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# WAGE STRUCTURE AND FIRM PRODUCTIVITY IN BELGIUM

Thierry Lallemand
Robert Plasman
Francois Rycx

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## ABSTRACT

The objective of this paper is twofold. First, we analyse the structure of wages within and between Belgian firms. Next, we examine how the productivity of these firms is influenced by their internal wage dispersion. To do so, we use a large matched employer-employee data set (i.e., a combination of the 1995 'Structure of Earnings' and 'Structure of Business' Surveys). On the basis of the methodology developed by Winter-Ebmer and Zweimuller (1999), we find that within-firm wage dispersion has a positive and significant effect on firm productivity. This result is robust to controls for individual and firm characteristics as well as to instrumenting the wage inequality variable. Findings also suggest that the intensity of this effect is stronger within firms with: i) a majority of blue-collar workers, and ii) a high degree of monitoring. These results are more in line with the 'tournament' models than with the 'fairness, morale and cohesiveness' models.

Thierry Lallemand
Universite Libre de Bruxelles,
Department of Applied Economics,
CP 140 - Av. F.D. Roosevelt, 50
1050 Brussels - Belgium
tlallema@ulb.ac.be

Robert Plasman
Universite Libre de Bruxelles,
Department of Applied Economics,
CP 140 - Av. F.D. Roosevelt, 50
1050 Brussels - Belgium
rplasma@ulb.ac.be

Francois Rycx
Universite Libre de Bruxelles,
Department of Applied Economics
& Institute for the Study of Labor (IZA)
CP 140 - Av. F.D. Roosevelt, 50
1050 Brussels - Belgium
frycx@ulb.ac.be

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## 1. Introduction

Relative wages are often considered as a key determinant of the workers' effort. Indeed, since workers often compare their wages with those of their co-workers, it is argued that the intra-firm wage dispersion has an impact on the individual worker's productivity and thus on the average firm performance. However, there is no consensus regarding the precise impact of intra-firm wage dispersion on firm productivity. On the one hand, the single-period rank-order version of the 'tournament' models (e.g., Lazear and Rosen, 1981) stresses the positive influence of wage inequality within a firm on the worker's effort. This model suggests that firms should implement a differentiated prize structure and award the largest prize to the most productive worker. On the other hand, other theories argue for some wage compression within a firm by emphasising the importance of fairness and cooperation among the workforce (e.g., Akerlof and Yellen, 1990; Levine, 1991).

Empirical studies, focusing on the relationship between wage disparities and firm performance, are not very numerous and their results vary significantly. Due to a lack of appropriate data, these studies often rely on economy-wide inequality indicators or use 'self-constructed' indicators of firm performance. Moreover, they are generally restricted to a specific segment of the labour force (e.g., the top-management level) or a particular sector of the economy (e.g., the manufacturing sector, academic departments, professional team sports). In sum, the available evidence does not appear to be very compelling yet (Frick *et al.*, 2003).

The aim of this paper is twofold. First, we analyse the structure of wages within and between Belgian firms. Next, we examine how the productivity of these firms is influenced by their internal wage dispersion. Our study is based on a unique matched employer-employee data set. This data set derives from the combination of the 1995 'Structure of Earnings Survey' and the 1995 'Structure of Business Survey'. The former contains detailed information on firm characteristics (e.g., sector of activity, size of the firm, and level of wage bargaining) and on individual workers (e.g., gross hourly wages, bonuses, age, education, sex, and occupation). The latter provides firm-level information on financial variables (e.g., gross operating surplus, value added, and value of production).

To analyse the impact of wage dispersion on firm productivity, we followed the methodology developed by Winter-Ebmer and Zweimüller (1999). It rests upon a two-step estimation procedure. Firstly, we compute conditional intra-firm wage differentials by taking the standard errors of wage regressions run for each firm. Next, we use these conditional wage differentials as an explanatory variable in a firm-level productivity regression. However, as a sensitivity test, we also analyse the impact of unconditional indicators of intra-firm wage dispersion on firm productivity. These indicators include the standard deviation, the coefficient of variation and the max-min ratio of the gross hourly wages within the firm. The productivity of a firm is measured by the value-added per employee. We address the potential simultaneity problem between wage dispersion and firm productivity using information from the Belgian income tax system. More precisely, we apply two-stage least squares (2SLS) and instrument the dispersion of wages *including* bonuses by the intra-firm standard deviation of income taxes on gross earnings *excluding* bonuses.

To our knowledge, this paper is one of the first to examine the effect of intra-firm wage dispersion on firm performance in the private sector using both a conditional wage inequality indicator and direct information on firm productivity. It is also one of the few, with Bingley and Eriksson (2001) and Heyman (2002), to consider potential simultaneity problems. Empirical findings, reported in this paper, support the existence of a positive and significant relationship between wage inequality and firm productivity. Moreover, we find that the intensity of this relationship is larger for blue-collar workers and within firms with a high degree of monitoring. These results are more in line with the 'tournament' models than with the 'fairness, morale and cohesiveness' models.

The remainder of this paper is organised as follows. Section 2 reviews the literature (both theoretical and empirical) dealing with the impact of intra-firm wage dispersion on firm productivity. Section 3 summarises the main features of the wage bargaining process in the Belgian private sector. Section 4 and 5 describe the data and variables as well as structure of wages within and between Belgian firms. The impact of intra-firm wage dispersion on firm productivity is analysed in Section 6. The last section concludes.

## 2. Review of the Literature

### 2.1. Theoretical Findings

A first interpretation of the relationship between within-firm wage dispersion and firm performance has been provided by Akerlof and Yellen (1988). On the basis of the effort version of the 'efficiency wage' theory (Solow, 1979), the authors argue that, in a firm where the workers' characteristics are not totally observable and where the monitoring of their actions is not perfect, employers have to find well-suited incentives to maximise the workers' effort. According to Akerlof and Yellen (1988), the effort function of a worker can be written as follows: $e = e(\sigma^2(w))$, where e denotes the level of effort and $\sigma^2(w)$ the variance of wages within the firm. This expression shows that the worker's effort does not only depend on the wage level but also on the degree of salary dispersion within the firm. Using this expression, the authors argue that a compressed wage distribution improves labour relations and stimulates the average workers' effort. To put it differently, firms should achieve a greater output per worker if their wage dispersion is low.

Later, Akerlof and Yellen (1990) developed the 'fair wage-effort' hypothesis. This hypothesis clarifies their previous reasoning by developing in greater detail the notion of fairness and introducing the concept of relative wages.[1] The basic idea is that workers often compare their wages either internally (i.e., with workers within the same firm) or externally (i.e., with workers in other firms or industries). Therefore, Akerlof and Yellen (1990) consider the following worker's effort function: $e = \min[(w / \hat{w}),\ 1]$, with $w$ the actual wage, $\hat{w}$ the fair wage and e equal to one if the level of effort is normal. This expression shows that workers reduce their effort if their actual wage falls short of the wage they regard as fair. According to the authors, a wage is generally considered as fair if the pay spread is lower than the performance differential. This means that a worker would act so as to preserve a certain equilibrium between the subjective value of input and the subjective value of return. Levine (1991) put forward this argument by stressing that pay compression, within a firm where

[1] The 'fair wage-effort' hypothesis is based on the social exchange theory in sociology (e.g., Blau, 1955; Homans, 1961) and on the equity theory in psychology (e.g., Adams, 1963). Both theories show the existence of a relationship between effort and fairness.

teamwork among employees is essential (i.e., participatory firms), sustains and stimulates cohesiveness, which increases the firm's total productivity.

The above notions of fairness, morale and cohesiveness led Hibbs and Locking (2000) to define the following firm-level production function: $Q = Ef\left[\sigma^2(w)\right]F(L,...)$, with Q the real value-added, Ef(.) the labour effectiveness depending on the within-firm wage dispersion, F a standard production function and L the labour inputs to production. This expression shows that the performance of a firm depends positively upon the efficiency of labour, which is negatively correlated with the intra-firm wage dispersion (i.e., Ef'<0, Ef''>0). As a result, this model of 'fairness, morale and cohesiveness' suggests that firms have a strong incentive to implement a wage distribution that is more compressed than the variation in workers' productivities.

A complementary theory promoting wage compression to increase firm performance has been developed by Milgrom (1988), and Milgrom and Roberts (1990). The authors emphasize that (white-collar) workers have incentives to: i) withhold information from managers in order to increase their influence and, ii) engage in costly rent-seeking activities instead of productive work. They also argue that the implementation of some wage equity can reduce the potential tendency of workers to take personal interest decisions, which may not be profitable for the organisation as a whole. Moreover, they stress that it is more costly to monitor the actions of white-collar workers. Therefore, lower levels of wage dispersion would be even more important for the latter.

In contrast to the previous literature, the 'relative compensation' or 'tournament' model, developed by Lazear and Rosen (1981), points to the benefits of a more dispersed wage structure, deriving from a performance-based pay system. The single-period rank-order version of the tournament model suggests that managers should introduce a large spread in the rewards of workers in order to stimulate their effort. In other words, firms should establish a prize structure and award the largest prize to the most productive worker.[2] The intuition of this model is as follows.[3] Consider two identical risk-neutral workers j and k and a risk-

[2] There is some ambiguity in the literature about the definition of a prize. It can be seen either as a promotion (i.e., to get a task with higher responsibilities and to rise in the firm hierarchy) or as a bonus.

