The Job Satisfaction-Productivity Nexus: A Study Using Matched Survey and Register Data

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Abstract

The authors examine the role of employee job satisfaction in Finnish manufacturing plants over the period 1996–2001 to determine the extent to which it affects establishment-level productivity. Using matched data on job satisfaction from the European Community Household Panel (ECHP) and information on establishment productivity from longitudinal register data linked to the ECHP, they estimate that the effect of an increase in the establishment's average level of employee job satisfaction on productivity is positive, but its magnitude varies depending on the specification of the model. The authors use an instrumental variables point estimate and find that an increase in the measure of job satisfaction by one within-plant standard deviation increases value-added per hours worked in manufacturing by 6.6%.

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PETRI BÖCKERMAN AND PEKKA ILMAKUNNAS*

The authors examine the role of employee job satisfaction in Finnish manufacturing plants over the period 1996–2001 to determine the extent to which it affects establishment-level productivity. Using matched data on job satisfaction from the European Community Household Panel (ECHP) and information on establishment productivity from longitudinal register data linked to the ECHP, they estimate that the effect of an increase in the establishment's average level of employee job satisfaction on productivity is positive, but its magnitude varies depending on the specification of the model. The authors use an instrumental variables point estimate and find that an increase in the measure of job satisfaction by one within-plant standard deviation increases value-added per hours worked in manufacturing by 6.6%.

Job satisfaction is an important attribute of all labor market matches, as it is a useful summary measure of utility at work. The effects of job satisfaction on various labor market outcomes such as employee quitting behavior, absenteeism, and job performance have been explored in the literature (see Warr 1999). Despite this, there are still relatively neglected areas of research. One of these neglected areas concerns the effect of employees' job satisfaction on firms' productivity rather than on individual performance. The issue has been high on the policy agenda. The European Union, for example, argues in its Lisbon strategy that job satisfaction positively affects firms' performance. This is a rather provocative claim because it implies that policies to improve job satisfaction would be beneficial for both employees and employers.

We use Finnish data to examine the connection between employees' job satisfaction and establishments' productivity. We created a unique data set by merging two data sets. The first one is the Finnish part of the European Community Household Panel (ECHP). The ECHP contains information on individual satisfaction. The ECHP is matched to longitudinal, register-based employer-employee data maintained by Statistics Finland. This matching makes it possible to calculate productivity for the establishments from which there are employees interviewed in the ECHP. We estimate models for productivity using the measure of average job satisfaction in the establishment as the primary explanatory variable. We are able to control for several establishment characteristics, such as the average age of employees, by using register-based information.

Our study contributes to the literature in three ways. First, we use the standard measures of productivity as the dependent variables. The literature has typically used various individual-level proxy variables for productivity. These include sickness absences, accidents, quits, self-reported performance measures, and supervisors' evaluations of their employees' performance (e.g., Iaffaldano and Muchinsky 1985; Judge, Thoresen, Bono, and Patton 2001; Zelenski, Murphy, and Jenkins 2008), but experimental situations have also been used (e.g., Oswald, Proto, and Sgroi 2008). Further, the studies that focus on the service sector commonly use customers' satisfaction scores. It could be challenging, however, to establish the relationship by using subjective measures on both sides of the estimated equation (Hamermesh 2004). Instead of these kinds of proxies, we use conventional measures of establishment productivity. Our preferred approach is to estimate a production function for the manufacturing plants with value added per hours worked (i.e., labor productivity) as the dependent variable. In the manufacturing sector we also calculate total factor productivity and explain it by means of job satisfaction. In the models that include the private service sector, we use sales per employee. What makes our use of these standard measures of productivity possible is that our longitudinal survey data on job satisfaction is linked to the establishment-level register data by using unique establishment identifiers.

Second, we use data that are representative in the private sector. Most of the earlier studies that have estimated the relationship between job satisfaction and productivity have focused only on some number of firms or narrow sectors of the economy (Ostroff 1992; Ryan, Schmit, and Johnson 1996; Patterson, West, Lawthorn, and Nickell 1997; Harter, Schmidt, and Hayes 2002; Schneider, Hanges, Smith, and Salvaggio 2003; Patterson, Warr, and West 2004). This makes it difficult to generalize the results obtained. For example, Harter et al. (2002) derive their set of estimates for the U.S. economy by using data that covers 36 firms (although with more than 7,000 workplaces).[1]

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[1]There are earlier studies of the effect of employees' working capacity on firms' performance using Finnish data (Vanhala and Tuomi 2002; Mäki-Fränti 2009; Von Bonsdorff, Janhonen, Vanhala, Husman, Ylöstalo, Seitsamo, and Nykyri 2009). These studies focus on selected samples of firms, and they do not address the potential endogeneity of employees' sense of well-being.

Third, we implement an instrumental variable (IV) estimator that addresses the concern about the endogeneity of job satisfaction in the estimated equation. This allows us to evaluate the validity of the estimates that have relied on the assumption about the exogeneity of job satisfaction. The existing literature has focused almost solely on the cross-sectional correlations between the variables of interest (for a survey, see Judge et al. 2001). Another reason for the use of the IV estimator is the possible measurement error in job satisfaction. Our estimates use employees' satisfaction with their housing conditions as an instrument for job satisfaction. Furthermore, we apply a variant of the method introduced by Olley and Pakes (1996) to tackle the simultaneity of job satisfaction and performance.

Connecting Job Satisfaction to Productivity

The issue of employee well-being and job performance has been discussed in a broad sense in connection with the happy/productive worker thesis (see Wright and Cropanzano 2007). The issue has also been viewed more narrowly as the connection of job satisfaction and job performance. According to the happy/productive worker thesis, the tendency of unhappy people to emphasize negative aspects of their work leads to lower job performance. This holds especially in jobs that require social interaction with coworkers or customers. The unhappy workers may also have negative spill-over effects on the performance of other employees.

