EUROPEAN CENTRAL BANK

EUROSYSTEM

WAGE DYNAMICS NETWORK

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NO 964 / NOVEMBER 2008

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EVIDENCE FROM HUNGARY

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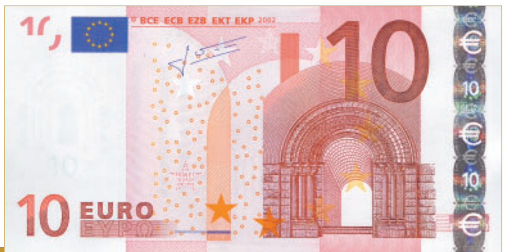

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Wage Dynamics Network

This paper contains research conducted within the Wage Dynamics Network (WDN). The WDN is a research network consisting of economists from the European Central Bank (ECB) and the national central banks (NCBs) of the EU countries. The WDN aims at studying in depth the features and sources of wage and labour cost dynamics and their implications for monetary policy. The specific objectives of the network are: i) identifying the sources and features of wage and labour cost dynamics that are most relevant for monetary policy and ii) clarifying the relationship between wages, labour costs and prices both at the firm and macro-economic level.

The WDN is chaired by Frank Smets (ECB). Giuseppe Bertola (Università di Torino) and Julian Messina (Universitat de Girona) act as external consultants and Ana Lamo (ECB) as Secretary.

The refereeing process of this paper has been co-ordinated by a team composed of Gabriel Fagan (ECB, chairperson), Philip Vermeulen (ECB), Giuseppe Bertola, Julian Messina, Jan Babecký (CNB), Hervé Le Bihan (Banque de France) and Thomas Mathä (Banque centrale du Luxembourg).

The paper is released in order to make the results of WDN research generally available, in preliminary form, to encourage comments and suggestions prior to final publication. The views expressed in the paper are the author's own and do not necessarily reflect those of the ESCB.

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CONTENTS

Abstract

In this paper I address the question to what extent wages are affected by product market uncertainty. Implicit contract models imply that it is Pareto optimal for risk neutral firms to provide insurance to risk averse workers against shocks. Using matched employer-employee dataset, I adopted the estimation strategy proposed by Guiso et al. (2005) to evaluate wage responses to both permanent and transitory shocks in Hungary and compared my results to similar studies on Italian and Portuguese datasets. I found that firms do insure workers against product market uncertainties, but the magnitude of the wage response differs depending on the nature of the shock. Broadly speaking, the wage response to permanent shocks is twice as high as the response to transitory shocks. Comparing my results to the two other studies, the main difference lies in the elasticity of wages to transitory shocks. Unlike these previous findings, my results show that full insurance to transitory shocks is rejected.

JEL classification: C33, D21, J33, J41

Keywords: product market uncertainty, risk sharing, wage insurance, optimal wage contract, matched employer-employee data

Non-technical summary

It is nowadays agreed that the market for labour cannot be represented satisfactorily by a standard competitive model and thus workers' wages are positively correlated with employer's ability to pay. According to the efficiency wage theory, managers tend to pay more than the market-clearing wage in order to attract more able job-seekers, to encourage workers and to minimize turnover. However, employees are generally viewed as risk-averse and, as such, they derive negative utility from the increase in the wage income variance. On the other hand, the owners of the firms have better access to capital markets and can more easily diversify idiosyncratic risks away. It follows that in the presence of uncertainty about future market conditions, it is Pareto optimal for risk neutral firms to provide insurance to risk averse workers against shocks. That is managers commit to pay a pre-agreed wage independently of product market fluctuations.

In this paper I address the question to what extent wages are affected by product market uncertainty. Using matched employer-employee dataset, I followed the estimation strategy proposed by Guiso et al. (2005) to evaluate wage responses to both permanent (mostly technological changes but also persistent demand shocks) and transitory shocks (temporary changes in demand or, for example, machine breakdowns) in Hungary and compared my results to similar studies on Italian and Portuguese datasets. I found that unlike Portuguese and Italian firms, Hungarian firms do not fully insure workers against transitory shocks. Wage responses to permanent value-added shocks are also higher indicating that, at least in this dimension, wages are more flexible in Hungary than in many Western European countries.

A set of factors may help to support the reason why the Hungarian case differs from the Italian and the Portuguese one. First, borrowing constraints for firms may serve as argument in favour of less insurance. According to the existing literature, for economies with a highly volatile macroeconomic environment, financial market imperfections may make it optimal to provide less insurance to employees. For Hungary, an economy in transition with rel-

atively high volatility of macroeconomic shocks and lower degree of financial market development than Western European countries, these findings provide a possible explanation for the results I obtained. Second, the difference in insurance against transitory fluctuations and persistent shocks only makes sense if firms can accurately recognize the nature of the shock. Again, the continuously restructuring economic environment with hardly predictable future path of the shocks may force Hungarian firms to stay, in many cases, on the safe side and react to a variety of shocks of a different nature as if they were persistent. And finally, the institutional background may play a major role in the amount of insurance provided by the firms. Like in most of the New Member States, companies operating in Hungary face much less constraints either in negotiating individual wages or on lay-offs. The insignificance of collective bargaining, the low level of unionization, the quasi-absence of indexation mechanism and the weak employment protection system give firms a lot of freedom for adjustments along both the intensive and extensive margins. Under these circumstances, firms can credibly use performance pay and the threat of layoff to motivate workers to a greater extent.

Wage flexibility is generally deemed to be good for employment and economic prosperity. If wages are more responsive to labour and product market conditions, the real fluctuations generated by both demand and supply shocks are smaller and the economy can operate at a higher level of activity without inflationary pressures. Furthermore, wage flexibility is often cited as the main substitute for an own monetary policy. In this respect, results are comforting as firms can more easily attenuate adverse shocks so common in an economy in transition. On the other hand, the negative aspect of this specific dimension of wage flexibility lies in the welfare costs generated by higher volatility of wages. It is a trade-off between flexibility and security and policy makers should definitely keep both aspects in mind when taking decisions.

1 Introduction

It is nowadays agreed that the market for labour cannot be represented satisfactorily by a standard competitive model and thus workers' wages are positively correlated with employer's ability to pay. An early work of Slichter (1950) showed that a competitive model fails to explain the observed wage differences between apparently homogeneous types of employees in different industries. Later, several empirical studies have recorded significant positive correlation between wages and profits using a richer and more detailed database than Slicher's. For instance, the efficiency wage theory provides an explanation for this phenomenon by arguing that, at least in some specific markets, managers pay more than the market-clearing wage in order to attract more able job-seekers, to encourage workers to increase effort and to minimize turnover. As a consequence, more able employees with higher level of effort and low turnover would increase firm's productivity.[1]

In most of the cases, firms' profits (or value-added) fluctuate so heavily that if wages followed them one-to-one, workers would suffer from excessively high jumps in their wages. Employees are generally viewed as risk-averse and, as such, they derive negative utility from the increase in the wage income variance. On the other hand, the owners of the firms (shareholders) have better access to financial markets and consequently they can more easily cover themselves against idiosyncratic risks by diversifying their portfolio of assets. It follows that in the presence of uncertainty about future market conditions it is Pareto optimal for risk neutral firms to provide insurance to risk averse workers against shocks. That is, managers commit to pay a pre-agreed wage, independently of product market fluctuations.

