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ESTUDOS DO GEMF
N.º 3 2006

PUBLICAÇÃO CO-FINANCIADA PELA
FUNDAÇÃO PARA A CIÊNCIA E TECNOLOGIA

Impresso na Secção de Textos da FEUC
COIMBRA 2006

Works Councils, Labor Productivity and Plant Heterogeneity: First Evidence from Quantile Regressions[†]

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February 2006

Abstract
Using OLS and quantile regression methods and rich cross-section data sets for western and eastern Germany, this paper demonstrates that the impact of works council presence on labor productivity varies between manufacturing and services, between plants that are or are not covered by collective bargaining, and along the conditional distribution of labor productivity. No productivity effects of works councils are found for the service sector and in manufacturing plants not covered by collective bargaining. Besides demonstrating that it is important to look at evidence based on more than one data set, our empirical findings point to the efficacy of supplementing OLS with quantile regression estimates when investigating the behavior of heterogeneous plants.

Keywords: Labor productivity, works councils, quantile regressions, heterogeneous firms

JEL classification: J50

[†]Acknowledgement: This paper is a completely revised and augmented version of Wagner, Addison, Schnabel and Schank (2004).

1. Motivation

In Germany, workers in establishments with at least five permanent employees have the right to elect a works council. Works councils have substantial information, consultation, and even codetermination rights. These rights as well as the number of councilors – both full-time and part-time – are increasing in establishment size (measured by the number of employees). Note that works councils while mandatory are not automatic and, as a practical matter, their presence is sporadic in smaller establishments and near universal in large plants with 500 workers or more (for details, see Addison, Bellmann, Schnabel, and Wagner 2004).

In theory, works councils can be expected to have both positive and negative impacts on various dimensions of firm performance, such as labor productivity and profitability. The reason resides in the two faces of works councils: On the one hand, works councils can use their powers to delay or modify management decisions and shift rents to the employees. On the other hand, they can also improve the efficiency of the establishment through productive information exchange, consultation, and codetermination. A canonical reference for the theoretical discussion of these issues is the Freeman and Lazear (1995) model that extends the well-known workplace union collective voice arguments of Freeman and Medoff (1984) to the specific case of works councils.

It follows that establishing the direction and extent of works councils' net impact on economic performance is an empirical question. The econometric literature on German works councils is a work in progress, so that there is ongoing debate as to the consequences of the institution (for a comprehensive survey, see Addison, Schnabel and Wagner 2004). One problem that has not yet been dealt with in a convincing way is unobserved heterogeneity: plant diversity that is not reflected in the control variables used in the economists' models employed for investigating the cet. par. relationship between works council presence and the relevant performance indicator.

To fix ideas, and to set the scene for the present inquiry, consider a core dimension of plant performance that has been analyzed in the empirical literature on works councils: establishment labor productivity, as measured by average value added per employee. A standard approach has been to estimate a single-equation model with productivity as the dependent variable and a set of factors that are related to productivity (e.g., percentage of skilled employees, hours worked per week, etc.) plus a dummy variable indicating the presence or otherwise of a works council as independent variables. Consider now the role of a variable that is not included in the set of determinants of productivity in the empirical model, namely, management competence. This omitted variable can be expected to have an impact on all dimensions of plant performance, including labor productivity. Highly-able managers will organize the production process in such a way that leads to rather high values of labor productivity for a given set of establishment characteristics, and conversely in the case of bad managers. In short, conditional on the productivity-determining characteristics of an establishment included in the empirical model, there will be over achievers (with able managers) and under performers (with incompetent managers).[1]

The competence of company or plant management is a variable for which no measure (or proxy) is readily available from the surveys used to investigate the works council-labor productivity nexus, and unmeasured management competence leads to unobserved establishment heterogeneity. The standard tools used in econometrics to control for unobserved heterogeneity cannot be used in this context for two reasons: First, the extant longitudinal data sets include only a small number of establishments that introduce or abandon works councils (see Addison, Bellmann, Schnabel, and Wagner 2004), meaning that estimated coefficients from fixed effects models may be unreliable. Second, unobserved management quality and some of the determinants of labor productivity included in the

[1] The terms *over achievers* and *under performers* are borrowed from a study on cross-country differences in economic growth by Barreto and Hughes (2004) that also uses quantile regression methods.

empirical model tend to be correlated, so that coefficient estimates from random effects models are biased.

Further, unmeasured management competence is not the only source of unobserved establishment heterogeneity. There are other variables that are relevant for productivity for which no information is available in survey data; the principal case in point for the data sets used here is the value of the capital stock, information on which could not be collected in interviews with the owner or manager.

Acknowledging that establishments are heterogeneous in the sense discussed above, we have good reason to suspect that the effects of the variables included in an empirical model to explain labor productivity need not be the same for all firms. Consider the way managers and works councils interact. In Germany, works councils are sometimes regarded as factors of production or as 'co-managers.' It may well be the case that highly competent managers will cooperate with a works council in a way that materially enhances productivity; managers who are incompetent or who oppose works councils in principle will fail here, too.[2] In these circumstances, a positive impact of works councils will be found in over-achieving establishments (i.e., in plants that, conditional on their observed characteristics, have a rather high labor productivity), while either no effect or a negative effect will be present in under-performing establishments.

