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New evidence on implicit contracts from linked employer-employee data

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Juha Kilponen – Torsten Santavirta

New evidence on implicit contracts from linked employer-employee data

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New evidence on implicit contracts from linked employer-employee data

The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Bank of Finland or the European Central Bank.

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New evidence on implicit contracts from linked employer-employee data

Bank of Finland Research
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Abstract

We improve the precision of the test of the implicit contract model that Beaudry and DiNardo proposed twenty years ago. Our data set allows us to define the precise industry and plant of a particular employment relationship, link local labour market characteristics and company characteristics to the individual level of wages, and control for composition effects. We find evidence in favour of the spot market model of wage setting in the whole sample, but there is significant variation across industries and educational levels. In particular, the spot market matters most for low-skill workers, while the implicit contract model with one-sided limited commitment applies better to high-skill workers.

Keywords: wage cyclicality, limited commitment, match-specific fixed effects

JEL classification numbers: E32, J41, J64

Implisiittisten palkkasopimusten tarkastelua yhdistetyllä työntekijä-työnantaja-aineistolla

Suomen Pankin keskustelualoitteita 12/2010

Juha Kilponen – Torsten Santavirta
Rahapolitiikka- ja tutkimusosasto

Tiivistelmä

Tässä keskustelualoitteessa tarkastellaan työntekijän ja työnantajan välisiä implisiittisiä sopimuksia palkan asetannassa. Tutkimuksessa käytetään Beaudryn ja DiNardon parikymmentä vuotta sitten kehittämän palkkamallin testiä, jonka tarkkuutta pyritään parantamaan aikaisempaan tutkimukseen verrattuna. Tutkimusaineiston avulla on mahdollista tunnistaa kunkin työsuhteen toimiala, toimipaikka ja alue luotettavasti, jolloin yksilötason palkan määräytymistä voidaan pyrkiä selittämään tarkentuvasti paikallisella työttömyysasteella ja yritystason muuttujilla. Luotettavasti mitattu työsuhteen pituus mahdollistaa myös suhdannevaihtelusta johtuvan työntekijöiden ja työnantajien kohtaannon vaihtelun vakioimisen. Tulokset osoittavat, että nykyinen työmarkkinatilanne selittää suuremman osan palkan vaihtelusta kuin työsuhteen aikana aikaisemmin vallinnut markkinatilanne. Tuloksissa on kuitenkin merkittäviä eroja koulutustaso- ja toimialakohtaisten osaotosten välillä. Matalapalkka-aloilla palkka määräytyy pääosin nykyisen työmarkkinatilanteen mukaan, kun taas korkeasti koulutetut työntekijät näyttäisivät sitoutuvan noudattamaan neuvoteltua palkkasopimusta yksipuolisesti.

Avainsanat: palkkamallit, implisiittiset sopimukset, suhdannevaihtelut

JEL-luokittelu: E32, J41, J64

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1 Introduction

Beaudry and DiNardo (1991) test empirically whether past labor market conditions have persistent effects on workers' wages during a job spell using US data. They estimate a wage equation that encompasses three wage-setting models: spot market, in which wages are determined by the current labor market conditions; a full-commitment model, in which wages are determined by the labor market conditions at the time the worker was hired; and a one-sided limited commitment model in which wages are related to the most favorable labor market conditions since the worker was hired. The latter two commitment models of wage setting are motivated by implicit contract literature.[1] Beaudry and DiNardo (1991) find the strongest evidence for the one-sided limited commitment model. A number of follow ups have attempted to enhance the understanding of implicit contracts but the results are so far inconclusive.[2] Recent evidence shows that improving the quality of the control vector may markedly reduce the explanatory power of the one-sided limited commitment model and shift the emphasis towards the spot market model.[3]

In this paper, we exploit a new linked employer-employee data set[4] from Finland to shed new light on the importance of implicit contracts in wage setting. We improve the precision of the test of the implicit contract model proposed by Beaudry and DiNardo (1991) in a number of ways. The data set allows us to define the exact industry and plant of a particular employment relationship and link local labor market characteristics (unemployment rate is measured at county level, ie, a worker's realistic go-to-work area) and firm characteristics to individual level wages. The key observable variables, such as wages and tenure, are derived directly from the employers' personnel records. Hence, they are likely to be more reliable than the corresponding survey answers by the employee. A reliable tenure variable not only improves the quality of the tenure control, but also purges the measurement error from the backward looking labor market links in the estimating equation. It also allows for testing the robustness of our results by controlling for match-specific fixed effects. Gertler and Trigari (2009) point out in a recent paper that if the match quality varies across jobs, omitted variable bias will contaminate the estimates for local labor market conditions unless match-specific fixed effects are allowed for. We also provide novel disaggregated results by educational level.