Job satisfaction is a narrower measure of well-being than happiness because it covers only well-being that is related to the job. Job satisfaction measures, however, have been easily available, and an extensive literature has examined the connections of job satisfaction with performance. There are various channels through which job satisfaction (or, more generally, well-being) can affect productivity.[2] First, there is the direct impact on a person's measured productivity (e.g., supervisor ratings). This may be a result of a lower tendency to conscious or unconscious shirking, i.e., less tendency to slow down work. Second, satisfied workers may also exhibit more organizational citizenship and less counterproductive organizational behavior. They may also have a lower tendency to strike and take other industrial action. Third, there are positive productivity effects through decreased absenteeism. Workers not satisfied with their jobs may have a greater tendency to develop illnesses or even remain absent from work without illness. While absent, a person's productivity is, of course, zero, and even if a substitute is found or the other workers can make up the work of the absent employee, productivity is likely to fall. Fourth, job dissatisfaction leads to quit intentions and actual separations. Quits and subsequent replacement hiring create costs for firms that may show up as lower productivity, even when it is the least productive who leave. Finally, it has been argued that job satisfaction is

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[2]The literature on the relationship between job satisfaction and individual performance is reviewed in Warr (1999), Judge et al. (2001), Wright and Cropanzano (2007), and Fisher (2010).

related to lower accident rates, which should lead to higher productivity. An accident causes a direct loss of production for the worker involved but may also cause wider disruptions in the production process.

At the individual level, meta-analyses have found a modest average correlation of 0.17 between various facets of job satisfaction and performance (Iaffaldano and Muchinsky 1985). When research attention is focused on overall job satisfaction, however, the average correlation is higher. Petty, McGee, and Cavender (1984) obtained the mean (corrected) correlation of 0.31. Judge et al. (2001) performed a meta-analysis covering 312 samples with combined observations of 54,417; the mean (corrected) correlation between job satisfaction and job performance was 0.30. Some of the highest estimates may have resulted from the fact that establishment characteristics had not been controlled for. The workforce of high-productivity plants, for example, is likely to consist of highly educated employees who may also have higher than average job satisfaction. Therefore, the failure to control for employee characteristics would bias the correlation between job satisfaction and job performance upwards.

Although the majority of the studies on the links between job satisfaction and productivity are analyses at the individual level, one can argue that the relationship can be aggregated to the establishment or firm level.[3] Harter et al. (2002) found in a meta-analysis of Gallup Workplace Audit studies of 7,939 business units from 36 firms that the (corrected) correlation of job satisfaction with business unit productivity was 0.20. With a composite performance indicator that included customer satisfaction, profitability, productivity, and turnover, the correlation was 0.37.

An obvious problem in determining the job satisfaction-productivity connection is the possibility of reverse causality (i.e., good performance may lead to higher job satisfaction) or the possibility that unobservable workplace characteristics affect both productivity and job satisfaction (see Judge et al. 2001). Schneider et al. (2003), for example, showed that in a sample of 35 firms the correlation of return on assets (ROA) with the previous year's job satisfaction was 0.20, but the correlation of job satisfaction with the previous year's ROA was 0.50. It is possible to mitigate this endogeneity problem by using lagged job satisfaction as an explanatory variable, by using fixed effects to remove the unobservable factors, or by using an instrumental variable for job satisfaction.

Data

We use the European Community Household Panel (ECHP) for Finland over the period 1996–2001.[4] The ECHP is based on a standardized question-

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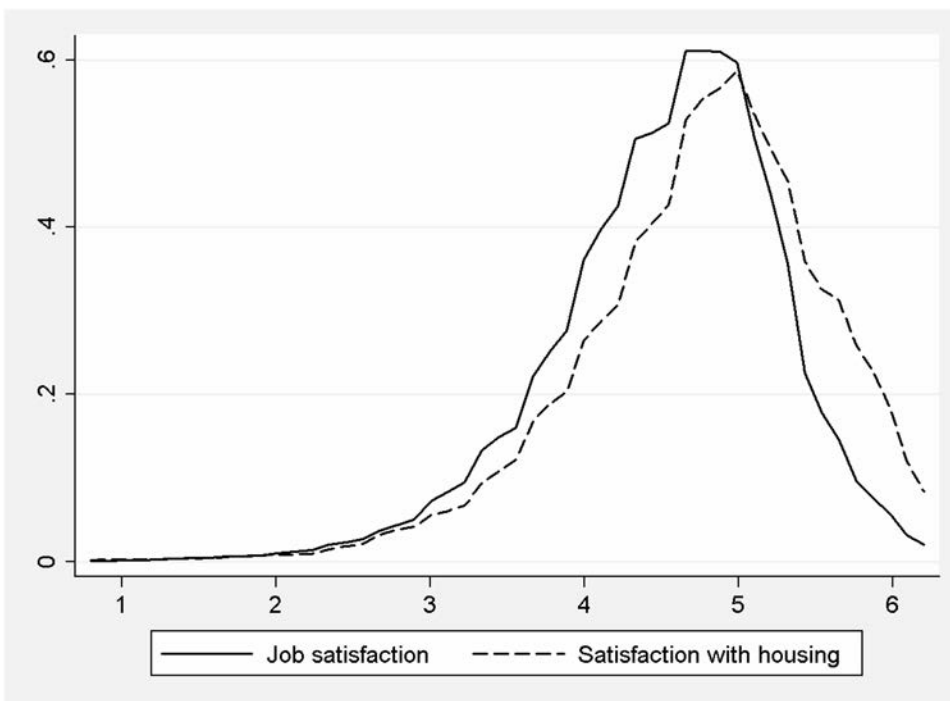[3]This may involve an aggregation bias if the units under study are too heterogeneous (see James 1982). Therefore, an establishment is a more appropriate unit of analysis than a firm.