If we are interested in the relationship between labor productivity on the one hand and a set of plant characteristics (such as works council presence, establishment size, skill intensity, etc.) on the other, and if we regress labor productivity on these independent variables using ordinary least squares (OLS), there is no room for plant heterogeneity of the kind discussed here. OLS assumes that the conditional distribution of labor productivity, given the set of plant characteristics, is homogeneous. This implies that, no matter what point on the

[2] Note that in their classic analysis of union efficiency effects, Freeman and Medoff (1984) not only stress the beneficial effects of collective voice, but also point to the importance of management response.

conditional distribution is analyzed, the estimates of the relationship between labor productivity (the dependent variable) and the plant characteristics (the independent variables) are the same. If one wants to test the empirical validity of this rather restrictive assumption, and if one is interested in the evaluation of the relative importance of the variables viewed as determining labor productivity at different points of the conditional distribution of labor productivity, one has to apply a different estimation technique that is tailor-made for this: quantile regression.

A discussion of the technical details of quantile regression is beyond the scope of this paper. The basic references are the comprehensive treatise by Koenker (2005), the pioneering study by Koenker and Bassett (1978), and the survey by Buchinsky (1998); while Koenker and Hallock (2001) provide a useful non-technical introduction. Suffice it to say here that, in contrast to OLS (that gives information about the effects of the regressors at the conditional mean of the dependent variable only), quantile regression can provide parameter estimates at different quantiles of the conditional distribution of productivity. The estimated regression coefficients can be interpreted as the partial derivative of the conditional quantile of the dependent variable (here, labor productivity in a plant) with respect to a particular regressor (e.g., the presence or otherwise of a works council), namely, the marginal change in labor productivity at the k^{th} conditional quantile due to a change in the works council status of the plant. For each quantile it can be shown whether the effect of a particular regressor is positive or negative, and how large this effect is compared to other quantiles. This method provides information about the heterogeneity of plants. Note that quantile regression is not the same as applying OLS to subsets of the data produced by dividing the complete data set into different percentiles of the dependent variable. This would mean that not all of the data are being used for each estimate, and it would introduce the familiar type of sample selection bias. In contrast, for each quantile regression estimate all of the data are being used, although some observations do get more weight than others.

This paper contributes to the literature on works councils' effects by for the first time applying quantile regression methods to the study of the relationship between labor productivity and works council presence.[3] Our discussion is organized as follows. Section 2 gives information on the plant-level data sets and the empirical models used. Section 3 reports and comments on the findings from the econometric investigation. Section 4 concludes.

2. Data and Empirical Models

Following Hamermesh's (2000, p. 376) dictum that "the credibility of a new finding that is based on carefully analyzing two data sets is far more than twice that of a result based only on one", our empirical investigation will use two plant level data sets. The first data set was collected in personal interviews conducted as part of a panel study, *Das Hannoveraner Firmenpanel*, investigating various aspects of firm behavior and firm performance. The population covered encompasses all manufacturing establishments with at least five employees in the state of Lower Saxony. We use the first (and largest) wave of this panel containing data for 1994. The interviews were conducted with the owner or top manager of the firm. Details of the Hannover Firm Panel data and how it can be accessed by researchers is given in Gerlach, Hübler, and Meyer (2003).

The second data set we employ is the IAB Establishment Panel of the Institute for Employment Research of the Federal Labor Agency. Each year since 1993 (1996), this panel has surveyed several thousand establishments (with at least one employee covered by social insurance) from all sectors of the economy in western (eastern Germany). We make use of the wave in 2000 since in this year the sample was substantially increased and information on the existence of works councils and profit sharing schemes was obtained. The data are again

[3] Although they have not been deployed previously in the works council literature, quantile regressions have been used in a number of firm productivity studies. Examples include analyses of the productivity effects of foreign ownership in Greece (Dimelis and Louri, 2002), of exporting in Turkey (Yasar, Nelson, and Rejesus, 2003), and of teleworking in Denmark (Kaiser, 2004).

collected in personal interviews with the owners or top managers of the plant. Since the panel is created to serve the needs of the Federal Labor Agency, its focus is on employment-related matters, including establishment performance. Kölling (2000) provides a detailed description of the IAB Establishment Panel.

The empirical model used here to investigate the relationship between labor productivity and the presence or not of a works council is an augmented version of that used in an earlier contribution by (three of) the present authors that investigated the effects of works councils on various aspects of establishment performance (see Addison, Schnabel, and Wagner 2001). Details of the model specification slightly differ for the two data sets due to data availability.

