The Effects of Self-Managed and Closely-Managed Teams on Labor Productivity and Product Quality: An Empirical Analysis of a Cross Section of Establishments

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Abstract

I estimate the effect of team production on labor productivity and product quality using a cross section of British establishments, finding that the typical establishment enjoys statistically significant increases in labor productivity (but not product quality) from using teams, though there is no statistically significant difference between the predicted gains from autonomous versus non-autonomous teams. I show that standard methodological approaches that treat teams and autonomy as exogenous induce biases of two forms: 1) the benefits from teams are inflated, 2) the benefits of autonomous teams relative to those of non-autonomous teams are inflated.

I. INTRODUCTION

This paper contributes to a vast and growing literature concerning the effects of team production on organizational performance. Using the 1998 Workplace Employee Relations Survey (WERS), a large and nationally-representative cross section of British establishments, I estimate the effects of team production on labor productivity and product quality and ask whether and how these effects differ when teams are granted autonomy. Table 1 summarizes the previous literature on the effects of team production on workplace outcomes. Some studies are single-firm cases that exploit temporal variation in human resource practices (such as a switch from individual production to team production). Others are cross sectional, exploiting variation in the use and nature of teams across individual firms or production units. Others use panel data spanning many organizations to exploit both types of variation, though there tends to be less variation temporally than across production units. Studies also differ widely in their choice of dependent variable (e.g. labor productivity, product quality, financial performance, turnover, wages, absenteeism, innovation and R&D, worker well-being and satisfaction, layoff rates) and in whether the focus is on team production alone or on an entire system of human resources practices of which team production is one component. Frequently these studies concern "self-managed" teams in which team members enjoy significant autonomy concerning how the work is executed, in contrast to closely-managed teams in which supervisors exercise considerable control over tasks. The emphasis on self-managed teams arises from theoretical considerations suggesting that the benefits of team production to organizational performance are contingent on teams being conferred with sufficient autonomy over their work.

While the studies in Table 1 differ in analysis samples, dependent variables, types of teams analyzed, and whether teams are analyzed alone or as part of a broader system, they are united by their common methodological approach of treating both team production and the degree of autonomy granted to team members as exogenous in models of organizational performance.[1] In contrast, the distinguishing feature of the present study is that I treat both of these variables as endogenous. The reason is that the existence of team production and the degree to which teams are conferred with authority over the execution of tasks are not exogenously assigned to firms in a random fashion. Rather, they are the result of employer decisions that are presumably made in an effort to improve organizational performance. This is important, because unmeasured determinants of an employer's choices of teams and autonomy (such as, for example, managerial personality and tastes, and the social atmosphere of the workplace) are likely correlated with unmeasured determinants of organizational performance. It might also be that good workers go to work in more productive establishments and that establishments with good workers choose team production. Correlations in the unobserved determinants of managerial choices and organizational performance result in biased estimates of the effects of interest if the endogeneity of teams and autonomy is ignored.

An advantage of the WERS is that it has variation not only in whether or not team production is used but in the type of team production used, in particular whether or not team members are granted autonomy. It also includes information on labor productivity and product quality. While panel data would be preferable to cross sectional data for the purpose of measuring the effects of teams on organizational outcomes, I do not know of any nationally-representative panel datasets that are appropriate and large enough for this analysis. My research strategy is therefore to exploit the unique and extensive information contained in the available cross sectional data, while simultaneously addressing the concerns arising from correlations in unobserved determinants of employer choices and organizational outcomes.

The focus on labor productivity and product quality in this paper is consistent with the main emphasis of the economics literature on the productivity effects of teams. Labor productivity is the most commonly-studied outcome measure in such studies (e.g. Hamilton, Nickerson, and Owan 2003, Eriksson 2003, Kato and Morishima 2002, Black and Lynch 2001, Ichniowski, Shaw, and Prennushi 1997, Banker, Field, Schroeder, and Sinha 1996, Ichniowski 1990). Often the studies in this literature consider product quality as a second outcome variable of interest (e.g. Ichniowski and Shaw 1999, Ichniowski, Shaw, and Prennushi 1997, Banker, Field, Schroeder, and Sinha 1996). The focus on labor productivity and product quality is driven by clear theoretical channels of influence predicting effects of teams on these outcomes, as discussed in the next section. The new contribution of the present study is to investigate the implications of endogeneity of teams and autonomy in the labor productivity (and to a lesser extent product quality) models that have been the central focus of economic studies of team production.[2]

The previous study that is nearest to the present analysis is DeVaro (2006), which considered financial performance as an outcome variable. That study also allowed for the endogeneity of teams and autonomy, finding a positive effect of teams for the typical workplace and no statistically significant difference between autonomous and non-autonomous teams in terms of their predicted benefits to financial performance. However, biases from ignoring the endogeneity of teams and autonomy were found to be relatively modest. In the present paper I apply the structural model that was developed in DeVaro (2006) to the study of labor productivity and product quality.

II. THEORETICAL BACKGROUND

All relevant aspects of the quality of a product or service would, in principle, be subsumed in a comprehensive definition of labor productivity. That is, the labor productivity measures would be fully "quality adjusted." If labor productivity measures are comprehensive, then an improvement in product quality that enhances the value (and thus price) of a product or service should also contribute to higher productivity. It then follows that an empirical result that teams improve productivity but not quality would shed light on the mechanism by which productivity enhancements are secured. Throughout the paper, however, I avoid drawing such inferences from comparisons between labor productivity results and quality results. While the two concepts are conceptually related, it is unclear whether the respondents report answers to the labor productivity question that fully account for quality, and this assumption is crucial to interpretations of the type just described.[3]

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). These synergies in information can give rise to new ideas about process improvement that lead to higher product quality.[4] The potential for such productive synergies should theoretically increase with the size of the group and the associated pool of ideas, though some costs also increase with group size including the greater likelihood of free riding.[5] 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. Mohrman and Novelli (1985) discuss two ways in which teams produce benefits to labor productivity and product quality. The first is that teams lead to idea generation and implementation, which in turn leads to improved productivity and quality. The second is that teams lead to improved job satisfaction, motivation, and task performance, which ultimately translates into increased productivity. A variety of costs are also associated with team production. These include regular team meetings and training, and shirking and free-riding among team members (Alchian and Demsetz 1972, Holmstrom 1982, Rasmusen 1987, Itoh 1991, 1992, McAfee and McMillan 1991, Legros and Matthews 1993).

It is frequently argued that teams confer the greatest benefits when they are granted autonomy, and indeed autonomous or self-managing teams have been the focus of much of the empirical teams literature. The distinguishing feature of self-managed or autonomous teams is that team members are given the latitude to jointly decide *how their work is to be done*. The alternative to an autonomous team is a non-autonomous or closely-managed team, in which team members have little discretion over tasks and are told not only what to do but how to do it. When the teams under study are autonomous or self-managing, a positive effect on firm performance is typically found in the literature. For example, Hamilton, Nickerson, and Owan (2003) found a fourteen percent increase in labor productivity after the introduction of self-managed teams in a garment manufacturing plant, and Eriksson (2003) found a positive effect of self-managed teams on labor productivity in a cross section of establishments.

Theoretical rationales for granting teams autonomy can be found both in economics and in organizational behavior. In economics the relevant literature concerns the delegation of authority within organizations, and the insights from this literature are relevant in the team context even though the theories are frequently framed in language pertaining to individual workers.[6] Grossman and Hart (1986), Hart and Moore (1990), and Hart (1995) suggested that authority may be conferred by the ownership of an asset, which gives the owner the right to make decisions concerning the use of this asset. More generally, authority may result from an explicit or implicit contract allocating decision rights to a team or to an individual worker in the organization. An idea that emerges from this literature is that the agent's incentives are weaker when he does not have control over asset-allocation decisions. In the team context, this suggests a benefit from granting autonomy. An important contribution to this incentives-based literature is Aghion and Tirole (1997), which develops a theory of the allocation of formal authority (the formal right to decide) and real authority (the effective or *de facto* control over actual decision making) within organizations.

Asymmetric information is key to the Aghion and Tirole model. A principal who has formal authority over a decision or activity can always reverse the subordinate's decision but will refrain from doing so if the subordinate is much better informed and if their objectives are reasonably congruent. In the Aghion and Tirole model, there are two main benefits associated with delegating formal authority to the agent (or team in the present context). First, it credibly increases the agent's initiative or incentive to acquire information, since the granting of authority prevents the principal from over-ruling the agent in those situations in which both parties have acquired the information. Second, granting authority over decisions that matter relatively more to the agent than to the principal (an example would be performing the job standing up versus sitting down) and for which the principal's overruling might hurt the agent will make the agent more likely to participate in the contractual relationship. The main cost of delegating authority is the principal's loss of control over the choice of tasks or projects and how they are executed. An increase in an agent's real authority promotes initiative but results in a loss of control for the principal. This basic tradeoff between loss of control and initiative is a central idea, and in the team context it implies that granting teams more autonomy is not necessarily better.

In organizational behavior, the rationale for granting autonomy evolved from work on motivational job design for individual workers (Hackman and Oldham 1976, 1980; Turner and Lawrence 1965).[7] According to the theory, the degree of autonomy a worker is granted affects three critical psychological states (experienced meaningfulness, experienced responsibility, and knowledge of results), which in turn induces a number of outcomes of interest both to workers and firms, such as high internal work motivation, high quality work performance, high satisfaction with work, and low absenteeism and turnover. Hackman (1987) applied these ideas to teams, synthesizing an extensive literature on group research to propose variables that are key to group job design. Hackman identified a number of task conditions that would produce high task motivation, and among these was autonomy. That is, the tasks assigned to the group should provide group members with substantial autonomy for deciding how best to accomplish them.

To the extent that workers experience autonomy in a team production context, Hackman (1987) argues that they experience greater motivation, which should translate into higher labor productivity. There is also evidence that in some production contexts monitoring by peers in self-managed teams is better than supervisory monitoring, encouraging team members to meet self-imposed group norms (Barker 1993). As mentioned earlier, 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. A theoretical counterargument is the agency perspective (Alchian and Demsetz 1972, Holmstrom 1982) that predicts shirking and free-riding problems to increase in a team context when workers are no longer closely monitored by supervisors.[8] Self-managed teams change the organizational structure of firms, from hierarchical to horizontal, as team members assume some of the discretion that would otherwise be held by management. This is another means by which team production can impact labor productivity. See Batt (2001) for further discussion.