[4]Finland was included in the ECHP for the first time in 1996 after the country joined the European Union. The European Union stopped gathering data for the ECHP in 2001, which means that we have six waves of the data.

naire that contains annual interviews with a representative panel of house-
holds and individuals in each European Union country (e.g., Peracchi
2002). The ECHP is composed of a separate personal file and a separate
household file. We use the data from the personal file because it is the file
that contains information on employees' subjective well-being. An individu-
al's job satisfaction status is an answer to the question on satisfaction with
work or main activity. Job satisfaction is measured on an ordinal six-point
Likert scale from "not satisfied" (1) to "fully satisfied" (6). The observations
on job satisfaction are concentrated at the higher end of the scale (Figure 1),
which is a well-known feature of the variables that measure employees' utility
at work (e.g., Clark 1996). This pattern has to be taken into account in the
interpretation of the estimates. We use the ECHP to calculate the average job
satisfaction level for each establishment from which there is at least one re-
sponse to the question on job satisfaction.

   The ECHP for Finland can be matched to data from the Finnish Longitu-
dinal Employer-Employee Data (FLEED). We were able to match the data
sources because all the data sets that we use contain the same unique identi-
fiers for persons and establishments. FLEED is constructed from a number
of different registers on individuals, firms, and their establishments that are

Figure 1. The Kernel Density Estimates for Job Satisfaction (*JS*) and Satisfaction
with Housing Situation (*HS*)

Notes: The figure shows Epanechnikov kernel densities with bandwidth 0.2. The satisfaction scores are
three-year averages for each establishment. The figure is drawn for all years and all sectors combined.

maintained by Statistics Finland (SF). FLEED contains detailed information on employee characteristics from Employment Statistics (ES). We have used this information to calculate the average employee characteristics for each establishment, and we then used these averages as control variables in the models for productivity. We have calculated the average employee characteristics for all those establishments from which there are at least five persons in ES. We also use ES to calculate the annual worker outflow measures for each plant that are used with a variant of the Olley-Pakes approach, as we explain later.

The information we used on value added, hours worked, capital stock and export status originates from the Longitudinal Database on Plants in Finnish Manufacturing (LDPM) of SF. The LDPM includes all plants in manufacturing owned by firms that have no fewer than 20 persons. Our preferred approach is to estimate a production function written in intensity form where the dependent variable, i.e., the productivity measure, is value added per hours worked in the plant. This measure of labor productivity is based on the LDPM, and it is available for the manufacturing sector only. The exact definitions of the variables, including the means and standard deviations, are documented in Appendix Table A.1.

Baseline Estimates

The baseline model for manufacturing is the following production function:

(1) $$ln(Y_{jt} / L_{jt}) = \beta_0 + \beta_1 JS_{jt-2} + \beta_2 ln(K_{jt} / L_{jt}) + \beta_3 X_{jt} + \varepsilon_{jt}$$

where Y_{jt}/L_{jt} is the measure of labor productivity, value added per hours worked, for the establishment j in the year t.

The variable of interest is JS_{jt-2} (job satisfaction), which is the average satisfaction score for the establishment j in the year t for all those establishments from which there is at least one employee in the ECHP. To support exogeneity of this main explanatory variable, we use job satisfaction lagged by two years. K_{jt}/L_{jt} is capital stock per hours worked and X_{jt} is the vector of control variables, as listed in Appendix Table A.1. It includes a set of establishment characteristics such as the average years of education and the average age of employees in the establishment. The controls also include the year effects. These time effects capture any cyclical changes that affect all establishments' productivity in the same way. Equation (1) can be interpreted as a Cobb-Douglas production function with constant returns to scale.

We report the baseline estimates, based on ordinary least squares (OLS), in column 1 of Table 1. The OLS estimates ignore the possibility that there are establishment-specific effects that are part of the error term and may be correlated with the explanatory variables. The OLS estimates, however, constitute a useful benchmark to which other results from more complex estimators can be compared. The results reveal that a one point increase in the average level of job satisfaction in the plant increases the level of value

Table 1. The Effect of Job Satisfaction on Logarithm of Value Added
Per Hours Worked in Manufacturing

Variables	OLS	Two-stage approach	
		1st stage (fixed effects)	2nd stage (OLS)
Job satisfaction (lagged by two years)	0.036**	..	..
	(0.015)		
Average job satisfaction (over the period 1996–2001)	..	..	0.090***
			(0.032)
Establishment-level control variables			
ln(Capital stock per hours worked)	0.276***	0.155***	..
	(0.031)	(0.057)	
Vintage -1976	Reference	..	..
Vintage 1977–1980	0.128**	..	..
	(0.060)		
Vintage 1981–1985	0.094	..	..
	(0.076)		
Vintage 1986–1990	0.126	..	..
	(0.084)		
Vintage 1991–1995	0.162**	..	..
	(0.074)		
Vintage 1996–2000	0.312	..	..
	(0.209)		
Establishment size <20 employees	Reference	Reference	..
Establishment size 20–49 employees	–0.564***	0.181***	..
	(0.143)	(0.046)	
Establishment size 50–99 employees	–0.538***	0.336***	..
	(0.144)	(0.116)	
Establishment size ≥100 employees	–0.615***	0.396**	..
	(0.141)	(0.158)	
Average years of education	0.212***	0.116*	..
	(0.030)	(0.059)	
Average age of employees	–0.011	–0.036	..
	(0.009)	(0.032)	
Average tenure of employees	0.0014**	0.0014	..
	(0.0006)	(0.0019)	
Share of females	–0.319***	–0.0043	..
	(0.110)	(0.4530)	
Exporter	–0.0085	–0.0002	..
	(0.0392)	(0.0761)	
Indicators			
Years (waves)	Yes	Yes	No
Industries	Yes	No	No
Regions	Yes	No	No
N	1139	1139	523