[3] For a more detailed description of the model see Gibbons and Waldman (1999) or Eriksson (1999).

neutral firm, with a compensation scheme such that the most productive worker receives a high wage ($W_H$) and the less productive a low wage ($W_L$). Let us also assume that the player's output level is given by (1):

$$q_i = e_i + \varepsilon_i , \quad i = j, k \tag{1}$$

with $q_i$ and $e_i$ respectively the player's output and effort level, and $\varepsilon_i$ a random component (e.g., luck). Finally, suppose that the expected utility of the jth player is given by (2):

$$P(W_H - C(e_j)) + (1 - P)(W_L - C(e_j)) = P(W_H - W_L) + W_L - C(e_j) \tag{2}$$

where P is the probability of winning the game and C(.) is a cost function, with C'>0 and C''<0. In this framework, the probability for the player j to win the game is as follows:

$$\begin{aligned} prob(q_j > q_k) &= prob((\varepsilon_k - \varepsilon_j) < (e_j - e_k)) \\ &= prob((e_j - e_k) > \zeta ) \\ &= G(e_j - e_k), \end{aligned} \tag{3}$$

where $\zeta = (\varepsilon_k - \varepsilon_j)$, $\zeta \sim g(\zeta)$ with zero mean, and G is the cumulative density function of $\zeta$. A worker maximizes his expected utility by choosing the effort level at which the marginal cost of effort is equal to its marginal benefit. Therefore, worker i's optimal effort choice is defined by (4):

$$(W_H - W_L)\, \partial P/\partial e_i - \partial C/\partial e_i = 0 \tag{4}$$

If both players are maximising (3), we find that:

$$\begin{aligned} \partial P/\partial e_j &= \partial G(e_j - e_k)/\partial e_j \\ &= g(e_j - e_k), \end{aligned} \tag{5}$$

which after substitution in (4) gives player j's best reaction function:

$$(W_H - W_L)\, g(e_j - e_k) = \partial C/\partial e_j \tag{6}$$

Given the assumption of identical workers, we know that both players will choose the same level of effort. In symmetric Nash equilibrium, $e_j = e_k$ and the outcome of the game is random, i.e. P = 0,5. Therefore, expression (6) can be rewritten as follows:

$$(W_H - W_L)\ g(0) = \partial C / \partial e_j \qquad (7)$$

Two lessons can be drawn from equation (7). Firstly, we find that *ceteris paribus* the level of effort is increasing with the prize dispersion ($W_H – W_L$). Secondly, expression (7) shows that, for a given wage spread ($W_H – W_L$), a higher density at the expectation of the random components of the output, the more it pays to exert effort. This theory has been generalized by McLaughlin (1988) for *n* players. The author shows that the number of players matters and that the probability to win a game decreases with the number of contestants. Consequently, to stimulate the workers' effort, there should be a positive correlation between the prize spread and the number of contestants.

Lazear (1989, 1995) argues, however, that high within-firm wage dispersion generates more competition between the workers which may negatively affect firm performance. Indeed, considering an organisation in which several workers are non-cooperative or have a sabotage behaviour ('hawks') and others who are less aggressive ('doves'), the author shows that wage compression is crucial for firm performance.[4] The point is that the non-cooperative activities adopted by 'hawks' reduce the total effort level of the workers. In other words, the positive impact of an output-based pay system on firm performance may be offset by a lower level of work cohesion due to the sabotage behaviour of 'hawks'. As a result, it appears profitable for a firm to: i) adequately sort out workers before hiring them and, ii) adjust the compensation scheme to the hierarchical level.

A further strand of the literature, developed by Frey (1997) and Frey and Osterloh (1997), focuses on the interplay between wage dispersion and intrinsic motivation.[5] This literature shows that the implementation of explicit incentive contracts (e.g., performance-based pay

[4] According to Lazear (1989, 1995), 'hawks' are often found at the top level of the organisation, i.e. mainly among white-collar workers. His arguments are thus in line with those of Milgrom (1988) and Milgrom and Roberts (1990). The counter-productive effect should be greatest within the higher echelons of the hierarchy.

[5] It derives from the psychological literature which suggests that intrinsic motivation is the main driving force of workers' effort.

systems) can crowd out the intrinsic motivation of the workers by generating excessive external monitoring (in particular, for workers who need autonomy in their job and who have high responsibilities). However, it can also enhance intrinsic motivation by supporting the workers' own motivation, self-esteem and feeling of competence. In sum, this literature emphasizes the importance of a correct match between the compensation scheme and the monitoring environment within a firm (Belfield and Marsden, 2003).

## 2.2. Empirical Findings

Empirical studies examining the relationship between wage disparities and firm performance are not very numerous and their results vary markedly. Due to a lack of appropriate data, these studies often rely on economy-wide inequality indicators or use 'self-constructed' indicators of firm performance. Moreover, they are generally restricted to a specific segment of the labour force (e.g., the top-management level) or a particular sector of the economy (e.g., the manufacturing sector, academic departments, professional team sports). In what follows, we review the main features of these studies.[6]

A first strand of the empirical literature provides evidence in favour of the 'fairness, morale and cohesiveness' theory, developed by Akerlof and Yellen (1990) and Levine (1991). Cowherd and Levine (1992), for instance, examine the relationship between interclass pay equity[7] and the performance of business units, by integrating the body of equity, relative deprivation and quality management theories. Their study is based on data collected from 102 business units with more than 59 employees, in North America (72%) and Europe (28%). The performance of a business unit is measured by the quality of its production.[8] According to the authors, product quality is a good indicator of firm performance since it is: i) difficult for managers to control, and ii) a function of the willingness of lower-level employees to contribute more than can formally be asked from them. Their empirical findings show the

[6] For a summary see Appendix 1.

[7] Interclass pay equity is measured by the pay relation of hourly paid employees to top-three levels of management, controlling for the business size effect. A business unit is defined as any autonomous organisational unit that has top management with decision-making authority in areas like manufacturing and sales.

[8] The latter is measured by customers in relative terms, i.e. in comparison with the product quality of the main competitors of each business unit.

existence of a substantial positive relationship between interclass pay equity and product quality. The authors attribute this result to the impact of pay equity on three aspects of lower-level employee motivation, i.e. commitment to managerial goals, effort and cooperation.

Pfeffer and Langton (1993) analyse how within-academic departments wage dispersion and pay schemes affect the individual's satisfaction, research performance and cooperation, using a large sample of college and university faculty in the UK.[9] Their data set contains information on *circa* 17,000 college and university professors from 600 academic departments located in some 300 institutions.[10] Salary dispersion is measured by an unconditional indicator, i.e. the coefficient of variation (the standard deviation divided by the mean) in salaries within a given academic department. Controlling for numerous predictors, the authors observe statistically and substantively significant negative effects of pay dispersion. To put it differently, they find that, on average, people are less satisfied, do less collaborate on research, and have a lower productivity when the pay distribution is more dispersed. Moreover, results show that the extent to which wage dispersion produces adverse effects depends upon one's position in the salary structure and factors such as information, commitment, consensus and the level of certainty in the evaluation process.

A number of studies, essentially concentrated on the US, have been devoted to the interaction between salary dispersion and performance in the team sports industry. Using mainly unconditional measures of wage inequality (e.g., the Gini-index), these studies generally conclude that pay compression is beneficial for team performance (e.g., the win-loss percentage).[11] The study of Frick *et al.* (2003) is the first to attempt to measure the impact of pay inequalities on the performance of professional team sports across different leagues. Their approach enables to implicitly control for the influence of different institutional regimes and production technologies. Using panel data from the four major North American sports leagues (i.e., baseball, basketball, football and hockey), their study supports neither the 'fairness, morale and cohesiveness' hypotheses nor the 'tournament' theories. Indeed, findings vary

[9] The data come from the Carnegie Commission's 1969 survey of college and university faculty.

[10] The authors confined their attention to respondents in departments with a size of 20 or larger that had a response rate to the questionnaire greater than 50%.

[11] For professional baseball teams, see Bloom (1999), DeBrock *et al.* (2001), Depken (2000), Harder (1992) or Richards and Guell (1998). For soccer and hockey teams, see respectively Lehmann and Wacker (2000) and Gomez (2002).

substantially between the four leagues. According to their estimates, a higher degree of intra-team wage dispersion is beneficial to the performance of professional basketball and hockey teams.[12] However, the reverse relationship is found for football and baseball teams, i.e. a team is more successful if its pay distribution is more compressed. The authors attribute the diversity in their results to the different degrees of 'cooperation requirements' in the four leagues.

Another strand of the empirical literature offers evidence in favour of the 'tournament' theory, developed by Lazear and Rosen (1981). Winter-Ebmer and Zweimüller (1999), for instance, investigate the impact of intra-firm wage dispersion on firm performance using panel data covering the whole Austrian workforce for the period 1975-91.[13] They measure within-firm wage inequality by the standard errors of firm-level wage equations. This conditional indicator controls for the composition of the workforce within each firm.[14] Unfortunately, the authors did not observe the financial performance of the firms. As a result, they have constructed their own performance indicator, i.e. standardised wages. Of course, this instrument is not perfectly adequate. Be it as it may, controlling for several predictors, their findings suggest the existence of a positive and hump-shaped relationship between intra-firm wage dispersion and firm performance, for both blue- and white-collar workers. Yet, the overall pattern appears more monotonic for blue-collar workers. These findings are in line with the hypothesis that too little wage inequality negatively affects firm performance due to a lack of incentives. However, they also suggest that excessive wage dispersion can be harmful for productivity because of fairness effects. According to the authors, the contrasting results for blue- and white-collar workers appear to be consistent both with theories of intrinsic motivation and rent-seeking, and with the prevalence of piece rates in blue-collar jobs.

Hibbs and Locking (2000) examine the effects of changes in the overall wage dispersion, during the periods 1964-93 and 1972-93, on the productive efficiency of Swedish industries and plants. To do so, they firstly decompose the total variance in individual wages *within* and *between* plants (and industries). Next, they integrate the squared coefficients of variation of

[12] For hockey teams, the coefficient is positive but not significantly different from zero.