[1] Although suggestive, these results were subject to a number of criticisms. The apparent correlation between pay and profit may be caused by unobservable industry/firm effects or employees' personal characteristics. For example, more productive industries/firms may require both high pay and a high rate of return on physical capital. The debate between competitive vs. efficiency wage theories is still not fully closed, however, other theories have not much success in explaining seemingly wide wage dispersion for narrowly defined occupations within one sector of one specific location.

Several empirical studies have tried to capture the existence of implicit insurance contracts between firms and workers. The first few studies used aggregate industry data (e.g. Gamber (1988)). Later, Beaudry and DiNardo (1991), Weinberg (2001) and Devereux (2005) used individual data on workers, but still defined shocks at the industry level. Nevertheless, as argued in Guiso et al. (2005), aggregate shocks are not diversifiable and consequently the positive correlation between aggregate productivity or demand shocks and workers' wages may simply reflect equilibrium response of wages to macroeconomic shocks and not necessarily the insurance between employers and employees. Indeed, the backward looking behaviour of economic agents in the basic Calvo model also ensures that real wages do not fully reflect output shocks. Similar results have been found by Pissarides (1985), who explain wage sluggishness by search and matching frictions.

Guiso et al. (2005) were the first to rely on longitudinal matched employer-employee micro dataset to quantify the impact of firm-level value-added shocks on individual wages. They allowed workers' wages to respond to both permanent and transitory shocks to the firm and they found that Italian firms provide full insurance against temporary shocks and only partial insurance against permanent shocks. Having replicated their empirical identification strategy, Cardoso and Portela (2005) have found similar results on Portuguese data.

In line with these previous studies, this paper presents an empirical analysis of wage responses to firm level shocks in Hungary following a similar methodology as in Guiso et al. (2005). One contribution of this paper is to adapt their estimation method to the case of dataset with panel structure for firms, but only repeated cross-sections for workers. In addition, I also use a more accurate productivity measure to evaluate its impact on workers' wages. However, the paper stresses the fact that these necessary extensions do not bias the results and the estimated parameters remain comparable to the previous findings.

The re-examination of the sensitivity of wages to idiosyncratic shocks on Hungarian data has the advantage that the economic and institutional background in this country differs substantially from the Italian and Portuguese environment in many respects. Like in most of the New Member States, the Hungarian labour market institutions are viewed as highly flexible in EU-comparison (see Section 3). The insignificance of collective bargaining, the low level of unionization, the quasi-absence of indexation mechanism and the weak employment protection system give firms a lot of freedom for adjustments. In other words, the Hungarian case can give insight into how firms and workers share the risk of business fluctuations in a weakly regulated setting.[2]

2 The theory of wage insurance

Several arguments have been advanced in the literature to support the role of employers as insurance providers. In his seminal work, Knight (1921) describes entrepreneurs as "confident and venturesome", willing to assume the risk while insuring the "doubtful and timid". Another argument is that entrepreneurs have better access to capital markets and can more easily diversify idiosyncratic risks away, while workers cannot smooth consumption privately because they have only limited access to credit markets. It follows that it is Pareto optimal for risk neutral firms to provide insurance to risk averse workers and insulate their salaries from adverse shocks to production, thereby improving the welfare of both parties. Although the extreme assumption of risk neutrality for employers is not crucial, employers and workers must have different degrees of risk aversion, with workers being more risk averse than employers.

[2] The Italian and Portuguese labour market are characterized by widespread unionization and relatively highly centralized wage bargaining system. Despite of this, the authors of the two papers argue that the wage component determined at the firm level (between 1/6 and 1/4 in case of Italy, not published for Portugal) is important enough for firms to influence the wages of their employees and thus, to test the existence of wage insurance within the firm. This paper does not cast doubt on the relevance of their findings, I rather extend their results.

The optimal risk allocation problem was first formalized in implicit contract models of Baily (1974), Gordon (1974) and Azariadis (1975). In these early models, workers sacrifice part of their expected salaries predicted by spot labour markets and enter in a long-term implicit contract in which wages are less sensitive to demand fluctuations. As noted by Holmström (1981), the major weakness of these earliest theoretical contributions is the assumption that the parties will never renege on the contract. If both workers and employers can end the current relationship when better outside opportunities arise, the relationship continues only if contracts are self-enforcing. In other words, parties will stick to the contract as long as it remains in their interest and they will violate contractual agreements as soon as outside opportunities become "too attractive" for one of the parties.

The issue of enforceability of contracts has been widely investigated in the last three decades. Modern implicit contract theory tries to set conditions under which the contract offsets any short-term gain from reneging by greater long-term benefits from compliance. The optimal contract depends on a set of factors such as differences in risk aversion, the variability of performance and others. In particular, Gamber (1988) showed that the possibility of bankruptcy constrains firms to provide insurance for the workers and consequently, persistent shocks to performance are less likely to be insured than temporary shocks. Weiss (1984) demonstrated that the higher the mobility costs are (including loss of specific human capital), the more insurance firms can provide. Holmström (1981) suggests a reputation-building process as a mechanism to make contracts enforceable. In the model of Harris and Holström (1982), firms have incomplete information about the workers' marginal product and update wages successively to prevent workers from quitting. Beaudry and DiNardo (1991) and, more recently, Grant (2003) and Bertrand et al. (2004) used the unemployment rate for proxying external opportunities for workers and found that real wages are renegotiated when either the worker's or the firm's outside option constraints become binding.

3 Wage setting institutions in Hungary

Generally speaking, the Hungarian labour market institutions are considered as highly liberal within Europe.[3] Although both national and industry-level wage agreements exist in the country, the major part of the wage bill is determined at the company or plant level. The national level forum for tripartite negotiations, the National Interest Reconciliation Council (Országos Érdekegyeztető Tanács, OÉT) has little influence on the factual wage growth and limits its role to provide recommendations and - as a key for influencing the market - agree on the level of the statutory minimum wage. The coverage of sectoral collective agreements is also low (less then 40%) by international comparison and the effect of extensions is not significant either.