[1] Theoretically wage persistence is motivated by implicit contracts that insure workers against wage declines (See eg Harris and Holmström 1982, Thomas and Worrall, 1988, 2007, Beaudry and DiNardo, 1991).

[2] In addition to Beaudry and DiNardo (1991), the extent of implicit contracting has been tested empirically in Grant (2003), Bertrand (2004), and Schmieder and von Wachter (2010) using US data, McDonald and Worswick (1999) using Canadian data, Seltzer and Merret (2000) using Australian data, and Hart and Devereaux (2007) using UK data. Implicit contracts are also studied by Haefke, Sonntag, and van Rens (2007) and Gertler and Trigari (2009) by comparing the wage cyclicality of new hires to that of ongoing contracts.

[3] Gertler and Trigari (2009) and Gertler, Huckfeldt, and Trigari (2008) raise the importance of reliable tenure controls and correct specification of the fixed effect model in estimating the Beaudry and DiNardo specification.

[4] Our data contain the complete population of blue collar workers for each member firm of *Elinkeinoelämän Keskusliitto*, the largest employer confederation in the country, between 1989 and 2004. There are 952,218 individual/year cells for 200,984 individuals in the data.

Overall, our results show that the spot market matters the most in the wage setting. The coefficient on current unemployment rate enters significantly at conventional levels with a negative sign in all specifications. Under the assumption that qualitative improvements of the data in relation to previous studies, ie, the use of more disaggregated measures of labor market conditions and more reliable measures of tenure and past labor market conditions, reduce attenuation bias, our results suggest that little implicit contracting is taking place in the wage setting in Finland.[5] While our results are robust across different wage measures, we find significant variation across skill levels. Low-skill workers' wages are primarily set at the spot market, while high-skill workers' individual wage patterns suggest that implicit contracts with limited commitment is a feature of the wage setting. Furthermore, we find clear evidence that the individual's wages are more responsive to the past states of the economy during the job spell for high-skill workers.

Direct comparisons between our results and the ones obtained using data from other countries, eg, US data, are complicated by differences in the labour market institutions such as the levels of unemployment insurance (UI) and union involvement in the wage setting. Rudanko (2009) shows that more extensive UI can both tighten the link between wage changes and productivity and increase the volatility of unemployment in the Mortensen-Pissarides matching framework.[6] This occurs in a situation where firms and workers sign optimal long-term wage contracts but cannot fully commit to the contract. Wages become more pro-cyclical along higher UI since workers are more indifferent between work and unemployment. This makes the relevant participation constraints bind more often and cause more procyclical adjustment of the contract wage. As a result, in Beaudry and Dinardo's (1991) framework, all other factors equal, we may expect to find a stronger link between wages and current unemployment rate (the spot market model) in labour markets with extensive unemployment insurance. Hogan (2001) in turn shows theoretically that unions can play an important role in enforcing implicit contracts by monitoring the employer's adherence to the 'terms' of the implicit contract. Also Grant (2003) finds empirical evidence for stronger implicit contracting in unionized sectors. Although we do not test directly for the importance of extensive unemployment insurance or the union's involvement in the wage setting, our results are consistent with the view that extensive unemployment insurance can tighten the link between wages and current business cycle conditions.

The remainder of the paper is organized as follows. Section 2 presents the empirical specification. Section 3 describes the data and sections 4 and

[5] Measuring unemployment rates within the worker's realistic go-to-work area may not necessarily reduce measurement error since the precision gained by a correctly specified regional unit is, at least partly, offset by the decreasing number of observations in each cell. We thank Till von Wachter for raising this point.

[6] A number of recent studies have considered alternative wage setting mechanisms that would correct the discrepancy between the predictions of the standard search model and observed labor market dynamics (see eg Shimer, 2005). Hall and Milgrom (2008) consider delay costs of bargaining while Pissarides (2009) introduces fixed matching costs. Gertler and Trigari (2008) introduce staggered wage bargaining and Rudanko (2009) long-term wage contracts.

5 present the main empirical results. Section 6 discusses measurement issues. Section 7 concludes.

2 Specification

In order to test the existence and the nature of implicit contracts, we let the wage setting models 'compete' with each other by including a proxy for each labor market link in the same regression. We relate wages to current unemployment rate (spot market model), to the start-of-tenure unemployment rate (full commitment risk-sharing model) and to the minimum and maximum unemployment rates (one-sided limited commitment model). Adding a vector of individual and firm covariates and controlling for fixed effects yields the following specification

$$\begin{aligned} \log(w_{ijrt}) &= \beta_1 u_{rt} + \beta_2 u^0_{irt} + \beta_3 u^{\min}_{irt} + \beta_4 u^{\max}_{irt} \\ &\quad + x'_{ijrt}\varphi + \delta_i + \eta_t + \epsilon_{ijrt}, \end{aligned} \tag{2.1}$$

where i, j, r, t, index individual, industry, region and time, respectively; w_{ijrt} is the wage rate for individual i; u_{rt} is the current local unemployment rate in region r at time t; u^0_{irt} is the local unemployment rate of region r that was prevailing in the year that individual i started working for her present (at time t) employer; $u^{\min}_{irt}$ and $u^{\max}_{irt}$ are the minimum and maximum local unemployment rates during tenure, until year t; x_{ijrt} is a vector of time-varying individual and firm characteristics; δ_i is a vector of individual fixed effects; η_t is a vector of time fixed effects; and ϵ_{ijrt} is the residual.