[13] Their sample is restricted to firms with more than 20 employees and with at least 4 data points.

[14] The data report monthly earnings that are top coded. The explanatory variables in the tobit wage regressions, ran separately for each firm, include age, age squared and dummies for sex, blue-collar, foreigner and two tenure dummies. Information on education levels is not available.

these components at the plant (or industry) level, in an Akerlof and Yellen's (1990) type of production function. The dependent variable in this equation, i.e. their performance indicator, is the log of real value-added at the plant (or industry) level.[15] Their empirical findings do not confirm that wage levelling within plants and industries enhance productivity. Therefore, they do not support the 'fairness, morale and cohesiveness' theories.

Bingley and Eriksson (2001) analyse the impact of pay spread and skewness on two performance indicators, i.e. firm productivity and employee effort. Their study uses longitudinal matched employer-employee data comprising information on Danish medium- and large private sector firms during the period 1992-95. It is the first to address potential simultaneity problems using information from the income tax system. Firm productivity and employee effort are estimated by the total factor productivity and the sickness absence, respectively. Differences in firm productivity effects between the occupational groups and types of firms give support to the theories of fairness, tournaments and tastes for skewness. In contrast, individual effort effects only back up the tournament theory.

Finally, a number of papers present evidence on the interaction between the pay structure of top executives and firm performance. Focusing on managers in large US firms, Leonard (1990) finds no significant relationship between the standard deviation of pay and firm performance, i.e. the return on investment. In contrast, using respectively US and Swedish data, Main *et al.* (1993) and Eriksson (1999) report a positive impact of top executive pay dispersion on firm performance. The latter is measured by returns on assets and the profits/sales ratio, respectively. The paper of Heyman (2002) is the first to explicitly control for firm differences in human capital when testing several predictions from the tournament theory for white-collar workers and in particular managers.[16] Potential endogeneity problems are addressed using lagged predetermined values of wage dispersion. On the basis of a large matched employer-employee data set for the Swedish economy in 1991 and 1995, the author finds a positive effect of wage dispersion on profits.

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[15] Their production function is as follows: $\ln[Q] = \ln[Ef(\sigma^2(w))\ F(.)]$, where $Ef(\sigma^2(w))) = Ef(CV^2(W),CV^2(B))$. In this expression, Q represent the real value-added, Ef(.) the labour effectiveness depending on $\sigma^2(w)$ (i.e., the total variation in individual wages), and F(.) a standard production function (e.g., Cobb-Douglas, CES or Translog). $CV^2(W)$ and $CV^2(B)$ stand respectively for the within and between components of the total variance of individual wages (squared coefficient of variation) among workers assortment by plants (or industries).

[16] His conditional indicator of wage dispersion is the same as in Winter-Ebmer and Zweimüller (1999).

## 3. Wage Bargaining in Belgium

Before describing our data set and turning to the empirical analysis, we briefly summarize the main features of the wage bargaining process in the Belgian private sector.

In the countries of North America the legal provisions offer workers the possibility of voting for or against their companies' joining a union in elections supervised by the public authorities. This means that the union can earn the exclusive right to represent all the workers, whether union members or not, in bargaining with the employers. Yet as the majority of the collective agreements are negotiated at the level of the individual companies, the institutional system leads to a clear distinction between the unionised establishments, in other words those which are subject to a collective agreement, and the non-unionised establishments. Hence, the rate of unionisation provides a good approximation of the coverage rate/the bargaining regime.

In Belgium, as in the majority of European countries, the situation is very different. The point is that wage bargaining in the Belgian private sector occurs at three levels : the national (interprofessional) level, the sectoral level and the company level. They generally occur every two years on a pyramidal basis. In principle, they are inaugurated by a national collective agreement defining a minimum level in wage terms. This national agreement can be improved within every sector of activity. Then we have the company negotiations where the sectoral collective agreements may be renegotiated, except where there is a so-called imperative clause. However, these cannot give rise to a collective agreement which would run counter to the sectoral and/or national agreements. In other words, the wage bargained at the firm level can only be greater or equal to the wage set at the national and/or industry level.

Belgium is characterised, in addition, by a coverage rate of about 90% (OECD, 1997). This stems from the fact that non-unionised workers, like employers not members of an employers' organisation, are generally covered by a collective labour agreement. The point is that Article 19 of the law dated 5 December 1968 specifies that a collective agreement is automatically binding upon the signatory organisations, employers who are members of those organisations or who have personally concluded the agreement, employers joining those organisations after the date of the conclusion of the agreement, and finally, all workers, *whether unionised or* *not*, who are employed by an employer so bound. Moreover, most of the sectoral collective agreements have been rendered obligatory by Royal Decree. This means that they apply compulsorily to all companies in the sector and to their workers, *whether or not they are members* of the signatory organisations (employers' organisations or unions).[17]

To sum up, unlike in the US or Canada, the bargaining regime in companies in the Belgian private sector does not derive directly from the latter's union membership. It is reflected more through the level of wage bargaining. The heart of the wage bargaining lies at the sectoral level in Belgium. However, in certain cases, sectoral agreements are renegotiated (improved) within individual companies.

## 4. Data and Variables

Our analysis is based upon a unique combination of two large-scale data sets. The first, conducted by Statistics Belgium[18], is the 1995 'Structure of Earnings Survey' (SES). It covers all Belgian firms employing at least 10 workers and with economic activities within sections C to K of the Nace Rev.1 nomenclature. It thus encompasses the following sectors: mining and quarrying (C), manufacturing (D), electricity and water supply (E), construction (F), wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods (G), hotels and restaurants (H), transport, storage and communication (I), financial intermediation (J), and real estate, renting and business activities (K). The survey contains a wealth of information, provided by the management of the firms, both on the characteristics of the firms (e.g., sector of activity, number of workers, level of collective wage bargaining, type of economic and financial control, region) and on the individual employees (e.g., age, educational level, tenure, gross earnings, paid hours, sex, occupation, type of contract, annual bonuses).[19] Gross hourly wages – *without* bonuses[20] – are calculated by dividing total gross

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[17] The trade union density in Belgium stands at around 54% (OECD, 1997).

[18] According to the instructions given by Eurostat (E-U regulation Nr. 2744/95)

[19] The SES is a stratified sample. The stratification criteria refer respectively to the region (NUTS1), the principal economic activity (NACE-groups) and the size of the firm (determined by the data obtained from the Social Security Organisation). The sample size in each stratum depends on the size of the firm. Sampling percentages of firms equal respectively 10, 50 and 100% when the number of workers is lower than 50, between 50 and 99, and above 100. Within a firm, sampling percentages of employees also depend on size. Sampling percentages of employees reach respectively 100, 20 and 10% when the number of workers is lower than 50,

earnings (including earnings for overtime hours and premiums for shift work, night work and/or weekend work) in the reference period (October 1995) by the corresponding number of total paid hours (including paid overtime hours). In contrast, gross hourly wages – *with* bonuses – are obtained by adding to the gross hourly wages (without bonuses) the annual bonuses divided by: i) the number of month to which the bonuses correspond and ii) the number of total paid hours in the reference period, respectively.

Unfortunately, the SES provides no financial information. This is why the SES has been combined with the 1995 'Structure of Business Survey' (SBS). It is a firm-level survey, conducted by Statistics Belgium, with a different coverage than the SES in that it includes neither the financial sector (Nace J) nor the firms with less then 20 employees. Both data sets have been merged by Statistics Belgium using the firm social security number. The SBS provides firm-level information on financial variables such as sales, value added, production value, gross operating surplus and value of purchased goods and services.

The final sample, combining both data sets, covers 34,969 individuals working for 1,498 firms.[21] It is representative of all firms employing at least 20 workers within sections C to K of the Nace Rev.1 nomenclature, with the exception of the financial sector.

## 5. Structure of Wages Within and Between Firms

In this section, we analyse the structure of gross hourly wages, with and without bonuses, in the Belgian private sector. In particular, we focus on the dispersion of wages within and between firms. Between firms wage dispersion is measured by the standard deviation of each firm's mean wage. Within firms wage inequality is estimated by the mean over all firms of each firm's standard deviation, coefficient of variation and max-min ratio of wages,

between 50 and 99, and above 100. The consequence of these stratification criteria is that the number of data points depends upon firm size. For this reason, wage inequality indicators computed in Sections 5 and 6 may be slightly biased. Finally, let us also notice that no threshold at the upper limit of wages is to be found in the SES. To put it differently, wages are not censored. For an extended description of the SES see Demunter (2000).

[20] Annual bonuses include irregular payments which do not occur during each pay period, such as pay for holiday, 13th month or profit-sharing.

[21] If we only consider full-time employees (i.e., individuals working minimum 30 hours per week) and firms with at least 25 workers, our sample still covers 31,788 individuals working for 1,445 firms.

respectively. As agreed, we only consider full-time employees (i.e., individuals working minimum 30 hours per week) and firms with at least 25 workers. Statistics on the structure of wages have been computed for the overall sample as well as by firm size (i.e., number of employees below *or* above 100), level of collective wage agreement (i.e. only national and/or sectoral collective agreement *versus* firm level collective agreement) and composition of the workforce (i.e., majority of blue- *versus* white-collar workers). Qualitative results are similar for gross hourly wages with and without bonuses. Therefore, in what follows, we solely comment on the latter.[22]

## 5.1. Overall Sample

Table 1 shows that, for the overall sample, the mean individual gross hourly wage stands at 12.25 EUR with a standard deviation equal to 5.38. We also find that the dispersion of wages between firms is slightly higher than within firms (3.01 versus 2.90). Moreover, there appears to be a positive and significant correlation between the average and standard deviation of wages within firms. Thus, results suggest that high-paying firms are characterized by a more dispersed wage structure.