Using data from the Hannover Firm Panel study the dependent variable is labor productivity, proxied by value added per employee. As independent variables, and in addition to a dummy variable for works council presence, we include establishment size (number of employees) and its square, as well as the status of the establishment as a branch plant to pick up possible internal and external factors conveying organizational and scale advantages. The productivity effects of human capital are captured by three variables describing the employment structure: the shares of females, skilled blue-collar workers, and academically-trained workers in employment. Another regressor, the proportion of part timers, is mechanically linked to value-added per head. For its part, the modernity of the physical capital stock is expected to lead to higher productivity, and the same holds for higher capacity utilization, a longer work week, the presence of shift working, and enhanced market share (i.e., price setting power). Dummy variables for the presence or otherwise of profit sharing schemes for both workers and managers are included to model any tendency they might have to stimulate higher productivity. Following Jirjahn (2003), the empirical model furthermore includes an interaction term of the two dummy variables indicating the presence or otherwise of a works council and profit sharing for managers. Jirjahn (2003) finds that works councils

seem to be of particular importance for the economic success of establishments when no managerial profit sharing is in place. Finally, we control for the age of the establishment and for industry affiliation.

The empirical model fitted to the IAB Establishment Panel data follows the above specification as closely as possible. As before, the dependent variable is value added per employee. We include the following regressors: a dummy for works council presence, the number of employees and its square, a dummy variable indicating that the establishment is a branch plant, the shares of female employees, skilled and part-time workers, the modernity of the capital stock, normally worked hours per week, a dummy variable for employee profit sharing, the age of the establishment and industry dummies. Each of these variables is also included in the specification based on the Hannover Firm Panel. Unfortunately, unlike the Hannover Firm Panel, the IAB Establishment Panel does not provide information on profit sharing for managers, so that this variable and its interaction with works council presence cannot be included. In addition, we could not use variables on shift work, capacity utilization and the market share.

In an important recent contribution to the debate on works councils' impact on firm performance, Hübler and Jirjahn (2003) use a bargaining model to derive the hypothesis that, in establishments covered by collective bargaining agreements, works councils are more likely to be constrained in their rent-seeking activities than their counterparts in uncovered establishments and hence more likely to focus on production issues. Their empirical analysis confirms this hypothesis: the presence of works councils exerts a positive impact on productivity within the covered industrial relations regime but not within the uncovered regime. To investigate the validity of this hypothesis in an empirical approach that uses quantile regression to take care of plant heterogeneity, we shall split our sample into two subsamples for establishments covered by collective bargaining or otherwise, and investigate both subsamples separately.

Furthermore, while the Hannover Firm Panel only includes plants from manufacturing industries in a single *Land* (of western Germany), the IAB Establishment Panel covers Germany as a whole, and it includes plants from all industries. Therefore, in our empirical investigation using this latter data set we separately look at plants from four groups: manufacturing industries and services in western and eastern Germany. This allows us, on the one hand, to replicate the results from the Hannover Firm Panel by analyzing the sub-sample of manufacturing plants in western Germany in the IAB Establishment Panel, while also taking a broader perspective on the other.

Given that the survey data sets used here do not have information on either the physical capital stock of the establishment or the physical output produced, our findings must necessarily be viewed with some caution. Nevertheless, the data are rich enough to help us to learn more about the variation of the productivity-works council relationship along the conditional distribution of value added per employee.[4]

3. Findings

In the first step of our econometric investigation, the empirical model is estimated by OLS using data for manufacturing plants from Lower Saxony (taken from the Hannover Firm Panel) and for manufacturing plants from western Germany (taken from the IAB Establishment Panel). Given our focus on the relationship between productivity and works councils, we only present the estimated coefficients of the works council dummy in Table 1, and do not comment on the results for the other variables included in our empirical models.

[4] Over-achieving plants may be expected to have a higher physical capital stock, but there is no reason to believe that the impact of a works council on productivity varies with the capital stock.

The full estimation results for plants covered/not covered by collective bargaining can be found in Tables 1 through 4 in the Appendix.[5]

As can be seen from the first panel and the first column of Table 1, for both data sets used the coefficient estimate of the works council dummy variable is positive and statistically significant (at an error level of less than one percent) for plants that are covered by collective bargaining only, while it is insignificant for the sub-samples of uncovered plants. This result is in line with the hypothesis and the findings of Hübler and Jirjahn (2003). Furthermore, the point estimate reported for manufacturing plants that are covered by collective bargaining indicates that value added per employee is some 26,000 DM (or about € 13,000) higher in establishments with a works council compared to those without when data from the Hannover Firm Panel are used. The corresponding point estimates from the IAB Establishment Panel are even higher (nearly 60,000 DM). These values are of course quite large from an economic point of view.

[Table 1 near here]

To repeat, application of OLS implies that, no matter what point on the conditional distribution is analyzed, the estimate of the relationship between labor productivity and the plant characteristics is the same. To test the empirical validity of this rather restrictive assumption, and to uncover the relative importance of the variables viewed as determining labor productivity at different points of the conditional distribution of value added per employee, quantile regression estimation is next applied. In this second step, we examine five points in the distribution, namely, at the 0.10, 0.25, 0.50, 0.75, and 0.90 quantiles. Detailed results are again consigned to the Appendix tables.

