Is there a relationship between intra-firm wage dispersion and productivity?

Evidence from a Belgian linked employer-employee panel data

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1. Introduction

Relative wage is undeniably a dominating factor in the determination of any worker's pay. When bargaining over their wage, employees usually consider what other comparable workers earn internally, within their own firm, and externally, in other firms. With this in mind, how should a firm organize its internal pay structure in order to maximize the productivity of its employees? If workers compare their wage to these of other workers within and outside the firm, such wage dispersion should influence the workers' effort and hence, higher the average firm performance. However, the related literature offers opposing theories. A first range of arguments (Lazear and Rosen, 1981; Lazear, 1989; Lazear, 1995) is related to efficiency wage theory and suggests a positive influence of wage inequality on the worker's efforts. Such theories encourage firms to use a differentiated wage structure, in which the largest wage, the prize, in awarded to the most productive worker. Because only the top performers can be awarded a prize, the incentives to attain the highest pay make everyone work as hard as possible. In contrast, other studies (Akerlof and Yellen, 1988; Milgrom, 1988; Milgrom and Roberts, 1990; Levine, 1991) stress the importance of fairness and cooperation within workers of the same firm. Such theories advocate that a more compressed wage structure tends to higher worker productivity.

Besides the inconclusive theoretical literature, the empirical counterpart has also had difficulties in finding a consensus for the impact of within-firm wage dispersion on performance/productivity. These works typically use different estimation methods, different measures (either for wage inequality or for firm performance) and obviously, also study various environments. As a result, the precise impact of wage dispersion on productivity remains unclear. To figure which level of pay compression can optimize worker productivity may indisputably have great appeal for firms that wish to higher their profits by increasing their employees' motivation. Similarly, since public institutions remain the major actors of income redistribution in any society, they may consider policies oriented towards wage dispersion or compression, if it can help achieve higher economic performances in their country. Hence, the purpose of this paper will be to investigate the relationship between intra-firm wage dispersion and firm productivity, by means of an employer-employee Belgian firm sample, to figure out in which direction firms and public institutions should aim.

The methodology follows that of Winter-Ebmer and Zweimüller (1999), which is based on a two-step estimation procedure. In the first step, the conditional wage dispersion indicator is measured, extracting the variation in wage accounting for worker characteristics. This measure is obtained by taking the standard errors of the wage regression run for each firm. In the second step, firm productivity, measured as the value added per worker, is regressed against the wage dispersion indicators and other explanatory variables affecting worker productivity. As a sensitivity test, the standard deviation of wages is also computed for each firm and for each year. However, this measure is unconditional and offers a much broader indicator of within firm wage inequality as it does not account for individual characteristics. Hence, the analysis focuses on the effect of conditional wage dispersion indicator on productivity. To test for an eventual hump-shaped relationship, the quadratic forms of wage dispersion are also included in the equation.

The equation is estimated by pooled ordinary least squares (POLS) estimation and the fixed effects (FE) model. In context of panel data, the consistency and efficiency of POLS estimates will typically suffer from pooling all observations together. POLS results contain a mixture of the within and between firm effects of conditional wage dispersion on productivity. On the other hand, the panel data method, FE, differentiate each firm and controls for unobserved firm heterogeneity, thereby preventing results to suffer from omitted variable bias. Theoretically, the FE model should be the most appropriate estimation technique for this study. However, the lack of within firm variation over time in our variable of interest, the conditional wage dispersion indicator, leads the FE model to produce extremely small estimates. Hence, both models are displayed and examined in the analysis hereunder. The issues of simultaneity and state dependence are also discussed as they may bias the results.

For this analysis, a Belgian matched unbalanced employer-employee panel data starting in 2002 and ending in 2010 was used. This data set derives from the combination of the Belfirst data (Bureau Van Dijk) and of the "Banque-Carrefour des Entreprises" ("SPF Economy, SMEs, Self-Employed and Energy") data base. The former provides information on employees (e.g. age, gender, wage, whether blue or white collar, sector of activity), while the latter contains firm-level information about financial variables (e.g. profits, cash flow, turnover, value added) as well as firm characteristics (e.g. Number of workers, capital, sector of activity). The resulting panel data covers 377,778 workers from 2,354 firms of at least 25 workers.

Results indicate a mostly positive relationship between conditional wage dispersion and worker productivity. The pooled OLS model signals the existence of a concave hump-shaped relationship, with the maximum being way beyond the average level of conditional wage dispersion. Hence, the effect of conditional wage dispersion on productivity turns negative, only at highly excessive levels of wage inequality between comparable workers. Furthermore, results show that the relationship differs for white and blue collar workers. As the proportion of white collar workers increases within firms, the effect of conditional wage dispersion on productivity becomes more important and positive. Inversely, at high proportions of blue collar workers, a larger wage dispersion leads, on average, to lower levels of productivity. These results suggest that tournament and expectancy theory apply to white collar workers, while blue collar workers, on the other hand, seem more sensitive to fairness and cohesiveness.