## 5.2. Firm Size

Besides, we see that the mean and dispersion of wages increase with firm size. We also notice that for both small and large firms: i) the correlation between the average and standard deviation of wages within firms remains positive and significant, and ii) the wage inequality between firms is slightly larger than the wage inequality within firms. However, wage dispersion within and between firms rises with firm size.

The positive relationship between wages and firm size is in line with neo-classical and institutional arguments supporting the existence of a positive size-wage premium. These arguments suggest *inter alia* that large employers: (i) hire more qualified workers (e.g., Hamermesh, 1990; Kremer and Maskin, 1996; Troske, 1999), (ii) compensate for bad working conditions, (iii) have more market power and share their excess profits with their workers (e.g., Mellow, 1982; Slichter, 1950; Weiss, 1966), (iv) avoid or mimic unionisation

[22] Statistics on the structure of gross hourly wages with bonuses are reported in Appendix 2.

(e.g., Brown *et al.*, 1990; Voos, 1983), and (v) substitute high monitoring costs with wage premia (e.g., Eaton and White, 1983; Garen, 1985; Lucas, 1978; Oi, 1983; Stigler, 1962).[23] How are we to explain that both within and between firms wage dispersion increase with firm size ? Davis and Haltiwanger (1996) argue that because large firms are more technologically diversified (horizontally and vertically) their workforce is more heterogeneous. Hence, within firms wage dispersion is likely to rise with employer size. However, in contrast to our findings, the authors expect between firms wage dispersion to fall with firm size (due to the life-cycle dynamics of firms). Another factor that can explain higher wage dispersion within large firms is linked to the tournament theory (Lazear and Rosen, 1981). The tournament theory points to the benefits of a more dispersed wage structure, deriving from a performance-based pay system. In other words, this theory suggests that firms should establish a prize structure and award the largest prize to the most productive worker. Moreover, according to McLaughlin (1988), to stimulate the workers' effort there should be positive correlation between the prize spread and the number of contestants. Since the number of contestants is likely to rise with firm size, one may expect a more dispersed wage structure within large firms.[24]

### 5.3. Level of Wage Bargaining

As expected, Table 1 indicates that on average workers, whose wages are renegotiated collectively at the firm level, earn higher wages. This result is in line with earlier findings for Belgium. Using the Oaxaca-Blinder decomposition, Rycx (2003) reports indeed that *ceteris paribus* workers covered by a company collective agreement (CA) earn 5.1% more than their opposite numbers who are (solely) covered by the national and/or sectoral CAs. A similar finding is found by Plasman *et al.* (2006). Table 1 also shows that while within firms wage dispersion is higher when wages are renegotiated collectively in house, between firms wage dispersion is larger when wages are solely covered by a national and/or sectoral CA. Although caution is required, these findings suggest that the bargaining regime has an impact on the structure of wages even in a corporatist country like Belgium (e.g., Freeman, 1980, 1982; Gosling and Machin, 1995; Rodriguez-Gutierrez, 2001).

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[23] Empirical evidence on the firm-size wage premium in Belgium is provided by Lallemand *et al.* (2005).

[24] Davis and Haltiwanger (1996) for the US and Lallemand and Rycx (2006) for European countries provided empirical evidence on how and why the wage distribution differs among firms of different sizes.

**Table 1 : Structure of Wages (Without Bonuses) Within and Between Firms, 1995**

| | Overall Sample[1] | *Firm Size:* Small firms (between 25 and 99 workers) | Large firms (at least 100 workers) | *Level of Wage Bargaining:* CA[5] only at national and/or sectoral level | Firm level CA[5] | Other or no CA[5] | *Workforce Composition:* Majority of blue-collar workers | Majority of white-collar workers |
|---|---|---|---|---|---|---|---|---|
| Average wage[2], observation = a person | 12.25 | 11.03 | 12.77 | 11.67 | 12.88 | 11.75 | n.a. | n.a. |
| (s.d.³) | 5.38 | 4.80 | 5.53 | 5.65 | 5.00 | 5.56 | n.a. | n.a. |
| (25%-ile) | 9.10 | 8.45 | 9.50 | 8.62 | 9.88 | 8.58 | n.a. | n.a. |
| (75%-ile) | 13.52 | 11.82 | 14.12 | 12.59 | 14.24 | 12.63 | n.a. | n.a. |
| [N – workers] | 31,788 | 9,450 | 22,338 | 14,123 | 15,713 | 1,952 | n.a. | n.a. |
| Average of firm average wage, obsv = a firm | 11.10 | 10.80 | 11.91 | 10.93 | 11.60 | 10.68 | 9.92 | 12.22 |
| (s.d.³) | 3.01 | 2.83 | 3.33 | 3.06 | 2.76 | 3.21 | 1.73 | 3.51 |
| (25%-ile) | 9.16 | 9.08 | 9.68 | 9.10 | 9.88 | 8.90 | 8.70 | 9.69 |
| (75%-ile) | 12.47 | 12.07 | 13.38 | 12.11 | 12.91 | 12.08 | 10.87 | 13.80 |
| [N – firms] | 1,445 | 590 | 855 | 795 | 530 | 120 | 760 | 685 |
| Average of s.d.² of wage, obsv = a firm | 2.90 | 2.79 | 3.21 | 2.87 | 2.96 | 2.94 | 1.80 | 3.95 |
| (s.d.³) | 2.53 | 2.38 | 2.88 | 2.61 | 2.36 | 2.46 | 1.33 | 2.92 |
| (25%-ile) | 1.19 | 1.15 | 1.27 | 1.12 | 1.44 | 1.02 | 0.82 | 1.82 |
| (75%-ile) | 4.03 | 3.76 | 4.45 | 4.04 | 3.93 | 4.28 | 2.30 | 5.20 |
| [N – firms] | 1,445 | 590 | 855 | 795 | 530 | 120 | 760 | 685 |
| Average c.v.[4] of wage, obsv = a firm | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.25 | 0.17 | 0.30 |
| (s.d.³) | 0.14 | 0.14 | 0.15 | 0.15 | 0.14 | 0.15 | 0.11 | 0.15 |
| (25%-ile) | 0.13 | 0.13 | 0.13 | 0.12 | 0.14 | 0.11 | 0.09 | 0.19 |
| (75%-ile) | 0.33 | 0.32 | 0.34 | 0.33 | 0.32 | 0.33 | 0.23 | 0.38 |
| [N – firms] | 1,445 | 590 | 855 | 795 | 530 | 120 | 760 | 685 |
| Average max-min ratio of wage, obsv = a firm | 2.61 | 2.63 | 2.58 | 2.56 | 2.62 | 2.99 | 2.04 | 3.16 |
| (s.d.³) | 1.58 | 1.62 | 1.45 | 1.44 | 1.64 | 2.13 | 1.06 | 1.78 |
| (25%-ile) | 1.54 | 1.56 | 1.50 | 1.54 | 1.54 | 1.46 | 1.39 | 1.91 |
| (75%-ile) | 3.16 | 3.14 | 3.22 | 3.15 | 3.12 | 3.37 | 2.36 | 3.76 |
| [N – firms] | 1,445 | 590 | 855 | 795 | 530 | 120 | 760 | 685 |
| Correlation (average wage, s.d.³ of wage), obsv = a firm | 0.820** | 0.812** | 0.840** | 0.832** | 0.800** | 0.832** | 0.630** | 0.821** |

Notes : [1] These statistics refer to the weighted sample only covering full-time workers in firms employing at least 25 employees. [2] Individual gross hourly wages (in EUR) include overtime paid, premiums for shift work, night work and/or weekend work. ³ s.d. stands for standard deviation. [4] c.v. refers to the coefficient of variation of wage (s.d. of wage/average of wage). [5] CA stands for collective agreement on wages. ** indicates that the Pearson correlation coefficient is significant at the 1% level. n.a stands for not applicable.

### 5.4. Composition of the Workforce

Finally, let us also note that: i) the mean wage is around 2.3 EUR higher within firms employing a majority of white-collar workers, and ii) the structure of wages is more compressed when blue-collar workers compose the majority of the workforce.

## 6. Wage Inequality and Firm Productivity

In this section, we analyse the impact of intra-firm wage dispersion on firm productivity in the Belgian private sector.

### 6.1. Methodology and Indicators

There are several ways to compute intra-firm wage inequality. On the one hand, wage dispersion can be measured between unequal workers by unconditional indicators (e.g., the Gini index, the white/blue-collar wage ratio or the pay gap between managers and the rest of the workforce). On the other hand, it can be defined for workers with similar observable characteristics. In this case, wage dispersion is measured by the residual inequality, after controlling for human capital variables.

Although unconditional indices may have appeal if the analysis focuses on the effect of CEO's pay on firm performance, many theories like 'tournaments' or 'hawks and doves' refer to wage differentials between similar workers (Winter-Ebmer and Zweimüller, 1999). As a result, a conditional indicator appears more appropriate for our study. Hence, we follow the methodology developed by Winter-Ebmer and Zweimüller (1999). However, as a sensitivity test, we also analyse the impact of three unconditional indicators of intra-firm wage dispersion on firm productivity. These indicators include the standard deviation, the coefficient of variation and the max-min ratio of the gross hourly wages within the firm.

The methodology of Winter-Ebmer and Zweimüller (1999) rests upon a two step estimation procedure. In the first step, we estimate by OLS the following wage equation for each firm:

$$\ln W_{ij} = \alpha_0 + \alpha_1' \, Y_{ij} + \varepsilon_{ij} \qquad (8)$$

where $W_{ij}$ is the gross hourly wage (with bonuses) of worker i in firm j, $Y_{ij}$ is a vector of individual characteristics including age, age squared, sex, education (two dummies) and occupation (one dummy) and $\varepsilon_{ij}$ is the usual error term. The standard errors of these regressions ($\sigma_j$) are used as a measure of conditional intra-firm wage dispersion.