The regression specification – henceforth, the BDN-specification after Beaudry and DiNardo (1991) – in (2.1) encompasses all three wage contract models. The spot market model is consistent with $\beta_1 < 0$, $\beta_2 = \beta_3 = \beta_4 = 0$; the full commitment risk-sharing model with $\beta_1 = 0$, $\beta_2 < 0$, $\beta_3 = \beta_4 = 0$ and finally, limited commitment model with $\beta_1 = 0$, $\beta_2 = 0$, $\beta_3 < 0$ and/or $\beta_4 < 0$.

Grant (2003) points out that all the relevant labor market coefficients may be significantly negative in the empirical application. This is because the contracting environment may differ, eg, across industries or levels of education. Hence, it is unlikely that we can unambiguously disentangle among different wage setting models. Instead, when nesting all four labor market variables in the same regression, we infer from the signs, size and precision of the parameter estimates which model is likely to dominate over the others. In particular, we interpret a weakening of the coefficient for current unemployment, β_1, after including the other labor market variables (u^0_{irt}, $u^{\min}_{irt}$ and $u^{\max}_{irt}$), as key evidence for the relevance of internal labor markets in wage determination. We explore the intersectoral differences in wage contracting by estimating separate regressions by sector and by levels of education in section 5.

The vector of individual characteristics, x_{ijrt}, is similar to the one used in the original contribution by Beaudry and DiNardo (1991) including a quartic in experience, a quadratic in tenure, dummies for levels of education, a dummy for working in shifts, regional dummies, and industry dummies. We incluce individual fixed effects to eliminate omitted variable bias caused by unobserved

characteristics that are constant over time, and to account for composition bias arising if individuals who start a new job in a recession differ along observable and unobservable dimensions from those who are hired in a boom.[7] Furthermore, we include time fixed effects to purge any spurious correlation with macro level shocks unrelated to changing local labor market conditions. We are particularly concerned that other macro shocks unrelated to the local labor markets may have affected wages since our period of observation contains the Finnish depression in the early 1990s. Union status, a variable included in the original study, is missing due to the Finnish Law forbidding employer organizations to collect information on employees union status. Grant (2003) however shows that omitting the union status does not affect the main results, since it is essentially uncorrelated with, at least, the backward looking measures of labor market conditions.

3 Data

We link employee data collected by the largest confederation of Finnish industries, *Elinkeinoelämän keskusliitto* (EK), to employer data and regional data on unemployment from Statistics Finland over the period 1989-2004. EK conducts a yearly wage survey among its member firms by which detailed information on wages and working hours on all employees (who are older than 15 years) for the last quarter of the year is collected. Hence, our data set comprises the entire population of blue collar workers in each of EK's member firms in manufacturing industries during 1989-2004. We are able to successfully link 952,218 observations with non-missing values on the variables included in the benchmark regressions and cleaned of extreme values in the variables.[8]

We restrict our attention to the wage contract that represents the individual's main source of wage income in each year. Wages are decomposed into different components, and information on hours spent on each component is available. Our preferred wage measure is the Consumer Price Index (CPI) deflated log of total hourly compensation for work, expressed in euros. The total hourly compensation is measured as the sum of base wage (time rate, piece rate and performance based compensation) and all wage complements (shift premiums, bonuses based on working conditions, and premiums for overtime and Sunday work), divided by the total hours worked. We cross validate the results by using 'hourly regular rate of pay', ie, base wage and regular complements (excluding overtime, and Sunday premiums) per total hours worked. Including only the regular part of overtime and Sunday pay make wage rates more comparable across occupational groups. Also time rate pay is considered.

[7] Solon, Barsky, and Parker (1994) show that the true procyclicality of wages is clouded by the fact that low-skill workers are given more weight during expansions than during recessions in the aggregate unemployment statistics.

[8] We exclude any observations for which the deflated hourly wage is less than one or more than 100 euros. Also observations for which potential experience or tenure is less than zero or more than 50 years are excluded.