The quantile regression coefficient estimates for the works council dummy variable in Table 1 confirm the insight of the OLS estimates that works councils do not play a significant

[5] All computations were done using Stata/SE 8.2. To facilitate replication and extensions the do-files for estimations using the the Hannover Firm Panel data and the IAB Establishment Panel data are available from the

role for labor productivity in plants not covered by collective bargaining, irrespective of the data set used. For plants covered by collective bargaining, however, the point estimates and the statistical significance of the coefficient estimates for the works council dummy variable differ widely across the regressions for the various quantiles, and vis-à-vis the benchmark results from the OLS regression.

Looking first at manufacturing plants from Lower Saxony, for the sub-sample of plants covered by collective bargaining the works council coefficients are positive but much smaller than in the OLS regression for all but the highest quantile investigated. Moreover, only for establishments at the very top of the conditional distribution of productivity **is** the works council coefficient estimate statistically significant at an error level of five percent or better. The null hypotheses that the coefficients of the works council dummy variable are equal between pairs of quantiles and across all quantiles may be tested using the variance-covariance matrix of the coefficients of the system of quantile regressions. As can be seen from Table 2 the null hypothesis is rejected at an error level of 3 percent or smaller for the 0.90 quantile vs. all other quantiles in pairwise tests, and at the same error level in a joint test for all quantiles.

[Table 2 near here]

Although this result seems to support the notion of special productivity-enhancing effects of works councils in over-achieving plants, it cannot be replicated for the larger sample of manufacturing plants from all states in western Germany. That is, using the IAB data, the coefficient estimates are statistically significant at the five percent level in the 0.25, 0.50 and 0.75 quantiles but not in the 0.10 and 0.90 quantiles. The null hypothesis of equal coefficients between pairs of quantiles and across all quantiles cannot be rejected at the five percent level for all tests other than the 0.10 vs. the 0.50 quantile. While we cannot rule out the possibility that the slightly different specifications of the empirical models used and the

first and the second author, respectively, on request.

different years analyzed play a role, these substantially different results illustrate that it is important not to base conclusions on results from a single data set.[6]

Similar reasoning suggests the need to extend the investigation of productivity effects beyond the boundary of western German manufacturing industry, the focus of most industrial relations research. In particular, it should be interesting to determine whether works councils have similar productivity effects in eastern Germany (which has a completely different history of industrial relations and has adopted works only in the wake of unification) and in the private service sector.

Results of using OLS and quantile regression to estimate the empirical model for manufacturing plants in eastern Germany are reported in the second panel of Table 1. In line with the results for manufacturing firms in western Germany, both the OLS and quantile regression estimates fail to indicate works council pro-productivity effects in plants not covered by collective bargaining. For firms covered by collective bargaining the effect of a works council on productivity is positive and statistically significant at the five percent level in the OLS estimation and in the regressions for the 0.10, 0.25 and 0.50 quantiles (but not for the 0.90 quantile of over achievers) in 2000. However, the null hypothesis that the coefficients of the works council dummy variable are equal between pairs of quantiles and across all quantiles cannot be rejected at a conventional level (see Table 2). Furthermore, when the OLS and quantile regressions are repeated for the year 2001, the results for the works council coefficient (which are not reported here but available on request) are almost always statistically insignificant, raising some doubt as to the robustness of the "works councils raise productivity" result in eastern Germany even for plants covered by collective bargaining.

[6] As a case in point, in the earlier version of the present paper (Wagner, Addison, Schnabel, and Schank, 2004) we argued *on the basis of results for manufacturing plants in Lower Saxony alone* that quantile regressions point to a positive impact of works councils only in over-achieving establishments (i.e., in plants that, conditional on their observed characteristics, have a very high labor productivity), with no statistically significant effect being recorded for the rest of the plants. We argued that our central finding of a positive impact of works councils in these over-achieving establishments alone might be due to the fact that only highly competent managers of over-achieving establishments tend to cooperate with a works council in a way that materially enhances productivity. Obviously, this conclusion is no longer valid given the results of estimations with the IAB panel data.

In the last step of our investigation, we look beyond manufacturing to the services sector, again considering plants from both parts of Germany. Results are reported in the lower panel of Table 1. Starting with plants not covered by collective bargaining, OLS and quantile regressions do not show any statistically significant effects of works councils on labor productivity at the five percent level, with the sole exception of the 0.10 quantile in eastern Germany. These results are broadly in line with our findings for manufacturing establishments. Contrary to the results for manufacturing, however, nor do works councils have an impact on labor productivity in service sector plants that are covered by collective bargaining. In other words, the Hübler and Jirjahn (2003) story does not seem to hold for services. This again underscores the insight that the impressive results from the Hannover Firm Panel cannot be readily generalized.