Notes: The two-stage approach is based on fixed effects estimation and OLS, as explained in the text. Robust standard errors are in parentheses.
*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

added per hours worked by 3.6% in manufacturing, other things being equal.[5] This is a very moderate effect quantitatively. Arguably, it is a very

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[5]Because the earlier studies typically report only cross-sectional correlations of job satisfaction and firm performance or use measures of job satisfaction that have a different scale than the one we use, it is difficult to relate our estimates in Table 1 directly to those in the existing literature. In our matched data the correlation coefficient between labor productivity and job satisfaction is 0.073 (significant at the 1% level). The correlation between labor productivity and three-year average of job satisfaction over the

challenging task for plants to increase the *average* level of their employees' job satisfaction by one point, say from 4 to 5, on a scale of 1 to 6, because there is a rather strong concentration of observations toward the higher end of the satisfaction scale. (The distribution of both job satisfaction and satisfaction with housing conditions is depicted in Figure 1.) It sheds light on the external validity of the estimates to note that the estimate for the coefficient of capital stock per hours worked is reasonable (~0.28) and accords with the results obtained earlier for Finland (e.g., Lehto 2007). Also, the influences of establishment-level labor characteristics (including the average years of education) are broadly consistent with those reported in Ilmakunnas and Maliranta (2005) for Finnish manufacturing.[6]

Sensitivity Analyses

To explore the robustness of the baseline estimates, we have estimated several additional specifications that use different productivity measures, various estimation methods, and varying specifications for job satisfaction, among other things. We briefly discuss each of these results, without presenting them in tables.

Measurement of Productivity

We use labor productivity (i.e., value added per hours worked) in manufacturing as the dependent variable in the baseline. It is well known, however, that production function estimation may be hampered by the endogeneity of the input variables on the right-hand side of the equation. One alternative is to use total factor productivity as the productivity measure. To calculate total factor productivity for the manufacturing plants, we use industry-level information on the labor share of the value added taken from the EU-KLEMS database.[7] Total factor productivity is defined as follows: $lnTFP_{jt} = ln(Y_{jt}/L_{jt}) - (1 - a)ln(K_{jt}/L_{jt})$, where a is the labor share of the value added. This share is a measure of the parameter β_2 in equation (1) that is allowed to vary by industry. The OLS estimate of the coefficient of job satisfaction (lagged by two years) for manufacturing using total factor productivity as the dependent variable was 0.032 with a robust standard error of 0.016. Thus, the result was almost identical to that obtained when labor productivity was the dependent variable and capital intensity one of the right-hand side variables.

The advantage of the production function estimation or of using total factor productivity as the productivity measure is that it allowed us to take into account capital intensity in the establishment. But data on capital stock

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period t, $t-1$ and $t-2$ is much higher at 0.141 (also significant at the 1% level). These correlations seem to be somewhat smaller than the average reported in earlier research.

[6]We have also estimated the model of column 1 in Table 1 without indicators for years, industries, and regions. These exclusions have only a relatively minor impact on the effect of job satisfaction on labor productivity.

[7]The data set is described at http://www.euklems.net/.

and hours worked (along with value added) are available only for manufacturing plants. To extend the analysis to the private service sector, we use a third productivity measure, sales per employee, which we obtained from the Business Register of SF. This increased the sample size considerably (N = 2101) because it allowed us to include nonmanufacturing establishments as well. The correlation coefficient between sales per employee and value added per hours worked is 0.58 in manufacturing (significant at the 1% level). Therefore, these measures capture partly different aspects of establishment performance.

Our estimates revealed that job satisfaction was not a statistically significant determinant of sales per employee in the larger sample that also contains the nonmanufacturing sector. To explore the relevance of sales per employee further, we have also estimated the OLS model for sales per employee for the manufacturing plants only. Job satisfaction, however, was clearly not related to sales per employee, even in manufacturing. An obvious explanation of the difference in the results with different productivity variables is that it is important to take capital intensity into account.[8] Furthermore, sales and the number of employees, compared to value added and hours worked, are imprecise measures of output and labor input.

High-Productivity Plants

We report the average relationship between job satisfaction and labor productivity for all plants in column 1 of Table 1. Because the relationship may vary across plants, we have estimated the model for the high-productivity manufacturing plants only, defined as plants that have above-average productivity. The results that used labor productivity as the dependent variable revealed that the relationship was particularly pronounced for these plants. The coefficient of job satisfaction is 0.049 with a robust standard error of 0.016. This implies that job satisfaction may indeed have more positive effects in establishments that already have high productivity.[9] But the relatively small sample size constitutes a limitation to the estimation of the relationship for subsamples. The confidence intervals are wide for the point estimates that are constructed for subsamples, and the differences in the point estimates are generally not statistically significant.

Fixed Effects Estimation

To account for the unobservable establishment-level heterogeneity, which may be correlated both with productivity and job satisfaction (and input

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[8]Otherwise, the estimates would be subject to omitted variable bias, because a substantial part of the differences in labor productivity emerges from the differences in capital intensity across plants. Capital intensity may also be related to unobserved job amenities that could be positively correlated with job satisfaction as well.

[9]One possible explanation for the pattern that job satisfaction seems to have a particularly pronounced effect on productivity among the high-productivity plants is that these plants may have unobserved job amenities, i.e., a generally good working environment. These could reinforce the effect of job satisfaction on productivity.

choices), we have also estimated equation (1) by including establishment fixed effects. The results from conventional fixed effects estimation revealed that job satisfaction is not a statistically significant determinant of labor productivity. A primary reason for this result is that there is not enough variation in job satisfaction after transforming the variables to differences from within establishment means.