III. DATA AND MEASURES

The data are from the management questionnaire in the 1998 Workplace Employee Relations Survey (WERS), jointly sponsored by the Department of Trade and Industry, ACAS, the Economic and Social Research Council, and the Policy Studies Institute.[9] Distributed via the UK Data Archive, the WERS data are a nationally representative stratified random sample covering British workplaces with at least ten employees except for those in the following 1992 Standard Industrial Classification divisions: agriculture, hunting, and forestry; fishing; mining and quarrying; private households with employed persons; and extra-territorial organizations. Some of the 3192 workplaces targeted were found to be out of scope, and the final sample size of 2191 implies a net response rate of 80.4% (Cully et al., 1999) after excluding the out-of-scope cases. Data were collected between October 1997 and June 1998 via face-to-face interviews, and the respondent manager was usually the most senior manager at the workplace with responsibility for employment relations.

Labor Productivity and Product Quality

Each respondent manager in the WERS is asked how the current labor productivity of the workplace compares with that of other establishments in the same industry. The analogous question is then asked for the establishment's current quality of product or service compared with that of other establishments in the industry. Responses to both questions are: "A lot better than average", "Better than average", "About average for industry", "Below average", "A lot below average", and "No comparison possible."

Since the survey is anonymous, there are no incentives for respondents to purposefully misrepresent their answers to either question. Nonetheless, since the measures are subjective responses they are potentially affected by reporting errors.[10] Unsystematic reporting errors add noise to the observed measures, biasing the treatment effects of interest towards zero. Such errors might result from imperfect information on the part of respondents, though it is hoped that the most senior manager at the establishment would usually be knowledgeable about the industry and have a good sense of how the establishment's productivity and product quality stand relative to that of the competition. Systematic reporting errors might arise from the "Lake Wobegon effect" whereby most respondents claim to have above-average performance.[11] Even if all respondents overstate productivity, this need not amount to anything more than a relabeling of the discrete categories describing productivity, with no implications for the treatment effects of interest as long as the systematic reporting error is uncorrelated with the treatment. Furthermore, the mere observation of a heavy concentration of responses on the high end of the scale is not necessarily evidence of reporting errors of the Lake Wobegon type but could instead be the result of length-biased sampling. The survey conditions on establishments being operational when sampled; the more successful establishments experience longer durations of operation and are therefore more likely than unsuccessful establishments to be sampled at a point in time.[12]

Systematic reporting errors could potentially be correlated with teams and autonomy. This could arise if an omitted variable, such as "managerial optimism," determines both the outcome measure (labor productivity or product quality) and the decision to engage in teams. It might be that the more optimistic managers have a rosier view of the establishment's performance relative to the industry average and that such managers are more likely to organize production in teams. Such reporting errors would bias estimates of the teams treatment in a regression of organizational performance on the use of teams. But my estimation approach explicitly accounts for correlations in the unobserved determinants of teams, autonomy, and organizational performance, so that these correlations are not confounded with the treatment effects of interest. It is precisely concerns such as these (namely omitted unobserved variables that might influence not only the employer's response to questions about organizational performance but also the issues of whether teams are chosen and granted autonomy) that motivate the structural approach taken in this paper.[13]

Teams and Autonomy

Respondent managers are asked to report the proportion of employees in the largest occupational group at the workplace that works in formally designated teams: "All 100%", "Almost all 80-99%", "Most 60-79%", "Around half 40-59%", "Some 20-39%", "Just a few 1-

19%", or "None 0%". An advantage of this question is that it specifically refers to "formally designated" teams, directing the respondent's attention to situations of true joint production and reducing the respondent's likelihood of reporting the use of teams simply on the basis of a cooperative atmosphere of "team spirit" at the workplace. The restriction to the establishment's largest occupational group is one limitation of the data. 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%".

The survey also contains a measure of team autonomy that closely corresponds to the notion of autonomy discussed in the economics literature on organizations and in the literature on organizational behavior (Aghion and Tirole 1997, Hackman 1987). Hackman (1987) writes that team members are motivated when "the task provides group members with substantial autonomy for *deciding about how they do the work* [emphasis added] – in effect, the group 'owns' the task and is responsible for the work outcomes." For establishments that report the use of formally designated teams in the largest occupational group, the respondent is asked to respond "Yes" or "No" to the following statement: "Team members jointly decide how the work is to be done." The distinguishing feature of an autonomous or self-managing team is that team members are granted discretion over how their work is to be done.[14] In contrast, closely-managed or non-autonomous teams are given a task and told not only what to do but how to do it.

There are 2182 non-missing observations for teams, 1774 for labor productivity, 1972 for product quality, 1769 for labor productivity and teams simultaneously, and 1966 for product quality and teams simultaneously. The tendency to use teams is similar whether or not labor productivity (product quality) is observed; the fraction using teams in the largest occupational group is 0.876 (0.871) when productivity (product quality) is non-missing and 0.843 (0.856) when it is missing. Appendix A presents descriptive information on the unconditional associations between teams and organizational performance.

IV. METHODOLOGY

Since the models estimated here have the same structure as the model for financial performance proposed and estimated in DeVaro (2006), the description here is brief (see Appendix B for technical details). The endogenous variables are defined as follows:

$LABPROD_i$ = 1 if labor productivity is “About average for industry” or below
= 2 if labor productivity is “Better than average”
= 3 if labor productivity is “A lot better than average”
$QUALITY_i$ = 1 if quality of product or service is “About average for industry” or below
= 2 if quality of product or service is “Better than average”
= 3 if quality of product or service is “A lot better than average”
$TEAMS_i$ = 1 if positive fraction of workers in the largest occupational group is in teams
= 0 otherwise
$AUTO_i$ = 1 if team members are allowed to jointly decide how the work is to be done
= 0 otherwise

The labor productivity and product quality measures aggregate 5 discrete categories to 3, and the teams measure aggregates 7 discrete categories to 2, to facilitate estimation of the structural models by reducing the number of discrete states.

The structural model for labor productivity (product quality) simultaneously estimates four equations: one for labor productivity (product quality) given that teams are used in the largest occupational group, a second for labor productivity (product quality) given that teams are not used in the largest occupational group, a third for teams, and a fourth for autonomy. I assume the four disturbance terms in each model follow the multivariate normal distribution, estimating the models by maximum likelihood. The exogenous variables included in each equation are defined in Table 2.

An indicator variable for “just-in-time” production appears in the teams equation but not the equations for labor productivity and product quality. Just-in-time is frequently cited as an important determinant of the decision to use team production. As argued by Berg et al. (1996) in the context of the apparel industry, the demands of just-in-time production require flexible organizational structures such as teams.[15] More recently, Hamilton, Nickerson, and Owan (2003) cite the demand by retailers for just-in-time production as a major reason for the introduction of teams during 1995-1997 in the garment manufacturing establishment they study. The assumption that just-in-time has no direct effect on either (within-industry) labor productivity or product quality is rather strong, though it should be noted that whether or not a production process is characterized by just-in-time is more central to discussions of teams in the literature than it is to discussions of labor productivity and product quality. Empirical studies of labor productivity or product quality rarely include just-in-time production as a determinant of labor productivity or product quality, nor do they discuss the implications of omitting it. Finally, my work with these data confirms that there is no noteworthy statistical relationship between just-in-time and either labor productivity or product quality, either unconditionally or in the presence of controls.[16]

Four variables that proxy for the organizational and informational structure of the establishment, the alignment of incentives between workers and owners, and the importance to the establishment of monitoring inputs appear only in the autonomy equation. The first three of these are qualitative measures of managerial opinion. The manager is asked to respond “Strongly agree” (1), “Agree” (2), “Neither agree nor disagree” (3), “Disagree” (4), or “Strongly disagree” (5) to each of the following statements:

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.”

The fourth, pertaining to the importance to the organization of closely monitoring labor inputs, is the proportion of workers at the establishment that ever work from home during normal working hours.[17] Responses include: “Half or more 50%+” (1), “A quarter up to a half 25-49%” (2), “Up to a quarter 10-24%” (3), “A small proportion 5-9%” (4), “Hardly any (less than 5%)” (5), or “None 0%” (6).

In establishments where top managers have better information for making decisions than workers on the line, autonomy is less likely to be granted to teams. Therefore, “Information” and “Decisions” should both have positive effects, meaning that employers who disagree with those statements are more likely to grant autonomy. In establishments where the interests and goals of workers are aligned with those of the firm, autonomy is more likely to be granted to teams.[18] Therefore “Incentive Alignment” should have a negative sign, since agreement with the statement is associated with more autonomy (Aghion and Tirole 1997). The fraction of employees who work at home might be thought of as a proxy for the importance the employer places on monitoring workers through direct supervision, as opposed to relying on the social norms and peer pressure that arise in a team context, as discussed in Kandel and Lazear (1992). Therefore, the expected sign on this variable is negative, meaning that workplaces that are more permissive of working from home are more likely to grant team autonomy.[19]

V. RESULTS

Tables 3 and 4 display the parameter estimates.[20,21] The following functions of these parameters give the effect of team production overall (whether autonomous or non-autonomous) on labor productivity and product quality for establishment i:

$(\text{Effect A1})_i = \text{Prob}(\text{LABPROD}_i = 1 \mid \text{TEAMS}_i = 1) - \text{Prob}(\text{LABPROD}_i = 1 \mid \text{TEAMS}_i = 0)$
$(\text{Effect A2})_i = \text{Prob}(\text{LABPROD}_i = 2 \mid \text{TEAMS}_i = 1) - \text{Prob}(\text{LABPROD}_i = 2 \mid \text{TEAMS}_i = 0)$
$(\text{Effect A3})_i = \text{Prob}(\text{LABPROD}_i = 3 \mid \text{TEAMS}_i = 1) - \text{Prob}(\text{LABPROD}_i = 3 \mid \text{TEAMS}_i = 0)$

$(\text{Effect A1Q})_i = \text{Prob}(\text{QUALITY}_i = 1 \mid \text{TEAMS}_i = 1) - \text{Prob}(\text{QUALITY}_i = 1 \mid \text{TEAMS}_i = 0)$
$(\text{Effect A2Q})_i = \text{Prob}(\text{QUALITY}_i = 2 \mid \text{TEAMS}_i = 1) - \text{Prob}(\text{QUALITY}_i = 2 \mid \text{TEAMS}_i = 0)$
$(\text{Effect A3Q})_i = \text{Prob}(\text{QUALITY}_i = 3 \mid \text{TEAMS}_i = 1) - \text{Prob}(\text{QUALITY}_i = 3 \mid \text{TEAMS}_i = 0)$

Panels 1 and 2 of Figure 1 convey this information graphically. Establishments predicted to benefit the most from team production are those farthest from the origin in the second quadrant, and those predicted to be hurt the most are those farthest from the origin in the fourth quadrant. In both the labor productivity and product quality plots, the predicted effect of team production is positive for many establishments and negative for many others, though the positive effects appear to dominate.