Table 1. Summary statistics

	All		Male	
Variable	Mean	Std	Mean	Std
Individual worker characteristics:				
Female	.28	.45	...	...
'Work in shifts' dummy	.53	.50	.54	.50
Tenure	3.27	3.31	3.32	3.33
Potential experience	15.13	10.14	13.90	9.50
Hourly compensation	10.16	2.58	10.69	2.57
Hourly regular rate of pay	9.52	2.08	9.94	2.05
Time rate pay	8.39	14.85	8.82	16.96
Years of education	11.46	1.53	11.58	1.44
Firm characteristics				
Number of employees	1,887	3,306	1,886	3,127
Labour market characteristics:				
Unemployment rate	14.10	5.54	12.32	7.13
Unemployment rate at start-of-tenure	12.98	6.89	14.29	5.59
Min unemployment rate during tenure spell	10.43	5.12	10.56	5.09
Max unemployment rate during tenure spell	17.83	5.65	17.58	5.79
Min unemp. rate during tenure spell (province level)	12.14	5.76	12.54	5.72
Sample size	952,218		684,020	

Sources: The individual characteristics (except for educational attainment) are derived from the wage survey of the largest confederation of Finnish industries, Elinkeinoelämän Keskusliitto (EK); Firm size and educational attainment are derived from the FLEED linked employer-employee data of Statistics Finland; Statistics Finland provided the unemployment rates. *Note:* The hourly compensation variable is (base wage+complements)/total hours. The hourly 'regular' rate of pay is (base wage+complements-(sunday+over time complements))/total hours. All wage measures are CPI-deflated to 1995 prices. The construction of other variables and definitions are contained in the main text (see section 3).

In order to calculate the regional unemployment rate, we use the regional entity that most likely represents the realistic go-to-work area for the average individual, ie the worker's working county.[9] Finland was divided into 88 counties during the period of observation, of which 75 are represented in the data.[10] Because county level unemployment rates are only available since 1987, all jobs that started prior to 1987 are excluded from the data set. The unemployment rate is measured as the total number of unemployed jobseekers registered at employment offices divided by the labor force (labor force is defined as all 15–64 years old employed and unemployed job seekers)

[9] The worker's working county refers to the location of the specific firm premises where the worker is based, recorded in the wage survey.

[10] To give a view of the average territorial size of one county, Finland is roughly the size of Germany and three quarters of the size of California.

in each county. The unemployment rates are obtained from Statistics Finland, which computes the rates based on unemployment data obtained from the Employment Service Statistics compiled by Ministry of Employment and Economy.

Tenure is available in EK's wage survey directly. The annual wage survey contains information on the exact date when the employee started her current job spell within the firm. If the employee has several consecutive job spells within the same firm, we consider the start of the first job spell within the firm as the relevant starting date. Since our tenure measure is derived from the employers' personnel records, it is likely to be more reliable than survey based data on tenure employed in previous studies estimating the BDN-specification.[11]

Potential experience is imputed as age minus years of education minus the starting age of schooling (seven). Education is measured by a five-class discrete variable with the classes being: basic education, secondary or vocational, post-secondary, bachelor, and graduate and Ph.D. degrees. Finally, 'work in shift' dummy refers to persons working in more than one shift, where a nine-to-fiver obtains value zero and an individual working in two or more shifts obtain value one. Table 1 presents the summary statistics of the main variables of interest in our sample.

4 Results from the Beaudry and DiNardo specification

Table 2 presents the main results from four variations of the BDN-specification using the whole sample and the sub-sample of males.[12] Columns 1–2 of Table 2 present the estimates for a specification including only the contemporaneous unemployment rate, while columns 3–4 present estimates for a variation of the BDN-specification that allows the spot market model to compete against the full-commitment risk sharing model. Columns 5–6 present estimates for a variation of the BDN-specification that allows one-sided limited commitment (limited to the firm), to compete against the two aforementioned models. Finally, in columns 7–8, we follow Grant (2003) and Devereaux and Hart (2007), and test for one-sided limited commitment (limited to the worker) by including maximum unemployment since the worker was hired in the BDN-specification.

[11] See Brown and Light (1992) for a discussion about the inconsistencies of tenure responses in the Panel Study of Income Dynamics (PSID) and National Surveys (NLS).

[12] We look separately at the male sub-sample because male's labor force participation is not interrupted by events typical for women such as child bearing. There is thus a reason to believe that males are more likely to reach implicit agreements with the employer on their wage.

The wage-unemployment elasticities are of the same order of magnitude as in previous studies and based on sign and magnitude of the regressors, the spot market model supersedes the other two models.[13] However, although small in magnitude, minimum rate of unemployment enters with negative and statistically significant coefficient at 5 per cent significance level for the male subsample. Thus, we cannot unambiguously exclude the existence of one-sided limited commitment in the wage setting. Similarly to what the previous studies find, maximum unemployment rate enters with a positive, but not statistically significant coefficient. Since the inclusion of maximum unemployment does not affect the other estimates and there is no realistic economic model justifying its presence in the specification, we restrict our attention to the other three labor market links in the rest of the analysis.