The preferred fixed effects approach is a two-stage method, used, for example, by Black and Lynch (2001: 441) and Buhai, Cottini, and Westergård-Nielsen (2008: 15–16). Both studies have data on workplace characteristics for one year, which they combine with panel data on production and inputs.[10] In the first stage of the estimating process, labor productivity is explained by the time-variant establishment-level characteristics and a set of indicators for years in the fixed effects estimation (Table 1, column 2).[11] This first-stage equation is a variation of equation (1) with the job satisfaction variable JS_{jt} excluded and establishment effects β_{0j} included:

$$(2) \qquad ln(Y_{jt} \, / \, L_{jt}) = \beta_{0j} + \beta_2 ln(K_{jt} \, / \, L_{jt}) + \beta_3 X_{jt} + \varepsilon_{jt}$$

After obtaining the fixed effects estimates from equation (2), we calculate the average residuals for each establishment as $v_j = \overline{ln(Y_{jt}/L_{jt})} - \hat{\beta}_2 \overline{ln(K_{jt}/L_{jt})} - \hat{\beta}_3 \overline{X}_{jt}$ and we then use the vector of these average residuals as the dependent variable in the second stage in a cross-sectional estimation. These residuals are estimates of the establishment fixed effects. The explanatory variable in the second stage is the average level of job satisfaction in the plant over the period 1996–2001:

$$(3) \qquad v_j = \alpha_0 + \alpha_1 \overline{JS}_j + \omega_j$$

The second stage of the estimation equation (3) does not include the time-varying Xs because the calculation of the residual for the second stage already takes their effect into account. This approach takes care of all time-invariant establishment effects that are potentially correlated with the choice of establishment's inputs (or job satisfaction) in the first stage, and at the same time it allows the use of variables that are time-invariant or do not have much variation over time. These estimates reveal that a one point increase in average job satisfaction increases the level of value added per hours worked by 9% (Table 1, column 3). Thus, the magnitude of the point estimate, based on the two-stage approach, is more than twice that of the baseline OLS estimate for manufacturing (Table 1, column 1). This suggests that the OLS results may have been downwardly biased.

Specification of Job Satisfaction

We have estimated several models by using different specifications for job satisfaction. Using labor productivity as the dependent variable in manufac-

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[10]Black and Lynch (2001) explore the effects of workplace practices and information technology, while Buhai et al. (2008) focus on the impacts of working conditions on firm performance.

[11]The indicators for vintage, industries, and regions are omitted from the vector of explanatory variables in column 2 of Table 1 because they are not time-variant.

turing, we found that job satisfaction lagged by one year obtained the coefficient of 0.043 with a robust standard error of 0.023. We also have tried to use the future value of job satisfaction ($t + 1$) to examine the potential reverse causality between the variables. This result, however, was far from being statistically significant.

The baseline model uses average within-establishment job satisfaction, which assumes that job satisfaction is cardinal. Since this is theoretically incorrect, we have calculated for each establishment the share of workers whose responses to the job satisfaction question is five or six on a six-point scale and used the result as an alternative explanatory variable. This variable lagged by two years obtained the coefficient of 0.095 with a robust standard error of 0.034 while using value added per hours worked as the dependent variable in manufacturing.[12] Thus, the conclusion on the positive productivity effect was not driven by the cardinality assumption.

We have also used the average job satisfaction scores over the period t, $t − 1$, and $t − 2$ for the establishments as the explanatory variable because there is a relatively small number of observations for each establishment on job satisfaction that may cause measurement error.[13] Mairesse and Greenan (1999) argue that the OLS estimate is downwardly biased when there are only a few observations on employee characteristics for each establishment in the combined data. But the corresponding t-value for the hypothesis that the effect for the employee character is zero remains unbiased under the null hypothesis of zero effect, even when there is only one employee observation per establishment. The coefficient of average job satisfaction over the period of three years turned out to be 0.048 with a robust standard error of 0.023. This estimate was somewhat larger than the baseline that uses job satisfaction lagged by two years (Table 1, column 1), although the estimates were not statistically significantly different from each other. A plausible explanation for the higher point estimate is that the use of the average level of job satisfaction over the period t, $t − 1$, and $t − 2$ alleviates the measurement error in job satisfaction. The central cause of concern about using the average is that job satisfaction over the period of three years is likely to be endogenous because it also includes current job satisfaction. Thus, we apply both the IV and the Olley-Pakes approaches to account for this.

Instrumental Variables Estimates

The potential endogeneity of the job satisfaction variable (three-year average job satisfaction) may cause a substantial bias in the OLS estimates. Indeed, by using the Wu-Hausman test, we can clearly reject the null hypothesis of the exogeneity of average job satisfaction in the model for labor

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[12]The ordinal specification gives a slightly better value of log-likelihood function. The correlation between labor productivity and job satisfaction is also slightly higher for the ordinal measure compared to the cardinal measure.

[13]The number of person observations on job satisfaction per establishment in manufacturing is as follows: 1 person (~55% of all establishments), 2 persons (~25%), 3 persons (~8%), 4 persons (~6%), 5 persons (~2%), and 6 persons or more (~4%). The distribution is quite similar for all sectors.

productivity in manufacturing (the *p*-value of the test is 0.021). Another apparent motivation for the use of the IV estimator is the potential measurement error in job satisfaction. The direction of bias in ordinary least squares is not obvious. Measurement errors in the measure of job satisfaction tend to attenuate the coefficients, i.e., the OLS estimate of the coefficient of job satisfaction is biased towards zero (Mairesse and Greenan 1999). This may still be a problem even when using a three-year average of job satisfaction, although it arguably involves less measurement error than using values for one year only. Nevertheless, the fact that job satisfaction may be positively correlated with unobserved determinants of productivity is likely to lead to an upwardly biased OLS estimate.