For the labor productivity model, I rank the establishments in order by their values of (Effect A3 – Effect A1), which is a measure of the predicted effect of teams on productivity. I then select three establishments of interest (the median establishment, the establishment at the 25th percentile, and the establishment at the 75th percentile), determining whether their respective values of Effects A1, A2, and A3 are statistically significantly different from zero. I follow the analogous approach for the product quality model, ranking firms by their values of (Effect A3Q – Effect A1Q) and selecting three new establishments of interest. For these six establishments, I also compute: 1) the effect of autonomous teams on labor productivity (or product quality), 2) the effect of non-autonomous teams on labor productivity (or product quality), 3) the incremental effect of autonomy on labor productivity (or product quality) given that teams are used.[22]

Tables 5 and 6 display the main results.[23] The first main result is that the median workplace benefits considerably from team production in terms of labor productivity but not in terms of product quality. The effect of team production is an 11.0 percentage point decrease in the probability that labor productivity is at or below the industry average. The point estimates suggest that of these 11.0 percentage points, 8.0 are accounted for by an increase in the probability that labor productivity is better than the industry average and the remaining 3.0 are accounted for by an increase in the probability that labor productivity is “a lot above average” for the industry. Although the point estimates reveal a positive effect of team production on product quality for the median workplace, this result is statistically insignificant.

The second main result is that there is no important difference between the effects of autonomous teams and those of non-autonomous teams. As was the case for team production in general, for both autonomous and non-autonomous team production the median workplace benefits considerably in terms of labor productivity. While the point estimates suggest slightly higher benefits from autonomous teams than from non-autonomous teams, the difference between the two types of teams is statistically insignificant. For product quality, the only effect that achieves significance at the ten percent level is the effect of autonomous teams on the probability that product quality is “a lot above” the industry average. As with labor productivity, the point estimates are slightly more favorable to autonomous than to non-autonomous teams, but again the difference between the two types of teams is statistically insignificant. The finding of no significant difference between autonomous and non-autonomous teams holds for the workplaces at the 0.25 and 0.75 quantiles as well as at the median. At least in terms of statistical significance, the data therefore do not support the notion that self-managed or non-autonomous teams are superior to closely-managed or non-autonomous teams.

The third main finding is that, while the workplaces at the 0.75 quantile experience predicted benefits to both labor productivity and product quality that far exceed those at the median, there is no evidence that the workplaces at the 0.25 quantile suffer in either dimension from using teams. For the workplace at the 0.75 quantile in the labor productivity model, using teams is associated with a decrease of 21.0 percentage points in the predicted probability that labor productivity is at or below the industry average and an 8.7 percentage point increase in the probability that productivity is “a lot above” the industry average, and these magnitudes are significantly higher than those for the median workplace. For the workplace at the 0.75 quantile in the product quality model, using teams is associated with a decrease of 13.2 percentage points in the predicted probability that quality is at or below the industry average and an increase of 11.4 percentage points in the probability that quality is “a lot above” the industry average. The corresponding numbers for the median workplace were only 3.7 and 6.0 percentage points, respectively, and neither were statistically insignificant. Turning to the workplaces at lower quantiles of the predicted benefits from using teams, for labor productivity none of the effects are statistically significant for the workplace at the 0.25 quantile and even the point estimates do not suggest a detriment to using teams. For product quality, while the point estimates for the workplace at the 0.25 quantile suggest a negative effect from using teams, the magnitudes are small and all effects are statistically insignificant.

The fourth set of findings concerns the correlations among the unobserved determinants of the endogenous variables. Note that σ_{13}, or cov(ε_1, ε_3), is the correlation between the unobserved determinants of autonomy (given that teams are used) and labor productivity (product quality) give that teams are used.[24] It is negative and statistically significant in both models, implying that unobserved factors that make an establishment more likely to grant autonomy to teams also tend to depress labor productivity and product quality. An example of such a factor might be fun, likable, and laid back managers at the workplace. Such managers might be popular among workers, and more likely to grant considerable discretion to team members, but lax in enforcing high standards for labor productivity and product quality. Further note that σ_{23}, or cov(ε_2, ε_3), is the correlation of the unobserved determinants of teams and autonomy (given that teams are used). It is negative and statistically significant in both models, suggesting some unobserved characteristic of the production process (or of managers) that makes closely-managed teams attractive. Finally, note that σ_{02}, or cov(ε_0, ε_2), is the correlation of the unobserved determinants of teams and labor productivity (product quality) given teams are not used. It is negative and statistically significant in the product quality model, suggesting that factors that make an establishment more likely to use teams are also likely to make that establishment have lower product quality in the absence of teams. One example of such a factor would be the degree to which product or service quality increases from the complementarities arising from information sharing among coworkers. When such benefits from information sharing are large, teams are more likely to be used, and product or service quality is more likely to suffer if teams are not used.

A frequent approach in management research is to treat the choice variables of the organization (such as team production and autonomy in this study) as exogenous on the right-hand side of regressions of organizational outcomes.[25] Ignoring the endogeneity of teams and autonomy means assuming that the disturbances are uncorrelated across equations. The last four rows of Tables 3 and 4 suggest that the data are incompatible with such restrictions for both labor productivity and product quality.[26] If the restrictions are imposed anyway, a visual summary of how the results change can be seen by comparing Panels 1 and 2 of Figure 1 to Panels 3 and 4. In Panels 3 and 4 the predicted effects are more heavily concentrated in the second quadrant (where the predicted benefits from teams are the highest) and less concentrated in the fourth quadrant (where the predicted benefits are the lowest) than in the corresponding structural scatter plots in Panels 1 and 2. This shift in the scatter is clearly more pronounced for product quality than for labor productivity. To reveal the magnitudes of these distortions, Tables 7 and 8 display the key effects of interest based on the constrained models. These tables are analogous to Tables 5 and 6, respectively, that were based on the structural models. For labor productivity, as seen by comparing Tables 5 and 7, the Effects A1, A2, and A3 that were found to be (-0.110, 0.080, 0.030) for the median establishment using the structural model would be (-0.125, 0.086, 0.039) if the endogeneity of teams and autonomy were ignored. In this case the magnitude of the distortion is relatively modest.

The magnitude of the bias is much larger in the case of product quality and gives rise to a qualitatively different conclusion. As was seen in Table 6, Effects A1Q, A2Q, and A3Q were (-0.037, -0.023, 0.060) for the median establishment using the structural product quality model, and each of these estimates were statistically insignificant. In contrast, as revealed in Table 8, when endogeneity is ignored the corresponding numbers are (-0.068, -0.014, 0.082) and are statistically significant. In summary, by treating teams and autonomy as exogenous in the 1998 WERS, we would incorrectly infer an economically and statistically significant positive effect of teams on product quality for the median workplace, whereas accounting for the endogeneity we would infer no statistically significant effect.

Ignoring the endogeneity of teams and autonomy in the 1998 WERS would also lead to mistaken inferences regarding the difference between autonomous and non-autonomous teams. As revealed in the fourth columns of Tables 5 and 6, the structural model implies that there are no statistically significant differences between autonomous and non-autonomous teams in their effects on either labor productivity or product quality. In contrast, if the endogeneity of teams and autonomy is ignored, the fourth column of Table 8 would lead us to the erroneous conclusion that autonomous teams yield statistically significantly larger benefits to product quality than do non-autonomous teams, at each of the three quantiles of interest. For labor productivity, both the structural and non-structural models yield roughly the same qualitative conclusions regarding the difference between autonomous and non-autonomous teams.

The finding that the endogeneity bias tends to inflate the relative benefits of autonomous teams as opposed to non-autonomous teams, at least in this data set with these measures of organizational performance, is interesting in light of the common view that autonomous teams tend to be superior to non-autonomous teams in terms of their benefits to organizational performance. For example, one of the leading texts in strategic human resource management argues that "Closely managed teams miss many of the advantages that internally autonomous teams can have, while possessing a number of the disadvantages. Except where concerns for internal equity are paramount, allowing teams the freedom to internally manage themselves seems to us the better strategy." (Baron and Kreps 1999). The results here suggest that neglecting the endogeneity of teams and autonomy might contribute to an overly sanguine view of the merits of autonomous teams relative to non-autonomous teams. While my best estimates suggest no differences between the two types of teams for any of the three measures of organizational performance, neglecting the endogeneity in the WERS data would lead one to the erroneous conclusion that the typical establishment benefits more (in terms of product quality) from autonomous than from non-autonomous teams.