Testing for differences across regions, the intensity of the relationship is also found to be stronger in Brussels compared to the other regions. Such differences may emanate from the fact that the region of Brussels is a more concentrated area containing a more diverse and surely more competitive workforce in most sectors. Also, results reveal weak and mostly insignificant differences in the effect of wage dispersion on productivity between Wallonia and Flanders. However, it seems that after a certain level of conditional wage dispersion, larger inequality strongly lowers worker productivity. In Flanders, the relationship between wage dispersion and productivity remains mainly positive. Interestingly, these observations support the argument that different ideologies and values, observed via political preferences (regional and trade union election results), may reflect worker behavior at different levels of wage dispersion.

The rest of this paper is organized as follows. Section 2 offers a review of the existing literature, both theoretical and empirical. Then, sections 3 and 4 present the methodology, showing how the conditional wage indicator and the basic specification are derived, and describe the data set. Section 5 presents the results and the last section concludes.

2. Literature Review

Personnel economics is the science that uses economic and mathematical approaches to address questions of human resource management. Pioneers in this field, such as Bengt Holmström, Edward Lazear, and Sherwin Rosen initially developed various concepts to describe the mechanisms occurring in the sphere of personnel economics, and in part, to income related questions. Owing to an overall persistently rising income inequality, especially in the US, a great deal of research has addressed questions regarding the causes and consequences of income inequality (Gordon and Dew-Becker, 2008). Is this type of inequality good for the economy? One way to tackle this question has been to conceptualize worker behavior to investigate how inequalities affect productivity. Hence, scholars have presented several theories to predict the potential effects that wage dispersion could have on workers' productivity. Later, the appearance of large and described data sets, containing employer-employee data, made the empirical testing of these theories possible. For this reason, it is mostly in the last few decades that the relationship between wage dispersion and productivity has received its highest attention. Hence, a growing empirical literature is devoted to the specific topic of wage dispersion within firms and how that relates to their performance. The section below is aimed at providing an overall picture of the existing literature, the so-called state of the art. First, each of the major theories are briefly developed. The section then provides an overview of the main empirical findings. Besides, the following section also clarifies the concept of wage dispersion, which has often led to ambiguity in the past when misinterpreted (Guta, Conroy and Delery, 2012).

2.1. Theoretical literature

As briefly introduced earlier, the theoretical literature somehow disagrees on how intra-firm wage spread affects productivity. Hence, many possible relationships are suggested. To start with, the theory of rank-order tournament of Lazear and Rosen (1981) suggests that a high wage dispersion fosters productivity and provides companies with high gains. According to this theory, a more differentiated wage structure in which the most productive workers is awarded the largest prize, stimulates worker's effort through the prize incentive. Moreover, wide pay dispersion will also create 'workforce sorting' within organization via two mechanisms. More specifically, as winners compete for higher prizes, they tend to accumulate while losers self-select out of the organization. In addition to poor performers being filtered out over time, which increases average performance, competition also attracts better applicants

(Lazear, 1999). Hence, it implies that the larger the wage spread between good and bad workers, the higher their efficiency/productivity.

However, in a later publication, Lazear (1989) nuances the tournament theory and even plague for wage compression if workers' rewards are based on relative comparisons. In this particular case, wage compression can reduce uncooperative behavior. This is known as the 'Hawks and Doves' model (Lazear, 1989; Lazear, 1995) where some workers, the hawks', adopt sabotage activities and non-cooperative behavior, which in turn reduces the chances that the other workers, the 'doves' win the tournament. According to Lazear (1989, 1995), if most of the workforce does not cooperate and adopt sabotage, a more compressed wage structure should be preferred. The model therefore stresses the importance of sorting out workers at the hiring stage and suggests that firms should adapt their compensation scheme to the characteristics of the workforce, or the hierarchical level (Lazear, 1989; Lazear, 1995). Hence, in line with Lazear (1989), a compressed wage structure is more efficient when initial incentive effect of a performance-related pay system is offset by a lower degree of work cohesion provoked by sabotage behavior of some workers.

Similarly, Milgrom (1988) as well as Milgrom and Roberts (1990) promote wage compression. Their argument is that workers may engage in rent-seeking behavior. More precisely, workers (especially white collars) choose to allocate some of their working time to unproductive activities, for example by trying to convince their supervisors to change the wage structure in their favor or by withholding information from their manager to increase their influence (Milgrom, 1988; Milgrom and Roberts, 1990). The authors claim that monitoring costs are typically higher for white collar workers, where this kind of behavior is more likely to occur. Consequently, firms can simply remedy such rent-seeking problems by compressing the wage structure.