Taken on the whole, three important findings stand out from the results presented in Table 2. First, the effect of the current unemployment rate on wages is fairly robust to the inclusion of the other labor market variables in the estimating equation. This is also the labor market variable with the largest and most precisely estimated coefficients in all the regressions. Second, the estimates for minimum unemployment observed since the worker was hired are small in magnitude but significantly negative at the 5 per cent level for the male subsample. For the whole sample, these estimates are negative but less precise. Third, neither the unemployment rate at the start of tenure nor the maximum unemployment rate since the worker was hired enter with statistically significant coefficient in any of the regressions.[14]

[13] The estimates from a specification that omits the individual fixed effects are reported in the Appendix. The wage-current unemployment elasticity estimates are somewhat smaller in magnitude (less negative) than the directly comparable ones obtained by Pekkarinen (2001) using Finnish data.

[14] In order to make sure that the results are not driven by our wage measure that encompasses all components of compensation, we cross validate the results by using log of hourly regular rate of pay (see section (3) for definition) and time rate pay as alternative wage measures. Identical regressions as the ones presented in column 5 result in the following coefficients ($t - statistics$) for $u_{irt}^{\min}$ when using hourly regular rate of pay and time rate as dependent variables: -.004 *(1.52)* and -.005 *(2.17)*, respectively. The complete set of results from the regressions using the alternative wage measures are available from the authors.

Table 2. Effect of current and past labor market conditions on wages

	All	Male	All	Male	All	Male	All	Male
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
u_{rt}	-.022	-.020	-.022	-.020	-.021	-.019	-.026	-.023
	(4.59)	(4.25)	(4.62)	(4.23)	(4.43)	(3.99)	(4.62)	(4.12)
	[3.63]	[2.90]	[3.72]	[2.97]	[3.63]	[2.84]	[3.18]	[2.95]
u^0_{irt}			.0002	-.002	.003	.0016	.001	.0003
			(.913)	(.73)	(1.23)	(0.66)	(.72)	(.12)
			[0.05]	[0.34]	[0.63]	[0.33]	[0.41]	[0.07]
$u^{\min}_{irt}$					-.004	-.005	-.003	-.004
					(1.86)	(2.23)	(1.63)	(2.01)
					[1.61]	[1.66]	[1.37]	[1.48]
$u^{\max}_{irt}$							.007	.008
							(1.52)	(1.50)
							[0.96]	[1.01]
Obs.	952,218	684,020	952,218	684,020	952,218	684,020	952,218	684,020
R^2	.50	.51	.50	.51	.50	.51	.50	.51

Note: Coefficients result from OLS regressions. The t-statistics in parentheses are adjusted for clustering within county/year of observation cells. Following the suggestion of Bertrand, Duflo and Mullainathan (2004), we report in square brackets the more conservative t-statistics adjusting for clustering within county of observation to account for potential serial dependence in errors within counties across time. The dependent variable is log real hourly employee compensation. u_{rt} is log current local unemployment rate, u^0_{rt} is log local unemployment rate at the start-of-tenure, $u^{\min}_{irt}$ is the log of minimum rate of local unemployment up to the current period in the work spell and $u^{\max}_{irt}$is the log of maximum rate of local unemployment up to the current period in the work spell. The control variables in each regression are individual fixed effects, a quadratic in tenure, a quartic in experience, 5 dummies for different levels of education, a 'work in shift'-dummy, size of firm (number of workers), 15 year dummies, 74 regional dummies, and 21 industry dummies.

5 Additional results

In the next two subsections we present additional results that explore the robustness of the results by splitting the data into subsamples and study differences in wage setting patterns across subgroups. We look at intersectoral differences, and differences across levels of education in wage setting.

5.1 Estimates by industry

Our data set is well suited for intersectoral comparisons since even the industry-subsamples are large in comparison to the whole sample size of the original study by Beaudry and DiNardo (1991). In contrast to the regressions by industry in Beaudry and DiNardo (1991), we can include the current unemployment rate in the analysis since we have cross-sectional unemployment data and our panel spans fifteen years. One caveat with our analysis is that we lack unemployment data for the industry/county/year cells.[15] Beaudry and DiNardo (1991) find that the estimates for minimum unemployment observed since the worker was hired are in general larger (more negative) with the industry-level unemployment measure than with the aggregate rates. This finding suggests that our estimates of the effect of minimum unemployment since the worker was hired can, with some caution, be interpreted as lower bound estimates.

