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IS VARIATION IN HOURS OF WORK DRIVEN BY SUPPLY OR DEMAND? EVIDENCE FROM FINNISH MANUFACTURING INDUSTRIES*

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Abstract

This paper uses panel data from 1989 to 1995 on blue-collar workers in Finnish manufacturing industries and their establishments to assess the extent to which hours of work are affected by individual or establishment characteristics - observed as well as unobserved. We argue that the recent research on hours of work has focused almost exclusively on the supply of labor, but that insights into the extent to which hours variation is driven not by supply but by demand will affect the likelihood that supply-side policies will succeed to overcome the high European unemployment trap. Our estimates show that establishment level variation is almost as important as that on the individual level in the total variation of hours. This suggests that at least part of the variation of hours is driven by demand.

Tiivistelmä

Tutkimuksessa tarkastellaan teollisuuden tuntipalkkaisten työntekijöiden työtuntien määräytymistä Suomessa vuosina 1989-1995. Pyrkimyksenä on esittää arvio siitä, missä määrin tehdyt työtunnit selittyvät sekä havaituilla että havaitsemattomilla yksilö- ja toimipaikkakohtaisilla tekijöillä. Tutkimuksessa väitetään, että viime aikainen kirjallisuus on keskittynyt liiaksi työn tarjonnan erittelyyn, mutta työn kysyntä- ja tarjontatekijöiden keskinäisen merkityksen arvioiminen on tärkeässä asemassa pohdittaessa keinoja työttömyyden vähentämiseksi Euroopassa. Tulosten valossa yksilö- ja toimipaikkakohtaiset tekijät ovat lähes yhtä tärkeässä roolissa teollisuuden tunti-palkkaisten työntekijöiden työtuntien määräytymisessä. Tämä merkitsee sitä, että työn kysynnällä on väliä.

1 Introduction

Employment, as measured by the total hours of work, can fluctuate for a variety of reasons. It is, for instance, a well-known empirical regularity that paid overtime hours tend to adjust most rapidly to changes in aggregate economic activity. As a result of this, there tends to be a decline in overtime during economic slowdowns.

The total hours of work consist of two major components. The so-called standard hours are determined by the binding collective labor agreements in much of the Finnish economy. By contrast, overtime hours are determined at the individual level. However, this inherently institutional distinction of the total hours of work into standard and overtime hours does not shed a lot of light into the central issue in the determination of the total hours of work, because the discussion of labor market policies and outcomes is usually structured in terms of labor supply and demand. This means that it is highly relevant to investigate the relative importance of labor supply and demand factors for the variations of the total hours of work performed in the economy. The issue is especially important in Europe, where a large proportion of the labor force is suffering from unemployment.

We attempt in this paper to assess the scope for supply and demand factors in hours of work by studying micro-data. The data consist of a panel of workers and (some information) on their establishments from key manufacturing industries in Finland covering the years between 1989 and 1995. The data do not allow us to directly identify individual supply and demand they face. Instead, we use panel data methods to assess the relative importance of individual versus establishment/firm level effects in the variation of hours.

Insights into the factors behind fluctuations in hours of work, however indirect, are important, because policies to combat unemployment have in recent years focused almost exclusively on supply factors. Thus, practically all policies have been directed toward lowering the effective marginal tax rates, especially for low income workers, and to lowering reservation wages by reducing income transfers to the jobless. These efforts to increase labor supply have met with only modest success and, in the absence of any demand considerations, the policy prescription hitherto has been to apply more of the same.

2 Previous Related Studies

The research most relevant to an empirical assessment of the relative importance of labor supply and demand factors in the total hours of work can be divided into two groups. The first group consists of studies that have decomposed the total hours of work into various components. The second group consists of studies of the determinants of employment, either at the aggregate level, using bargaining

models, or on the micro level, modelling individual labor supply.

Hamermesh (1993) provides a summary of the empirical literature on the adjustment rates for hours and workers, wherein the first group of studies belongs. A typical finding in that literature is that the adjustment rate is more rapid for hours than for workers. This means that declines in hours precede declines in employment during economic downturns. Firms usually adjust to demand fluctuations primarily using overtime hours – sometimes called the *intensive margin* of labor utilisation in contrast to the *extensive margin* of labor utilisation – because of the presence of the quasi-fixed cost of employment, such as hiring and training costs and various employee benefits, that are related to employment but not to working hours.

Time series methods have been employed for decomposing aggregate hours. For example, Chang and Kwark (2001) use a structural Vector Auto Regression (VAR) model to study the behaviour of the monthly series of total hours in the United States from 1947:1 to 1997:1. They decompose the disturbances in total hours into three components: (i) disturbances that shift the steady-state level of hours, (ii) those that change the sectoral composition of employment in the long-run, and, finally, (iii) those that cause temporary movement of hours around the steady-state. According to their variance decomposition, disturbances which shift the steady-state level of hours account for three quarters of the cyclical fluctuations in aggregate hours.

However, the empirical literature has rarely focused on the relative importance of supply and demand factors for the total hours of work by using individual-level data. For example, Bianchi et al. (2001) study the labor supply response to income tax cuts in Iceland with no emphasis the potential role of labor demand in the changes in hours worked, despite the fact that the Icelandic economy experienced a strong upswing during the tax reforms. This is an issue of great importance, because empirical studies that neglect variations in labor demand may give biased estimates of the labor supply response to for instance tax reforms.

Agell and Meghir (1995) examine the wage elasticity of hours for men, in part to assess the hours impact of marginal tax rate cuts using individual-level data from Swedish manufacturing industries in the last quarter of every year from 1970 to 1987. They conclude that the 1991 tax reform in Sweden would unlikely have large effects on hours worked. While Agell and Meghir (1995) are most interested in labor supply, their data do permit at least indirectly an examination of demand.

The second group of the empirical studies we identified at the outset address the scope for raising employment levels by affecting supply side factors. For example, IMF (2001) and OECD (2001) stress in their recent country reports the notion that various incentive problems (i.e., determinants of labor supply) associated in particular with income transfers to the jobless, are the key reason for the

persistently high Finnish unemployment rate. Indeed, a chief reason for income tax reductions during the 1990s – for example, by expanding the earned income tax allowance – has been to induce labor supply responses (see Laine and Uusitalo, 2001; OECD, 2001).

Koskela (2002) summarises the theoretical and empirical literature that examines the effects of taxes on employment in a bargaining model framework, but does not treat demand for labor at length. The focus on the role of effective labor taxes and supply side bottlenecks for the variation in the hours of work seems to implicitly assume that any increase in supply can be absorbed by the labor market. Much of the available evidence is based on aggregate data that use the average tax wedge as an explanatory variable in the standard employment equation.[1] Empirical findings and the policy recommendations that flow from them tend to downplay the role of labor demand.

Indeed, the relative importance of supply and demand factors in accounting for the variation in the total hours of work is an empirical matter. Assuming, *a priori*, that there is an endless demand for labor seems premature, not least in light of the fact that the estimated labor supply elasticities tend to be small, at best. In order to get a fuller picture of the likely employment impact of supply-side reforms, it may be useful to know the extent to which hours variation is demand driven. The estimated labor supply elasticities for Finland, based on micro-data, that are summarised by Kuismanen (2001) provide some idea of how successful tax reforms will be in inducing supply responses. The estimated elasticities are typically very small, which conflicts with the view, popular in policy circles and based, for the most part, on aggregate evidence, that tax-transfer reform is the solution to current high level of unemployment in Finland.