Moreover, another strand of the literature has focused on the negative effect of wage dispersion on productivity, pointing out the importance of fairness and cohesion between workers. Akerlof and Yellen (1988) argues that a compressed wage distribution improves labor relations and firm performance by stimulating the average worker's effort. They derive a variation of Solow's efficiency wage theory (Solow, 1979) based on 'fair' wages. In their model, the workers' effort depends both on the wage level in absolute terms and on the degree of wage dispersion within the firm, that is at the relative level. In other terms, firms should aim for a low wage dispersion in order to achieve higher output per worker.

Akerlof and Yellen (1990) later developped the notion fairness in their 'wage-effort' hypothesis, in which workers tend to compare their wages both internally (with other workers of the same firm) and externally (with other workers of the same sector or industry). Basically, the theory predicts that workers will typically reduce effort if their actual wage falls short of the wage that they consider as fair (Winter-Ebmer and Zweimüller, 1999). According to Akerlof and Yellen (1990), the 'fair wage' can be obtained by combining the average wage of a reference group with the market clearing wages. Levine (1991) also comes up with a similar argument and states that in participatory firms where teamwork is important, wage compression stimulates cohesiveness, thereby increasing the firms' overall productivity. The concept of cohesiveness, defined as the propensity to obey group norms because approval of the group is valued, is at the core of Levine (1991)'s work. The results of Hibbs and Locking (2000) obtained with a firm-level production function suggest that firms should establish a wage distribution that is more compressed than the variation in workers' productivity. Frey and Oberholzer-Gee (1997) also points out the possible crowding out effect of monetary rewards on intrinsic motivation. If a firm raises wage dispersion to create incentive for workers to become more productive, this so-called crowding out might reverse the effect and result in a smaller or even negative effect on the workers' productivity.

Besides the theories of tournament and equity, a third theoretical approach is typically invoked in studies of pay variation: the expectancy theory. This theory was first developed by Vroom (1964) and describes how workers' motivation is related to their performance. More precisely, it states that pay dispersion will increase employees' motivation if (i) these workers find the outcome attractive (such as a high pay level), (ii) they believe that putting higher effort will lead to better performance and (iii) that a higher performance will be rewarded by a higher outcome. Hence, the Expectancy theory implies that larger rewards combined with closer relationships between pay and performance will result in greater motivation (Downes and Choi 2014). The theory therefore advocates for larger differences in pay which are predicted to result in higher worker productivity through greater motivation.

As shown so far, the literature about reward allocations seems to be indecisive as to whether intra-firm wage dispersion fosters or reduces the firms' productivity. The concept of a theoretical dilemma introduced by Pfeffer and Langton (1993) poses the question of which of the two, dispersed or compressed wage structure, is better suited to facilitate individual motivation and organizational effectiveness (Shaw, 2014). Should firms favor competition and increase pay dispersion or should they support fairness and equity compression by compressing wages? The last two paragraphs point out reasons for which it might be desirable to set up a compressed wage scheme. Accordingly, reducing wage dispersion within a firm may bring more cohesiveness among employees and avoid rent-seeking activities. Such egalitarian policies are advisable, considering social comparison, as they would further productivity. However, at a certain point, they might also encourage top performers to leave these egalitarian firms and to switch to other firms with higher wage dispersion, which would reduce the average productivity of the former firm (Winter-Ebmer and Zweimüller, 1999). Consequently, it seems that neither a too compressed nor a too dispersed wage scheme is desirable. In this respect, one could think of a certain level of wage dispersion for each firm that would be optimal in terms of productivity.

2.2. Empirical studies

Similarly, to its theoretical counterpart, the empirical literature, regarding the impact of intra-firm wage dispersion on firm productivity, is very inconclusive. The following section provides an overview of the main findings and further interrogates the issue of discrepancy among the results. A common approach that has been used throughout the literature has been to investigate which effect, positive or negative, dominates the other. The section below reviews the main contributions that have examined the relationship between wage dispersion and firm productivity, and highlights the different working environments in which they were performed. Appendix A provides an overview of the development of the empirical literature over the past decades.

A first part of the literature provides evidence supporting the 'fairness, morale and cohesiveness' theory presented above (Akerloff and Yellen, 1990; Levine, 1991). This theory suggests that increasing wage dispersion will lower firms' performance. Cowherd and Levine (1992) provide evidence based on linked employer-employee data of 102 business units from North-America and the United Kingdom. They use a measure of product quality to assess the performance of each business unit. Regarding the wage inequality measure, they compute wage differences between management and hourly-paid workers and between upper and lower management. For both measures, their empirical findings show the existence of a strong negative relationship, which the authors attribute to the impact of pay equity on the employees' motivation.