To sum up, we find that the estimated impact of works councils on labor productivity varies between manufacturing and services, between eastern and western Germany, between plants that are or are not covered by collective bargaining, and along the conditional distribution of labor productivity. One of the few findings that *is* robust across data sets and estimation methods is that works councils in plants that are not covered by collective bargaining never have significantly higher labor productivity. The same applies for establishments and works councils in the service sector, be they covered by collective bargaining or not. For covered plants in manufacturing the estimated coefficients of the works council dummy variable are positive and statistically significant at the mean of the conditional distribution of labor productivity (i.e. when looking at results from OLS regressions), but not for all quantiles along this distribution. The different impact of works council presence on labor productivity in plants from different quantiles of the conditional productivity distribution points to unobserved firm heterogeneity as an important factor influencing the way works councils act and interact with management. The picture that emerges from our

different subsamples and data sets is, however, far from clear enough to allow informed speculation on what might be going on here.

4. Concluding Remarks

Using OLS and quantile regression methods and rich cross-section data sets for manufacturing and services plants from western and eastern Germany, this paper has demonstrated that the impact of works council presence on labor productivity varies between manufacturing and services, between plants that are or are not covered by collective bargaining, and along the conditional distribution of labor productivity. No productivity effects of works councils were found in the service sector and in manufacturing plants that are not covered by collective bargaining. While there is some evidence for pro-productivity effects of works council presence in manufacturing plants covered by collective bargaining, their magnitude and statistical significance differs widely and unsystematically along the conditional productivity distribution and between different sets of data.

Besides demonstrating that it is important to look at evidence based on more than one data set, our empirical findings point to the need to supplement OLS (or any other econometric method that focuses on the conditional mean of a dependent variable) estimation with quantile regression when investigating the behavior of heterogeneous plants. To put it differently, and to quote Buchinsky (1994, p. 453): "'On the average' has never been a satisfactory statement with which to conclude a study on heterogeneous populations."

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Table 1: Estimation Results for the Coefficient of the Works Council Dummy

Sample	OLS estimates	Quantile regression estimates				
		0.10	0.25	0.50	0.75	0.90
Manufacturing plants						
Lower Saxony, covered by collective bargaining (n=458)	26.198 (0.004)	7.290 (0.521)	1.792 (0.840)	5.892 (0.425)	16.990 (0.059)	44.145 (0.000)
Lower Saxony, not covered by collective bargaining (n=231)	10.850 (0.556)	5.550 (0.744)	6.560 (0.707)	-2.070 (0.907)	-9.958 (0.652)	3.507 (0.929)
Western Germany, covered by collective bargaining (n=880)	59.716 (0.000)	10.733 (0.100)	17.384 (0.005)	27.571 (0.000)	24.883 (0.000)	22.186 (0.291)
Western Germany, not covered by collective bargaining (n=360)	7.958 (0.624)	14.404 (0.067)	6.937 (0.504)	2.006 (0.836)	-2.938 (0.851)	-0.626 (0.981)
Eastern Germany, covered by collective bargaining (n=349)	38.128 (0.006)	28.055 (0.001)	19.319 (0.016)	26.351 (0.005)	40.908 (0.057)	1.437 (0.079)
Eastern Germany, not covered by collective bargaining (n=605)	3.527 (0.682)	4.169 (0.598)	-3.534 (0.532)	-0.886 (0.870)	1.297 (0.904)	9.731 (0.600)
Services plants						
Western Germany, covered by collective bargaining (n=783)	69.422 (0.228)	9.443 (0.061)	10.289 (0.082)	4.635 (0.560)	17.276 (0.143	21.223 (0.438)
Western Germany, not covered by collective bargaining (n=626)	34.255 (0.337)	12.990 (0.193)	9.994 (0.206)	15.068 (0.196)	5.723 (0.745)	37.725 (0.749)
Eastern Germany, covered by collective bargaining (n=321)	-1.162 (0.913)	5.347 (0.253)	2.750 (0.574)	6.934 (0.355)	0.794 (0.944)	-3.614 (0.876)
Eastern Germany, not covered by collective bargaining (n=409)	5.641 (0.754)	16.015 (0.008)	8.770 (0.231)	14.708 (0.117)	2.176 (0.930)	48.979 (0.288)

Notes: Prob-values reported in parentheses. The prob-values for quantile regressions are based on standard errors bootstrapped with 100 replications.

Table 2: Tests on the Equality of Works Council Dummy Coefficients

(Establishments Covered by Collective Bargaining Only)

	Manufacturing plants			Services plants	
Quantiles tested	Lower Saxony	Western Germany	Eastern Germany	Western Germany	Eastern Germany
Pairwise tests					
0.10 vs. 0.25	0.54	0.28	0.26	0.87	0.51
0.10 vs. 0.50	0.90	0.02	0.88	0.55	0.83
0.10 vs. 0.75	0.47	0.19	0.57	0.52	0.70
0.10 vs. 0.90	0.01	0.59	0.33	0.67	0.70
0.25 vs. 0.50	0.58	0.07	0.43	0.40	0.53
0.25 vs. 0.75	0.15	0.44	0.31	0.53	0.86
0.25 vs. 0.90	0.00	0.81	0.21	0.69	0.78
0.50 vs. 0.75	0.17	0.77	0.38	0.21	0.58
0.50 vs. 0.90	0.00	0.79	0.27	0.53	0.64
0.75 vs. 0.90	0.03	0.88	0.47	0.87	0.84
Joint test for all quantiles	0.03	0.19	0.57	0.73	0.91

Note: The null hypothesis is that the coefficients are equal between pairs of quantiles and across all quantiles. Test statistics are based on the variance-covariance matrix of the coefficients of the system of quantile regressions reported in Table 1. Table 2 reports the prob-values for the F-values; if the prob-value is less than the level of significance, the null hypothesis of equal coefficients is rejected.