3 Data

We examine hours worked in selected manufacturing industries in Finland from 1989 to 1995. The restriction to just a few manufacturing industries and to these years is driven by data restrictions. We use data that is obtained directly from the payroll records of the Confederation of Finnish Industry and Employers (*Teollisuus ja Työnantajat*, TT).[2] In order to follow the realization of collective bargaining agreements, TT gathers from its member companies highly detailed information on wages and salaries paid and the hours of work of blue-collar manufactur-

[1] Pehkonen and Kiander (1999) have recently studied the issue in Finland.

[2] Approximately 5 600 companies are members of the Confederation. These companies employ nearly 470 000 persons. The member companies account for more than 75 percent of the nation's industrial value added and export income.

ing workers.[3] Out of the TT's registers, researchers drew a sample of workers in five manufacturing industries in 1990, who were then traced in the registers backwards to 1980 and forward to 1995. To keep the panel representative in every cross-section, additional observations were drawn to replace those who attrited.[4] The data in each year consists of information in the fourth quarter on wages and salaries, broken down by type of pay, the hours associated with each type of pay and other individual level and establishment level variables. The data set consists of about 9000 individuals.

The data set originally covers the years from 1980 to 1995, but a major change in the coding of establishments occurred in 1989. For this reason, we examine primarily the period from 1989 to 1995. We must also note that we are not working with a complete linked employer-employee data, because we have but a few establishment level characteristics. On the other hand, since wages and hours are reported by employers, there should be little problem with measurement errors. The fact that we can examine wages and hours broken down by type of pay – enabling us, for instance, to look at overtime and Sunday work separately – is a great advantage that is not available in other Finnish data sources. Further, the data consists only of blue-collar workers. This restriction is less serious than it first seems, because white-collar workers typically have fixed weekly hours of work and receive little over time pay. The bulk of the variation in *paid* overtime occurs for blue-collar workers. Finally, the restriction to a few manufacturing industries is unfortunate, since there is little reason to think these are in any sense representative of the labor force, lacking, as they do, not only other manufacturing industries and service sectors but also the public sector, which accounts for a sizeable proportion of the total labor force. The reason why only five manufacturing industries were sampled is that these had the longest and most consistent data collections. The manufacturing industries included are: (i) metal industries, (ii) clothing industries, (iii) textile industries, (iv) manufacture of wood and wood and cork products, and (v) manufacture of paper and paper products.

The decomposition of the total hours of work presented in the next section of the paper assumes that employees can choose their hours of work freely without constraints given by employers. Ilmakunnas (1997) provides evidence that there exist some disparities in desired and actual hours of work in Finland. However, as Agell and Meghir (1995) point out, within data that contains information about the whole quarters, employees can vary their total hours of work by taking days or weeks off in addition to varying their hours per week.

The variables available to us are summarised in Table 1. Most of the selected

[3]Kettunen and Vartiainen (1993) provide a description of the data.

[4]In 1990, within each firm, the workers were sorted according to their salary and every 15th worker was drawn.

variables are (almost) self-evident. The variable HOURS is constructed by adding together time, piece-rate and overtime hours. The variable NEWCOMER captures the new employees in the manufacturing industries (and the variable LEAVER captures the employees that leave the manufacturing industries). It can be argued that the newcomers and the leavers are more volatile, i.e., they represent more loose matches between employees and establishments.

We do not have the detailed industry affiliation of the worker/establishment, but manufacturing workers sort under one of five industry-level collective bargaining agreements, which identifies the broad classification of industries we use. In addition, we can control for municipality, occupation and of course year. Controlling for year is the only way of taking the aggregate demand conditions into account, which is important since the period captures the deepest peace-time economic downturn in the recorded Finnish economic history (see Kiander and Vartia, 1996).

We show in Figure 1-3 the estimates of the average wage, total and average hours within the five manufacturing industries along with information from quarterly national accounts by Statistics Finland. The evolution of the industries over the period of investigation underlines the importance of the great slump of the early 1990s and the following export-led recovery from the depression.[5]

In Table 2, we show our estimates of the share of average hours per worker allocated to different type of work. Our data show, as do the aggregate data in Figures 1 to 3, a decline in hours per worker and a partial rebound by 1995. The share of overtime declined sharply from 1989 to 1991 and has since returned to pre-depression levels (see Böckerman, 2002). Time rate working hours have declined, with the increase being taken by piece rate, that is defined as a combination of piece and product rates. In 1995 Sunday work was at its highest level during the observation period.

4 Analysis

In this section, we start by examining the determinants of log hours of work, in particular their estimated wage elasticities (i.e., labor supply elasticities). We estimate simple regression models of the form

$$\ln h_{ijt} = X_{ijt}\beta + Z_{it}\delta + a_i + b_{ij} + \varepsilon_{ijt}, \tag{1}$$

where $\ln h$ is the natural logarithm of hours worked in the 4th quarter of each year t by worker i in the jth establishment, X is our set of individual level controls (age up to a 4th order polynomial, gender, a new worker or a leaving worker) and

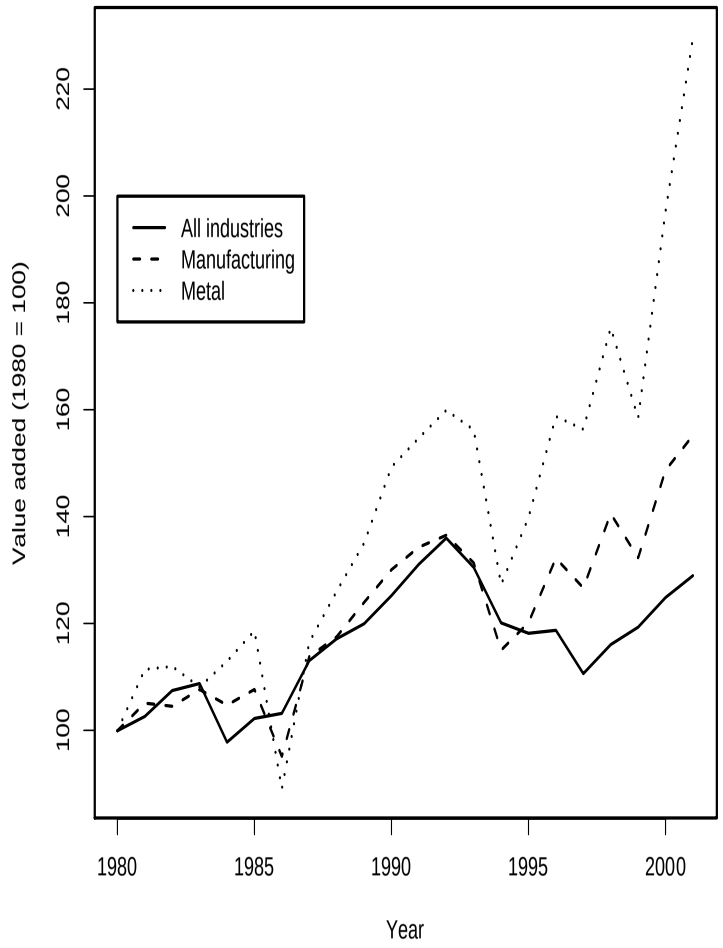
[5]The fi gures have not been seasonally adjusted.