Typically, wage negotiations are conducted on an individual company basis and wage changes take place once a year. The frequency of wage settlements is not completely stable over time, as a second wage increase during the same year was somewhat more usual during the first years of the transition period with high inflation. Based on the Hey Group survey, the average number of wage increases within a year was around 1.2 in 2000 and the second wage change has almost entirely disappeared since then.[4] In about half of the cases wage changes take effect on the first pay day in January each year. Another large fraction of wage changes take effect in April-May (20-30% of the changes).

The Hungarian Employment Protection Legislation (EPL) also gives firms a lot of autonomy. As noted in Horváth and Szalai (2007), EPL in Hungary is closer to the Anglo-Saxon countries than to most of the European countries. Unlike many European countries with stricter EPL, there is no special procedure for individual dismissal such as obligatory negotiations with the involvement of a third party(ies) or legal commitment to support retraining of the employee. Social considerations do not need to be taken into account

[3] A recent work of Horváth and Szalai (2007) gives a comprehensive overview of the labour market institutions in place in Hungary through several dimensions.

[4] Unfortunately, no data is available for earlier period.

either. In the case of collective dismissals, the State requires a notification but there is no any additional rule to follow.

In summary, the Hungarian labour market is much less regulated than those which served as a base for previous similar empirical investigations. Companies face much less obstacles either in setting wages or firing and consequently firms have a lot of freedom for adjustments along both the intensive and extensive margins.

4 Modeling firms' performance and workers' earnings

4.1 The data

To put it simply, the basic idea underlying the identification strategy is to estimate idiosyncratic shocks to performance and to wages in the first step, and estimate the sensitivity of wage shocks to firm-specific changes in productivity in the second step. In case of full insurance, the two shocks should be orthogonal. For this purpose I use two different datasets: firm-level shocks to output are estimated using the corporate tax returns of all double entry book keeping firms operating in Hungary between 1993 and 2004 (*Apeh database*); wage shocks are obtained using the National Labour Centre's *Wage Survey* for the same period which covers a representative sample of firms and on average a 10% sample of their workers. Both were subject to several systematic checks and cleaning procedure. The two datasets are combined and constitute a matched employer-employee dataset.

I restricted my analysis to non-farm and non financial private companies with more than four employees. As for the *Apeh dataset*, I filtered out missing observations for value added, number of employees, capital and input materials (12% of the total number of observation). I also checked for possible outliers: I eliminated firms for which the capital to value-added ratio or the input material to value-added ratio is 1.5 times the inter-quartile interval below the first quartile or over the third quartile in a specific year in a specific industry (4% of the observations).

The *Wage Survey* includes all companies above 20 employees and a random sample of those between 11 and 20 employees for the years 1995-1999 and between 5 and 20 employees for 2000 and later. In the case of companies below 20 employees, all full-time employees were surveyed. In the case of companies above this critical size, the sample includes all full-time employees born on the 5th, 15th or 25th of any month.

The serious deficiency of the wage survey is that individual observations are not linked across years, making computation of individual wage growth rates and the use of lagged individual data impossible. For this reason I necessarily depart from the estimation strategy of Guiso et al. (2005) and estimate wage equations at a more aggregated level. Potential biases associated with this deficit are discussed later.

The number of observations used for the analysis as well as basic descriptive statistics of the variables are summarized in Table 1. Detailed information on the variables used is presented in the Appendix.

4.2 Firms' performance

Shocks to firm's performance are captured by the change in the residual of the production function. For simplicity, I assume Cobb-Douglas technology:

$$q_{jt} = \alpha_l l_{jt} + \alpha_k k_{jt} + \underbrace{Z'_{st}\gamma + f_j + \varepsilon_{jt}}_{\text{Solow residual}} \tag{1}$$

where q_{jt}, l_{jt} and k_{jt} stand for the value-added, labour and capital of firm j in time t. All variables are in logarithms. The Solow residual is further decomposed into firm-level fixed effect f_j, aggregate shocks Z'_{st} (year and industry dummies) and firm-level shock to value added ε_{jt}.

I estimated productions functions for each 2-digit industry separately using the Levinsohn and Petrin (2003) method. However, some consecutive

Table 1: Worker and firm characteristics

	Whole sample		Matched sample	
	mean	std. dev.	mean	std. dev.
	Firm characteristics			
Value added	116.23	1811.61	386.53	3153.95
Number of employees	43.88	447.83	140.78	708.01
Capital	121.05	3053.88	416.10	4952.41
Nb. of observations	446184		78955	
Nb. of firms	101659		23468	
	Woker characteristics			
Gross earnings	24921	26272	25056	26440
Net earnings	17964	16454	18009	16586
Male	0.58	0.49	0.59	0.49
Age	39.23	10.81	39.17	10.88
Vocational	0.34	0.47	0.35	0.48
Secondary	0.34	0.47	0.34	0.47
Higher	0.13	0.33	0.13	0.33
Manager	0.11	0.32	0.11	0.32
Non-manual	0.29	0.45	0.28	0.45
Nb. of observations	1231069		1017164	

Source: Wage Survey and Apeh database, 1993-2004

Notes: Value added and capital measured in million of HUF and earnings in HUF, all expressed in 1991 prices. Value added is deflated by sectoral GDP deflator and earnings are deflated by CPI. The capital stock was constructed following the procedure described in Kátay and Wolf (2004). For firms, the "whole sample" includes non-farm and non financial private companies with more then 4 employees, after missing variables and outliers are removed. For workers, it is the largest simple for the same industries. The matched dataset includes only observations for which we have contemporaneous observations on both the worker and the firm.

industries were merged to evade small samples.[5] In the second step, I took the differences of the estimated Solow-residual in order to eliminate firm-level fixed effects f_j and I regressed out aggregate shocks Z'_{st} using OLS. I

[5] Similarly to Kátay and Wolf (2008), I have also taken into account the change in output price/input price ratio in the Levinsohn-Petrin estimation procedure and included relative prices in the regression as an additional instrument. For the details, see the paper previously mentioned.

obtained idiosyncratic shocks to value added ($\Delta\varepsilon_{jt}$) as the residuals of this latter regression.

Note that I modeled firm performance differently than in Guiso et al. (2005) or Cardoso and Portela (2005). These previous works used a simple AR(1) process augmented with additional dummies controlling for aggregate shocks. As admitted by the authors, their model is much simplified and shocks to value-added should be investigated once variation in the production factors, capital and labour, have been controlled for. However, Guiso et al. (2005) addressed this issue as a robustness check and after having controlled for capital and labour, the estimated wage responses to both permanent and transitory value-added shocks confirmed their baseline findings. Hence, the deviation from the benchmark procedure improves the precision of the measurement of the shocks but has visibly little effect on the estimates of interest. Nevertheless, the simplified version of the model may work in a stable economy such as in Italy or in Portugal, but a simple AR(1) process is much less likely to capture the data generating process in a transition economy with countless individual and aggregate shocks. As for the estimation procedure, I choose Levinsohn-Petrin instead of GMM because previous production function estimations on Hungarian data suggest that the former estimation procedure enhance the accuracy of the parameters and provide more credible TFP measures.[6]

The estimated parameters of the production functions are presented in Table 2. Results are broadly in line with expectations as the parameter estimates well reflect sectoral differences in labour and capital intensity. On the other hand, the sum of the two coefficients of the production function are generally lower than unity implying decreasing returns to scale in most of the industries. While many of the previous papers on production function estimation report higher returns to scale, my results are not out of line with the existing empirical literature.[7]

[6] For detailed analysis of the estimated TFP measures, see Kátay and Wolf (2008).