We have used employees' satisfaction with their housing situation (three-year average) as an instrument for job satisfaction. We implemented the estimator by using the two-stage least squares approach. The equation of interest that describes the effect of job satisfaction on productivity is similar to equation (1), where the establishment effect is part of the error term of the equation. The first-stage regression equation is

$$(4) \qquad JS_{jt} = \gamma_0 + \gamma_1 HS_{jt} + \gamma_2 ln(K_{jt} / L_{jt}) + \gamma_3 X_{jt} + \varepsilon_{jt}$$

where the term (*HS*) is the employees' average satisfaction with their housing situation for those employed in the establishment *j* in the year *t*. We calculated *HS* for all those establishments from which there is at least one employee interviewed in the ECHP.[14] *HS* is omitted from the second-stage equation.

In order for satisfaction with housing conditions to be a valid instrument, it must be correlated with job satisfaction. But it must not be a determinant of the establishments' productivity, i.e., it must be uncorrelated with the error term in the equation for productivity.[15] Thus, satisfaction with housing must have no influence on the establishments' productivity other than through the first-stage channel.[16] We could not perform an overidentification test for the validity of the instrument because we were using only one instrument.[17] On the basis of the psychology literature, we would expect to
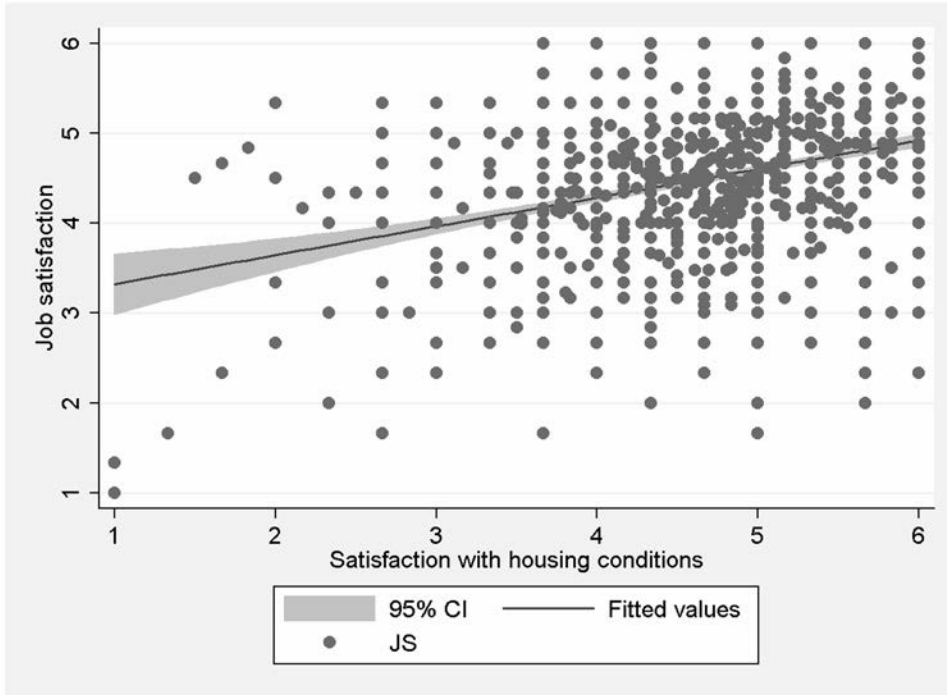
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[14]The answers on satisfaction with the housing situation in the ECHP are measured similarly to job satisfaction on an ordinal six-point Likert scale from "not satisfied" (1) to "fully satisfied" (6).

[15]One can imagine only rather extreme examples in which the assumption about satisfaction with housing being uncorrelated with the productivity equation residual could clearly be violated. For example, in an economy that consists of a great number of islands with one plant and their employees located on each island and employees living in employer-provided houses there would probably be a connection between satisfaction with housing conditions and productivity through other channels than job satisfaction.

[16]Most of the individuals live in a house that has been acquired before they have switched to their current job. This means that the characteristics of the current job should not have any major influence on satisfaction with housing conditions. Satisfaction with housing also contains less measurement error than job satisfaction for the very reason that housing tenure is usually much longer than job tenure. Thus, the use of the IV estimator is able to alleviate the measurement error in job satisfaction in addition to addressing the potential endogeneity of job satisfaction in the productivity equations.

[17]A potential worry with the instrument is that a job in a good firm may also result in a good housing accommodation, given that a good job might result in better material benefits, among other things. But the plant-level correlation of the average real wage level with average satisfaction with housing is only 0.002.

Figure 2. The Relationship between Job Satisfaction (*JS*) and
Satisfaction with Housing Conditions (*HS*)

Notes: The 95% confidence level is shaded. The satisfaction scores are three-year averages for each establishment. The figure is drawn for all years and all sectors combined.

find a positive correlation between job satisfaction and satisfaction with housing conditions. The positive correlation that makes the instrument relevant is in accordance with the well-known "spillover hypothesis" (e.g., Wilensky 1960; Rain, Lane, and Steiner 1991). This theory states that satisfaction in a given aspect of life (e.g., housing) spills over into other aspects of subjective well-being (e.g., satisfaction at work).[18] The positive correlation between job satisfaction and satisfaction with housing conditions is illustrated in Figure 2. Formal tests confirmed the visual pattern.[19]

According to the IV estimate in manufacturing, a one point increase in the average level of job satisfaction in the plant increases value added per hours worked by ~20%. The fact that the IV estimate is larger than the OLS

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[18]Satisfaction with housing is the only aspect of satisfaction available in the ECHP that is not directly linked to utility at work.