Table 1 Variables

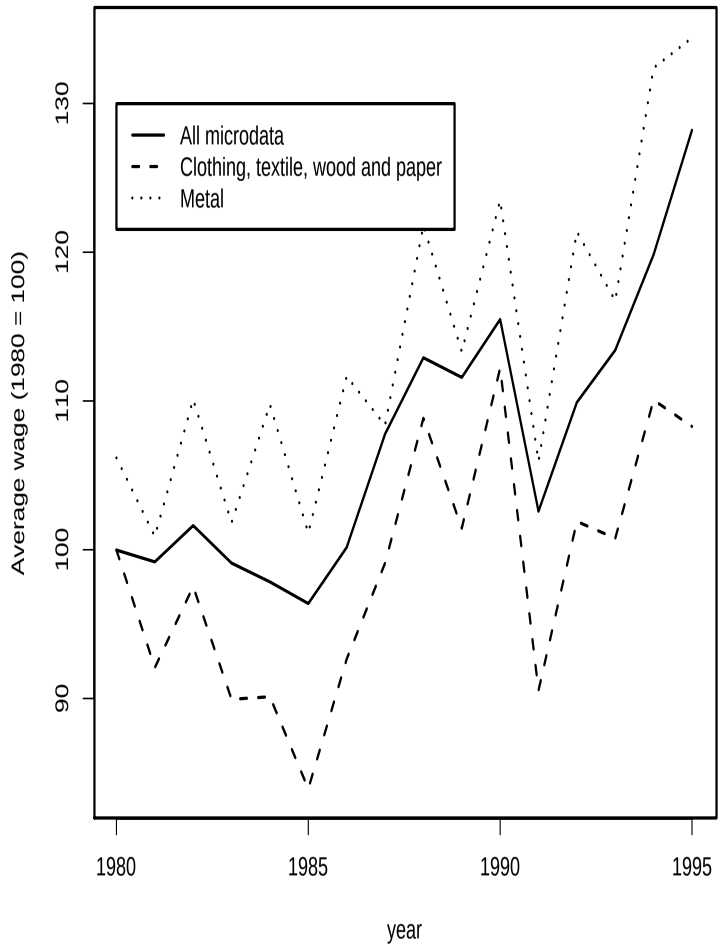
Variable	Definition/measurement
Individual-level characteristics	
hours	The hours of work during the quarter Time rate, piece rate, over time and Sunday hours
wage	The wages paid in the quarter Time rate, piece rate, over time, and Sunday wage as well as various wage supplements
age	Age of the employee
gender	1=female, 0=male
newcomer	Employee that was not in the manufacturing industries one year previously, 1=newcomer, 0 otherwise.
leaver	Employee who leaves the manufacturing industries between this year and the next, leaver=1, 0 otherwise
occupation	based on the classification of occupations by TT
Establishment-level characteristics	
size	Size of establishment measured by the number of employees
women	Share of women in the establishment
metropolitan	The collective agreements stipulate slightly higher pay in the metropolitan areas where the costs of living (such as housing) are presumably higher, a person is living in the metropolitan area=1, 0 otherwise
regions	Based on the municipalities in Finland
industries	Attached to employees based on the union code of an employee
Other	
years	from 1989 to 1995

Figure 1 Value added and wages in Finnish manufacturing industries – National Accounts and Micro data 1980-1995

National accounts



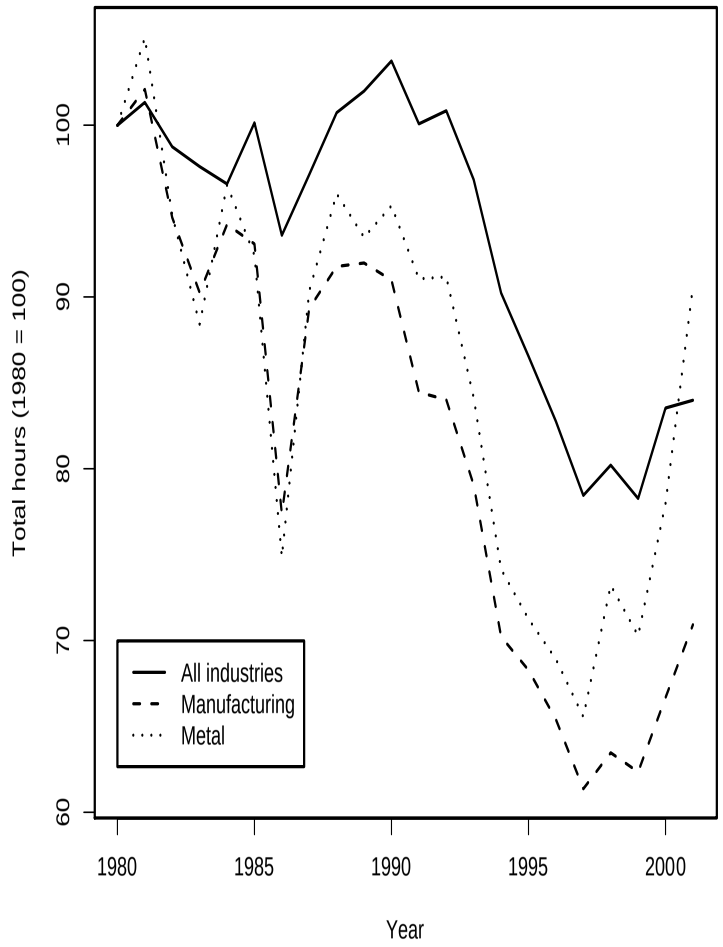
Micro data



Source: Quartely national accounts and authors' calculations from TT micro data.

Figure 2 Total hours in Finnish manufacturing industries – National Accounts and Micro data 1980-1995

