*	0.059
	(0.071)	(0.229)	(0.141)	(0.099)
Union workers	−0.059	0.003	0.189*	−0.007
	(0.077)	(0.168)	(0.099)	(0.094)
Financial participation	−0.039	0.016		
	(0.054)	(0.147)		
Owner manager	0.206**	0.179		
	(0.103)	(0.186)		
Foreign owned	0.079	−0.283		
	(0.072)	(0.265)		
Operation over five years	0.037	0.388*		
	(0.078)	(0.213)		
Multi-skilling	0.020	0.049		
	(0.018)	(0.031)		
Number of recognized unions	−0.047**	−0.064		
	(0.016)	(0.070)		
Induction training	0.067	0.116		
	(0.066)	(0.160)		
Off-site training	0.018	0.003		
	(0.013)	(0.034)		
Private sector franchise	0.517*	0.261	0.840	−0.578
	(0.276)	(1.206)	(1.384)	(0.356)
Private sector non-franchise	0.373**	0.492*	−0.031	−0.093
	(0.077)	(0.259)	(0.152)	(0.114)
Alternative private sector franchise	0.068	0.007	−0.070	−0.402
	(0.279)	(0.858)	(0.347)	(0.345)
Alternative private sector non-franchise	0.282**	0.547*	−0.126	0.004
	(0.094)	(0.281)	(0.162)	(0.111)
Just-in-time			0.303**	
			(0.086)	
Information				0.071**
				(0.027)
Incentive alignment				−0.202**
				(0.038)

Table A3. **(***Continued***)**

	QUALITY* (TEAMS = 1)	QUALITY* (TEAMS = 0)	TEAMS*	AUTO*
Decisions				0.057*
				(0.032)
Work at home				−0.071**
				(0.035)
Constant	−0.586**	−1.490**	0.748**	0.808**
	(0.185)	(0.367)	(0.207)	(0.292)
c	1.177			
	(0.069)			
σ_{02}	−0.719**			
	(0.003)			
σ_{12}	0.071			
	(0.391)			
σ_{13}	−0.741**			
	(0.002)			
σ_{23}	−0.489**			
	(0.045)			

Note: Standard errors from the parametric bootstrap are in parentheses and are based on 75 bootstrap replications. Controls for industry and establishment's largest occupational group are also included in the TEAMS* and AUTO* equations. The omitted firm ownership category is public sector. Sample size is 1,839.

*Indicates significance at the 10% level.

**Indicates significance at the 5% level.