Another point that emerges regarding the relative advantages of autonomous and non-autonomous teams is that whether autonomous teams are preferable to non-autonomous teams for the typical workplace depends on the measure of organizational performance considered. In the present study of labor productivity and product quality, the point estimates favored autonomous teams. In an earlier analysis of financial performance in DeVaro (2006), the reverse was true. In the empirical teams literature, the most commonly used measures of performance are labor productivity and product quality, whereas broader measures of organizational performance such as profit are much rarer. The results of this study suggest that a second possible reason (apart from the endogeneity issue) for the relatively favorable view of autonomous teams is the heavy focus in the literature on outcome measures such as labor productivity. If the focus of future work shifts more in the direction of broader measures of organizational performance, then the results from the WERS suggest that the evidence in favor of non-autonomous or closely-managed teams may improve. Increased attention to broader outcome measures such as financial performance would be desirable in any case. Such measures are more inclusive of the full spectrum of benefits and costs resulting from teams than are intermediate outcomes such as labor productivity. Most firms will ultimately care the most about what effect a given human resource practice has on profit, regardless of how various intermediates such as labor productivity and product quality may be affected. In summary, the work here suggests that greater attention both to endogeneity and to broader measures of organizational performance in future research is likely to yield results that are more favorable to non-autonomous teams than have been found in previous work.

APPENDIX A

Table A1 displays the distribution of labor productivity categories by the percentage of workers in teams. A chi-square test of independence has a p-value of 0.005, providing strong evidence against the null that the team production and labor productivity classifications are independent of each other. Restricting our attention to those establishments that use teams and that grant teams autonomy by allowing team members to jointly decide how the work is to be done, column percentages are given in Table A2. The chi-square test of independence has a p-value of 0.271, so the null that the autonomous teams and labor productivity classifications are independent cannot be rejected at conventional significance levels. Tables A3 and A4 display the results for product quality, and the p-values from chi-square tests of independence are 0.820 and 0.880, respectively. In summary, the descriptive evidence suggests that team production is empirically related to labor productivity but that, given that teams are used, self-managed or autonomous team production is not. In contrast, neither team production in general nor autonomous team production is empirically related to product quality. However, these tabulations are unconditional.

TABLE A1: Labor Productivity by % of Largest Occupational Group in Teams

	0%	***1-19%***	***20-39%***	***40-59%***	***60-79%***	***80-99%***	***100%***
Distribution of Labor Productivity (unweighted)							
A lot below average	0.9	1.1	1.4	2.3	1.0	0.0	0.2
Below average	3.7	3.2	7.8	6.7	6.1	5.6	3.6
About average for industry	50.9	48.9	35.5	51.7	43.2	43.9	40.0
Better than average	34.3	36.2	46.8	32.6	42.1	40.0	40.9
A lot better than average	10.2	10.6	8.5	6.7	7.6	10.8	15.4
Column sum	100	100	100	100	100	100	100
Distribution of Labor Productivity (weighted)							
A lot below average	0.4	0.6	2.8	0.9	1.6	0.0	0.0
Below average	1.0	2.4	8.5	3.5	9.4	2.5	3.8
About average for industry	51.2	64.8	26.8	61.6	36.8	45.9	37.2
Better than average	38.0	26.3	39.0	29.0	44.1	40.1	43.2
A lot better than average	9.5	5.9	23.0	5.0	8.1	11.5	15.7
Column sum	100	100	100	100	100	100	100

Note: Column categories represent the fraction of the largest occupational group that is engaged in team production. Row categories represent the labor productivity of the establishment relative to the industry average, as reported by the respondent manager. Sample size is 1727.

TABLE A2: Labor Productivity by % of Largest Occupational Group in Autonomous Teams

	1-19%	*20-39%*	*40-59%*	*60-79%*	*80-99%*	*100%*
Distribution of Labor Productivity, Given Autonomous Teams (unweighted)						
A lot below average	2.2	1.6	2.3	1.9	0.0	0.0
Below average	4.4	6.3	4.7	6.5	4.7	3.8
About average for industry	47.8	35.9	46.5	43.0	39.8	38.8
Better than average	34.8	50.0	37.2	39.3	44.5	42.6
A lot better than average	10.9	6.3	9.3	9.4	11.0	14.8
Column sum	100	100	100	100	100	100
Distribution of Labor Productivity, Given Autonomous Teams (weighted)						
A lot below average	1.1	6.6	0.1	2.5	0.0	0.0
Below average	1.5	4.8	3.0	12.2	1.4	4.7
About average for industry	65.2	19.3	53.8	34.3	38.1	34.0
Better than average	26.2	50.0	35.7	40.7	51.5	44.8
A lot better than average	5.9	19.3	7.3	10.2	9.0	16.4
Column sum	100	100	100	100	100	100

Note: Column categories represent the fraction of the largest occupational group that is engaged in team production, given that teams are used and granted autonomy. Row categories represent the labor productivity of the establishment relative to the industry average, as reported by the respondent manager. Sample size is 843.

TABLE A3: Product Quality by % of Largest Occupational Group in Teams

	0%	*1-19%*	*20-39%*	*40-59%*	*60-79%*	*80-99%*	*100%*
Distribution of Product Quality (unweighted)							
A lot below average	0.0	0.0	0.0	1.1	0.0	0.0	0.3
Below average	3.2	2.0	2.7	1.1	2.3	2.3	2.3
About average for industry	26.5	24.2	29.5	24.7	25.2	25.6	23.7
Better than average	51.8	54.6	46.6	51.7	51.9	52.6	48.9
A lot better than average	18.5	19.2	21.2	21.4	20.6	19.5	24.8
Column sum	100	100	100	100	100	100	100
Distribution of Product Quality (weighted)							
A lot below average	0.0	0.0	0.0	0.8	0.0	0.0	0.0
Below average	0.9	1.4	1.7	1.5	5.6	0.9	2.7
About average for industry	21.0	12.0	35.1	21.0	23.7	25.8	18.8
Better than average	52.7	66.4	44.5	50.8	50.5	53.2	49.2
A lot better than average	25.3	20.2	18.7	26.0	20.1	20.1	29.3
Column sum	100	100	100	100	100	100	100

Note: Column categories represent the fraction of the largest occupational group that is engaged in team production. Row categories represent the product quality of the establishment relative to the industry average, as reported by the respondent manager. Sample size is 1917.

TABLE A4: Product Quality by % of Largest Occupational Group in Autonomous Teams

	1-19%	*20-39%*	*40-59%*	*60-79%*	*80-99%*	*100%*
Distribution of Product Quality, Given Autonomous Teams (unweighted)						
A lot below average	0.0	0.0	0.0	0.0	0.0	0.2
Below average	2.0	3.0	2.4	1.7	1.8	1.8
About average for industry	24.0	31.8	16.7	28.6	26.1	22.3
Better than average	60.0	45.5	59.5	50.4	50.0	50.0
A lot better than average	14.0	19.7	21.4	19.3	22.1	25.7
Column sum	100	100	100	100	100	100
Distribution of Product Quality, Given Autonomous Teams (weighted)						
A lot below average	0.0	0.0	0.0	0.0	0.0	0.0
Below average	1.1	3.3	2.3	7.8	0.7	1.6
About average for industry	8.7	41.7	16.5	31.7	27.6	16.2
Better than average	73.3	38.2	60.2	43.2	50.4	48.5
A lot better than average	16.9	16.8	21.1	17.3	21.4	33.7
Column sum	100	100	100	100	100	100

Note: Column categories represent the fraction of the largest occupational group that is engaged in team production, given that teams are used and granted autonomy. Row categories represent the product quality of the establishment relative to the industry average, as reported by the respondent manager. Sample size is 942.

In addition to establishment characteristics, the exogenous variables in the teams and autonomy equations of the structural models include industry controls since the establishment's choices of teams and autonomy are also likely to vary by industry. I exclude these industry controls from the labor productivity and product quality equations since the survey asks the employer to rate the establishment's current labor productivity and product quality compared with other establishments in the same industry, so industry differences are in effect already controlled by the nature of the question.[27] The 12 industry controls are dummy variables indicating the 1992 SIC code that most closely corresponds to the main activity of the establishment. The upper panel of Table A5 displays the distribution of the sample by industry. Since both the teams and autonomy variables measure organizational choices in the largest occupational group, I also include as exogenous variables in these equations a set of occupational dummy variables indicating the establishment's largest occupational group. All survey responses correspond to SOC codes, some at the 1-digit level and others at the 2-digit level. I aggregated all observations to the 1-digit level, and sample frequencies for the resulting 9 occupational groups are displayed in the lower panel of Table A5. Table A6 displays means and standard deviations for all variables in the structural models except for the occupation and industry variables that were summarized in Table A5.

TABLE A5: Distribution of Establishments by Industry and Largest Occupational Group

	Number	*Percent*	*Number*	*Percent*
Distribution by Industry				
Manufacturing	253	14.7	276	14.4
Electricity, Gas, and Water	68	3.9	69	3.6
Construction	95	5.5	102	5.3
Wholesale and Retail	267	15.5	292	15.2
Hotels and Restaurants	114	6.6	122	6.4
Transport and Communication	113	6.5	122	6.4
Financial Services	86	5.0	95	5.0
Other Business Services	178	10.3	197	10.3
Public Administration	108	6.3	120	6.3
Education	178	10.3	215	11.2
Health	178	10.3	210	11.0
Other Community Services	89	5.2	97	5.1
Total	***1727***	***100***	***1917***	***100***
Distribution by Largest Occupational Group				
Managers & Administrators	10	0.6	13	0.7
Professional Occupations	210	12.2	258	13.5
Associate Professional & Technical Occupations	140	8.1	151	7.9
Clerical & Secretarial Occupations	295	17.1	321	16.7
Craft & Related Occupations	203	11.8	212	11.1
Personal & Protective Service Occupations	231	13.4	272	14.2
Sales Occupations	202	11.7	225	11.7
Plant & Machine Operatives	235	13.6	252	13.2
Other Occupations	201	11.6	213	11.1
Total	***1727***	***100***	***1917***	***100***

Note: Columns 1 and 2 use the subsample on which the labor productivity model is estimated, and columns 3 and 4 use the subsample on which the product quality model is estimated.