In the second step, we estimate by OLS the following firm-level performance regression:

$$\ln P_j = \beta_0 + \beta_1' \sigma_j + \beta_2' X_j + \beta_3' Z_j + \upsilon_j \quad (9)$$

where Pj is the productivity of firm j, $\sigma_j$ is the conditional indicator of the intra-firm wage dispersion, Xj contains aggregated characteristics of workers, Zj includes employer characteristics and $\upsilon$j is the usual error term. The productivity of a firm (Pj) is measured by the value-added (at factor costs) per employee. It is obtained by dividing the firm annual gross operating income (plus subsidies, minus indirect taxes) by the number of workers in the firm. The main explanatory variable in equation (9) is the conditional intra-firm wage dispersion ($\sigma_j$) estimated in step 1. Equation (9) contains numerous control variables for the composition of the workforce (Xj) as well as for firm characteristics (Zj). These control variables include the share of the workforce that: i) at most has attended lower secondary school, ii) has more than 10 years of tenure and iii) is younger than 25 and older than 50 years, respectively. The share of women, the share of blue-collar workers, the share of workers supervising co-workers, sectoral affiliation (5 dummies), the size of the firm (the number of workers) and the level of wage bargaining (2 dummies) are also included.

An important problem to consider is the potential simultaneity between productivity and wage dispersion. Indeed, it may be argued that highly productive firms pay larger bonuses, which in turn leads to more wage inequality. We address this issue using information from the income tax system. More precisely, we use two-stage least squares (2SLS) and instrument the dispersion of wages *including* bonuses by the intra-firm standard deviation of income taxes on gross earnings *excluding* bonuses. Of course, it is very difficult to find an appropriate instrument for intra-firm wage inequality. However, we believe that our instrument is of potential interest for breaking the simultaneity problem between productivity and wage dispersion since it is less affected by rent-sharing. In other words, we expect the intra-firm standard deviation of income taxes on gross earnings *excluding* bonuses to be uncorrelated (or at least less correlated) with the error term and highly correlated with the endogenous variable (i.e., wage dispersion). Statistics on workers' income taxes, available in our data set, have been estimated by Statistics Belgium. To do so, Statistics Belgium relied on individual gross annual earnings, excluding bonuses and social security contributions (13.07%). After deduction of professional costs, they obtained the assessable income. From this, they derived the base income tax (7 different scales), the municipality taxes (7%)[25], the supplementary crisis contribution (3%) and the special social security contribution (6 different scales). The sum of these four elements provides an estimation of the individual income taxes.[26]

### 6.2. Descriptive Statistics

The first step of our estimation procedure requires a large number of data points per firm. Therefore, our sample has been restricted to firms with at least 200 workers. This restriction guarantees a minimum of 10 observations per firm. Our definitive sample is representative of all firms employing at least 200 workers within sections D to K of the Nace Rev. 1 nomenclature, with the exception of hotels and restaurants (H) and the financial sector (J).[27] It covers 17,490 individuals working for 397 firms. The mean number of data points per firm is 44 and for 75% of the firms there are between 10 and 41 observations.

Table 2 depicts the means and standard deviations of selected variables.[28] We note that, on average, the value-added per employee amounts to 61,344 EUR and that the residual pay inequality is equal to 0.17. Moreover, we find that the estimated intra-firm wage dispersion is highest when measured by the max-min ratio, that the mean age is around 37 years, and that, on average, approximately 26% of the workers are women, 48% are blue-collar, and 42%

[25] Statistics Belgium had no information on the workers municipality of residence. Therefore, they applied the average municipality tax (7%) to all employees.

[26] The most important restriction of these estimates is that they do not consider the specific situation of the employee, e.g. composition of the family. For more information see Demunter (2000).

[27] Our sample is representative of all firms employing at least 200 workers within the following sectors: i) manufacturing (D), ii) electricity, gas and water supply (E), iii) construction (F), iv) wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods (G), v) transport, storage and communication (I), and vi) real estate, renting and business activities (K). The mining and quarrying sector (C) and the hotels and restaurants (H) are not part of our final sample because almost all firms in these sectors employ less than 200 workers.

[28] For a detailed description see Appendices 3 and 4.

have a low level of education (i.e., lower secondary school at most). Finally, Table 2 shows that, on average, firms employ 480 workers and are essentially concentrated in the manufacturing sector (64%); wholesale and retail trade, repair of motor vehicles (19%); and real estate, renting and business activities (11%).

**Table 2: Means and Standard Deviations of Selected Variables+**

| Variables | Mean | SD |
|---|---|---|
| Value-added per employee at factor costs[1] (in thousands of EUR) | 61.34 | 1,618.9 |
| Residual pay inequality[2] | 0.17 | 0.07 |
| Standard deviation of wages[3] | 0.24 | 0.10 |
| Coefficient of variation of wages[3] | 0.29 | 0.14 |
| Max-min ratio of wages[3] | 3.17 | 1.60 |
| Age (years) | 37.2 | 9.6 |
| Female | 25.9 | |
| Education | | |
| No degree, primary/lower secondary | 41.5 | |
| General upper secondary, technical/artistic/prof. upper secondary | 38.8 | |
| Higher non university, university and post graduate | 19.7 | |
| Blue-collar workers | 48.4 | |
| Size of the firm (number of workers) | 480.4 | 621.1 |
| Sector | | |
| Manufacturing (D) | 63.5 | |
| Electricity, gas and water supply (E) | 0.2 | |
| Construction (F) | 3.6 | |
| Wholesale and retail trade; repair of motor vehicles (G) | 18.6 | |
| Transport, storage and communication (I) | 3.7 | |
| Real estate, renting and business activities (K) | 10.6 | |
| Number of employees | 17,490 | |
| Number of firms | 397 | |

+ The descriptive statistics refer to the weighted sample.
[1] Estimated by the firm annual gross operating income per worker (plus subsidies, minus indirect taxes).
[2] Conditional measure of the intra-firm wage dispersion (i.e., standard errors of wage regressions run for each firm separately).
[3] Individual gross hourly wages include overtime paid, premiums for shift work, night work and/or weekend work and bonuses, i.e. irregular payments which do not occur during each pay period, such as pay for holiday, 13th month and profit sharing.

## 6.3. Empirical Analysis

### i) Basic Specification

Table 3 reports our estimates of the effect of wage dispersion on firm productivity. These estimates are obtained by applying respectively OLS and 2SLS, with White (1980) heteroscedasticity consistent standard errors, to equation (9).

**Table 3: Effect of Wage Inequality on Firm Productivity, OLS vs. 2SLS**

| *Dependent variable:* | Value added per employee[1] (ln) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | OLS | | | | 2SLS | | | |
| Intercept | 7.22** (0.27) | 7.20** (0.27) | 7.27** (0.27) | 7.49** (0.26) | 6.92** (0.26) | 7.05** (0.27) | 7.12** (0.28) | 7.60** (0.27) |
| Residual pay inequality ² | 1.25** (0.45) | | | | 4.38** (0.72) | | | |
| Standard deviation of wages ³ | | 1.03** (0.27) | | | | 2.09** (0.36) | | |
| Coefficient of variation of wages ³ | | | 0.48** (0.20) | | | | 1.47** (0.27) | |
| Max-min ratio of wages ³ | | | | 0.08** (0.02) | | | | 0.13** (0.02) |
| Worker characteristics [4] | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm characteristics [5] | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Adjusted $R^2$ | 0.53 | 0.54 | 0.53 | 0.55 | 0.44 | 0.52 | 0.48 | 0.53 |
| F-stat | 130.43** | 136.62** | 126.69** | 134.75** | 138.59** | 145.04** | 132.77** | 143.03** |
| Hausman test: p-value | | | | | 0.00 | 0.00 | 0.00 | 0.00 |
| Number of employees | 17,490 | 17,490 | 17,490 | 17,490 | 17,490 | 17,490 | 17,490 | 17,490 |
| Number of firms | 397 | 397 | 397 | 397 | 397 | 397 | 397 | 397 |

Notes: **/*/° indicate significance at the 1, 5 and 10% level, respectively. White (1980) heteroscedasticity consistent standard errors are reported between brackets. [1] Estimated by the firm annual gross operating income per worker (plus subsidies, minus indirect taxes). [2] Conditional measure of the intra-firm wage dispersion (i.e. standard errors of wage regressions run for each firm separately). ³ Individual gross hourly wages include overtime paid, premiums for shift work, night work and/or weekend work and bonuses, i.e. irregular payments which do not occur during each pay period, such as pay for holiday, 13th month and profit sharing. [4] Share of the workforce that : i) at most has attended lower secondary school, ii) has more than 10 years of tenure and iii) is younger than 25 and older than 50 years, respectively. The share of women, the share of blue-collar workers and the share of the workers supervising co-workers are also included. [5] Sectoral affiliation (5 dummies), size of the firm (number of workers), and level of wage bargaining (2 dummies).

Findings, obtained from OLS regressions, emphasize the existence of a positive and significant relationship between intra-firm wage dispersion and firm productivity. Overall, the point estimates range between 1.25 and 0.08, which yields an elasticity of between 0.25 and 0.14 at sample means. These results suggest that, on average, a rise of 10% in wage inequality increases firm productivity by between 2.5 and 1.4%.[29] Yet, it could be argued that because of the potential simultaneity between productivity and wage dispersion, OLS estimates are not only biased but also inconsistent.[30] To account for this problem, we run 2SLS regressions instrumenting the dispersion of wages *including* bonuses by the intra-firm standard deviation

[29] Similar positive and significant results have been found for the unconditional indicators when we extended our sample to all firms with 20 workers or more. These results are available on request. Yet, due to a limited number of data points within small firms, we were not able to determine whether this is also the case using a conditional indicator.