Table 3 shows that there are substantial differences across industries in terms of sign, magnitude and significance of the different labor market variables. Implicit contracting with one-sided limited commitment seems to be strong in the Machinery, ICT and Precision instruments manufacturing. In Wood manufacturing, unemployment at start of tenure enters with the largest and the most significant coefficient, suggesting that wage setting is best characterised by implicit contracts with full commitment. In line with the findings from the regressions using the whole sample, the estimate for current unemployment is negative across industries. Interestingly, notwithstanding the precision, the estimates of current unemployment are large and negative in the industries where implicit contracting applies.

Overall, the industry specific regressions show that implicit contracting plays an important role in some industries, whereas in others, wage setting is more strongly dominated by the spot market model. In this sense, our results are comparable to those of Grant (2003). In line with Grant's conclusion, wages are likely to be set by a more general model yielding negative estimates for the coefficients of both current and past labor market measures. Our results may also reflect the fact that the type of wage contract offered and accepted by workers differ across market characteristics on which firms operate, eg, volatility of demand over the business cycle.

[15] It is however challenging to define unambiguously the unemployed's industry since workers may accept jobs across industries. Groups that cause particular ambiguity are the young, the students, the immigrants and the ones who enter unemployment without any work history. Also, many unemployed have worked in multiple industries before entering the unemployment spell, ie, a truck driver may be assigned to many different industries. Furthermore, our data on unemployment does not come from a survey, which makes it even harder, if not impossible, to construct industry/county/year specific unemployment rates.

Table 3. Effect of current and past labour market conditions on wages by industry

	Regressor			
Industry	u_{rt}	u^0_{irt}	$u^{\min}_{irt}$	N
Food and beverages	-.033	.019	-.007	93,837
	(1.87)	(2.95)	(1.17)	
Wood manufacturing	-.003	-.018	.003	77,330
	(.18)	(2.18)	(.32)	
Pulp, paper and	-.016	-.005	.002	90,685
paper products	(1.15)	(1.23)	(.69)	
Chemicals and	-.012	.039	-.016	46,494
chemical products	(0.75)	(3.07)	(1.45)	
Basic metals	-.006	.007	-.013	58,909
	(.41)	(0.48)	(0.97)	
Machinery and equip.	-.015	.017	-.024	117,427
	(1.44)	(3.21)	(3.55)	
Office machinery	-.067	-.023	-.013	7,940
and computers	(5.03)	(1.58)	(1.20)	
Radio, television and	-.013	.006	-.019	77,741
communication equip.	(0.66)	(0.67)	(2.01)	
Medical, precision and	-.040	.019	-.022	14,086
optical instruments	(1.84)	(1.69)	(2.11)	

Note: Coefficients result from OLS regressions. The t-statistics in parentheses are adjusted for clustering within county/year of observation cells. The dependent variable is log real hourly employee compensation. u_{rt} is log current local unemployment rate, u^0_{rt} is log local unemployment rate at the start-of-tenure, $u^{\min}_{irt}$ is the log of minimum rate of local unemployment up to the current period in the work spell. The control variables in each regression are individual fixed effects, a quadratic in tenure, a quartic in experience, 5 dummies for different levels of education, a 'work in shift'-dummy, size of firm (number of workers), 15 year dummies, 74 regional dummies.

5.2 Estimates by level of education

Estimates by level of education are to our knowledge novel to the implicit contracting literature. Table 4 shows that implicit contracting gets stronger the higher the workers level of education. In contrast, the higher the education, the weaker the evidence that the spot market model applies. This regularity in the weakening of the spot market model is reversed for the subgroup with a bachelor degree, for which both implicit contracts and the spot market seem to matter. Note that since our data contains only blue collar workers, the largest subgroups of workers are the group with the lowest possible completed level of education ($\leq$ 9 years), and the group with standard vocational education or completed high school (12 years).

An apparent candidate for an omitted variable that could drive the differences in wage setting across levels of education is differences in unionization rates across groups. Descriptive statistics based on survey data shows that union membership is somewhat more common among high-skill workers (82 per cent in 2000) than among the workers with vocational training (75 per cent), and low-skill workers (74 per cent) (Böckerman and Uusitalo, 2006). These differences across education groups are rather small in relative terms and as the coverage rates typically exceed 90 per cent we concede that differences in the unionization rates are unlikely to drive the results.[16] Consistent with our results is the finding by Bellante and Link (1982) that, controlling for other factors, high-skill workers take jobs that are subject to low earnings risk.