National accounts



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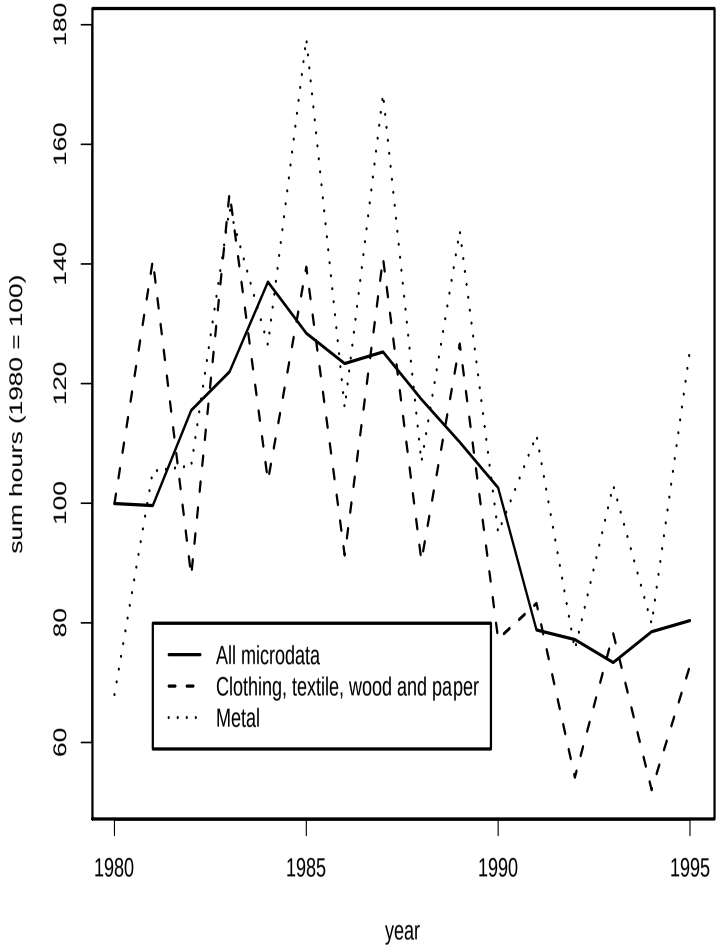
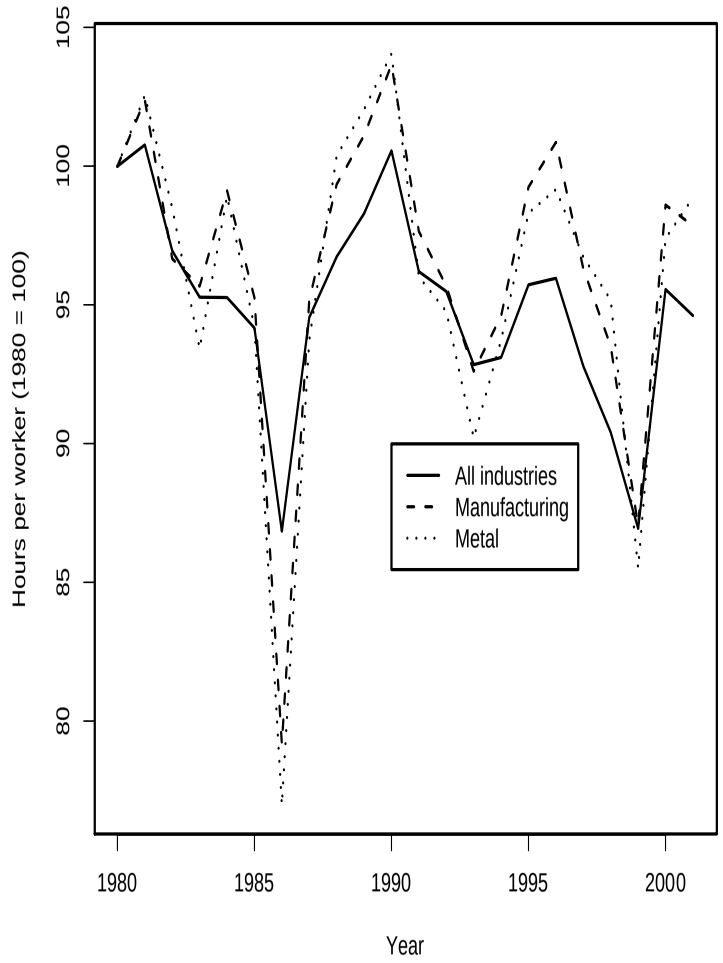


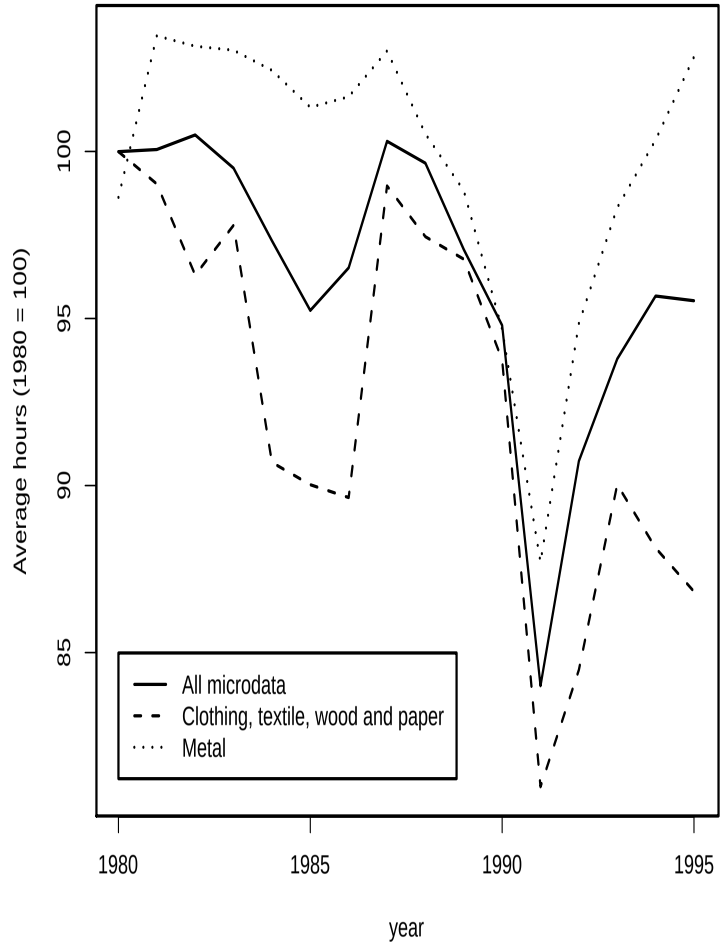
Source: Quartely national accounts and authors' calculations from TT micro data.

Figure 3 Hours per worker in Finnish manufacturing industries – National Accounts and Micro data 1980-1995

National accounts



Micro data



Source: Quartely national accounts and authors' calculations from TT micro data.

Table 2 Share of hours by type of pay

Year	Share of all hours				
	Time	Piece	Overtime	Sunday	All hours
1980	0.529	0.412	0.024	0.034	445
1981	0.529	0.417	0.024	0.031	445
1982	0.528	0.425	0.022	0.025	447
1983	0.519	0.436	0.021	0.024	443
1984	0.531	0.417	0.026	0.026	433
1985	0.519	0.426	0.028	0.028	424
1986	0.502	0.440	0.029	0.028	430
1987	0.488	0.452	0.032	0.028	446
1988	0.477	0.456	0.036	0.031	444
1989	0.480	0.453	0.032	0.034	432
1990	0.457	0.481	0.028	0.033	422
1991	0.484	0.465	0.020	0.032	374
1992	0.482	0.461	0.025	0.032	404
1993	0.442	0.491	0.031	0.036	417
1994	0.438	0.494	0.031	0.038	426
1995	0.437	0.489	0.032	0.041	425

Source: Authors' calculations from TT micro data.

Table 3 The wage elasticity of hours

OLS	Estimate	Std. Error
Panel A. 1980-1995		
All	0.032	0.008
Women	0.109	0.016
Men	0.006	0.010
Panel B. 1989-1995		
All	-0.058	0.013
Women	-0.001	0.027
Men	-0.074	0.015

Note: Dependent variable is the natural logarithm of hours and the wage is the natural logarithm of the wage rate. Estimates are obtained by OLS. Other controls include age up to a 4th order polynomial, gender, industry, metropolitan area, establishment size, proportion women, new worker, leaving worker and year dummies. Full regressions are shown in the appendix.
Source: Authors' calculations from TT micro data.

Z is our set of establishment level controls (establishment size, the proportion of women, year, industry and metropolitan area).[6] The random intercepts a and b are associated with individuals and establishments and allow an assessment of the sources of variation – individual or establishment level – in $\ln h$ that is not captured by the controls included.[7]

We start by showing the estimates of the wage elasticity of labor supply based on the data for two periods, the full 1980 to 1995 and 1989 to 1995, estimated using OLS (Table 3). The latter period is used in the remainder of the paper, because there was a major change in the coding of establishments in 1989. Interestingly, the point estimates in the longer period are positive (but statistically indistinguishable from zero for men) but they are negative in the shorter period.