[7] See e.g. Fuss and Wintr (2008)

Table 2: Estimation results, production functions

INDUSTRY	NACE	Labour		Capital	
		coef.	*Z stat.*	*coef.*	*Z stat.*
MINING AND QUARRYING	10 - 14	0.43	*10.78*	0.33	*4.41*
FOOD PRODUCTS AND BEVERAGES + TOBACCO	15 - 16	0.48	*35.03*	0.31	*15.32*
TEXTILES	17	0.60	*25.35*	0.26	*9.87*
WEARING APPAREL; DRESSING AND DYEING OF FUR	18	0.72	*27.36*	0.16	*6.90*
LEATHER AND LEATHER PRODUCTS	19	0.74	*18.33*	0.33	*7.68*
WOOD AND WOOD PRODUCTS	20	0.50	*16.29*	0.33	*11.75*
PAPER AND PAPER PRODUCTS	21	0.36	*6.10*	0.21	*4.38*
PUBLISHING, PRINTING	22	0.41	*12.39*	0.21	*13.17*
FUEL + CHEMICAL PRODUCTS	23 - 24	0.27	*6.39*	0.42	*6.55*
RUBBER AND PLASTIC PRODUCTS	25	0.50	*17.55*	0.29	*11.61*
OTHER NON-METALLIC MINERAL PRODUCTS	26	0.52	*24.11*	0.25	*7.52*
BASIC METALS	27	0.42	*7.37*	0.24	*2.85*
FABRICATED METAL PRODUCTS	28	0.52	*38.92*	0.30	*18.51*
MACHINERY	29	0.54	*34.89*	0.26	*10.80*
OFFICE MACHINERY AND COMPUTERS	30	0.47	*5.71*	0.19	*2.55*
ELECTRICAL MACHINERY	31	0.49	*11.71*	0.37	*5.45*
COMMUNICATION EQUIPMENT	32	0.48	*13.87*	0.29	*7.15*
MEDICAL, PRECISION AND OPTICAL INSTRUMENTS	33	0.40	*10.08*	0.30	*8.41*
MOTOR VEHICLES	34	0.46	*10.20*	0.49	*5.92*
OTHER TRANSPORT EQUIPMENT	35	0.59	*6.50*	0.22	*2.25*
MANUFACTURE OF FURNITURE + RECYCLING	36 - 37	0.50	*17.13*	0.27	*7.19*
ELECTRICITY, GAS, STEAM AND HOT WATER SUPPLY	40	0.49	*12.87*	0.20	*2.12*
COLLECTION AND DISTRIBUTION OF WATER	41	0.74	*13.20*	0.12	*2.79*
CONSTRUCTION	45	0.60	*69.10*	0.27	*33.92*
SALE AND REPAIR OF MOTOR VEHICLES	50	0.54	*28.19*	0.27	*15.22*
WHOLESALE TRADE	51	0.27	*27.83*	0.29	*35.29*
RETAIL TRADE	52	0.44	*45.04*	0.24	*27.37*
HOTELS AND RESTAURANTS	55	0.74	*40.07*	0.14	*9.99*
TRANSPORT	60 - 62	0.49	*29.88*	0.29	*21.51*
AUXILIARY TRANSPORT ACTIVITIES	63	0.60	*26.05*	0.24	*9.97*
POST AND TELECOMMUNICATIONS	64	0.48	*12.13*	0.20	*3.48*
REAL ESTATE ACTIVITIES	70	0.46	*19.85*	0.20	*8.84*
RENTING OF MACHINERY AND EQUIPMENT	71	0.23	*4.43*	0.43	*4.11*
COMPUTER AND RELATED ACTIVITIES	72	0.58	*19.39*	0.27	*14.23*
RESEARCH AND DEVELOPMENT	73	0.43	*8.39*	0.30	*6.22*
OTHER BUSINESS ACTIVITIES	74	0.55	*50.99*	0.20	*21.01*
EDUCATION	80	0.43	*8.70*	0.31	*7.70*
HEALTH AND SOCIAL WORK	85	0.21	*4.20*	0.22	*5.91*

Source: Apeh database 1993-2004

Notes: The table reports sectoral level production function estimation results using Levinsohn and Petrin (2003) algorithm. For further analyse of the estimation results, see Kátay and Wolf (2007) (only manufacture).

Despite the differences in modeling firm's performance and the estimation method, the autocorrelation structure of the firm level value-added shocks is similar to the results reported in Guiso et al. (2005) (see Table 3). The autocorrelation structure of shocks to value added is consistent with an MA(2) process: after 3 lags the covariance of the first-differenced residuals is insignificant.

Table 3: Autocorrelation structure of shocks to value added

Order (τ)	*corr.*	*p-values*
1	-0.275	*0.00*
2	-0.037	*0.00*
3	-0.003	*0.37*
4	0.002	*0.65*
5	-0.002	*0.66*

Notes: The autocorrelations are computed using all years pooled.

As suggested by Guiso et al. (2005), the process for ε_{jt} can be represented as a sum of random walk and an MA(1) component:

$$\begin{cases} \varepsilon_{jt} = \xi_{jt} + (1 - \theta L)\, v_{jt} \\ \xi_{jt} = \xi_{jt-1} + u_{jt} \end{cases} \tag{2}$$

By assuming that $E\left(u_{jt}^2\right) = \sigma_u^2$ and $E\left(v_{jt}^2\right) = \sigma_v^2$ for all t, $E\left(u_{js}u_{jt}\right) = E\left(v_{js}v_{jt}\right) = 0$ for all $s \neq t$ and $E\left(u_{js}v_{jt}\right) = 0$ for all s and t, this representation is consistent with the autocovariance structure in Table 3. Taking the first difference of ε_{jt} leads to $\Delta\varepsilon_{jt} = (1 - \theta L)\, \Delta v_{jt} + u_{jt}$.