TABLE A6: Descriptive Statistics for Variables in Structural Teams Models

	Mean	*Standard Deviation*	*Mean*	*Standard Deviation*
Dependent Variables				
Labor Productivity	1.632	0.683	1.630	0.684
Product Quality	1.946	0.699	1.940	0.700
Teams	0.875	0.331	0.870	0.336
Autonomy	0.558	0.497	0.565	0.496
Firm Controls				
Single-Establishment Firm	0.219	0.414	0.223	0.417
Establishment Size	302.1	934.4	294.4	896.7
Fraction of Part-Time Workers	0.263	0.285	0.264	0.283
Temporary Workers	0.379	0.485	0.376	0.484
Fixed-Term Workers Under 1 Year	0.429	0.495	0.432	0.495
Fixed-Term Workers Over 1 Year	0.232	0.422	0.235	0.424
Union Workers	0.647	0.478	0.646	0.478
Private Sector Franchise	0.014	0.117	0.013	0.111
Private Sector Non-franchise	0.404	0.491	0.389	0.488
Alternative Private Sector Franchise	0.013	0.115	0.012	0.109
Alternative Private Sector Non-franchise	0.302	0.459	0.309	0.462
Public Sector	0.271	0.445	0.281	0.450
Just-in-time	0.318	0.466	0.307	0.461
Information	2.733	1.085	2.734	1.090
Incentive Alignment	2.311	0.846	2.298	0.845
Decisions	3.737	0.987	3.740	0.988
Work at Home	5.377	0.931	5.380	0.933
Sample Size	***1727***		***1917***	

Note: Columns 1 and 2 use the subsample on which the labor productivity model is estimated, and columns 3 and 4 use the subsample on which the product quality model is estimated. The structural models also include indicators for industry and largest occupational group, and Table A5 reports the distributions of these variables. See Table 2 for definitions of the variables.

APPENDIX B

The models have the same structure as the model estimated in DeVaro (2006), and that earlier paper contains more details on the methodology. Let i index establishments. Let $TEAMS_i^*$, $AUTO_i^*$, and $LABPROD_i^*$ denote latent indexes for teams, autonomy (given that teams are chosen), and labor productivity. Let $\mathbf{X}_{1i}$, $\mathbf{X}_{2i}$, and $\mathbf{X}_{3i}$ denote vectors of (exogenous) firm characteristics. Assuming linear functional forms for the latent indexes, the structural model for labor productivity is as follows:

$$LABPROD_i^* = \alpha AUTO_i + \mathbf{X}_{1i}\boldsymbol{\delta}_1 + \varepsilon_{1i} \qquad \text{if } TEAMS_i = 1$$
$$= \mathbf{X}_{1i}\boldsymbol{\delta}_2 + \varepsilon_{0i} \qquad \text{if } TEAMS_i = 0$$
$$TEAMS_i^* = \mathbf{X}_{2i}\boldsymbol{\beta} + \varepsilon_{2i}$$
$$AUTO_i^* = \mathbf{X}_{3i}\boldsymbol{\gamma} + \varepsilon_{3i} \qquad \text{if } TEAMS_i = 1$$

$$LABPROD_i = 1 \text{ if } LABPROD_i^* < 0$$
$$= 2 \text{ if } 0 \leq LABPROD_i^* < c$$
$$= 3 \text{ if } LABPROD_i^* \geq c \qquad \text{where } c > 0$$
$$TEAMS_i = 1 \text{ if } TEAMS_i^* > 0$$
$$= 0 \text{ otherwise}$$
$$AUTO_i = 1 \text{ if } AUTO_i^* > 0 \text{ and } TEAMS_i^* > 0$$
$$= 0 \text{ if } AUTO_i^* \leq 0 \text{ and } TEAMS_i^* > 0$$

The model for product quality has the same structure. The disturbances are assumed to follow a multivariate normal distribution. That is, $(\varepsilon_0, \varepsilon_1, \varepsilon_2, \varepsilon_3) \sim MVN(\mathbf{0}, \boldsymbol{\Sigma})$. I impose some standard identifying restrictions on the covariance matrix (all diagonal elements are normalized to 1, and $cov(\varepsilon_0, \varepsilon_1) = cov(\varepsilon_0, \varepsilon_3) = 0$. Since a small number of establishments have missing values for some of the exogenous variables, the estimation sample sizes are slightly smaller than those listed in the tabulations of the endogenous variables in Tables A1 – A4 of Appendix A. I computed standard errors via the parametric bootstrap with 100 replications. The treatment effects of interest are as follows, where P_1= Prob(LABPROD=1,TEAMS=1,AUTO=1), P_2 = Prob(LABPROD=1,TEAMS=1,AUTO=0), P_3 = Prob(LABPROD=2,TEAMS=1,AUTO=1), P_4 = Prob(LABPROD=2,TEAMS=1,AUTO=0), P_5 = Prob(LABPROD=3,TEAMS=1,AUTO=1), P_6 = Prob(LABPROD=3,TEAMS=1,AUTO=0), P_7 = Prob(LABPROD=1,TEAMS=0), P_8 = Prob(LABPROD=2,TEAMS=0), and P_9 = Prob(LABPROD=3,TEAMS=0):

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

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

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

$$\left(\text{Effect B1}\right)_i = \frac{P_{1i}}{P_{1i}+P_{3i}+P_{5i}} - \frac{P_{7i}}{P_{7i}+P_{8i}+P_{9i}}$$

$$\left(\text{Effect B2}\right)_i = \frac{P_{3i}}{P_{1i}+P_{3i}+P_{5i}} - \frac{P_{8i}}{P_{7i}+P_{8i}+P_{9i}}$$

$$\left(\text{Effect B3}\right)_i = \frac{P_{5i}}{P_{1i}+P_{3i}+P_{5i}} - \frac{P_{9i}}{P_{7i}+P_{8i}+P_{9i}}$$

$$\left(\text{Effect C1}\right)_i = \frac{P_{2i}}{P_{2i}+P_{4i}+P_{6i}} - \frac{P_{7i}}{P_{7i}+P_{8i}+P_{9i}}$$

$$\left(\text{Effect C2}\right)_i = \frac{P_{4i}}{P_{2i}+P_{4i}+P_{6i}} - \frac{P_{8i}}{P_{7i}+P_{8i}+P_{9i}}$$

$$\left(\text{Effect C3}\right)_i = \frac{P_{6i}}{P_{2i}+P_{4i}+P_{6i}} - \frac{P_{9i}}{P_{7i}+P_{8i}+P_{9i}}$$

$$\left(\text{Effect D1}\right)_i = \frac{P_{1i}}{P_{1i}+P_{3i}+P_{5i}} - \frac{P_{2i}}{P_{2i}+P_{4i}+P_{6i}}$$

$$\left(\text{Effect D2}\right)_i = \frac{P_{3i}}{P_{1i}+P_{3i}+P_{5i}} - \frac{P_{4i}}{P_{2i}+P_{4i}+P_{6i}}$$

$$\left(\text{Effect D3}\right)_i = \frac{P_{5i}}{P_{1i}+P_{3i}+P_{5i}} - \frac{P_{6i}}{P_{2i}+P_{4i}+P_{6i}}$$

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NOTES

[1] An exception is DeVaro (2006) which treats teams and autonomy as endogenous.

[2] Other outcome measures, while not the focus of this study, are also important and worthy of study and have indeed been the focus of many studies, particularly outside of economics, as seen in Table 1. Turnover, worker satisfaction, and absenteeism are examples of such alternative measures.

[3] There is precedent in the literature for treating empirical measures of labor productivity and product quality as distinct concepts. For example, in the analysis of the effects of HRM systems on labor productivity in the context of steel finishing lines, Ichniowski, Shaw, and Prennushi (1997) rely on a labor productivity measure that subsumes no notion of product quality. The authors also report results from an independent and complementary analysis of product quality (measured as the grade of the finished product). In their study, the empirical measures of labor productivity and product quality were clearly distinct and non-overlapping. It is reasonable to expect that some of the WERS respondents would also have in mind distinct concepts of labor productivity and product quality when responding to the survey questions.

[4] The idea that team production should yield benefits through the particular channel of product quality has also been discussed in the quality management literature, including Juran and Gryna (1980) which suggests the benefits of "breakthrough" teams and Deming (1986) which argues that quality improvement is realized through worker input and cooperation between workers and management.

[5] Petersen (1992a) showed that group target-rate schemes, in which pay is high if a production target is reached and low otherwise, provide a potential solution to the free-rider problem. Three alternative "non-market" solutions to the free-rider problem were proposed in Petersen (1992b), namely work-group-level social rewards, altruistic preferences, and moral commitment.

[6] See DeVaro (2006) for a more detailed discussion of the theory of delegation of authority in organizations and the rationale for granting teams autonomy. In addition, there is an industrial relations literature concerning the motivation of employers in instituting worker involvement. While these decisions are driven in part by a desire to improve organizational performance, they also reflect idiosyncratic managerial motivations such as their own career advancement. For a review of this literature see Bryson and Millward (1997).

[7] See Griffin and McMahan (1994) for a review of this literature. More recently, DeVaro, Li, and Brookshire (2006) review the empirical literature and test some propositions of the Job Characteristics Model using the 1998 WERS.

[8] Petersen (1992a, 1992b) discusses alternative solutions to the free-rider problem

[9] The 2004 WERS was released after this work was completed. I chose not to switch to the 2004 dataset prior to publishing the paper, because I wanted to maintain comparability between the results in this paper and those in DeVaro (2006) and DeVaro and Kurtulus (2006), both of which use the 1998 WERS.

[10] Of course, objective measures of organizational performance are also subject to reporting errors and often lead to higher rates of non-response, leading to suspicions of reporting bias. Subjective measures may contain information to which the respondent is privy that would not be reflected in objective data such as accounting measures. For an extended discussion of the advantages and disadvantages of subjective responses versus objective measures, see Kersley et al. (2006), the sourcebook for the 2004 WERS.

[11] This effect was named in tribute to the mythical radio comedy community of Lake Wobegon. Its origin appears to be the following statement: "Welcome to Lake Wobegon, where all women are strong, all the men are good-looking, and all the children are above average." – Garrison Keillor, *A Prairie Home Companion*

[12] Furthermore, some time elapsed between sampling and field work, and this is relevant to the extent that low-performing units were sampled but closed before field work occurred. This cannot account for much of the heavy concentration of responses in the upper tail, however, since only 5 percent of sampled workplaces closed prior to field work.

[13] Since the data are cross sectional, all that can be estimated is the correlation across unobservables at a point in time. Nothing can be said about differences in the correlations between unobservables over time.