We show in Figure 4 the estimated density functions of ln hours and ln wages.

[6] Equation 1 is known as a linear mixed effects model (Pinheiro and Bates, 1999) or, e.g., as a multi-level or hierarchical model. We estimate the parameters using the `lme` function in R, see Pinheiro and Bates (1999) and Ihaka and Gentleman (1996).

[7] The error components in equation 1 as it is written assume the variation of individuals to be within establishments. Since some workers are observed at several establishments, it is possible to estimate models with errors "within" workers across establishments. However, while possible, we think this does not make a lot of sense. Finally, it is in principle possible to relax the assumption that worker and establishment effects are uncorrelated to allow, e.g., assortative matching of establishments and workers on unobserved characteristics. However, given the relatively small amount of persons who are observed across multiple establisments, the covariances are very weakly identifi ed and possibly selectively observed.

The upper panel, showing the distribution of wages, shows a tendency to move both to the right and to contract across the years. The distribution of ln hours, on the other hand, has first shifted left and the back right again (but not all the way), while its dispersion seems to be larger in the mid 1990s than in 1989. This means that the decline and partial rebound in hours worked has been accompanied by an increase in dispersion. Given that the dispersion in the wage rates has declined, it would seem that there is less scope for wage capturing hours variation in 1995 than in 1989.

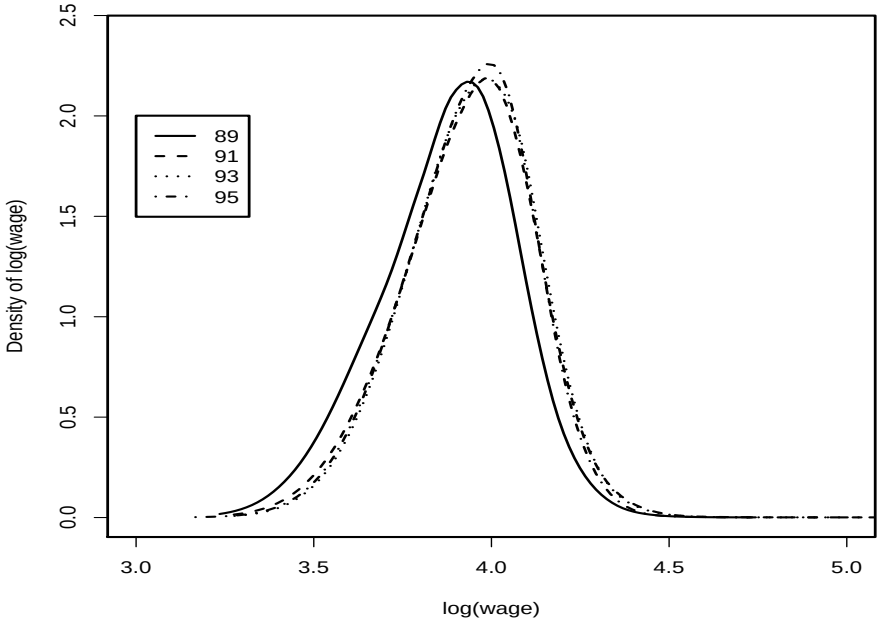
The annual non-parametric regressions of ln hours on ln wages, shown in Figure 5, may explain part of why the wage elasticities in Table 3 are negative from 1989 to 1995. Namely, while for low wages, where the density of wages is highest (see upper panel, Figure 4), hours increase moderately with wages, the conditional mean curve declines rather steeply at higher levels. Broadly speaking, this is consistent with the backward-bending labor supply curve. Note, however, that we have no controls in Figure 5. Thus, the least-squares estimates seem to be driven by a group of outlying observations in the south-east corner of Figure 5.

While the non-parametric regressions suggest that a log-linear formulation of the hours equation may be inappropriate, we proceed to regress each components of hours – hours paid by time rate, piece rate, overtime and Sunday work in order to get a somewhat more detailed picture of the elasticities. This means that the "wage elasticity" is with respect to the pay in that particular mode. The other controls are those described for equation 1, namely age up to a 4th order polynomial, gender, industry, metropolitan area, establishment size and proportion women, new worker, leaving worker and year dummies. It is possible, of course, to estimate the cross elasticities (e.g., the elasticity of time pay hours to the overtime wage rate).

We show in Table 4 the estimated wage elasticities from 1989 to 1995. The absolute magnitudes of these estimates are very large, but all except that for overtime are negative. Overtime work seems to strongly respond to the overtime wage rate, based on the Finnish evidence. However, it is possible that these point estimates are being driven by non-linearities and outliers, as suggested by the shape of the conditional mean function for overall hours as shown in Figure 5. In addition, a bias to the elasticities may be induced by the selectivity of blue-collar manufacturing workers into particular pay modes, because the elasticities are estimated conditional on receiving those particular pay modes.

We proceed next to assess the impact of unobserved worker and establishment effects on the total hours of work. Equation 1 has two levels of random effects. One, labelled a, which is associated with workers and another, b which is associated with establishments. Our regressors include both individual- and establishment-level covariates. It is difficult to quantitatively assess the relative contribution of each set of regressors to the total variation in hours (the statistical

Figure 4 Density estimates of ln hours and ln wages in selected industries 1989–1995



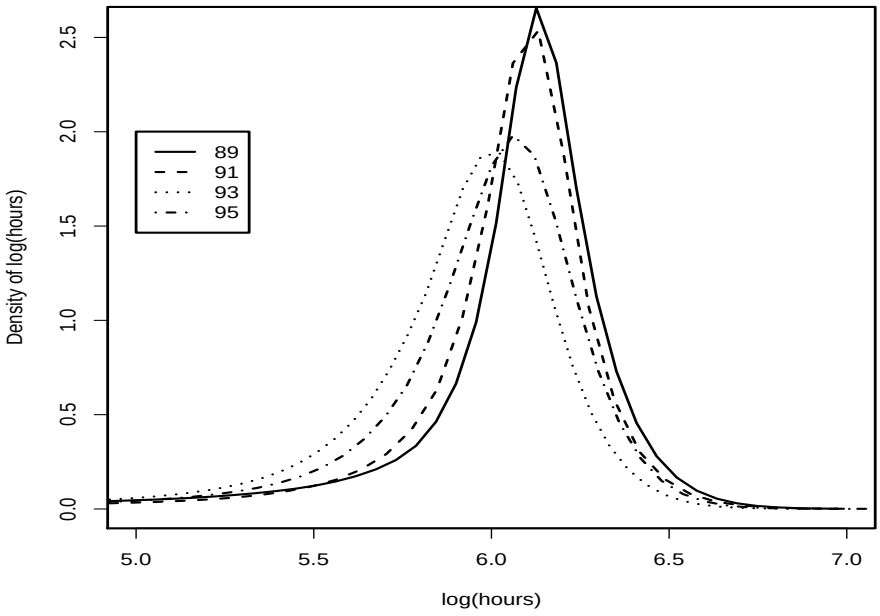


Figure 5 Hours worked conditional on the wage rate – non-parametric conditional expectations 1989–1995