Appendix 1: Labor Productivity Estimations, Lower Saxony

(Dependent Variable: Log Value Added per Employee in Lower Saxony, Manufacturing Establishments Covered by Collective Bargaining)

	OLS	Quantile Regression				
Variable		0.10	0.25	0.50	0.75	0.90
Works council	26.198	7.290	1.792	5.892	16.990	44.145
(Dummy; 1 = plant has a works council)	(0.004)	(0.521)	(0.840)	(0.425)	(0.059)	(0.000)
Plant size	-0.026	0.003	-0.013	-0.002	-0.006	-0.016
(Number of employees)	(0.149)	(0.893)	(0.554)	(0.923)	(0.847)	(0.768)
Plant size squared	8.36e-06	-4.14e-06	1.11e-05	5.34e-06	2.89e-06	-6.47e-07
	(0.196)	(0.817)	(0.469)	(0.701)	(0.856)	(0.981)
Branch plant status	6.771	-4.017	1.082	9.835	17.864	21.859
(Dummy; 1 = firm is a branch plant)	(0.465)	(0.714)	(0.905)	(0.329)	(0.174)	(0.308)
Plant age	-11.449	-5.688	-4.187	-13.455	-10.796	-10.366
(Dummy; 1 = plant founded before 1960)	(0.075)	(0.361)	(0.470)	(0.026)	(0.082)	(0.345)
Percentage of female employees	-0.740	-0.407	-0.293	-0.312	-0.643	-1.008
	(0.000)	(0.059)	(0.090)	(0.109)	(0.010)	(0.005)
Percentage of skilled workers	-0.254	-0.130	-0.104	-0.123	-0.092	-0.493
(*Facharbeiter*)	(0.069)	(0.430)	(0.456)	(0.370)	(0.647)	(0.066)
Percentage of employees with a university	0.749	0.896	0.709	0.825	1.035	1.625
or polytechnic degree	(0.184)	(0.137)	(0.208)	(0.194)	(0.265)	(0.140)
Percentage of part time employees	-0.583	-0.364	-0.515	-0.705	-0.843	-0.881
	(0.026)	(0.110)	(0.009)	(0.000)	(0.006)	(0.212)
Shiftwork	10.512	9.026	8.417	11.862	15.598	-4.925
(Dummy; 1 = plant has shift work)	(0.162)	(0.203)	(0.243)	(0.129)	(0.110)	(0.693)
Number of normal weekly hours	-1.581	-5.136	-3.140	-0.756	-0.788	1.511
	(0.539)	(0.030)	(0.233)	(0.767)	(0.757)	(0.758)
Index of capacity utilization	4.420	4.242	5.387	4.340	5.092	1.733
(from 1 = under 85% to 6 = more than 100%)	(0.011)	(0.042)	(0.002)	(0.065)	(0.025)	(0.559)
Advanced production technology	16.999	8.722	6.470	8.373	11.950	22.253
(Dummy; 1 = plant has state-of-the-art technology)	(0.005)	(0.052)	(0.161)	(0.161)	(0.129)	(0.025)
Profit sharing for the workforce	2.393	1.586	0.811	0.178	3.531	22.686
(Dummy; 1 = yes)	(0.793)	(0.865)	(0.921)	(0.981)	(0.794)	(0.389)

Profit sharing for management	11.347	6.537	-6.949	2.165	10.269	22.668
(Dummy; 1 = yes)	(0.291)	(0.638)	(0.506)	(0.867)	(0.506)	(0.235)
Works council * profit sharing for management	0.278	0.770	19.806	8.765	-5.708	-25.002
(Interaction term of two dummy variables)	(0.982)	(0.959)	(0.096)	(0.511)	(0.723)	(0.327)
Market share for most important product line in most	5.833	4.105	4.054	2.027	0.684	-14.113
important market (Dummy; 1 = over 5%)	(0.354)	(0.481)	(0.479)	(0.768)	(0.930)	(0.350)
Constant	141.547	234.738	177.557	115.454	124.285	91.909
	(0.168)	(0.010)	(0.071)	(0.242)	(0.205)	(0.625)
Number of observations	458	458	458	458	458	458
R^2	0.349					
Pseudo R^2		0.239	0.227	0.243	0.300	0.362

Notes: (1) Prob-values reported in parenthesis; the prob-values for quantile regressions are based on standard errors bootstrapped with 100 replications.

(2) All regressions include dummy variables for 31 manufacturing industries.