[14] While the definition of autonomy I use corresponds most closely to the notion discussed in the literature, the WERS contains 3 measures that capture different dimensions of autonomy or the degree to which tasks are interrelated. Given that teams are reported to be used in the largest occupational group, the respondent is asked to respond "yes" or "no" to the following statements: "Team members are able to appoint their own team leaders." "Teams are given responsibility for specific products or services." "Teamworking depends on team members working together." Not surprisingly, if any of these alternatives are used to define team autonomy, the point estimates of the treatment effects of interest differ from those reported here. Throughout the paper, I use the general terminology "autonomy", though it is important to remember that the empirical measure is restricted to worker

autonomy for *deciding about how they do the work*, and, thus, all empirical results I report are specific to this particular dimension of team autonomy.

[15] While the argument that teams offer a more flexible organizational structure appears reasonable for autonomous teams, it can also be made for non-autonomous teams. Team production (even non-autonomous team production) by its very nature frequently leads to workers having more knowledge of others' tasks than they would in the case of individual production. This allows team members to reallocate efforts more quickly from one task to another, or from one product line to another in response to sudden fluctuations in product demand, than would be possible in the case of individual production. This can happen even if the teams are closely managed (because even if closely managed the workers are still working together).

[16] For example, in ordered probits of labor productivity and product quality the coefficients on "just-in-time" are statistically insignificant. For labor productivity, the just-in-time coefficient is -0.047 (Z = 0.40), and for product quality it is 0.152 (Z = 1.27). If industry controls are included in these ordered probits, the just-in-time coefficient is 0.026 (Z = 0.20) in the labor productivity model and 0.195 (Z = 1.52) in the product quality model.

[17] Though I treat percentage of employees working from home as a proxy for the importance of monitoring, it might also indicate some of the physical requirements of production or service delivery, since clearly some tasks are not easily transferred to the home.

[18] Among other places, this is argued in Baron and Kreps (1999). Following a measured endorsement of granting autonomy to teams, they append the following footnote describing the necessary preconditions for the granting of autonomy to be beneficial. "Of course, this takes as given that team members have internalized the organization's goals and possess the information and resources (including training) necessary to manage themselves effectively. If these conditions are not satisfied, then the management involved has been derelict in establishing the preconditions for a [self-managed or autonomous] team to work effectively." Baron and Kreps (1999)

[19] A potential concern is that some of these variables might have a direct effect on either teams or labor productivity (product quality), though the only one of these variables that is statistically significant in any of these equations is whether the employees are fully committed to the values of the organization, which has a positive effect on labor productivity (product quality). Identification does not hinge on this particular variable, however, and its inclusion in the performance equations (and the teams equation) yields results similar to those I report in the paper. Furthermore, a potential concern is that employer perceptions of incentive alignment and employee commitment might be functions of team autonomy rather than determinants of autonomy. However, if the models are re-estimated using only "percent working at home" and the statement that "those at the top are best placed to make decisions about this workplace" as exclusions, the results are roughly similar to those reported here.

[20] An established theoretical literature (e.g. Huselid and Becker 1996) and a WERS empirical literature (e.g. McNabb and Whitfield 1997) suggest the potential importance of interactions between team effects and financial incentives for team members. To explore this, I constructed a new dummy variable equaling one if performance-related pay is used in the establishment *and* workers in the largest occupational group at the establishment receive it *and* some non-managerial occupations are eligible for it *and* it is based on an output measure based on "group or team performance", and zero otherwise. So the variable captures team-based performance pay in the largest occupational group. Interacting this with the teams treatment (and the autonomy treatment) in ordered probits of labor productivity and product quality yields no statistically significant interaction effects.

[21] Note that 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) and work at home (6 categories). To economize on the number of parameters to be estimated, I treat each of these variables as continuous indexes rather than creating multiple dummies for each category. In unreported sensitivity checks I found the same qualitative results in models that include these variables as multiple dummies rather than as continuous indexes.

[22] More precisely, the effects for labor productivity are as follows:

What is the effect of autonomous, or self-managing, teams on labor productivity?
Effect B1 = Prob(LABPROD=1 | TEAMS=1, AUTO=1) – Prob(LABPROD = 1 | TEAMS = 0)
Effect B2 = Prob(LABPROD=2 | TEAMS=1, AUTO=1) – Prob(LABPROD = 2 | TEAMS = 0)
Effect B3 = Prob(LABPROD=3 | TEAMS=1, AUTO=1) – Prob(LABPROD = 3 | TEAMS = 0)

What is the effect of non-autonomous teams on labor productivity?

Effect C1 = Prob(LABPROD=1 | TEAMS=1, AUTO=0) – Prob(LABPROD = 1 | TEAMS = 0)
Effect C2 = Prob(LABPROD=2 | TEAMS=1, AUTO=0) – Prob(LABPROD = 2 | TEAMS = 0)
Effect C3 = Prob(LABPROD=3 | TEAMS=1, AUTO=0) – Prob(LABPROD = 3 | TEAMS = 0)

What is the incremental effect on labor productivity of autonomy, given that teams are used?
$(\text{Effect D1})_i = (\text{Effect B1})_i - (\text{Effect C1})_i$
$(\text{Effect D2})_i = (\text{Effect B2})_i - (\text{Effect C2})_i$
$(\text{Effect D3})_i = (\text{Effect B3})_i - (\text{Effect C3})_i$

The effects for product quality are analogous. For further details, see Appendix B and DeVaro (2006).

[23] When interpreting the results of this section one should bear in mind the possibility of biases resulting from reporting errors in the subjective measures of labor productivity and product quality.

[24] See Appendix B for a statement of all equations in the model.
[25] For a recent discussion of this problem and its prevalence in the management literature see Hamilton and Nickerson (2003).
[26] Likelihood ratio tests reject the restrictions $\boldsymbol{\Sigma} = \mathbf{I}$ at the five percent level in the labor productivity model ($p = 0.025$) and at the one percent level in the product quality model ($p < 0.001$).
[27] As a check, I estimated the model including industry controls in the equations for labor productivity and product quality and found that they were statistically insignificant.

Table 1: Empirical Studies Testing the Relationship between Teams and Organizational Performance

Study	**Measure of Organizational Performance**	**Variable of interest**	**Firm Type**	**Data**	**Econometric Methodology**	**Impacts**
Askenazy, Caroli &Marcus(2001)	Work injuries, Psychological strain	Job rotations Use of quality norms	Sample nationally representative	French 1998 cross-section on individual workers	Rubin's method of causal estimation	+
Banker, Field,Schroeder&Sinha(1996)	Product quality, Labor productivity	Formation of teams	Electromechanical assembly plant	U.S. 1992-1993 longitudinal field study 1	Fixed effects model, SUR	+
Bartel(2004)	Growth of Deposits and Loans	Human Resources Management indices based on employees surveys	Retail banking	U.S. 1995-1997 longitudinal field study	OLS, Fixed effects model	+ for incentives dimension
Batt (2004)	Worker Satisfaction	Self-managed team participation	Large unionized telecommunications company	U.S. 1994 cross-section on individual workers	Weighted OLS	+ (except for supervisors and middle managers)
Batt&Appelbaum (1995)	Worker Satisfaction	On-line participation, team-based systems	Multinational apparel companies	U.S. 1992 cross-section on individual workers	OLS, Ordered Logit	+
Bauer&Bender (2001)	Wages& Employment Structure	Use of HPWOs	National sample (excluding agricultural, mining and construction sector),Selection process favoring big firms	German. 1993-1997 Employer-employee linked data set	Weighted OLS	- (wage) 0 (employment structure)
Black&Lynch (2001)	Labor Productivity	Joint decision making coupled with incentive-based compensation	Nationally representative sample	U.S. 1987–1993 cross section and panel data	GMM	+
Black&Lynch (2004)	Labor Productivity	Self-managed teams participation	Sample nationally representative	U.S. 1993-1996 panel data	Weighted OLS, Fixed effects	+
Boning, Ichniowski & Shaw (2003)	Labor productivity	Group incentive pay, problem-solving teams	Steel minimills	U.S. 5-years longitudinal field study	Hazard rate models of the adoption of teams, OLS, Fixed-effects	+
Capelli & Neumark (2001)	Labor	Self-managed teams	Manufacturing	U.S. 1976-1997	OLS	+ on ULC

	productivity Unit Labor Costs		sector	panel-Data		weak on labor productivity
Caroli&Van Reenen (2001)	Labor Productivity	Organizational change	Establishment based nationally representative	U.K and French. repeated Cross section	OLS	+ in French skill-intensive firms
DeVaro(2006)	Profit	Team productions	Establishment based nationally representative	U.K. 1998. Workplace Employment Relation Survey	Ordered Probit with endogenous switching	+
Eriksson(2003)	Labor Productivity	Self-Managed teams	National sample, selection process favoring big firms	Danish 1980-1997 employer-employee linked data set	OLS, Fixed-Effects	+
Godard(2001)	Worker Satisfaction	On-line participation, team-based systems		Canada (except Quebec) 1997 telephone survey of employed	OLS	+
Hamilton, Nickerson & Owan (2003)	Labor Productivity	On-line participation, team-based systems	Corporation garment manufacturing	Californian 1995-1997 longitudinal field study	OLS, Fixed Effects	+
Huselid(1995)	Turnover, Labor Productivity, Financial Performance	2 factors extracted of a factor analysis on HPW practices. One interpreted as “Employee motivation”, the other as “Employee Skills and Organizational Structure”		U.S.1991 Sample of publicly held firms	OLS	+ (Productivity, Performance) - (Turnover)
Ichniowski(1990)	Labor Productivity, Q Tobin	HPWO practices	Manufacturing sector	U.S. 1986 survey Compustat business Lines	OLS	+
Ichniowski&Shaw(1999)	Labor Productivity	Teamwork	Steel production lines	U.S.& Japanese 1986-1992	GLS, Panel specific serial correlation	+
Ichniowski,Shaw and Prennushi (1997)	Labor Productivity	Teamwork	Steel production lines	US companies.	OLS, Fixed effects	+
Jones and Kato (2007)	Labor Productivity and Product Quality	Membership in offline teams	Operators in a single plant in central NY	Daily data for rejection, production, and downtime rates	Fixed effects, OLS	+
Kato&Morishima(2002)	Labor Productivity	Employment Participation/Involve	Sample of manufacturing	Japanese 1973–1992	OLS, IV, Probit	+

		ment	firms listed in Stock Exchanges.			
MacDuffie(1995)	Labor Productivity, Product Quality	Teamwork	Automotive assembly plants	International data set 1989-90	OLS	+
Michie&Sheenan(1999)	Innovation &RD	Teamwork	Sample nationally representative	U.K. 1990.Workplace Industrial Relation Survey	Probit	+
Osterman(2000)	Firms Layoff Rates Real Wages Gains	HPWO practices	Representative sample of American establishments- private sector, at least fifty employees	U.S. 1992&1997 Repeated Cross-Sections	Logit/OLS	+ on layoff 0 on Wages Gains