[30] Hausman's (1976) specification error tests, reported in Table 3, support the existence of a simultaneity problem.

of income taxes on gross earnings *excluding* bonuses. Results from these regressions, presented in Table 3, confirm the positive and significant impact of wage dispersion on productivity. Moreover, we find that the elasticity between wage dispersion and productivity is significantly larger when using 2SLS. At sample means, the elasticity now stands at between 0.75 and 0.43. This means that, on average, when wage dispersion increases by 10%, firm productivity rises by between 7.5 and 4.3%.[31]

How are we to interpret these results ? The positive impact of wage dispersion on firm productivity tends to support the 'tournament' models (Lazear and Rosen, 1981). Indeed, these models demonstrate that if the workforce is relatively homogeneous, wage differentials stimulate workers' effort and their productivity. To put it differently, these models suggest that firms should establish a differentiated prize structure and award the largest prize to the most productive workers. Lazear's model (1989, 1995) of 'hawks' and 'doves' suggests that it is profitable for a firm to: i) adequately sort out workers at the hiring stage, and ii) adjust the compensation scheme to the characteristics of the workforce (i.e., the hierarchical level). This model shows that if the majority of the workforce adopts a sabotage or non-cooperative behaviour, a more compressed wage structure should be preferred. According to this theory, our sample is essentially composed of 'doves'. To put it in another way, it is because the majority of the workforce adopts a cooperative behaviour that firms can achieve a higher productivity by implementing a more dispersed wage structure. However, our findings offer no support to the 'fairness, morale and cohesiveness' theories (Akerlof and Yellen, 1990;

[31] To test for a hump-shaped relationship, three methods have been used. Firstly, we added within-firm wage inequality indicators in quadratic form to our regression model. Results obtained with OLS were inconclusive because of a strong multicollinearity between indicators in level and squared. However, 2SLS estimates showed a significant positive and hump-shaped pattern for three instrumented wage inequality indicators, i.e. the standard deviation, the coefficient of variation, the max-min ratio of wages. Next, we divided our sample into two homogeneous parts containing low and high inequality firms, respectively. The idea was to test whether the impact of wage inequality on firm productivity is larger in low inequality firms. Using OLS, we found no significant differences in the elasticities for both sub-samples (with the exception of the max-min ratio of wages). In contrast, 2SLS estimates supported, for all instrumented wage inequality indicators, the existence of a positive and hump-shaped relationship between wage dispersion and firm productivity. Finally, we tested for a non-linear relationship using dummy variables (two or more) indicating the magnitude of the intra-firm wage inequality. This methodology led to insignificant results using both OLS and 2SLS regressions. In sum, we found some evidence in favour of a hump-shaped relationship. However, results (available on request) were not very robust.

Levine, 1991). Indeed, these theories suggest a negative relationship between intra-firm wage dispersion and firm productivity.

**ii) Composition of the Workforce**

According to the 'New Economics of Personnel' (Lazear, 1995), we should expect the elasticity of firm productivity with respect to pay inequality to be influenced by the composition of the workforce. In particular, various theories suggest that the relationship between pay dispersion and firm productivity depends upon the proportion of white- and blue-collar workers within the firm. In this section, we test this hypothesis by letting our intra-firm wage dispersion indicators interact with a dummy variable that is equal to one if the share of white-collar workers within the firm is larger than 50% and zero otherwise. The results of this new specification are presented in Table 4.

Whatever the indicator used for intra-firm wage dispersion, OLS estimates show that the intensity of the relationship between pay dispersion and productivity is significantly lower in firms that are essentially composed of white-collar workers. Indeed, the point estimates vary between 1.70 and 0.09 for blue-collar workers and between 0.79 and 0.05 for white-collar workers. At sample means, this yields an elasticity of between 0.39 and 0.26 for blue-collar workers and of between 0.14 and 0.06 for white-collar workers. In sum, results suggest that following a 10% rise in wage inequality, productivity increases by approximately 2.1 percentage points more within firms that are essentially composed of blue-collar workers. 2SLS estimates, reported in Table 4, confirm that the elasticity between wage dispersion and productivity is positive and substantially larger within firms with a majority of blue-collar workers. Yet, caution is required because regression coefficients associated to the interaction variables are only significant at the 15% level. As in the basic specification, 2SLS point estimates are larger than those obtained by OLS. Using 2SLS, the elasticity, at sample means, ranges between 0.57 and 0.30 for white-collar workers and between 0.91 and 0.55 for blue-collar workers, respectively. These findings suggest that if wage dispersion rises by 10%, productivity increases by approximately 2.9 percentage points more in firms essentially composed of blue-collar workers.

**Table 4: Effect of Wage Inequality on Firm Productivity – Interaction with the Composition of the Workforce, OLS vs. 2SLS**

| *Dependent variable:* | Value added per employee[1] (ln) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | OLS | | | | 2SLS | | | |
| Intercept | 7.32** | 7.30** | 7.35** | 7.61** | 7.00** | 7.13** | 7.20** | 6.71** |
| | (0.26) | (0.26) | (0.26) | (0.26) | (0.26) | (0.26) | (0.26) | (0.67) |
| Residual pay inequality | 1.70** | | | | 4.53** | | | |
| (RPI) ² | (0.50) | | | | (0.72) | | | |
| RPI * White-collar ³ | -0.91* | | | | -0.61°° | | | |
| | (0.40) | | | | (0.41) | | | |
| Standard deviation of | | 1.36** | | | | 2.20** | | |
| wages (SD) [4] | | (0.30) | | | | (0.35) | | |
| SD * White-collar ³ | | -0.69** | | | | -0.41°° | | |
| | | (0.24) | | | | (0.26) | | |
| Coefficient of variation | | | 0.79** | | | | 1.56** | |
| of wages (CV) [4] | | | (0.24) | | | | (0.25) | |
| CV * White-collar ³ | | | -0.55** | | | | -0.34°° | |
| | | | (0.20) | | | | (0.21) | |
| Max-min ratio of wages | | | | 0.09** | | | | 0.14** |
| (MM) [4] | | | | (0.02) | | | | (0.02) |
| MM * White-collar ³ | | | | -0.04* | | | | -0.03° |
| | | | | (0.02) | | | | (0.02) |
| Worker characteristics [5] | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm characteristics [6] | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Adjusted $R^2$ | 0.53 | 0.54 | 0.53 | 0.55 | 0.57 | 0.57 | 0.57 | 0.57 |
| F-stat | 126.89** | 131.88** | 123.69** | 132.05** | 136.48** | 137.15** | 137.11** | 137.49** |
| Hausman test: p-value | | | | | 0.00 | 0.00 | 0.00 | 0.00 |
| Number of employees | 17,490 | 17,490 | 17,490 | 17,490 | 17,490 | 17,490 | 17,490 | 17,490 |
| Number of firms | 397 | 397 | 397 | 397 | 397 | 397 | 397 | 397 |

Notes: **/*/°/°° indicate significance at the 1, 5, 10 and 15% level, respectively. White (1980) heteroscedasticity consistent standard errors are reported between brackets. [1] Estimated by the firm annual gross operating income per worker (plus subsidies, minus indirect taxes). [2] Conditional indicator for within-firm wage dispersion (i.e. standard errors of wage regressions run for each firm separately). ³ "White-collar" is a dummy variable that is equal to 1 if the share of white-collar workers within the firm is larger than 50% and 0 otherwise. [4] Individual gross hourly wages include overtime paid, premiums for shift work, night work and/or weekend work and bonuses, i.e. irregular payments which do not occur during each pay period, such as pay for holiday, 13th month and profit sharing. [5] Share of the workforce that : i) at most has attended lower secondary school, ii) has more than 10 years of tenure and iii) is younger than 25 and older than 50 years, respectively. The share of women, the share of blue-collar workers and the share of the workers supervising co-workers are also included. [6] Sectoral affiliation (5 dummies), size of the firm (number of workers), and level of wage bargaining (2 dummies).

Why is the effect of pay dispersion on firm performance different for blue- and white-collar workers ? As suggested by Winter-Ebmer and Zweimüller (1999), a first possible explanation is that piece rates are more frequently used in firms with a majority of blue-collar workers. The point is that the implementation of piece rates increases wage dispersion but also productivity because, in general, workers will put in more effort and top-performers will stay in these firms. Another argument may be that, on average, white-collar workers have a higher degree of autonomy in their jobs, more responsibilities and superior career prospects (Winter-Ebmer and Zweimüller, 1999). Therefore, their level of effort is thought to be more determined by their intrinsic motivation. To put it differently, strong incentive schedules such as ‘pay-for-performance’, which in general need more monitoring, could be seen as a threat to their autonomy by white-collar workers, and as such crowd out their intrinsic motivation and reduce the intensity of their effort (Frey, 1997). Our findings can also be interpreted on the basis of the theory of Milgrom (1988) and Milgrom and Roberts (1990). Indeed, monitoring costs are likely to be higher for white-collar workers. Therefore, white-collar workers may have more incentives to: i) withhold information from managers in order to increase their influence, and ii) engage in costly rent-seeking activities instead of productive work. This could be an additional reason explaining why the elasticity between wage dispersion and productivity might be lower for white-collar workers.

**iii) Monitoring Environment**

Another important question is whether the relationship between wage dispersion and firm productivity is affected by the degree of monitoring within the firm. To address this question, we have let our intra-firm wage dispersion indicators interact with a dummy variable that is equal to one if the share of the workforce with supervising authority over co-workers is lower than or equal to 20% and zero otherwise.