Appendix 2: Labor Productivity Estimations, Lower Saxony

(Dependent Variable: Log Value Added per Employee in Lower Saxony, Manufacturing Establishments Not Covered by Collective Bargaining)

	OLS	Quantile Regression				
Variable		0.10	0.25	0.50	0.75	0.90
Works council	10.850	5.550	6.560	-2.070	-9.948	3.507
(Dummy; 1 = plant has a works council)	(0.556)	(0.744)	(0.707)	(0.907)	(0.652)	(0.929)
Plant size	-0.055	0.082	0.022	-0.006	-0.033	-0.026
(Number of employees)	(0.639)	(0.598)	(0.876)	(0.967)	(0.850)	(0.940)
Plant size squared	2.18e-08	1.98e-08	1.06e-05	1.99e-05	-1.38e-05	-4.02e-05
	(0.803)	(0.945)	(0.963)	(0.940)	(0.974)	(0.947)
Branch plant status	14.523	-19.192	6.400	42.561	31.361	16.352
(Dummy; 1 = firm is a branch plant)	(0.467)	(0.439)	(0.844)	(0.160)	(0.223)	(0.653)
Plant age	17.656	-7.970	-13.489	-8.855	8.446	-11.521
(Dummy; 1 = plant founded before 1960)	(0.101)	(0.445)	(0.171)	(0.388)	(0.550)	(0.543)
Percentage of female employees	-0.708	-0.273	-0.532	-0.852	-0.679	-0.482
	(0.039)	(0.330)	(0.066)	(0.013)	(0.101)	(0.473)
Percentage of skilled workers	0.281	0.135	-0.047	-0.039	-0.066	0.123
(*Facharbeiter*)	(0.272)	(0.406)	(0.782)	(0.840)	(0.791)	(0.816)
Percentage of employees with a university	1.422	-0.574	0.003	1.291	1.191	3.244
or polytechnic degree	(0.106)	(0.615)	(0.998)	(0.295)	(0.444)	(0.185)
Percentage of part time employees	-0.535	-0.268	-0.435	-0.413	-0.639	-0.857
	(0.034)	(0.270)	(0.102)	(0.157)	(0.152)	(0.172)
Shiftwork	41.259	7.306	14.931	17.748	25.431	53.143
(Dummy; 1 = plant has shift work)	(0.012)	(0.633)	(0.227)	(0.125)	(0.095)	(0.059)
Number of normal weekly hours	1.543	-0.514	-1.094	-2.962	-2.527	0.053
	(0.605)	(0.851)	(0.685)	(0.281)	(0.467)	(0.993)
Index of capacity utilization	3.119	5.737	4.240	6.026	6.168	5.466
(from 1 = under 85% to 6 = more than 100%)	(0.276)	(0.030)	(0.207)	(0.078)	(0.070)	(0.364)
Advanced production technology	-7.549	-4.146	-3.170	-3.108	-3.288	-1.596
(Dummy; 1 = plant has state-of-the-art technology)	(0.474)	(0.654)	(0.732)	(0.750)	(0.824)	(0.941)
Profit sharing for the workforce	8.713	4.049	7.768	19.198	11.651	3.567
(Dummy; 1 = yes)	(0.528)	(0.699)	(0.450)	(0.038)	(0.302)	(0.864)

Profit sharing for management	25.173	4.049	7.617	9.488	7.079	25.988
(Dummy; 1 = yes)	(0.050)	(0.734)	(0.528)	(0.413)	(0.627)	(0.315)
Works council * profit sharing for management	-15.244	-12.641	-11.264	-14.125	2.495	-22.406
(Interaction term of two dummy variables)	(0.456)	(0.435)	(0.535)	(0.464)	(0.912)	(0.649)
Market share for most important product line in most	-14.548	-11.550	4.699	2.508	-11.745	-15.322
important market (Dummy; 1 = over 5%)	(0.231)	(0.172)	(0.559)	(0.792)	(0.386)	(0.563)
Constant	38.999	75.589	111.504	200.394	217.731	123.173
	(0.755)	(0.469)	(0.260)	(0.052)	(0.096)	(0.625)
Number of observations	231	231	231	231	231	231
R^2	0.307					
Pseudo R^2		0.195	0.168	0.188	0.273	0.310

Notes: (1) See Appendix 1, Notes (1)-(2).

Appendix 3: Labor Productivity Estimations, Western Germany

(Dependent Variable: Log Value Added per Employee in Western Germany, Manufacturing Establishments Covered by Collective Bargaining)