The advantage of this representation over a single variance component following an MA(2) process is that it allows different shocks to have different dynamic influence on value-added: some shocks have permanent effects (mostly technological changes but also persistent demand shocks), others are transitory by nature (temporary changes in demand or, for example, machine breakdowns).[8] Moreover, I performed the test for the existence of a random walk component in the levels, as proposed by Meghir and Pistaferri (2004). The test rejects the null hypothesis of the absence of such a component with a p-value inferior to 0.001.[9]

On the basis of this representation, equation 1 can be decomposed into the sum of a deterministic D_{jt}, a permanent P_{jt} and a transitory component T_{jt}:

$$q_{jt} = D_{jt} + P_{jt} + T_{jt} \tag{3}$$

where $D_{jt} = \alpha_l l_{jt} + \alpha_k k_{jt} + Z'_{st}\gamma + f_j$, $P_{jt} = \xi_{jt}$ and $T_{jt} = (1 - \theta L)\, v_{jt}$

4.3 Workers' earnings

I write the log wage of individual i working in firm j in a standard Mincer-type wage equation:

$$\varphi(L)\, w_{ijt} = X'_{ijt}\delta + F_{jt} + \underbrace{\alpha\xi_{jt} + \beta(1 - \theta L)\, v_{jt} + \psi_{ijt}}_{\omega_{ijt}} \tag{4}$$

where $\varphi(L)\, w_{ijt}$ is a lag structure of the natural logarithm of the net monthly wage of worker i in firm j in period t, X_{ijt} is a set of observable individual characteristics (gender, age, occupation...) and F_{jt} includes firm's characteristics as well as a firm-level unobserved fixed effect, industry and year dummies. Following Guiso et al. (2005), I include in the wage regression the permanent and transitory components of the firm-specific shocks, P_{jt} and T_{jt}, respectively. The parameters α and β show how these shocks translate into wage changes. Remember that our database does not permit linking individual observation across years, thus, worker fixed effect remains in the error term ψ_{ijt}. This issue will be further investigated in Section 5.3.

[8] Remark that $\lim_{k\to\infty}(\partial q_{j,t+k}/\partial u_{jt}) \neq 0$ and $\lim_{k\to\infty}(\partial q_{j,t+k}/\partial v_{jt}) = 0$. In case of a simple MA(2) representation, all shocks have permanent effects or, if the two parameters of the MA(1) and MA(2) terms sum to -1, all shocks have only temporary effects.

[9] The test confronts the null $\Delta\varepsilon_{jt} = (1 - \theta L)\, \Delta v_{jt}$ with the alternative $\Delta\varepsilon_{jt} = (1 - \theta L)\, \Delta v_{jt} + u_{jt}$. Under the null hypothesis, $E\left(\Delta\varepsilon_{jt}\left(\Sigma^2_{\tau=-2}\Delta\varepsilon_{jt+\tau}\right)\right) = 0$

In order to overcome the deficiency of our database, I aggregate the observations at the firm level. Taking the first differences of the variables yields to:

$$\begin{aligned}\varphi(L)\,\Delta\bar{w}_{jt} &= \Delta\bar{X}'_{jt}\delta+\Delta F_{jt}+\alpha u_{jt}+\beta\,(1-\theta L)\,\Delta v_{jt}+\Delta\bar{\psi}_{jt} && (5)\\ &= \Delta\bar{X}'_{jt}\delta+\Delta F_{jt}+\Delta\bar{\omega}_{jt} && (6)\end{aligned}$$

with $\bar{a}_{jt}$ being the firm level weighted average of variable $a=\{w,X,\psi\}$ at time t.

Equation 5 is estimated with Arrelano and Bond (1991) GMM technique, using lags 4-5 as instruments for the endogenous variables. The estimation results are presented in Column 1 of Table 4.

As a robustness check, I also estimated firm-level fixed effect model by taking the mean differences of all variables, i.e.:

$$\varphi(L)\,\tilde{w}_{ijt}=\tilde{X}'_{ijt}\delta+\tilde{\psi}_{ijt} \qquad (7)$$

where $\tilde{a}_{ijt}=a_{ijt}-\bar{a}_{jt}, a=\{w,X,\psi\}$

Mean differencing eliminates all firm level observed and unobserved terms and assuming that all variables in X are exogenous and the error term is white noise, equation 7 can be estimated using OLS. This estimation is presented in Column 2 of Table 4.

Comparing the two estimates, I found that the parameters of individual characteristics are close to each-other and are broadly consistent with the results of other similar wage regressions. Wage surplus of managers and non-manual workers are somewhat higher in the baseline model than in the fixed effect regression, but these differences may be due to the fact that the classification I used is very simplified and the variables may not reflect homogeneous group of employees (see Appendix). Parameter of the lagged dependent variable in the baseline model is also comparable to other studies. The second lag is also almost significant at 5% so I left it in the regression.[10]. The Hansen J-statistic indicates the validity of the instruments. The Arrelano-Bond test

[10] Dropping it out does not change the results

Table 4: Estimation results, wage equations

	Baseline		Firm-level fixed effect	
	(1)		(2)	
	coef.	*Z stat.*	*coef.*	*Z stat.*
Earnings growth at *t-1*	0.585	*2.41*		
Earnings growth at *t-2*	-0.364	*-1.90*		
Male	0.156	*7.89*	0.140	*213.09*
Age	0.026	*5.42*	0.022	*123.09*
Age square / 100	-0.025	*-4.49*	-0.020	*-90.60*
Vocational	0.089	*5.82*	0.096	*116.50*
Secondary	0.149	*7.36*	0.158	*167.18*
Higher	0.399	*9.84*	0.448	*346.39*
Manager	0.584	*11.92*	0.470	*427.98*
Non-manual	0.219	*6.35*	0.113	*126.48*
Wald test for year dummies	443.37	[<0.001]		
Wald test for sector dummies	70.72	[<0.001]		
Hansen J-test	21.87	[0.057]		
AR2 test	2.01	[0.044]		
AR3 test	-2.33	[0.020]		
AR4 test	1.14	[0.254]		
AR5 test	-1.76	[0.078]		
AR6 test	0.69	[0.492]		
AR7 test	-0.65	[0.513]		
aR2			0.414	
RMSE			0.279	

Source: Wage Survey, 1993-2004

Notes: The first column reports the results of the GMM regression of our baseline model on firm-level average values (see text for details). Instruments are constructed using the GMM approach of Arellano and Bond (1991) and include the log of earnings dated *t-4* and earlier. The second column presents the firm-level fixed effect estimation on individual data. For year and sector dummies F-statistics are reported; values in brackets are p-values. Heteroscedasticity-robust standard errors estimates. References are female, primary school, manual worker.

for serial correlation of the differenced error term shows that the 3rd lag is still significant and becomes nonsignificant at lag 4. This autocorrelation structure is consistent with the choice of instruments (lag 4-5).