Table 4. Effect of current and past labor market conditions on wages by level of education

	Regressor			
	u_{rt}	u^0_{irt}	$u^{\min}_{irt}$	N
Basic ($\leq$ 9 years)	-.024	.002	.0009	220,397
	(4.65)	(0.64)	(.38)	
Vocational or				
secondary general	-.021	.003	-.005	669,510
	(4.11)	(1.26)	(2.38)	
Upper vocational	-.018	.004	-.012	54,838
	(1.91)	(1.16)	(2.67)	
Bachelor degree	-.074	.022	-.052	6,491
	(4.38)	(1.80)	(4.11)	

Note: Coefficients result from OLS regressions. The t-statistics in parentheses are adjusted for clustering within county/year of observation cells. The dependent variable is log real hourly employee compensation. u_{rt} is log current local unemployment rate, u^0_{rt} is log local unemployment rate at the start-of-tenure, $u^{\min}_{irt}$ is the log of minimum rate of local unemployment up to the current period in the work spell. The control variables in each regression are individual fixed effects, a quadratic in tenure, a quartic in experience, a 'work in shift'-dummy, size of firm (number of workers), 15 year dummies, 74 regional dummies, and 21 industry dummies. The results for the two groups with the highest levels of education, Master's degree and Ph.D., are not reported due to the small number of observations.

6 Measurement issues

Our basic results from the BDN-specification including individual fixed effects suggest that the backward looking labour market variables have little persistent effects on individuals' wages and thus show weak evidence of implicit contracts.

[16] Note that we can only rely on overall survey information, since the data on the individuals' union membership is not available.

However, the basic fixed effect version of the BDN-specification deserves closer scrutiny. Gertler, Huckfeldt, and Trigari (2008), and Gertler and Trigari (2009) (henceforth, GHT and GT) raise two concerns. The first one is omitted variable bias due to omission of controls for match quality. The second is measurement error in the tenure variable. GHT and GT argue that the failure to control for cyclical movements in the composition of job quality may overstate the true effect of implicit contracts because better matches are made in booms than in recessions.[17] An imprecisely measured tenure variable may in turn attenuate the coefficients of the the backward looking labor market variables u^0_{irt}, $u^{\min}_{irt}$ and $u^{\max}_{irt}$, since the individual's tenure is key to determining that the individual's wage is correctly linked to these variables.[18] Furthermore, this attenuation bias is likely to be exacerbated by the use of individual fixed effects.[19] We address these concerns in the following subsections by including match-specific controls and by using the instrumental variable estimation.

6.1 Controlling for job match quality

GHT and GT allow for an additional fixed effect φ_{im} for each job m that the invidual i has worked in, instead of just δ_i, in specification (2.1) in order to account for compositional shifts in match quality. The variable φ_{im} is identified by the individuals who change jobs within the sample. The match-specific fixed effect is thus a combination of an individual effect that is invariant to the worker's current job, and a component that varies along the matches.

The first panel of Table 5 shows that, after controlling for match-specific fixed effects, minimum unemployment since the worker was hired no longer enters significantly in the BDN-specification for the whole sample.[20] Instead, all the explanatory power has shifted to current unemployment. This result is in line with the findings of GHT and GT. However, the second panel of Table 5 shows that the coefficient for the minimimum unemployment rate changes qualitatively only for vocational workers, suggesting that composition effects are important only for these workers. A possible explanation for this result is that on-the-job training is proportional to the level of education and thus prevents large compositional shifts in match quality for high-skill workers.

[17] Their example is a high-skill machinist who takes a job as a taxi driver in recession and then is re-employed as a machinist in the next boom.

[18] In the extreme case of entirely omitting the tenure control, the direction of the bias is however reversed. Re-estimating column 5 in Table 2 withouth the tenure variable leads to a both economically, and statistically more significant coefficient ($t-statistic$) for minimum unemployment since the worker was hired, -.026 *(12.14)*. A similar pattern is found by GHT.

[19] 'Although they (fixed effects) control for certain type of omitted variables, fixed effects estimates are notoriously susceptible to attenuation bias from measurement error.' (Angrist and Pischke, 2009)

[20] Notice that the unemployment rate at the start of tenure is excluded due to lack of within-group variation.

Table 5. Effect of current and past labor market conditions on wages – controlling for compositional shifts in match quality

	u_{rt}	$u_{irt}^{\min}$	N
Whole sample			
	-.019	.002	952,218
	(3.94)	(0.52)	
By level of education			
Basic ($\leq$ 9 years)	-.020	.007	220,397
	(4.10)	(1.73)	
Vocational or secondary general	-.020	.002	669,510
	(3.64)	(.48)	
Upper vocational	-.015	-.022	54,838
	(1.78)	(2.88)	
Bachelor degree	-.057	-.092	6,491
	(3.17)	(4.12)	

Note: Coefficients result from OLS regressions. The t-statistics in parentheses are adjusted for clustering within county/year of observation cells. The dependent variable is log real hourly employee compensation. u_{rt} is log current local unemployment rate, $u_{irt}^{\min}$ is the log of minimum rate of local unemployment up to the current period in the work spell. The control variables in each regression are individual fixed effects, match specific fixed effects, a quadratic in tenure, a quartic in experience, a 'work in shift'-dummy, size of firm (number of workers), 15 year dummies, 74 regional dummies, and 21 industry dummies. In the regression including the whole sample we additionally include 5 dummies for different levels of education.