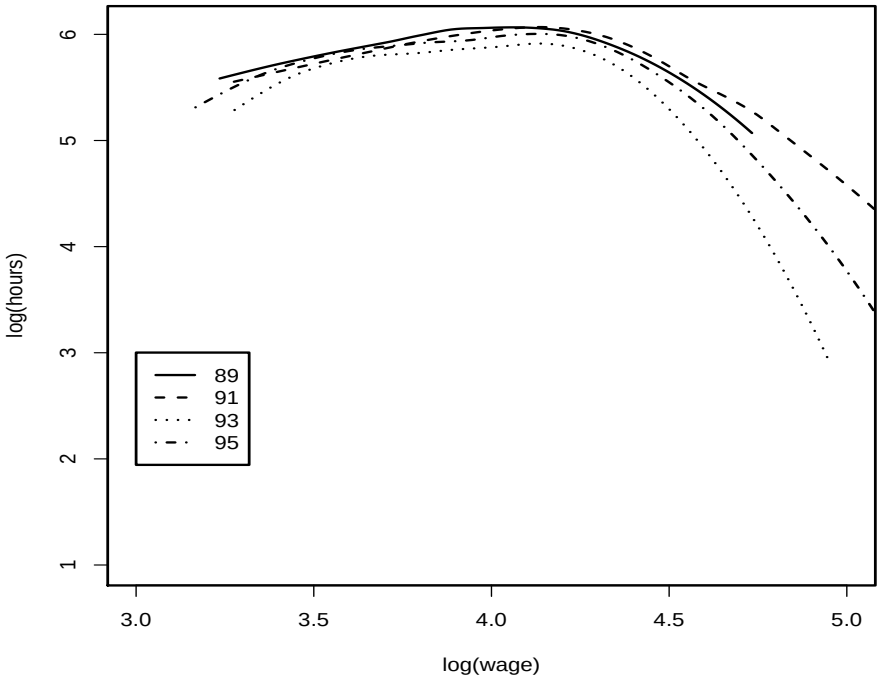


Table 4 The wage elasticity of hours by type of pay

A. OLS estimates		
Type of pay	Estimate	Std Error
Time	-1.065	0.050
Piece	-1.208	0.026
Overtime	1.144	0.022
Sunday	-0.619	0.023
B. `lme` estimates		
Type of pay	Estimate	Std Error
Time	-0.931	0.054
Piece	-1.281	0.032
Overtime	1.182	0.022
Sunday	-0.357	0.024

Note: Dependent variable is the natural logarithm of the relevant type of hours and the wage is the natural logarithm of the relevant wage rate. Estimates are obtained by OLS and lme. Other controls include age up to a 4th order polynomial, gender, industry, metropolitan area, establishment size, proportion women, new worker, leaving worker and year dummies. The full regression results are shown in the appendix.
Source: Authors' calculations from TT micro data.

Table 5 Decomposition of error variance – worker and establishment effects

A. Dependent: Overall hours

Estimated model	**Individual**	**Establishment**	**Residual**
	σ_a^2	σ_b^2	σ_ε^2
Ind. effect	0.072	NA	0.142
Est. effect	NA	0.022	0.178
Est/Ind effect	0.049	0.030	0.135

B. Dependent: Hours by type of pay

Type of pay	**Individual**	**Establishment**	**Residual**
	σ_a^2	σ_b^2	σ_ε^2
Time	0.409	1.298	0.735
Piece	0.103	0.437	0.307
Overtime	0.053	0.327	0.871
Sunday	0.051	0.483	0.265

Note: The dependent variable is the natural logarithm of of hours (Panel A) or the ln of hours for that pay mode (Panel B). Estimates obtained by `lme`, see Pinheiro and Bates (1999). Controls include age up to a 4th order polynomial, gender, industry, metropolitan area, establishment size, proportion women, new worker, leaving worker and year dummies. The full regression results are shown in the appendix.
Source: Authors' calculations from TT micro data.

significance of each set of regressors is of course easily testable by e.g. anova and is beyond doubt in this case). We focus instead on the unexplained part of the variation. The error term in equation 1 is a fairly standard variance component model, with three components, assumed to be orthogonal. Their variances can be estimated and the relative contribution of either unobserved worker or establishment characteristics to the overall unobserved variance can be assessed. The results are shown in Table 5.

The first row of Table 5 in panel A shows the variance components when we ignore the establishment level and only include an individually varying random effect. The second row shows the result of including only the firm level. Statistical tests strongly suggest that the model with both components is superior to that with either only a worker or only an establishment effect. The numbers in the third row suggest that establishment level factors, unaccounted for in our analysis, are almost as important for the overall variance as are individually varying unobserved effects. The remainder is accounted for by the white-noise disturbances. The results reported in Table 5 in panel B show that the establishment level random effects are, especially, overwhelmingly more important for the overall variance

than the worker effects for overtime and sunday work.

5 Conclusions

We argue that it is a mistake to focus the discussion that addresses employment policies on only labor supply. One explanation for the limited success of supply-side changes of e.g. tax and transfer rules, intended to boost labor supply, may be that labor demand is dormant. This paper has examined the role of supply and demand factors in individual-level hours of work by using panel data on workers in Finnish manufacturing industries from 1989 to 1995.

The total hours of work have declined from 1980 to 1995, with a large decline between 1989 and 1995. The decline was largest for overtime work during the slump, but time rate work declined as well. By 1995, average working hours were quite close to 1989 levels, but their dispersion was clearly larger. The distribution of wages, by contrast, has both moved to the right and become less dispersed, which suggests that wages will likely to be less important determinants of hours of work than before. The estimated wage elasticities are positive when considering the whole period from 1980 to 1995, but they are negative or zero when restricting interest between 1989 and 1995. This is revealed by non-parametric regression to be driven in large part by outlying observations. Analysis of the constituent parts of hours, separated by the type of pay they receive, suggest, in turn, that although most wage elasticities are negative, overtime seems to strongly positively respond to wage increases.

Finally, we estimate the extent to which variation in hours is associated – in addition to observed worker and establishment characteristics – with random effects on the worker or the firm level. The results suggest that both kinds of effects are present, and establishment effects account for a substantial part of the overall variance.

Our results can be interpreted to say that demand matters. It should be noted, however, that supply-side reforms are often directed at making the discrete choice by a worker to participate in the labor market. The workers in our sample have, for the most part, a strong attachment to the labor force. Extending the analysis of participation in the labor market to include demand-side factors is an important challenge for the future work.