	OLS	QuantileRegression				
Variable		0.10	0.25	0.50	0.75	0.90
Works council	59.716	10.733	17.384	27.571	24.883	22.186
(Dummy; 1 = plant has a works council)	(0.000)	(0.100)	(0.005)	(0.000)	(0.008)	(0.291)
Plant size	0.006	0.006	0.005	0.011	0.011	0.023
(Number of employees)	(0.348)	(0.097)	(0.391)	(0.093)	(0.270)	(0.073)
Plant size squared	-7.87e-08	1.80e-08	2.79e-08	-1.53e-07	-2.00e-07	-5.09e-07
	(0.589)	(0.971)	(0.963)	(0.836)	(0.860)	(0.616)
Branch plant status	61.960	17.055	12.891	23.273	44.607	78.561
(Dummy; 1 = firm is a branch plant)	(0.025)	(0.035)	(0.037)	(0.016)	(0.016)	(0.007)
Plant age	-10.274	12.305	5.543	-0.837	2.442	-18.635
(Dummy; 1 = plant founded before 1980)	(0.571)	(0.041)	(0.317)	(0.879)	(0.786)	(0.265)
Percentage of female employees	0.616	-0.363	-0.326	-0.223	-0.394	-1.058
	(0.591)	(0.014)	(0.052)	(0.203)	(0.200)	(0.056)
Percentage of skilled employees	0.189	-0.029	0.142	0.228	0.158	0.210
	(0.562)	(0.766)	(0.222)	(0.028)	(0.392)	(0.583)
Percentage of part time employees	-1.671	-0.259	-0.392	-0.688	-1.141	-2.040
	(0.083)	(0.123)	(0.003)	(0.000)	(0.002)	(0.003)
Number of normal weekly hours	8.190	-7.423	-4.203	-3.063	1.760	1.211
	(0.148)	(0.006)	(0.012)	(0.152)	(0.584)	(0.832)
Advanced production technology	17.094	0.146	4.338	7.078	19.358	11.289
(Dummy; 1 = plant has state-of-the-art technology)	(0.079)	(0.978)	(0.287)	(0.187)	(0.027)	(0.489)
Profit sharing for the workforce	-2.031	10.719	11.448	17.587	23.723	8.746
(Dummy; 1 = yes)	(0.870)	(0.085)	(0.105)	(0.016)	(0.021)	(0.537)
Constant	-217.191	330.498	217.324	195.370	79.424	327.059
	(0.371)	(0.002)	(0.001)	(0.020)	(0.516)	(0.164)
Number of observations	880	880	880	880	880	880
R^2	.087					
Pseudo R^2		0.131	0.116	0.115	0.114	0.156

Notes: (1) See Appendix 1, Note (1)

(2) All regressions include dummy variables for 15 manufacturing industries.

Appendix 4: Labor Productivity Estimations, Western Germany

(Dependent Variable: Log Value Added per Employee in West Germany, Manufacturing Establishments Not Covered by Collective Bargaining)

	OLS	Quantile Regression				
Variable		0.10	0.25	0.50	0.75	0.90
Works council	7.958	14.404	6.937	2.006	-2.938	-0.626
(Dummy; 1 = plant has a works council)	(0.624)	(0.067)	(0.504)	(0.836)	(0.851)	(0.981)
Plant size	0.064	0.075	0.083	0.140	0.115	0.110
(Number of employees)	(0.300)	(0.199)	(0.193)	(0.042)	(0.199)	(0.396)
Plant size squared	-3.17e-05	3.3e-05	-3.6e-05	-8.7e-05	-2.0e-05	-4.6e-05
	(0.526)	(0.591)	(0.544)	(0.234)	(0.820)	(0.643)
Branch plant status	7.781	-8.426	11.529	0.633	7.128	4.459
(Dummy; 1 = firm is a branch plant)	(0.819)	(0.649)	(0.442)	(0.975)	(0.836)	(0.965)
Plant age	-6.065	-0.203	0.268	1.801	-11.934	15.945
(Dummy; 1 = plant founded before 1980)	(0.651)	(0.975)	(0.972)	(0.828)	(0.436)	(0.545)
Percentage of female employees	0.147	-0.016	-0.067	-0.086	0.205	1.199
	(0.557)	(0.938)	(0.743)	(0.729)	(0.666)	(0.068)
Percentage of skilled employees	0.186	0.299	0.098	0.101	0.362	0.126
	(0.284)	(0.058)	(0.527)	(0.477)	(0.121)	(0.712)
Percentage of part time employees	-0.899	-0.150	-0.387	-0.583	-0.962	-1.008
	(0.000)	(0.451)	(0.068)	(0.012)	(0.011)	(0.029)
Number of normal weekly hours	1.835	2.831	1.117	0.271	6.453	5.954
	(0.354)	(0.105)	(0.466)	(0.870)	(0.105)	(0.323)
Advanced production technology	20.620	12.143	10.372	14.815	10.262	22.724
(Dummy; 1 = plant has state-of-the-art technology)	(0.052)	(0.040)	(0.146)	(0.027)	(0.410)	(0.341)
Profit sharing for the workforce	46.203	15.344	10.157	6.778	28.501	115.277
(Dummy; 1 = yes)	(0.074)	(0.122)	(0.298)	(0.591)	(0.225)	(0.113)
Constant	6.216	-113.452	-7.806	63.144	-138.523	-101.295
	(0.941)	(0.127)	(0.909)	(0.404)	(0.417)	(0.689)
Number of observations	360	360	360	360	360	360
R^2	0.158					
Pseudo R^2		0.133	0.111	0.115	0.113	0.164

Notes: (1) See Appendix 1, footnote (1) and Appendix 3, footnote (2).

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