Table 2: Exogenous Variables Included in Structural Model

	$LABPROD_i$ and $QUALITY_i$	$TEAMS_i$	$AUTO_i$
	$\mathbf{X_1}$	$\mathbf{X_2}$	$\mathbf{X_3}$
Establishment Size	YES	YES	YES
Single-Establishment Firm	YES	YES	YES
Fraction of Part-Time Workers	YES	YES	YES
Temporary Workers	YES	YES	YES
Fixed-Term Workers Under 1 Year	YES	YES	YES
Fixed-Term Workers Over 1 Year	YES	YES	YES
Union Workers	YES	YES	YES
Private Sector Publicly-Traded Franchise	YES	YES	YES
Private Sector Publicly-Traded Non-franchise	YES	YES	YES
Private Sector Franchise	YES	YES	YES
Private Sector Non-franchise	YES	YES	YES
Public Sector	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

Establishment Size: total number of full time, part time, and temporary workers at the establishment

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

Fraction of Part-Time Workers: number of temporary 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 1 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 1 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 variables that equals 1 if any of the workers at the establishment belong to a union and equals 0 otherwise

Private Sector Publicly-Traded Franchise: dummy variable that equals 1 if the establishment is a private sector publicly-traded company and a franchise and equals 0 otherwise

Private Sector Publicly-Traded Non-franchise: dummy variable that equals 1 if the establishment is a private sector publicly-traded company but not a franchise and equals 0 otherwise

Private Sector Franchise: dummy variable that equals 1 if the establishment is a private sector (non-publicly-traded) firm and a franchise and equals 0 otherwise

Private Sector Non-franchise: dummy variable that equals 1 if the establishment is a private sector (non-publicly-traded) firm but not a franchise and equals 0 otherwise

Public Sector: dummy variable that equals 1 if the establishment is in the public sector and equals 0 otherwise

Table 3: Estimates from Structural Model for Labor Productivity

	LABPROD (TEAMS=1)*	*LABPROD* (TEAMS=0)*	*TEAMS **	*AUTO**
AUTO	0.816** (0.173)	●	●	●
Single-Establishment Firm	0.023 (0.082)	-0.089 (0.189)	-0.138 (0.105)	-0.184* (0.105)
Establishment Size	-0.002 (0.004)	-0.068 (0.057)	0.052** (0.022)	-0.004 (0.004)
Fraction of Part-Time Workers	0.203* (0.114)	0.133 (0.307)	-0.263 (0.250)	0.066 (0.183)
Temporary Workers	-0.035 (0.067)	-0.133 (0.241)	0.146 (0.108)	-0.261** (0.080)
Fixed-Term Workers Under 1 Year	0.017 (0.070)	-0.059 (0.213)	0.227** (0.106)	-0.043 (0.076)
Fixed-Term Workers Over 1 Year	0.067 (0.083)	-0.481 (0.301)	0.259* (0.150)	0.008 (0.098)
Union Workers	-0.017 (0.078)	0.313 (0.215)	0.145 (0.115)	-0.025 (0.104)
Private Sector Publicly-Traded Franchise	0.611** (0.245)	0.245 (2.010)	0.521 (1.124)	-0.411 (0.321)
Private Sector Publicly-Traded Non-franchise	0.229** (0.077)	0.444 (0.300)	-0.045 (0.173)	-0.032 (0.118)
Private Sector Franchise	-0.369 (0.334)	0.174 (1.375)	-0.105 (0.349)	-0.131 (0.371)
Private Sector Non-franchise	0.018 (0.091)	0.670** (0.322)	-0.162 (0.190)	0.155 (0.122)
Just-in-time	●	●	0.312** (0.119)	●
Information	●	●	●	0.102** (0.030)
Incentive alignment	●	●	●	-0.193** (0.047)
Decisions	●	●	●	0.071** (0.033)
Work at home	●	●	●	-0.063* (0.038)
Constant	-0.627** (0.169)	-0.893 (0.561)	0.968** (0.277)	0.686** (0.320)
c	1.145 (0.065)			
σ_{02}	-0.200 (0.157)			
σ_{12}	0.381 (1.283)			
σ_{13}	-0.527** (0.012)			
σ_{23}	-0.692**			

	(0.009)

Note: Standard errors from the parametric bootstrap are in parentheses (100 bootstrap replications). * and ** indicate significance at the 10% and 5% levels, respectively. Industry controls and indicators for the largest occupational group are also included in the TEAMS* and AUTO* equations. Sample size is 1727.

Table 4: Estimates from Structural Model for Quality of Product or Service

	QUALITY (TEAMS=1)*	*QUALITY* (TEAMS=0)*	*TEAMS **	*AUTO**
AUTO	1.141** (0.138)	●	●	●
Single-Establishment Firm	0.176** (0.076)	0.242 (0.151)	-0.159 (0.111)	-0.152 (0.100)
Establishment Size	0.001 (0.004)	-0.091** (0.044)	0.049** (0.023)	-0.005 (0.005)
Fraction of Part-Time Workers	0.006 (0.108)	0.221 (0.196)	-0.194 (0.211)	0.038 (0.163)
Temporary Workers	0.028 (0.070)	-0.318* (0.174)	0.090 (0.102)	-0.184** (0.072)
Fixed-Term Workers Under 1 Year	-0.075 (0.060)	-0.046 (0.157)	0.210** (0.101)	-0.037 (0.078)
Fixed-Term Workers Over 1 Year	-0.045 (0.074)	-0.184 (0.210)	0.250** (0.120)	0.079 (0.085)
Union Workers	-0.135* (0.073)	-0.052 (0.144)	0.185** (0.091)	0.035 (0.091)
Private Sector Publicly-Traded Franchise	0.470* (0.252)	0.020 (1.396)	0.609 (1.455)	-0.398 (0.330)
Private Sector Publicly-Traded Non-franchise	0.408** (0.086)	0.542** (0.249)	-0.025 (0.158)	-0.008 (0.101)
Private Sector Franchise	0.198 (0.298)	-0.037 (0.834)	-0.036 (0.346)	-0.199 (0.382)
Private Sector Non-franchise	0.375** (0.095)	0.576** (0.235)	-0.135 (0.155)	0.073 (0.121)
Just-in-time	●	●	0.316** (0.096)	●
Information	●	●	●	0.078** (0.029)
Incentive alignment	●	●	●	-0.211** (0.047)
Decisions	●	●	●	0.064** (0.030)
Work at home	●	●	●	-0.075** (0.035)
Constant	-0.329* (0.180)	-0.855** (0.294)	0.944** (0.264)	0.813** (0.347)
c	1.201 (0.084)			
σ_{02}	-0.653** (0.006)			
σ_{12}	0.096 (0.491)			

σ 13	-0.697** (0.003)
σ 23	-0.464** (0.046)

Note: Standard errors from the parametric bootstrap are in parentheses and are based on 100 bootstrap replications. * and ** indicate significance at the 10% and 5% levels, respectively. Industry controls and indicators for the establishment's largest occupational group are also included in the TEAMS* and AUTO* equations. Sample size is 1917.

Table 5
Effect of Team Production on Labor Productivity of Selected Workplaces
AUTO = Team Members Jointly Decide How the Work is to be Done

Panel 1: Results for Workplace at 0.25 Quantile of (Effect A3 – Effect A1)

	All Teams	*Autonomous Teams*	*Non-Autonomous Teams*	*Difference*
Average or below	-0.016 (0.059)	-0.042 (0.061)	-0.002 (0.064)	-0.040 (0.039)
Better than average	0.029 (0.047)	0.050 (0.048)	0.018 (0.049)	0.032 (0.025)
A lot better than average	-0.013 (0.034)	-0.008 (0.035)	-0.016 (0.036)	0.009 (0.018)

Panel 2: Results for Workplace at Median of (Effect A3 – Effect A1)

	All Teams	*Autonomous Teams*	*Non-Autonomous Teams*	*Difference*
Average or below	-0.110** (0.051)	-0.112* (0.057)	-0.107** (0.054)	-0.005 (0.044)
Better than average	0.080** (0.039)	0.081** (0.041)	0.079** (0.040)	0.002 (0.024)
A lot better than average	0.030 (0.021)	0.031 (0.025)	0.028 (0.022)	0.003 (0.023)

Panel 3: Results for Workplace at 0.75 Quantile of (Effect A3 – Effect A1)

	All Teams	*Autonomous Teams*	*Non-Autonomous Teams*	*Difference*
Average or below	-0.210** (0.056)	-0.246** (0.060)	-0.193** (0.061)	-0.053 (0.050)
Better than average	0.124** (0.059)	0.142** (0.063)	0.114** (0.057)	0.028 (0.030)
A lot better than average	0.087** (0.026)	0.103** (0.028)	0.079** (0.034)	0.025 (0.025)

Notes: Cell entries denote the effects of team production on the probability that labor productivity is a lot better than average for the industry, better than average for the industry, and at or below the industry average. Standard errors from the parametric bootstrap (100 replications) are in parentheses. * and ** denote statistical significance at the 10% and 5% levels, respectively

Table 6
Effect of Team Production on Product Quality of Selected Workplaces
AUTO = Team Members Jointly Decide How the Work is to be Done

Panel 1: Results for Workplace at 0.25 Quantile of (Effect A3Q – Effect A1Q)