5 Wage insurance in Hungary

5.1 Identification strategy

I adopt the estimation strategy of Guiso et al. (2005) in order to estimate the two insurance parameters α and β. The estimation strategy relies on two different instrumental variable regressions with different instruments allowing the identification of the two parameters of interest. In both cases, $\Delta\omega_{ijt}$ is regressed on $\Delta\varepsilon_{jt}$. Guiso et al. (2005) showed that the moment condition $E\left[\left(\sum_{\tau=-2}^{2}\Delta\varepsilon_{jt+\tau}\right)\left(\Delta\bar{\omega}_{jt}-\alpha\Delta\varepsilon_{jt}\right)\right]=0$ allows the identification of the parameter of the permanent shock α, while $E\left[\left(\Delta\varepsilon_{jt+1}\right)\left(\Delta\bar{\omega}_{jt}-\beta\Delta\varepsilon_{jt}\right)\right]=0$ identifies the parameter of the transitory shock β. Thus any power of $\left(\sum_{\tau=-2}^{2}\Delta\varepsilon_{j,t+\tau}\right)^{k}$ is a valid set of instruments to estimate α and $\left(\Delta\varepsilon_{j,t+1}\right)^{k}$ to estimate β, as for any $k\geq 1$, these instruments are correlated with the right-hand side variable $\Delta\varepsilon_{jt}$ and uncorrelated with the error term.[11]

5.2 Results

I estimated α and β using feasible efficient GMM procedure. The instruments were constructed for $k=1$ to 5 as explained in the previous section. Results are presented in Table 5.

[11] The reason behind the validity of the orthogonality conditions is purely statistical. From 2 and 5, it is seen that $\Delta\varepsilon_{jt}=u_{jt}+(1-\theta L)\,\Delta v_{jt}$ and $\Delta\bar{\omega}_{jt}=\alpha u_{jt}+\beta\,(1-\theta L)\,\Delta v_{jt}+\Delta\bar{\psi}_{jt}$. It follows that $\Delta\bar{\omega}_{jt}-\beta\Delta\varepsilon_{it}=(\alpha-\beta)\,u_{jt}+\Delta\bar{\psi}_{jt}$ and consequently $E\left[\Delta\varepsilon_{it+1}\left(\Delta\bar{\omega}_{jt}-\beta\Delta\varepsilon_{it}\right)\right]=E\left[\left(u_{jt+1}+(1-\theta L)\,\Delta v_{jt+1}\right)\left((\alpha-\beta)\,u_{jt}+\Delta\bar{\psi}_{jt}\right)\right]=0$. Similarly, it can be easily shown that $E\left[\left(\sum_{\tau=-2}^{2}\Delta\varepsilon_{jt+\tau}\right)\left(\Delta\bar{\omega}_{jt}-\alpha\Delta\varepsilon_{jt}\right)\right]=E\left[\left((1-\theta L)\,(v_{jt+2}-v_{j-3})+\sum_{r=-2}^{2}u_{jt+r}\right)\left((\beta-\alpha)\,(1-\theta L)\,\Delta v_{jt}+\Delta\bar{\psi}_{jt}\right)\right]=0$

Table 5: Estimation results, sensitivity of earnings to value-added shocks

	Permanent shock		Transitory shock	
	coef.	*Z stat.*	*coef.*	*Z stat.*
Sensitivity	0.107	*5.26*	0.055	*2.51*
Hansen J-test	6.73	[0.151]	6.607	[0.158]

Source: Wage Survey and Apeh database, 1993-2004

Notes: The table reports the GMM estimates of the sensitivity of wages to value-added shocks. The estimation procedure and instruments are explained in the text. Heteroscedasticity-robust standard errors estimates. Values in brackets are p-values.

In both regressions, the overidentifying restriction tests reinforce the validity of the instruments used. Both the parameter of the permanent and the transitory shocks appear to be significant, but the magnitude of the response differs. Broadly speaking, the wage response to permanent shocks is twice as high as the response to transitory shocks. Comparing my results to the two other studies it is seen that the wage sensitivity to permanent shock is somewhat higher in Hungary than in Italy ($\alpha = 0.069$) or in Portugal ($\alpha = 0.086$). Nevertheless, the main difference in my results compared to these previous studies lies in the elasticity of wages to transitory shocks. Recall that the two studies have found that firms provide full insurance against transitory shocks to value-added in Italy and in Portugal, that is, the parameter β is close to zero and insignificant in both cases. In case of Hungary, results show that full insurance to transitory shocks is rejected.[12]

In order to give an idea of the significance of these sensitivity parameters, it is sufficient to have a look at the total variability of the value-added shocks. The standard deviation of estimated shocks to value added is 0.56, which is particularly high compared to the Italian results (0.24 for both transitory and permanent shocks) but still lower then the variability obtained for Portugal (0.75 for the permanent shocks and 0.81 for the transitory shocks). If we take the standard deviation of the mixture of transitory and permanent shocks as

[12] Full insurance means that wages shocks are orthogonal to shocks to value-added.

the benchmark, a shock of this magnitude implies for workers an additional increase or decrease of their wage by 6% if the shock is permanent and 3% if it is transitory. For comparison, the average wage change in 2004, for example, was 9.34%. One can conclude that after either permanent or transitory shock to firm's performance, deviation in workers' wage growth from the average is quite substantial.

5.3 Robustness check

Before proclaiming that Hungarian workers are more exposed to product market fluctuation than Western European employees, some robustness checks are in order. Table 6 presents various deviations from the baseline estimation. In particular I checked the robustness of my regression results to an alternative sample selection of workers by excluding employees who entered the firm within a year (column 2); I tested whether considering gross earnings instead of net earnings as a measure of compensation changes the results (column 3); and last but not least, I re-estimated the model by taking the simple non-weighted firm-level average of the variables in the wage equation 5 (column 4). The results based on these alternative measures, sample selection and aggregation method are similar to the baseline estimation. The sensitivity of wages to permanent shocks is slightly higher in the case of gross earnings as the dependent variable and when I exclude new entrants, and it is somewhat lower if I do not use weights in the aggregation. As for the sensitivity to transitory shock, the elasticity is faintly smaller when I restrict my analysis to workers with larger tenure track but still largely different from zero.[13] Nevertheless, these differences are not statistically significant.

However, the issue of aggregation bias remains at the core of interest. Due to the nature of the database, estimations were carried out at the company-level, while controlling for the composition of the workforce within and be-

[13]In that case, the Z-statistics are close to the 5% significance level. Note that as I aggregate individual observations to the firm level, the number of observation I use in the regressions is much smaller then the sample used in the Italian and Portuguese case, which may affect the significance level of the estimated parameters.

tween firms. As shown in the firm-level fixed effect wage regression in Table 4, almost half of the within-firm wage differentials is captured by the observed individual characteristics included in the regression. The other half of the variation is not explained and incorporates unobserved worker fixed effects (let's say f_i) associated with individuals' abilities and outside opportunities. Such unobserved component remains in the residual of the wage equation and may bias the results of interest. In particular, if the composition of the workforce changes from one period to the other and the aggregate wage change associated with the change in composition is not fully captured by the observed individual characteristics, the residual of the wage equation can be correlated with the firm-level value-added shock even in the absence of individual wage change, i.e. $E\left(\Delta \bar{f}_i \Delta \varepsilon_{jt}\right) \neq 0$. That is, in addition to its influence on individual wage growth, firms have the possibility to adjust the composition of the workforce to a profit maximizing level.