OLS estimates relative to this new specification, presented in Table 5, show that the elasticity of productivity to pay dispersion is positive and significantly higher among firms with a high degree of monitoring (‘supervising firms’). At sample means, the elasticity of productivity to intra-firm pay dispersion ranges between 0.37 and 0.23 in firms with a high degree of monitoring and between 0.20 and 0.10 in firms with a low degree of monitoring. 2SLS estimates also show a positive and significant effect of wage dispersion on firm productivity. However, while coefficients associated to the interaction variables remain negative, none of them are significantly different from zero. This result suggests that findings from OLS regressions have to be interpreted with care. Yet, it should be noted that our instrumenting procedure may have led to some loss of information.

**Table 5: Effect of Wage Inequality on Firm Productivity – Interaction with the Monitoring Environment, OLS vs. 2SLS**

| *Dependent variable:* | Value added per employee[1] (ln) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | OLS | | | | 2SLS | | | |
| Intercept | 7.27** | 7.23** | 7.29** | 7.50** | 6.95** | 7.07** | 7.13** | 7.60** |
| | (0.26) | (0.27) | (0.27) | (0.26) | (0.26) | (0.26) | (0.26) | (0.26) |
| Residual pay inequality (RPI) ² | 1.66** | | | | 4.42** | | | |
| | (0.47) | | | | (0.71) | | | |
| RPI * Low monitoring ³ | -0.71* | | | | -0.26 | | | |
| | (0.32) | | | | (0.33) | | | |
| Standard deviation of wages (SD) [4] | | 1.21** | | | | 2.12** | | |
| | | (0.30) | | | | (0.93) | | |
| SD * Low monitoring ³ | | -0.29°° | | | | -0.09 | | |
| | | (0.17) | | | | (0.21) | | |
| Coefficient of variation of wages (CV) [4] | | | 0.64** | | | | 1.48** | |
| | | | (0.22) | | | | (0.24) | |
| CV * Low monitoring ³ | | | -0.25°° | | | | -0.04 | |
| | | | (0.16) | | | | (0.18) | |
| Max-min ratio of wages (MM) [4] | | | | 0.09** | | | | 0.14** |
| | | | | (0.02) | | | | (0.02) |
| MM * Low monitoring ³ | | | | -0.03° | | | | -0.01 |
| | | | | (0.01) | | | | (0.02) |
| Worker characteristics [5] | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm characteristics [6] | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Adjusted R² | 0.54 | 0.54 | 0.53 | 0.55 | 0.57 | 0.57 | 0.57 | 0.57 |
| F-stat | 128.41** | 129.52** | 120.02** | 130.51** | 136.29** | 135.21** | 134.89** | 135.31** |
| Hausman test: p-value | | | | | 0.00 | 0.00 | 0.00 | 0.00 |
| Number of employees | 17,490 | 17,490 | 17,490 | 17,490 | 17,490 | 17,490 | 17,490 | 17,490 |
| Number of firms | 397 | 397 | 397 | 397 | 397 | 397 | 397 | 397 |

Notes: **/*/°/°° indicate significance at the 1, 5, 10 and 15% level, respectively. White (1980) heteroscedasticity consistent standard errors are reported between brackets. [1] Estimated by the firm annual gross operating income per worker (plus subsidies, minus indirect taxes). [2] Conditional indicator for within-firm wage dispersion (i.e. standard errors of wage regressions run for each firm separately). ³ "Low monitoring" is a dummy variable that is equal to 1 if the share of the workforce with supervising authority over co-workers is lower than or equal to 20% and 0 otherwise. [4] Individual gross hourly wages include overtime paid, premiums for shift work, night work and/or weekend work and bonuses, i.e. irregular payments which do not occur during each pay period, such as pay for holiday, 13th month and profit sharing. [5] Share of the workforce that : i) at most has attended lower secondary school, ii) has more than 10 years of tenure and iii) is younger than 25 and older than 50 years, respectively. The share of women, the share of blue-collar workers and the share of the workers supervising co-workers are also included. [6] Sectoral affiliation (5 dummies), size of the firm (number of workers), and level of wage bargaining (2 dummies).

Overall, findings reported in Table 5 emphasize the importance of a correct match between the compensation scheme and the monitoring environment within a firm. To put it differently, results appear to be consistent with the hypothesis that "it is not so much the choice of pay system that drives the organisational outcomes, but the combination of pay system and monitoring environment" (Belfield and Marsden, 2003, pp. 469). It is also noteworthy that our descriptive statistics indicate that 'supervising firms' have a greater proportion of blue-collar workers (66% vs. 43%) and that their mean conditional pay inequality is larger (0.20

vs. 0.15). Hence, our findings seem to be consistent with Milgrom (1988) and Milgrom and Roberts (1990), who suggest a lower pay spread within firms that are mainly composed of white-collar workers.

## 7. Conclusion

The objective of this paper is twofold. First, we analyse the structure of wages within and between Belgian firms. Next, we examine how the productivity of these firms is influenced by their internal wage dispersion. To do so, we rely on a unique combination of two large-scale data sets (i.e. the 1995 'Structure of Earnings Survey' and 'Structure of Business Survey'). The former contains detailed information on firm-level characteristics (e.g., sector of activity, size of the firm, and level of wage bargaining) and on individual workers (e.g., gross hourly wages, bonuses, age, education, sex, and occupation). The latter provides firm-level information on financial variables (e.g., gross operating surplus, value added, and value of production).

Our methodology is consistent with that of Winter-Ebmer and Zweimüller (1999). It rests upon a two-step estimation procedure. Firstly, we compute conditional intra-firm wage differentials by taking the standard errors of wage regressions run for each firm separately. Next, we use these conditional wage differentials as an explanatory variable in a firm-level productivity regression. As a sensitivity test, we also analyse the impact of unconditional indicators of intra-firm wage dispersion on firm productivity. These indicators include the standard deviation, the coefficient of variation and the max-min ratio of gross hourly wages within the firm. The productivity of a firm is measured by the value-added per employee. The potential simultaneity problem between wage dispersion and firm productivity is addressed using information from the Belgian income tax system. More precisely, we apply two-stage least squares (2SLS) and instrument the dispersion of wages *including* bonuses by the intra-firm standard deviation of income taxes on gross earnings *excluding* bonuses.

To our knowledge, this paper is one of the first to examine the effect of intra-firm wage dispersion on firm performance in the private sector using both a conditional wage inequality indicator and direct information on firm productivity. It is also one of the few, with Bingley and Eriksson (2001) and Heyman (2002), to consider potential simultaneity problems.

Empirical findings, reported in this paper, support the existence of a positive and significant relationship between wage inequality and firm productivity. Moreover, we find that the intensity of this relationship is stronger for blue-collar workers and within firms with a high degree of monitoring. These findings are more in line with the 'tournament' models (Lazear and Rosen, 1981) than with the 'fairness, morale and cohesiveness' models (Akerlof and Yellen, 1990; Levine, 1991).

Future research in this area should rely on matched employer-employee panel data so as to control for the non observed characteristics of the workers and/or firms. Unfortunately, at the moment such data do not exist for Belgium. It would also be interesting to extend the analysis to small firms using a conditional measure of intra-firm wage dispersion. However, this option requires a rich data set with a larger number of observations per firm.

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## Appendix 1 : Intra-firm Wage Dispersion and Firm Performance – Some Empirical Results

| Study | Country | Data / Coverage | Wage Dispersion | Firm Performance | Methodology | Results |
|---|---|---|---|---|---|---|
| Cowherd and Levine (1992) | North America and Europe | OASIS program: 102 business units >= 59 workers | Semi-unconditional: pay of employees relative to top 3 management level | Product quality | Cross-section (OLS) | Negative relationship between wage spread and firm performance → fairness and cooperation theory + relative deprivation theories |
| DeBrock *et al.* (2001) | US | Professional baseball teams, 1985-98 | Several unconditional measures and standard error of earnings regression | Win-loss percentage by team | Cross-section (OLS) and fixed-effects | Negative impact of wage dispersion on team performance → fairness theory |
| Eriksson (1999) | Denmark | 2,600 managers from 210 Danish firms, 1992-95 | Unconditional: coefficient of variation | Profits/sales ratio | Cross-section (OLS) and fixed-effects | Weak positive relationship between these variables among executives → tournament theory |
| Frick *et al.* (2003) | US | Professional baseball, basketball, football and hockey teams, data for min. 7 years in each league | Unconditional: GINI index of wage inequality | Win-loss percentage by team | Cross-section (OLS), fixed-effects or random-effects | Ambiguous result. For basketball and hockey teams, a higher degree of wage dispersion is beneficial for team performance but the reverse is found for football and baseball teams. |
| Gomez (2002) | US | Professional hockey teams, 1993-98 | Unconditional: GINI coefficient | Win-loss percentage by team and season-ending point totals | Cross-section (OLS) and fixed-effects | Negative relationship between these variables → fairness theory |
| Harder (1992) | US | Professional baseball teams, data for 4 seasons (1976, 1977, 1987, 1988) Professional basketball (1987) | Two separate continuous measures of inequity (% overrewarded and % underrewarded players) | Technical measures for baseball (e.g. 'runs created', 'total average') and for basketball (e.g. points scored) | Cross-section (OLS) and lagged dependent values as explanatory variables | Negative relationship between these variables for basketball, results less clear for baseball → partial support of pay equity theory (underreward leads to selfish behaviour, overreward to cooperative behaviour) |