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Table 6 Regressions of log(hours) on wages and covariates – OLS regressions

lm	**1980-95**			**1989-95**		
	All	Women	Men	All	Women	Men
(Intercept)	5.4 (0.14)	6.6 (0.26)	4.9 (0.16)	5.3 (0.26)	6.3 (0.53)	4.9 (0.3)
log(wage/hours)	0.032 (0.0082)	0.11 (0.016)	0.0062 (0.0096)	−0.058 (0.013)	−0.00068 (0.027)	−0.074 (0.015)
age	0.046 (0.015)	−0.12 (0.029)	0.1 (0.018)	0.086 (0.028)	−0.053 (0.058)	0.13 (0.033)
age^2/10	−0.0099 (0.0062)	0.051 (0.012)	−0.032 (0.0073)	−0.026 (0.011)	0.026 (0.023)	−0.042 (0.013)
age^3/100	0.00054 (0.0011)	−0.0091 (0.002)	0.004 (0.0013)	0.0033 (0.002)	−0.0048 (0.004)	0.0058 (0.0023)
age^4/1000	$2.4e-05$ ($6.7e-05$)	0.00058 (0.00012)	−0.00018 ($8e-05$)	−0.00015 (0.00012)	0.00031 (0.00025)	−0.0003 (0.00014)
GenderFemale	−0.055 (0.0031)	NA	NA	−0.071 (0.0051)	NA	NA
ordered(year)81	0.0077 (0.0067)	0.0062 (0.013)	0.008 (0.0077)	NA	NA	NA
ordered(year)82	0.016 (0.0065)	−0.0039 (0.013)	0.022 (0.0075)	NA	NA	NA
ordered(year)83	0.00053 (0.0064)	−0.012 (0.012)	0.0033 (0.0075)	NA	NA	NA
ordered(year)84	−0.014 (0.0062)	−0.016 (0.012)	−0.017 (0.0073)	NA	NA	NA
ordered(year)85	−0.047 (0.0062)	−0.05 (0.012)	−0.049 (0.0073)	NA	NA	NA
ordered(year)86	−0.039 (0.0063)	−0.051 (0.012)	−0.037 (0.0074)	NA	NA	NA
ordered(year)87	−0.00077 (0.0064)	−0.028 (0.012)	0.0081 (0.0075)	NA	NA	NA
ordered(year)88	−0.0093 (0.0065)	−0.048 (0.012)	0.0046 (0.0076)	NA	NA	NA
ordered(year)89	−0.044 (0.0066)	−0.082 (0.013)	−0.03 (0.0077)	NA	NA	NA
ordered(year)90	−0.062 (0.0067)	−0.13 (0.013)	−0.036 (0.0079)	−0.015 (0.0064)	−0.047 (0.012)	−0.0031 (0.0074)
ordered(year)91	−0.2 (0.0069)	−0.2 (0.014)	−0.2 (0.0081)	−0.16 (0.0066)	−0.12 (0.013)	−0.17 (0.0077)
ordered(year)92	−0.11 (0.0071)	−0.16 (0.014)	−0.099 (0.0082)	−0.071 (0.0068)	−0.079 (0.013)	−0.07 (0.0078)
ordered(year)93	−0.1 (0.0073)	−0.1 (0.014)	−0.11 (0.0084)	−0.061 (0.007)	−0.022 (0.014)	−0.075 (0.008)
ordered(year)94	−0.071 (0.0072)	−0.096 (0.015)	−0.065 (0.0084)	−0.022 (0.0069)	−0.0075 (0.014)	−0.029 (0.0079)
ordered(year)95	−0.11 (0.0074)	−0.16 (0.015)	−0.094 (0.0085)	−0.053 (0.0071)	−0.062 (0.014)	−0.052 (0.0081)
UnionTextile	0.011 (0.0068)	0.0039 (0.0077)	0.054 (0.025)	0.036 (0.012)	0.028 (0.014)	0.068 (0.044)
UnionMetal	0.013 (0.0055)	0.016 (0.0064)	0.04 (0.023)	0.067 (0.01)	0.059 (0.013)	0.089 (0.042)
UnionWood	−0.041 (0.006)	−0.069 (0.0083)	−0.0064 (0.023)	0.038 (0.011)	−0.00076 (0.016)	0.068 (0.042)
UnionPaper	−0.081 (0.0059)	−0.11 (0.0082)	−0.046 (0.023)	−0.036 (0.011)	−0.071 (0.016)	−0.0071 (0.042)
Metro1	−0.007 (0.0026)	−0.0087 (0.0049)	−0.0061 (0.0031)	−0.026 (0.0042)	−0.011 (0.0086)	−0.03 (0.0048)
entrant	−0.084 (0.0036)	−0.075 (0.0062)	−0.087 (0.0044)	−0.14 (0.0064)	−0.13 (0.012)	−0.14 (0.0076)
leaver	−0.3 (0.0033)	−0.29 (0.0058)	−0.31 (0.004)	−0.3 (0.0058)	−0.3 (0.01)	−0.3 (0.007)
n	150231	43566	106665	56086	15163	40923
k	29	28	28	20	19	19
σ	0.44	0.44	0.43	0.44	0.46	0.43
$\overline{R^2}$	0.094	0.088	0.093	0.092	0.088	0.088

Table 7 Regressions of log(hours) on wages and covariates – linear mixed effects models

lme	Ind. effect	Est. effect	Est/Ind effect	Ind/Est effect
(Intercept)	5.77 (0.31)	5.62 (0.257)	5.77 (0.313)	5.92 (0.296)
age	0.103 (0.0343)	0.0682 (0.028)	0.105 (0.0347)	0.08 (0.0325)
age^2/10	−0.0311 (0.0139)	−0.0176 (0.0112)	−0.032 (0.014)	−0.0212 (0.0131)
age^3/100	0.00412 (0.0024)	0.0018 (0.00194)	0.00425 (0.00242)	0.00233 (0.00227)
age^4/1000	−0.000204 (0.000151)	$-5.48e-05$ (0.000121)	−0.000211 (0.000152)	$-8.76e-05$ (0.000142)
GenderFemale	−0.103 (0.00773)	−0.0929 (0.00541)	−0.105 (0.00773)	−0.113 (0.00706)
log(wage/hours)	−0.254 (0.0172)	−0.112 (0.0155)	−0.261 (0.0173)	−0.236 (0.0176)
ordered(year)90	−0.0122 (0.00566)	−0.00828 (0.00653)	−0.0112 (0.00564)	−0.00747 (0.00596)
ordered(year)91	−0.155 (0.00594)	−0.138 (0.00703)	−0.151 (0.00597)	−0.138 (0.00647)
ordered(year)92	−0.0734 (0.00615)	−0.0514 (0.00736)	−0.07 (0.0062)	−0.0547 (0.00682)
ordered(year)93	−0.0613 (0.00636)	−0.0418 (0.00764)	−0.0571 (0.00642)	−0.0417 (0.00712)
ordered(year)94	−0.0191 (0.00641)	−0.00228 (0.00759)	−0.0155 (0.00648)	−0.00183 (0.00715)
ordered(year)95	−0.0354 (0.00672)	−0.0278 (0.00784)	−0.0315 (0.00678)	−0.0198 (0.00748)
UnionTextile	0.0366 (0.0177)	0.00477 (0.0222)	0.0359 (0.0178)	0.00746 (0.0238)
UnionMetal	0.103 (0.0146)	0.0346 (0.0182)	0.102 (0.0147)	0.0637 (0.0197)
UnionWood	0.062 (0.0161)	0.0108 (0.021)	0.0631 (0.0162)	0.0327 (0.0225)
UnionPaper	0.00468 (0.0159)	−0.105 (0.0221)	0.00784 (0.016)	−0.0677 (0.0236)
Metro1	−0.0326 (0.00652)	−0.0395 (0.0103)	−0.0351 (0.00655)	−0.0433 (0.011)
sizeestab	0.000724 ($8.12e-05$)	0.00153 (0.000216)	0.000771 ($8.37e-05$)	0.00186 (0.000212)
womenestab	0.000154 (0.000124)	0.000102 (0.000143)	0.000186 (0.000125)	$4.04e-05$ (0.000139)
entrant	−0.126 (0.00638)	−0.13 (0.00643)	−0.125 (0.00637)	−0.124 (0.0064)
leaver	−0.272 (0.00571)	−0.291 (0.00582)	−0.271 (0.00571)	−0.276 (0.00576)
n	55914	55914	55914	55914
σ	0.376	0.422	0.368	0.372
logLik	-3.2e+04	-3.21e+04	-3.19e+04	-3.15e+04
AIC	6.41e+04	6.43e+04	6.39e+04	6.31e+04