Whether this phenomenon biases the results or not is difficult to answer. Obviously, if the pool of workers in the sample does not change from period to period, worker fixed effects cancel out when we take first differences and as $\Delta \bar{f}_i = 0$, no bias is present. Clearly, the drawback of the database is that one cannot directly test the orthogonality between $\Delta \bar{f}_i$ and $\Delta \varepsilon_{jt}$. It is possible, however, to interfere manually in the sampling and weighting scheme and thus to influence $\Delta \bar{f}_i$. For instance, the similarity of the results in column 1, 2 and 4 of Table 6 suggests that different sampling and weighting procedure - which may affect $\Delta \bar{f}_i$ - has little effect on the results and carefully insinuate that the aggregation bias is small or insignificant. I also performed a bootstrap procedure in which I randomly dropped out 50% of the workers in each firm each year, I aggregated the variables (without weighting) to the firm level and re-estimated the model. The strength of this bootstrap procedure depends on, for example, the size of the sample and the subsample: when the sample size goes to infinity, the half-sample is expected to have the same statistical properties as the whole sample and accordingly, the resampling procedure has little effect on $\Delta \bar{f}_i$. In our sample, the median number of observations is 6 and the mean is 12.8 per firm per year. It is reasonable to assume that the bootstrap procedure I used has a significant influence on the distribution of the workers and consequently on $\Delta \bar{f}_i$. After 30 iterations, the standard deviations of the estimated parameters (0.033 for α and 0.017 for β) indicate that results are robust for different samplings and consequently the change in the workforce composition has only marginal effect on the results.

Another possibility for testing the aggregation bias is to create longitudinal links using individuals' observed characteristics and re-estimate the model on the individual data. Evidently, linking individuals manually might create measurement error in the differenced variables, the size of which largely depends on the narrowness of the classification of the variables used for creating longitudinal links. In this experiment, I linked observations within the same firm using gender, birth date (year and month for 2002-2004 and only year for the earlier period), educational level and the detailed, 4-digit ISCO (International Standard Classification of Occupations) classification. This latter criterion also ensures that workers changing occupation are excluded from the experiment and wage changes associated with occupational changes do not affect the results. In order to minimize the measurement error I restricted my analysis to the years 1996-2004, as from 1996, information on educational level is more detailed (9 classes instead of 5). The database contains information on tenure after 2002 which I have also taken into account when creating individual links. In cases where I found more than one possible link for a specific observation, I excluded it from the analysis. I also dropped out observations for which a link was created and the worker was registered as new entrant. As a result, I found at least one preceding observation for 29% of the cases. Knowing that only around 10% of the individuals are new entrants, this result seems rather poor. Nevertheless, the strategy I used minimizes the risk of using erroneous links and the resulting database is still large enough to perform the robustness check. Results are presented in the last column of Table 6 and are very similar to the baseline findings. As the sample size increases considerably when using individual data, it is not surprising that the significance intervals of the regression coefficients are reduced. On the other hand, Hansen's tests of overidentifying restrictions are in fact rejected at the 5% level but the statistics are not far from the acceptable range, especially in case of the sensitivity to the transitory shocks. Since the reliability of the longitudinal links is subject to scepticism, I have also tested whether results are sensitive to extreme values of wage increases by recursively reestimating the model for different outlier-thresholds (1^{st} to 99^{th}, 5^{th} to 95^{th} and 10^{th} to 90^{th} percentiles of the distribution). All these estimates are significantly different from zero and fall inside the 95% confidence interval of the original estimation.

Probably the most convincing way to rule out all doubt about the aggregation bias is to estimate the parameters of interest using both the original procedure and the aggregated version on an adequate panel dataset and compare the results. Re-estimating the model published in Guiso et al. (2005) on the same Italian database using my estimation strategy produces similar parameter estimates to the original. Most importantly the parameter of the transitory shock remains close to zero and insignificant.[14] This experiment together with the previous statistical tests provide robust evidence to discard the aggregation bias.

5.4 What makes the difference?

A set of factors may help to support the reason why the Hungarian case differs from the Italian and the Portuguese one. These factors may be related to the combination of the economic environment and the institutional background. Due to the lack of an adequate database, the influence of these factors is hard to test directly and this challenge definitely represents a new research direction. At this stage it would be pretentious to make clear the reasons behind the peculiarity of the Hungarian results or even to give an exhaustive review of all possible explanations. Based on the theoretical literature, previous empirical findings and on common sense, this section is rather intent to set the possible directions to follow.

[14] These results are not published in this paper. I am heavily indebted to Fabiano Schivardi, who helped me a lot by comparing the two estimation methods on the Italian dataset.

Table 6: Robustness checks

	Baseline		Excluding new entrants		Gross earnings		Not weighted		Linked individuals	
	(1)		(2)		(3)		(4)		(5)	
	Permanent shock									
	coef.	*Z stat.*	*coef.*	*Z stat.*	*coef.*	*Z stat.*	*coef.*	*Z stat.*	*coef.*	*Z stat.*
Sensitivity	0.107	*5.26*	0.121	*6.24*	0.128	*6.44*	0.071	*3.33*	0.093	*7.47*
Hansen J-test	6.73	[0.151]	6.392	[0.172]	5.736	[0.220]	4.061	[0.398]	11.082	[0.026]
	Transitory shock									
	coef.	*Z stat.*	*coef.*	*Z stat.*	*coef.*	*Z stat.*	*coef.*	*Z stat.*	*coef.*	*Z stat.*
Sensitivity	0.055	*2.51*	0.038	*1.82*	0.043	*2.16*	0.057	*2.45*	0.047	*3.12*
Hansen J-test	6.61	[0.158]	2.442	[0.655]	4.608	[0.330]	5.352	[0.253]	9.515	[0.049]

Source: Wage Survey and Apeh database, 1993-2004

Notes: The table reports the GMM estimates of the sensitivity of wages to value-added shocks. Columns 1 to 4 report estimation results on firm-level aggregated data for the whole sample (1993-2004) and the last column presents results obtained using manually linked individual data for years 1996-2004. The estimation procedure and instruments are explained in the text. Heteroscedasticity-robust standard errors estimates. Values in brackets are p-values.