**Appendix 1 (*cont.*) : Intra-firm Wage Dispersion and Firm Performance – Some Empirical Results**

| Study | Country | Data / Coverage | Wage Dispersion | Firm Performance | Methodology | Results |
|---|---|---|---|---|---|---|
| Heyman (2002) | Sweden | Panel data for white-collar workers and around 10,000 managers in 1991 and 1995 | Conditional: standard error of wage regression | Profits | Cross-section (OLS) and fixed-effects (lagged value of wage spread as instrumental variable) | Positive relationship between these variables among white-collar workers and managers → tournament theory |
| Hibbs and Locking (1995) | Sweden | Aggregated individual wage data, 1974-93 | Unconditional: squared coefficient of variation | Real value added | Cross-section (OLS) and instrumental variable (lagged value of output) | Positive relationship between these indicators → tournament theory |
| Leonard (1990) | US | 439 large corporations, 1981-85 | Unconditional: standard deviation of pay | Return on investment | Cross-section (OLS) and fixed-effects | No significant relationship between these indicators for top executives |
| Main *et al.* (1993) | US | Executives in 210 firms, 1980-84 | Unconditional: coefficient of variation | Return on assets | Cross-section (OLS) | Positive relationship between these indicators for executives → tournament theory |
| Pfeffer and Langton (1993) | UK | 17,000 college and university professors from 600 academic departments | Unconditional: coefficient of variation | Workers' satisfaction, productivity, and cooperation | Cross-section (OLS) | Negative relationship between wage spread and (1) satisfaction, (2) productivity, (3) cooperation → fairness and cooperation theory |
| Richards and Guell (1998) | US | Professional baseball teams, 3 seasons (1992, 1993, 1995) | Unconditional: variance of team salaries | Win-loss percentage by team | Cross-section (OLS) and fixed-effects | Negative effect of wage spread on the win percentage but not on the probability to win a title → partial support of fairness theory |
| Winter-Ebmer and Zweimüller (1999) | Austria | Panel of Austrian firms (>= 20 workers with at least 4 data points), 1975-91 | Conditional: standard error of wage regression | Standardized wage for white-and blue-collar workers | Cross-section (OLS) and fixed-effects | Positive relationship between these variables. Stronger for blue-collar workers → results more in line with tournament theory |

## Appendix 2 : Structure of Wages (With bonuses) Within and Between Firms, 1995

| | Overall Sample[1] | *Firm Size:* Small firms (between 25 and 99 workers) | Large firms (at least 100 workers) | *Level of Wage Bargaining:* CA[5] only at national and/or sectoral level | Firm level CA[5] | Other or no CA[5] | *Workforce Composition :* Majority of blue-collar workers | Majority of white-collar workers |
|---|---|---|---|---|---|---|---|---|
| Average wage[2], observation = a person | 13.85 | 12.36 | 14.49 | 13.14 | 14.63 | 13.21 | n.a. | n.a. |
| (s.d.²) | 6.67 | 6.01 | 6.83 | 7.10 | 6.08 | 6.90 | n.a. | n.a. |
| (25%-ile) | 9.94 | 9.17 | 10.43 | 9.27 | 10.92 | 9.22 | n.a. | n.a. |
| (75%-ile) | 15.39 | 13.43 | 16.11 | 14.31 | 16.21 | 14.45 | n.a. | n.a. |
| [N – workers] | 31,788 | 9,450 | 22,338 | 14,123 | 15,713 | 1,952 | n.a. | n.a. |
| Average of firm average wage, obsv = a firm | 12.46 | 12.11 | 13.44 | 12.25 | 13.11 | 11.94 | 10.81 | 14.04 |
| (s.d.[3]) | 3.80 | 3.59 | 4.16 | 3.89 | 3.35 | 4.15 | 2.08 | 4.35 |
| (25%-ile) | 9.98 | 9.82 | 10.58 | 9.80 | 10.83 | 9.40 | 9.45 | 10.91 |
| (75%-ile) | 14.02 | 13.74 | 15.41 | 13.80 | 14.75 | 13.47 | 11.89 | 16.03 |
| [N – firms] | 1,445 | 590 | 855 | 795 | 530 | 120 | 760 | 685 |
| Average s.d.² of wage, obsv = a firm | 3.52 | 3.38 | 3.89 | 3.51 | 3.53 | 3.50 | 2.14 | 4.83 |
| (s.d. [3]) | 3.20 | 3.08 | 3.48 | 3.35 | 2.83 | 3.12 | 1.63 | 3.73 |
| (25%-ile) | 1.40 | 1.39 | 1.48 | 1.29 | 1.64 | 1.17 | 0.99 | 2.16 |
| (75%-ile) | 4.80 | 4.60 | 5.36 | 4.81 | 4.75 | 5.00 | 2.80 | 6.38 |
| [N – firms] | 1,445 | 590 | 855 | 795 | 530 | 120 | 760 | 685 |
| Average c.v.[4] of wage, obsv = a firm | 0.25 | 0.25 | 0.26 | 0.25 | 0.25 | 0.26 | 0.19 | 0.32 |
| (s.d.[3]) | 0.15 | 0.15 | 0.16 | 0.16 | 0.14 | 0.15 | 0.12 | 0.16 |
| (25%-ile) | 0.13 | 0.13 | 0.13 | 0.13 | 0.14 | 0.11 | 0.10 | 0.19 |
| (75%-ile) | 0.34 | 0.34 | 0.35 | 0.34 | 0.33 | 0.35 | 0.25 | 0.40 |
| [N – firms] | 1,445 | 590 | 855 | 795 | 530 | 120 | 760 | 685 |
| Average max-min ratio of wage, obsv = a firm | 2.79 | 2.81 | 2.74 | 2.76 | 2.76 | 3.11 | 2.14 | 3.42 |
| (s.d.[3]) | 1.80 | 1.88 | 1.59 | 1.74 | 1.79 | 2.22 | 1.09 | 2.11 |
| (25%-ile) | 1.63 | 1.64 | 1.56 | 1.64 | 1.58 | 1.46 | 1.43 | 2.03 |
| (75%-ile) | 3.27 | 3.26 | 3.45 | 3.31 | 3.18 | 3.53 | 2.49 | 4.04 |
| [N – firms] | 1,445 | 590 | 855 | 795 | 530 | 120 | 760 | 685 |
| Correlation (average wage, s.d.[3]of wage), obsv = a firm | 0.831** | 0.829** | 0.839** | 0.844** | 0.800** | 0.866** | 0.642** | 0.825** |

Notes : [1] These statistics refer to the weighted sample only covering full-time workers in firms employing at least 25 employees. [2] Individual gross hourly wages (in EUR) include overtime paid, premiums for shift work, night work and/or weekend work. [3] s.d. stands for standard deviation. [4] c.v. refers to the coefficient of variation of wage (s.d. of wage/average of wage). [5] CA stands for collective agreement on wages. ** indicates that the Pearson correlation coefficient is significant at the 1% level. n.a stands for not applicable.

**Appendix 3: Means and Standard Deviations of Variables – Workers' Level (First Step)**

| | Mean | SD |
|---|---|---|
| Gross hourly wage (in EUR) | 13.5 | 262.6 |
| Includes overtime paid, premiums for shift work, night work and/or weekend work and bonuses (i.e. irregular payments which do not occur during each pay period, such as pay for holiday, 13th month, profit sharing, etc.). | | |
| Age (years) | 37.2 | 9.6 |
| Female | 25.9 | |
| Education: | | |
| No degree, primary/lower secondary | 41.5 | |
| General upper secondary, technical/artistic/prof. upper secondary | 38.8 | |
| Higher non university, university and post graduate | 19.7 | |
| Blue-collar workers | 48.4 | |
| Number of employees | 17,490 | |
| Number of firms | 397 | |

[+] The descriptive statistics refer to the weighted sample

## Appendix 4: Means and Standard Deviations of Variables – Firm Level (Second Step)

| | Mean | SD |
|---|---|---|
| **I. Firm productivity:** | | |
| Estimated by the value added per worker (in thousands of EUR). The value added is approximated by the firm annual gross operating income per worker (plus subsidies, minus indirect taxes). | 61.34 | 1,618.89 |
| **II. Intra-firm wage dispersion:** | | |
| Residual pay inequality | 0.17 | 0.07 |
| Conditional measure of the intra-firm wage dispersion (i.e. standard errors of wage regressions run for each firm separately) | | |
| Standard deviation of wages[1] | 0.24 | 0.10 |
| Coefficient of variation of wages[1] | 0.29 | 0.14 |
| Max-Min ratio of wages[1] | 3.17 | 1.60 |
| **III. Control variables:** | | |
| ***a) Share of the workforce:*** | | |
| Age < 25 years | 10.2 | 11.5 |
| Age > 50 years | 9.3 | 8.5 |
| Female | 30.1 | 27.0 |
| Low educated (no degree, primary or lower secondary) | 40.6 | 31.0 |
| Blue-collar | 52.4 | 34.2 |
| Tenure > 10 years | 42.2 | 23.4 |
| Supervising their co-workers (monitoring) | 15.1 | 13.4 |
| ***b) Firm characteristics:*** | | |
| Size (number of workers) | 480.4 | 621.1 |
| Level of wage bargaining: | | |
| CA only at national and/or sectoral level[2] | 41.7 | |
| CA at the company level[2] | 53.5 | |
| Other | 4.8 | |
| Sector: | | |
| Manufacturing (D) | 63.5 | |
| Electricity, gas and water supply (E) | 0.2 | |
| Construction (F) | 3.6 | |
| Wholesale and retail trade; repair of motor vehicles (G) | 18.6 | |
| Transport, storage and communication (I) | 3.7 | |
| Real estate, renting and business activities (K) | 10.6 | |
| Number of employees | 17,490 | |
| Number of firms | 397 | |

[+] The descriptive statistics refer to the weighted sample

[1] Individual gross hourly wages include overtime paid, premiums for shift work, night work and/or weekend work and bonuses, i.e. irregular payments which do not occur during each pay period, such as pay for holiday, 13th month and profit sharing.

[2] CA stands for collective labour agreement.