[19]The *F*-statistic for a test of the hypothesis that the coefficient on the instrument is zero in a regression of job satisfaction on the instrument is substantially higher (36.90) than the threshold of 10 proposed by Staiger and Stock (1997) for a weak instrument. The *F*-test from a regression of residualized job satisfaction on the residualized instrument (44.11) is also well above 10. The residualized values are obtained by taking into account the effects of establishment-level control variables and indicators, as listed in Appendix Table A.1. Note that because we have only one instrument, the *F*-values are squares of *t*-values.

estimate is consistent with the arguments in Mairesse and Greenan (1999). But the IV estimate is not particularly precise, because it has a robust standard error of 0.080 and a 95% confidence interval from 0.050 to 0.364. Thus, the OLS estimate for the coefficient of average job satisfaction over the period of three years (0.048) is almost included in the 95% confidence intervals of the IV estimate.[20]

The Olley-Pakes Approach

Olley and Pakes (1996) introduced a semiparametric method that allowed them to tackle simultaneity problems in the estimation of production functions.[21] Simultaneity arises because firms usually choose their output level at the same time as they choose the set of inputs. Firms tend to increase the use of inputs as a result of positive production shocks. The central idea of the Olley-Pakes method is to use a proxy variable that is correlated with the shocks. They assume that investment is a proxy variable that depends on the shocks and the existing capital stock (a state variable) and that there is a monotonic relationship between the shocks and investment. This relationship can be solved for the shocks as a function of investment and capital, which is approximated by a polynomial, and inserted back into the production function.

We have modified this procedure. In our estimates job satisfaction plays the same role as capital and worker exits the same role as investment in the Olley-Pakes model. The endogeneity of job satisfaction arises because its level is partly a choice of the firm. The firm's managers realize that job satisfaction contributes to productivity and therefore may make efforts to improve it. Job satisfaction, however, is a variable that evolves slowly over time through changes in the job satisfaction of employees who are staying in the plant and through the entry and exit of employees whose job satisfaction may differ from that of the average employees who stay. We have assumed that the exit (outflow) of employees is a function of average job satisfaction and productivity shocks. On one hand, low job satisfaction arguably leads to voluntary quits or forced exits through layoffs.[22] On the other hand, negative productivity shocks also increase exits. We have assumed that there is a monotonic inverse relationship between exits and the shocks. Then we were able to solve for the shocks as a function of satisfaction and exits and pro-

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[20]We have also estimated Generalized Method of Moments (GMM) panel data models in which we have experimented with the use of lagged values as instruments. The tests for overidentifying restrictions, however, revealed that these lagged variables are not valid instruments.

[21]The method also accounts for selection effects in the estimation of production functions. Selection effects emerge because the exit process of firms from the market is not random. We have modeled the probability of plant survival as a function of lagged total factor productivity and plant size. The results remain the same in the specification that takes the plant survival probability into account. A primary reason for this is that the panel covers a relatively short period of time over which there has not been major turnover among the plants.

[22]For example, Freeman (1978), Clark, Georgellis, and Sanfey (1998), Böckerman and Ilmakunnas (2009), and Green (2010) provide evidence that low job satisfaction predicts worker outflow.

ceed in otherwise the same way as Olley and Pakes (1996). Hence, we have used job satisfaction as a state variable and worker outflow as a proxy variable for unobserved time-varying productivity shocks. Because our attention is on the coefficient of average job satisfaction, rather than on the coefficients of the inputs, we have not estimated a production function but used total factor productivity directly as the dependent variable. The control variables were the same as the ones for labor productivity in column 1 of Table 1 (with the exception of capital stock, which is accounted for in total factor productivity).

The results based on a variant of the Olley-Pakes approach showed that average job satisfaction obtained the coefficient of 0.035 with a robust standard error of 0.007. (Hence, the estimate was statistically significant at the 1% level. We calculated the standard error for the estimate by using bootstrapping with 250 replications.) This result was close to the one we obtained with OLS.

Conclusions

We have explored the role of job satisfaction in the determination of establishment-level productivity. Our study contributes several extensions of the existing knowledge to the literature. We have used standard measures of productivity and representative data. The earlier studies have typically used various proxy variables for productivity and focused on narrow sets of firms. In particular, we have taken advantage of matched survey and register data in which the measures of productivity and job satisfaction are drawn from separate data sources. Therefore, by their construction the variables of interest are unrelated. In contrast, the previous studies on the relationship between job satisfaction and performance have frequently used subjective measures on both sides of the estimated equation. Furthermore, while the existing studies have focused on the cross-sectional correlations (see Judge et al. 2001), we have implemented an instrumental variable estimator that addresses the potential endogeneity of job satisfaction in the estimating equation. We have also applied a variant of the method introduced by Olley and Pakes (1996) to tackle the simultaneity of job satisfaction and performance.

Our estimates for the effect of a one point increase in the average level of employees' job satisfaction in the establishment on productivity (on a scale of 1 to 6) varied depending on the specification of the model. The OLS estimate, which explains productivity with lagged job satisfaction, implied that a one point increase in average job satisfaction increases value added per hours worked by 3.6% in manufacturing. A fixed effects model yielded the result of 9%, and our variant of the Olley-Pakes approach produced the result of 3.5%. We obtained the largest point estimate for manufacturing, 20%, by using the instrumental variables estimation.

These positive estimates are consistent with various arguments about the channels through which job satisfaction affects productivity, i.e., less shirk-

ing, absenteeism, and turnover; fewer accidents; and more organizational commitment. But because we are investigating the issue at the establishment level, we have not been able to pinpoint the exact mechanism.