First, borrowing constraints for firms may serve as argument in favour of less insurance. In case of imperfect capital markets, the optimal risk allocation between firm and workers is a result of counter-weighting gains from reducing the variability in the compensation of risk averse workers and increasing cost of external capital and tightening borrowing constraints caused by higher leverage.[15]. Kharroubi (2004) also shows that in economies with highly volatile macroeconomic environment, financial market imperfections may make it optimal to provide less insurance to employees. For Hungary, being an economy in transition with relatively high volatility of macroeconomic shocks and lower degree of financial market development than Western European countries, these findings provide a possible explanation for the results I obtained.

Second, the difference in insurance against transitory fluctuations and persistent shocks only makes sense if firms can accurately recognize the nature of the shock. Again, the continuously restructuring economic environment with hardly predictable future path of the shocks may force firms to stay, in many cases, on the safe side and react to a variety of shocks of different nature as if they were persistent.

And finally, the institutional background may play a major role in the amount of insurance provided by the firms. As already mentioned, companies operating in Hungary face much less constraints either in negotiating individual wages or on lay-offs. Under these circumstances, firms can credibly use performance pay and the threat of a layoff to motivate workers to a greater extent. As a side effect workers feel less secure in their employment. Based on OECD measures of job security, Hungarian workers' perception of employment security is among the worst in Europe.[16] If employees feel vulnerable about their job security and future job prospects, enforcement problems may well arise as the attractiveness of a long-term implicit wage insurance contract - which can be violated at any time - may be limited.

[15] see e.g. Ichino (1994)

[16] See Horváth and Szalai (2007) for details.

6 Conclusion

This paper provides empirical evidence that Hungarian workers are more exposed to product market fluctuations in their wages than their Italian and Portuguese counterparts. Using matched employer-employee dataset, I followed the estimation strategy proposed by Guiso et al. (2005) and later replicated by Cardoso and Portela (2005) and I found that unlike Portuguese and Italian firms, Hungarian firms do not fully insure workers against transitory shocks. Wage responses to permanent value-added shocks are also higher, indicating that at least in this dimension, wages are more flexible in Hungary than in most of the Western European countries. The paper puts emphasis on evaluating the possible bias that might arise as a result of the necessary deviation from the original estimation procedure and strongly suggests that it has only marginal effect on the parameters of interest.

Wage flexibility is generally deemed to be good for employment and economic prosperity. If wages are more responsive to labour and product market conditions, the real fluctuations generated by both demand and supply shocks are smaller and the economy can operate at a higher level of activity without inflationary pressures. Furthermore, wage flexibility is often cited as the main - though imperfect - substitute for an own monetary policy. In this respect results are comforting as firms can more easily attenuate adverse shocks which are so common in an economy in transition with often unpredictable economic policy. On the other hand the negative aspect of this specific dimension of wage flexibility lies in the welfare costs generated by higher volatility of wages. It is a trade-off between flexibility and security and policy makers should definitely keep both aspects in mind when taking decisions.

In order to clearly see the reasons behind my findings further investigation is required. Several arguments are put forward in the paper supporting the results, such as tighter borrowing constraints for firms, the continuously restructuring economic environment with hardly predictable future path of the shocks or the highly flexible labour market institutions in EU-comparison.

Disentangling these effects is not a challenge for its own sake. On the one hand, it is needed to better understand the consequences of these particularities of the economy on the wage setting behaviour of the firms, and on the other hand to anticipate the evolution of the flexibility of wages in the future. One day Hungary is expected to catch up with Europe and most of the specificities previously mentioned will vanish. Only the institutional background is expected to remain unchanged without government intervention and consequently its effect on wage sensitivity to product market fluctuations would persist.

Finally, the paper reinforces that the European labour market is far from being homogeneous between countries. Similarly to Guiso et al. (2005) I also suggest extending the analysis to other countries, especially to economies in transition. In fact the circumstances in which firms are operating in Hungary are rather close to those of other New Member States in many respects. If not "only" ten million Hungarians are concerned but the results presented in this paper are relevant to most of the Central and Eastern European countries, it gives another dimension to these differences.

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Appendix

As noted in Section 4.1, the variables used in this study come from two sources: corporate tax returns of all double entry book keeping firms (*Apeh database*) and the National Labour Centre's *Wage Survey*. Variables are either taken directly from the datasets or constructed from variables available in the datasets.

Information on firms from the *Apeh database*:

Value added: Value added was calculated by subtracting the value of input material costs from the value of turnover net of indirect taxes, deflated by the 2-digit sectoral GDP deflator. Due to change in accounting legislation in 2001, total turnover includes indirect taxes as well. As we have no information in the database on the magnitude of this latter, the bias was corrected by subscribing the industry-level mean fraction of indirect taxes from total turnover. The following numbers are provided by the Hungarian CSO, expressed as the ratio of indirect taxes in total turnover and in input material costs:

Year	NACE	Turnover	Input materials
2001	15	0.0232	0.0044
	16	0.5622	-
	23	0.2239	0.0894
2002	15	0.0233	0.0044
	16	0.5915	-
	23	0.2265	0.0861
2003	15	0.0229	0.0005
	16	0.6713	-
	23	0.2165	0.0791
2004	15	0.0234	0.0005
	16	0.7265	-
	23	0.2520	0.0912

Capital: The capital stock was constructed using the idea of the perpetual inventory method (PIM) as described in Kátay and Wolf (2004).

Labour: Annual average full-time equivalent employment at the firm, rounded to the nearest integer.

Input materials: I used input material costs as a proxy in the Levisohn-Petrin procedure. It includes raw materials and consumables, contracted services, other service activities, original cost of goods sold, value of services sold (intermediated)[17], deflated by sectoral input material price deflator. As yet the Hungarian Central Statistics Office has not published industry specific input material price indices, hence I simply calculated them as the ratio of intermediate input material consumption (the difference between sales and GDP) at current and constant prices.

Industry: Classification based on NACE codes.

Information on workers from the *Wage Survey*:

Gross earnings: Gross monthly wage includes all regular and overtime pay plus nonwage compensation paid to the worker in May, the month of the survey. I deflated earnings using the consumer price index.

Net earnings: Net earnings were calculated by subtracting personal income tax, pension, social security and employee contributions from gross earnings on the basis of the effective taxation legislation in a given year. Tax credits are not taken into account.

Job grade: Simplified classification based on ISCO (International Standard Classification of Occupations) codes. I defined managers (1^{st} major group), non-manual (2^{nd} to 4^{th} major group) and manual workers (5^{th} and greater major group)

New entrants: Workers who entered the firm within the last 12 months.

Individual characteristics: Gender, age and highest completed educational grade.

Individual weight: It is the number of workers represented by a respondent within the firm.

[17] Terminology is taken from the official translation of the Act C of 2000 on Accounting.

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