	All Teams	*Autonomous Teams*	*Non-Autonomous Teams*	*Difference*
Average or below	0.033 (0.044)	0.033 (0.047)	0.031 (0.049)	0.002 (0.043)
Better than average	-0.028 (0.059)	-0.033 (0.059)	-0.018 (0.064)	-0.016 (0.039)
A lot better than average	-0.005 (0.043)	-0.0002 (0.043)	-0.014 (0.052)	0.014 (0.035)

Panel 2: Results for Workplace at Median of (Effect A3Q – Effect A1Q)

	All Teams	*Autonomous Teams*	*Non-Autonomous Teams*	*Difference*
Average or below	-0.037 (0.042)	-0.038 (0.048)	-0.035 (0.042)	-0.004 (0.039)
Better than average	-0.023 (0.063)	-0.030 (0.069)	-0.012 (0.059)	-0.018 (0.036)
A lot better than average	0.060 (0.037)	0.069* (0.040)	0.047 (0.041)	0.022 (0.028)

Panel 3: Results for Workplace at 0.75 Quantile of (Effect A3Q – Effect A1Q)

	All Teams	*Autonomous Teams*	*Non-Autonomous Teams*	*Difference*
Average or below	-0.132** (0.057)	-0.141** (0.061)	-0.123** (0.063)	-0.019 (0.052)
Better than average	0.018 (0.087)	0.020 (0.094)	0.015 (0.084)	0.006 (0.043)
A lot better than average	0.114** (0.049)	0.121** (0.054)	0.108* (0.061)	0.013 (0.035)

Notes: Cell entries denote the effects of team production on the probability that product quality is a lot better than average for the industry, better than average for the industry, and at or below the industry average. Standard errors from the parametric bootstrap (100 replications) are in parentheses. * and ** denote statistical significance at the 10% and 5% levels, respectively.

Table 7
"Non-Structural" Effect of Team Production on Labor Productivity of Selected Workplaces
AUTO = Team Members Jointly Decide How the Work is to be Done

Panel 1: Results for Workplace at 0.25 Quantile of (Effect A3 – Effect A1)

	All Teams	*Autonomous Teams*	*Non-Autonomous Teams*	*Difference*
Average or below	-0.027 (0.045)	-0.046 (0.045)	-0.014 (0.048)	-0.032 (0.023)
Better than average	0.015 (0.035)	0.025 (0.034)	0.008 (0.036)	0.017 (0.013)
A lot better than average	0.012 (0.027)	0.021 (0.027)	0.006 (0.028)	0.015 (0.012)

Panel 2: Results for Workplace at Median of (Effect A3 – Effect A1)

	All Teams	*Autonomous Teams*	*Non-Autonomous Teams*	*Difference*
Average or below	-0.125** (0.047)	-0.137** (0.046)	-0.105** (0.049)	-0.032 (0.023)
Better than average	0.086** (0.033)	0.094** (0.034)	0.074** (0.034)	0.020 (0.013)
A lot better than average	0.039** (0.019)	0.043** (0.020)	0.031 (0.019)	0.012 (0.012)

Panel 3: Results for Workplace at 0.75 Quantile of (Effect A3 – Effect A1)

	All Teams	*Autonomous Teams*	*Non-Autonomous Teams*	*Difference*
Average or below	-0.214** (0.071)	-0.221** (0.072)	-0.189** (0.072)	-0.032 (0.023)
Better than average	0.126* (0.065)	0.129** (0.066)	0.115* (0.065)	0.014 (0.011)
A lot better than average	0.088** (0.024)	0.092** (0.026)	0.074** (0.023)	0.018 (0.013)

Notes: Cell entries denote the effects of team production on the probability that labor productivity is a lot better than average for the industry, better than average for the industry, and at or below the industry average. Standard errors from the parametric bootstrap (100 replications) are in parentheses. * and ** denote statistical significance at the 10% and 5% levels, respectively.

Table 8
"Non-Structural" Effect of Team Production on Product Quality of Selected Workplaces
AUTO = Team Members Jointly Decide How the Work is to be Done

Panel 1: Results for Workplace at 0.25 Quantile of (Effect A3 – Effect A1)

	All Teams	*Autonomous Teams*	*Non-Autonomous Teams*	*Difference*
Average or below	-0.045 (0.033)	-0.062* (0.035)	-0.022 (0.034)	-0.039** (0.020)
Better than average	0.024 (0.021)	0.033 (0.022)	0.013 (0.021)	0.020* (0.012)
A lot better than average	0.021 (0.029)	0.029 (0.031)	0.010 (0.029)	0.019 (0.019)

Panel 2: Results for Workplace at Median of (Effect A3 – Effect A1)

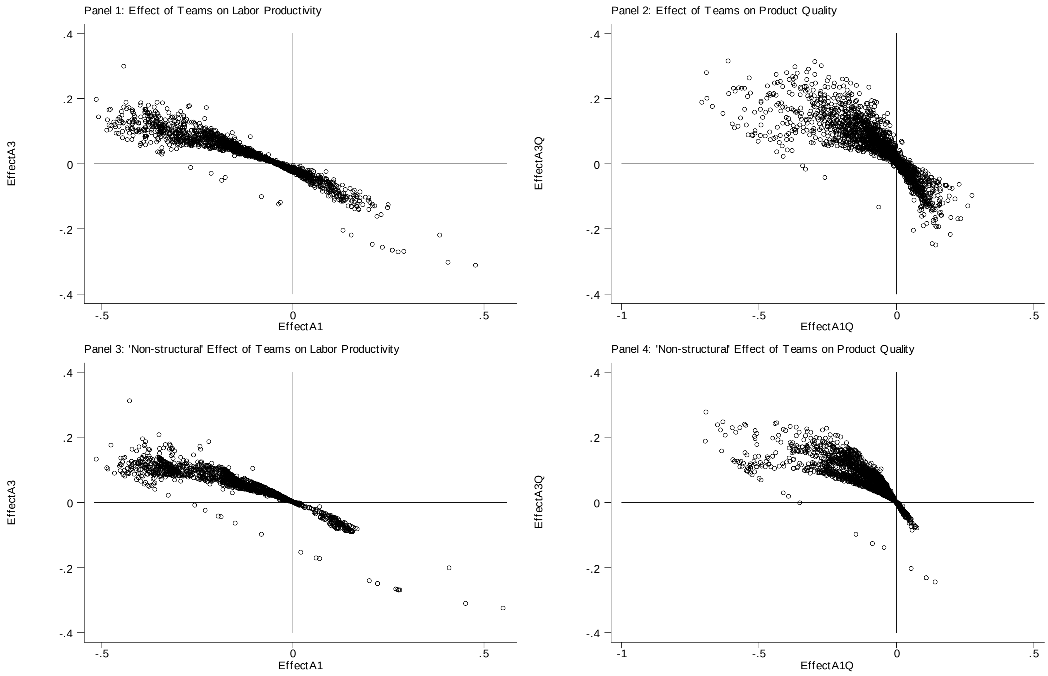
	All Teams	*Autonomous Teams*	*Non-Autonomous Teams*	*Difference*
Average or below	-0.068* (0.041)	-0.084* (0.043)	-0.059 (0.040)	-0.025 (0.019)
Better than average	-0.014 (0.036)	-0.022 (0.037)	-0.010 (0.033)	-0.012 (0.010)
A lot better than average	0.082** (0.031)	0.106** (0.034)	0.070** (0.031)	0.037* (0.020)

Panel 3: Results for Workplace at 0.75 Quantile of (Effect A3 – Effect A1)

	All Teams	*Autonomous Teams*	*Non-Autonomous Teams*	*Difference*
Average or below	-0.196** (0.064)	-0.213** (0.068)	-0.175** (0.061)	-0.039* (0.022)
Better than average	0.116* (0.060)	0.123* (0.063)	0.107* (0.055)	0.017 (0.012)
A lot better than average	0.080** (0.034)	0.090** (0.038)	0.068** (0.034)	0.022 (0.016)

Notes: Cell entries denote the effects of team production on the probability that product quality is a lot better than average for the industry, better than average for the industry, and at or below the industry average. Standard errors from the parametric bootstrap (100 replications) are in parentheses. * and ** denote statistical significance at the 10% and 5% levels, respectively.

Figure 1: Effect of Teams on Labor Productivity and Product Quality



Notes: Workplaces with the highest predicted benefits from teams are those farthest from the origin in the second quadrant, whereas those with the lowest predicted benefits are those farthest from the origin in the fourth quadrant. Panels 1 and 2 compute the effects of interest from the unconstrained structural model, whereas Panels 3 and 4 compute the effects using the estimates from the models that impose $\Sigma = \mathbf{I}$ in estimation. Sample sizes are N = 1727 in the labor productivity model and N = 1917 in the product quality model. The axes are defined as follows:

$(\text{Effect A1})_i = \text{Prob}(\text{LABPROD}_i = 1 \mid \text{TEAMS}_i = 1) - \text{Prob}(\text{LABPROD}_i = 1 \mid \text{TEAMS}_i = 0)$

$(\text{Effect A2})_i = \text{Prob}(\text{LABPROD}_i = 2 \mid \text{TEAMS}_i = 1) - \text{Prob}(\text{LABPROD}_i = 2 \mid \text{TEAMS}_i = 0)$

$(\text{Effect A3})_i = \text{Prob}(\text{LABPROD}_i = 3 \mid \text{TEAMS}_i = 1) - \text{Prob}(\text{LABPROD}_i = 3 \mid \text{TEAMS}_i = 0)$

$(\text{Effect A1Q})_i = \text{Prob}(\text{QUALITY}_i = 1 \mid \text{TEAMS}_i = 1) - \text{Prob}(\text{QUALITY}_i = 1 \mid \text{TEAMS}_i = 0)$

$(\text{Effect A2Q})_i = \text{Prob}(\text{QUALITY}_i = 2 \mid \text{TEAMS}_i = 1) - \text{Prob}(\text{QUALITY}_i = 2 \mid \text{TEAMS}_i = 0)$

$(\text{Effect A3Q})_i = \text{Prob}(\text{QUALITY}_i = 3 \mid \text{TEAMS}_i = 1) - \text{Prob}(\text{QUALITY}_i = 3 \mid \text{TEAMS}_i = 0)$