6.2 Instrumental variable regressions

Since our fixed effects estimates presented in Table 2 are in general smaller (less negative) than the results from the specification that omits the fixed effects, presented in Table 7 in the Appendix, it is possible that the fixed effects estimates are attenuated due to measurement error. We address this problem by instrumenting the county level minimum unemployment rate since start of tenure by the province level rate in order to correct for attenuation bias.[21] Furthermore, instrumental variable estimation enables us to separate the lessening of composition bias from potentially increased attenuation entailed from the inclusion of match-specific fixed effects in section (6.1). We run

[21] This approach rests on the assumption that the measurement error in the county rate is uncorrelated with the measurement error in the province rates. Note furthermore, that there are 20 provinces in Finland, all of which are represented in our sample.

2SLS regressions for the whole sample and by level of education. The results summarized in Table 6 show that instrumental variable estimation leads in general to somewhat less accurate estimates, but the magnitude of the coefficients do not differ from those obtained in the OLS regressions. We therefore conclude that controlling for match-specific fixed effects is unlikely to increase attenuation bias and that our results in the previous sections are robust to measurement error in the unemployment variable.

Table 6. Instrumental variable regressions

	OLS			IV			
	Whole sample			*By level of education*			
				Basic	Vocational	Upper voc.	Bachelor
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
u_{rt}	-.021	-.021	-.020	-.022	-.021	-.015	-.057
	(4.43)	(4.29)	(4.10)	(4.39)	(3.72)	(1.68)	(3.05)
$u_{irt}^{\min}$	-.004	-.004	.010	.022	.007	-.021	-.090
	(1.86)	(1.38)	(1.42)	(2.96)	(0.99)	(1.71)	(2.53)
Match specific fixed effects	NO	NO	YES	YES	YES	YES	YES
N	952,218	952,218	952,218	220,397	669,510	54,838	6,491
R^2	.50	.50	.45	.41	.46	.41	.41

Note: All entries in Table 6, except for column 1, result from 2SLS regressions. The results from the first stage regressions are available from the authors. The t-statistics in parentheses are adjusted for clustering within county/year of observation cells. The dependent variable is log real hourly employee compensation. u_{rt} is log current local unemployment rate and $u_{irt}^{\min}$ is the predicted log of minimum rate of local unemployment up to the current period in the work spell. The control variables in columns 1–2 are individual fixed effects, a quadratic in tenure, a quartic in experience, a 'work in shift'-dummy, size of firm (number of workers), 15 year dummies, 74 regional dummies, 21 industry dummies, and 5 dummies for different levels of education (except for in columns 4–7). Individual fixed effects are replaced with match-specific fixed effects in columns 3–7.

7 Conclusions

We have exploited a new linked employer-employee data set from Finland to shed new light on the importance of implicit contracts in wage setting. The wage regression similar to Beaudry and DiNardo (1991), with reliable data on tenure and unemployment rate measured at the go-to-work-area level suggest that the past labor market conditions exhibit only little persistence on workers' wages during a job spell. Accounting for compositional changes in match quality over the business cycle and possible measurement error in the local unemployment rates, our results suggest that overall little implicit contracting

is taking place in the wage setting in Finland. However, when examining the robustness of the results across subgroups we find that both industry specific characteristics and worker characteristics matter for the worker's wage persistence. In particular, we find more evidence for implicit contracting among high-skill workers. Although not directly tested, the results are also consistent with the view that extensive unemployment insurance can tighten the link between wages and current business cycle conditions.

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A Appendix

A.1 Additional tables

Table 7. Effect of current and past labor market conditions - excluding individual fixed effects

	All	Male	All	Male
	(1)	(2)	(3)	(4)
u_{rt}	-.024	-.024	-.029	-.027
	(2.88)	(3.14)	(3.25)	(3.35)
u^0_{irt}			.016	.009
			(6.95)	(4.06)
$u^{\min}_{irt}$			-.003	-.002
			(1.56)	(.99)
N	952,218	684,020	952,218	684,020
R^2	.49	.47	.49	.47

Note: Coefficients result from OLS regressions. The t-statistics in parentheses are adjusted for clustering within county/year of observation cells. The dependent variable is log real hourly employee compensation. u_{rt} is log current local unemployment rate, u^0_{rt} is log local unemployment rate at the start-of-tenure, $u^{\min}_{irt}$ is the log of minimum rate of local unemployment up to the current period in the work spell. The control variables are a quadratic in tenure, a quartic in experience, 5 dummies for level of education, a 'work in shift'-dummy, size of firm (number of workers), 15 year dummies, 74 regional dummies, and 21 industry dummies.

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