In comparing the quantitative magnitude of the estimates, we need to consider two issues. First, there are reasons to believe that because of measurement error our OLS estimate may be biased downwardly. Second, there may be reverse causality between productivity and job satisfaction, or an unobserved factor affecting both, that likely leads to upwardly biased results. By using lagged job satisfaction in the OLS estimation we have at least addressed the issue of temporal relationship between the variables. The measurement error problem still remains, and therefore the estimate of 3.6% is a lower bound for the likely effects. In our other estimations the job satisfaction variable is an averaged value, which may still include some measurement error. Our two-stage fixed effects estimation took into account unobservable time-invariant establishment characteristics that may affect productivity and job satisfaction, but it used average job satisfaction over the period 1996–2001 and gave a higher value than OLS. The Olley-Pakes approach, which addresses the question of endogeneity but not specifically that of measurement error, gave almost the same result as the OLS estimation. The IV estimate was substantially larger than the others. Because the instrumental variables estimate can account for both endogeneity and measurement error, we have concluded that measurement error in the job satisfaction variable is most likely a more serious problem than reverse causality. This conclusion is also supported by the fact that the future value of job satisfaction was not a statistically significant determinant of productivity.

Because the 95% confidence interval for the preferred IV estimate was fairly wide, from 5% to 36%, we cannot give an exact answer to the question how much job satisfaction affects productivity, although the impact is clearly positive. The magnitude of a realistic potential productivity improvement is, however, much smaller than the point estimate. Arguably, it is very challenging for a plant to increase the *average* level of job satisfaction for its employees by one point on a scale of 1 to 6 because the observations on job satisfaction are bunched at the higher end of the scale. Within-plant standard deviation of the average job satisfaction measure in manufacturing was 0.33. Therefore, if we were to use the preferred IV point estimate, a one–standard deviation improvement in within-plant job satisfaction would improve productivity by 6.6 %. Hence, even the highest point estimate (20%) implies that the economic significance of job satisfaction as a determinant of productivity is smaller.

We have also found that job satisfaction is not positively related to sales per employee in a larger sample that covers non-manufacturing establishments also. This is an interesting observation because some of the earlier studies have used sales per employee as the measure of establishment performance. Our result points out that when capital intensity in the establishments cannot be controlled for, production is measured by sales, and labor input is measured by the number of employees, the estimates are unreliable. Our findings

call for more empirical studies that combine information on productivity from linked employer-employee data sources to subjective measures of employees' well-being.

Appendix

Table A.1. Definitions and Descriptive Statistics of the Variables

Variable	Mean (st. dev.)	Definition/measurement
Dependent variables		
ln(Value added per hours worked)	3.526 (0.735)	Logarithm of value added divided by the hours worked in the plant, deflated to the base year 2000 by using the price index for value added from national accounts, expressed in euros. Value added and hours worked are available only for the manufacturing sector. (Source: LDPM).
ln(Total factor productivity)	2.126 (0.691)	$lnTFP = ln(Y/L) - (1 - a)ln(K/L)$, where Y/L is value added (in euros) per hours worked in the plant, K/L is capital stock (in euros) per hours worked in the plant, and a is the industry-level measure of the labor share of the value added. Y/L and K/L are deflated to the base year 2000. Computation assumes constant returns to scale and perfect competition. Capital stock is available only for the manufacturing sector. (Sources: LDPM and EU-KLEMS database).
ln(Sales per employee)	11.994 (0.868)	Logarithm of sales (in euros) divided by the number of employees in the establishment, deflated to the base year 2000 by using the price index for gross production from national accounts. (Source: Business Register).
Independent variables		
Job satisfaction (*JS*)	4.479 (0.700)	The average job satisfaction level for the employees in the establishment. Job satisfaction is measured on an ordinal 6-point Likert scale from "not satisfied" (1) to "fully satisfied" (6). A higher value means that a person currently feels more satisfied. (Source: ECHP).
Establishment-level control variables		
ln(Capital stock per hours worked)	3.296 (1.280)	Logarithm of capital stock (in euros) divided by the hours worked in the plant. Capital stock is calculated by the perpetual inventory method in which plant's past investments are accumulated assuming that the depreciation rate is 10% and using the year 2000 prices. The variable is available only for the manufacturing sector. (Source: LDPM).
Vintage		The year of foundation of the establishment is recorded in six categories: -1976 (reference), 1977–1980, 1981–1985, 1986–1990, 1991–1995 and 1996–2000. (Source: FLEED).
Establishment size		The establishment size in terms of employees is recorded in four categories: <20 (reference), 20–49, 50–99 and ≥100. (Source: FLEED).
Average years of education	11.486 (0.953)	The average years of education of all employees in the establishment (including all education levels). (Source: FLEED/ES).

Table A.1. Continued.

Variable	Mean (st. dev.)	Definition/measurement
Average age of employees	40.777 (3.680)	The average age of all employees in the establishment. (Source: FLEED/ES).
Average tenure of employees	147.137 (57.802)	The average tenure of all employees in the establishment (measured in months). (Source: FLEED/ES).
Share of females	0.322 (0.225)	The share of female employees in the establishment. (Source: FLEED/ES).
Exporter	0.415 (0.493)	The share of exports of the value added in the plant is at least 50% = 1, otherwise 0. Export status is available only for the manufacturing sector. (Source: LDPM).
Indicators		
Years (waves)		Indicators for the years 1996–2001.
Industries		Indicators for 24 industries based on Standard Industry Classification.
Regions		Indicators for 6 NUTS2 regions.
Instrument for job satisfaction		
Satisfaction with housing situation (*HS*)	4.707 (0.785)	The average level of satisfaction with housing conditions for the employees in the establishment over the period t, $t-1$ and $t-2$. Satisfaction with housing situation is measured on an ordinal 6-point Likert scale from "not satisfied" (1) to "fully satisfied" (6). A higher value means that a person currently feels more satisfied. (Source: ECHP).

Note: Descriptive statistics are reported for manufacturing.

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