Table 8 Regressions of log(hours) on wages and covariates – OLS

lm	Time	Piece	Overtime	Sunday
(Intercept)	8.79 (0.963)	7.93 (0.631)	−3.26 (0.984)	5.61 (0.936)
wtime	−1.07 (0.0504)	NA	NA	NA
age	−0.0215 (0.106)	0.192 (0.0694)	0.229 (0.109)	−0.0349 (0.102)
$age^2/10$	0.0234 (0.0427)	−0.0578 (0.0279)	−0.0975 (0.0439)	0.0191 (0.0411)
$age^3/100$	−0.00559 (0.00737)	0.00737 (0.0048)	0.0175 (0.00758)	−0.00358 (0.0071)
$age^4/1000$	0.000427 (0.000463)	−0.000325 (0.000301)	−0.00115 (0.000477)	0.000217 (0.000447)
GenderFemale	−0.472 (0.0201)	−0.2 (0.0123)	0.0599 (0.0202)	−0.204 (0.0176)
ordered(year)90	−0.0205 (0.0238)	0.0556 (0.015)	−0.15 (0.0228)	0.041 (0.0207)
ordered(year)91	0.00479 (0.0249)	−0.0938 (0.0157)	−0.311 (0.0259)	0.000503 (0.0226)
ordered(year)92	0.0483 (0.0256)	−0.0175 (0.0162)	−0.159 (0.0253)	−0.00396 (0.0223)
ordered(year)93	−0.0131 (0.0266)	0.0665 (0.0165)	−0.0843 (0.0247)	0.0436 (0.022)
ordered(year)94	−0.0196 (0.0259)	0.137 (0.0163)	−0.111 (0.0242)	0.0723 (0.0211)
ordered(year)95	0.0845 (0.0269)	0.181 (0.0165)	−0.159 (0.0247)	0.133 (0.021)
UnionTextile	0.452 (0.0429)	0.0524 (0.0296)	0.174 (0.0627)	−0.405 (0.139)
UnionMetal	0.143 (0.0346)	0.279 (0.0235)	0.329 (0.0523)	−0.0884 (0.135)
UnionWood	−0.223 (0.0395)	0.214 (0.0249)	0.115 (0.0549)	−0.0558 (0.137)
UnionPaper	0.613 (0.0386)	0.289 (0.0255)	−0.247 (0.0547)	0.497 (0.135)
Metro1	−0.121 (0.0155)	−0.103 (0.0111)	−0.0957 (0.0154)	−0.0253 (0.0141)
sizeestab	−0.000378 (0.000245)	0.00279 (0.000119)	−0.00203 (0.000189)	0.00572 (0.000144)
womenestab	−0.00129 (0.000428)	−0.00204 (0.000282)	0.00182 (0.00045)	−0.00222 (0.000436)
entrant	0.0354 (0.0232)	−0.21 (0.0158)	0.134 (0.0231)	−0.0675 (0.0229)
leaver	−0.0942 (0.0212)	−0.341 (0.0141)	−0.0993 (0.0235)	−0.188 (0.0232)
wpiece	NA	−1.21 (0.0259)	NA	NA
wover	NA	NA	1.14 (0.0216)	NA
wsun	NA	NA	NA	−0.619 (0.0234)
n	40310	33466	26135	20309
k	22	22	22	22
σ	1.42	0.805	1.1	0.846
$\overline{R^2}$	0.0447	0.111	0.14	0.236

Table 9 Regressions of log(hours) on wages and covariates – linear mixed effects models

lme	Time	Piece	Overtime	Sunday
(Intercept)	9.3 (1.05)	8.26 (0.747)	−3.56 (1.05)	2.58 (1.01)
wtime	−0.931 (0.0542)	NA	NA	NA
age	−0.133 (0.116)	0.173 (0.0826)	0.254 (0.117)	0.174 (0.109)
age^2/10	0.0611 (0.047)	−0.0496 (0.0333)	−0.109 (0.0474)	−0.0685 (0.0441)
age^3/100	−0.0109 (0.00815)	0.00597 (0.00577)	0.0196 (0.00822)	0.0118 (0.00764)
age^4/1000	0.000694 (0.000512)	−0.000245 (0.000363)	−0.00128 (0.000518)	−0.000749 (0.000482)
GenderFemale	−0.437 (0.0277)	−0.188 (0.0184)	0.0709 (0.0231)	−0.143 (0.0238)
ordered(year)90	−0.0826 (0.0163)	0.041 (0.0118)	−0.161 (0.0211)	−0.0227 (0.0149)
ordered(year)91	−0.0916 (0.0178)	−0.132 (0.013)	−0.359 (0.0245)	−0.124 (0.0169)
ordered(year)92	−0.069 (0.0188)	−0.0576 (0.0137)	−0.197 (0.0241)	−0.113 (0.0171)
ordered(year)93	−0.106 (0.0198)	0.0162 (0.0142)	−0.125 (0.0238)	−0.0451 (0.0175)
ordered(year)94	−0.121 (0.02)	0.0914 (0.0143)	−0.16 (0.0237)	−0.0024 (0.0174)
ordered(year)95	−0.0418 (0.0215)	0.148 (0.0148)	−0.209 (0.0244)	0.0576 (0.0178)
UnionTextile	0.407 (0.0597)	0.058 (0.0452)	0.164 (0.0699)	−0.348 (0.208)
UnionMetal	0.179 (0.0483)	0.303 (0.0348)	0.324 (0.0577)	0.0479 (0.203)
UnionWood	−0.188 (0.06)	0.219 (0.0397)	0.0913 (0.0632)	0.16 (0.205)
UnionPaper	0.598 (0.06)	0.353 (0.041)	−0.332 (0.0627)	0.729 (0.203)
Metro1	−0.169 (0.0249)	−0.111 (0.0181)	−0.0952 (0.0198)	−0.0874 (0.0221)
sizeestab	−0.00184 (0.000371)	0.00314 (0.000246)	−0.0014 (0.000284)	0.0045 (0.000281)
womenestab	−0.00101 (0.00037)	−0.00142 (0.000285)	0.00084 (0.000485)	−0.000201 (0.000448)
entrant	0.0416 (0.0189)	−0.143 (0.0144)	0.144 (0.0224)	0.00432 (0.02)
leaver	−0.082 (0.0173)	−0.278 (0.0128)	−0.0873 (0.0228)	−0.108 (0.02)
wpiece	NA	−1.28 (0.0319)	NA	NA
wover	NA	NA	1.18 (0.0224)	NA
wsun	NA	NA	NA	−0.357 (0.0235)
n	40310	33466	26135	20309
σ	0.857	0.554	0.933	0.514
logLik	-6.32e+04	-3.68e+04	-3.88e+04	-2.2e+04
AIC	1.27e+05	7.36e+04	7.76e+04	4.41e+04