Moreover, Pfeffer and Langton (1993) also provide results showing a negative impact wage dispersion on workers' satisfaction, productivity and collaboration in the academic environment. More specifically, they use a cross-sectional data from more than 17,000 college and university professors in about 600 different academic departments. Wage dispersion is measured by the coefficient of variation in wages within each academic department and productivity calculated by the number of publications each professor published. In other words, Pfeffer and Langton (1993) show that when pay dispersion increases, workers are less satisfied, they are less productive and collaborate less on research. Furthermore, they show that this negative impact depends not only on a person's position on the salary structure but also on other factors such as the availability of information about wage inequality and a legitimate base of reward allocation. Additionally, multiple studies have examined the relation between wage dispersion and performance in the professional team sports environment (Harder, 1992; Bloom, 1999; Depken, 2000; Frick et al., 2003; DeBrock et al., 2004). These studies can be generalized as they focus on a work environment with specific characteristics and are essentially performed in the US. They generally also conclude that wage dispersion is detrimental for team performance (based on win-loss percentages).

On the other hand, other studies have empirically demonstrated the existence of a tournament mechanism (Lazear and Rosen, 1981). Eriksson (1999) for example, shows a positive impact of pay dispersion at the executive level on pay performance, obtained with a profit-sales ratio, using a Swedish panel data from 439 firms. Also using Swedish data, but with larger and older aggregate data (1964-1993), Hibbs and Locking (2000) find a positive relationship between wage inequality and firm performance, measured as value-added. Additionally, Beaumont and Harris (2003) demonstrate a positive effect of wage dispersion on the workers' productivity from a UK panel data in 4 out of 5 industrial sectors. They measure wage inequality as the ratio of wages of manual to non-manual labor and use gross value added to assess productivity.

Lallemand et al. (2007) also find a positive and significant relationship for large Belgian firms using a matched employer-employee cross section data of 1995.

Besides, many other researches provide mixed results supporting both theories, at different levels of wage dispersion. For instance, Winter-Ebmer and Zweimüller (1999) investigate the impact of intra-firm wage dispersion on firm performance using panel data that covers the whole Austrian workforce over the period 1975-1991. Their work is an important contribution to this literature as they are the first to develop a conditional measure of wage dispersion. Based on a firm-level wage equation, Winter-Ebmer and Zweimüller (1999) measure within firm dispersion using the standard errors. Hence, their measure controls for workers' individual characteristics within each firm. Their findings suggest the existence of a positive hump-shaded relationship between intra-firm wage dispersion and firm performance. They further imply that neither a too compressed nor a too dispersed wage structure is desirable due to inventive and fairness considerations respectively. By the same token, Bingley and Eriksson (2001) also find a hump-shaded relationship for white collar workers using a similar approach as Winter-Ebmer and Zweimüller (1999) (using residuals from wage regression) to compute their wage dispersion measure on Danish panel data. Their productivity measure differs though, since they use total factor productivity. They find no effect of wage dispersion on blue collar productivity. Other studies find this hump-shaded relationship (Grund and Westergard-Nielsen, 2008; Braakmann, 2008; Mahy, Rycx and Volral, 2009; Aperte, 2013).

Furthermore, mixed results also arise due to specificities in certain working environments. For instance, the impact of intra-firm wage dispersion on worker productivity may depend on the position of each worker within the firm (Pfeffer and Langton, 1993). Such predictions may imply that workers at different levels of the organization or with different skills, presumably behave differently to wage dispersion. In fact, this is consistent with the theoretical perspective of the 'Hawks and Doves' model of Lazear (1989, 1995) suggesting that firms should adjust their compensation scheme to the characteristics of their workforce. According to Lazear (1989, 1995), since the presence of 'hawks', i.e., those who behave opportunistically, is more likely at the executive or top-level, firms should lower wage dispersion at these levels to prevent sabotage or rent-seeking activities. Empirically, the effect of the workers' skills on the relationship between wage dispersion and firm productivity show mixed results, as shown in appendix A).

Each of the theoretical positions presented earlier provide an important contribution to the study of wage dispersion and its impact on productivity. However, the related empirical research has been unable to depict the truth and has led to inclusive results. Guta, Conroy and Delery (2012) have identified a number of reasons that cause such discrepancy among the findings.

To start with, some studies are performed in specific context/working environment. These environments create different sources of pay variation that are likely to have different effects. In fact, much of the previous evidence is often restricted to a specific segment of the labor force (e.g. executive level[1]) or a particular sector of the economy (e.g. professional sport[2] or college and university faculty[3]) (Guta, Conroy and Delery, 2012). Consequently, the results are usually mixed between these strands of the literature (Braakmann, 2008). Moreover, scholars have used many different construct and measures to assess pay variation (e.g. Coefficient of variation, pay range, Gini coefficient). According to Guta et al. (2012), different measurement approaches may induce different conclusions. In particular, Mahy, Rycx and Volral (2011) point out that some studies rely on unconditional indicators of wage dispersion, while tournament and fairness theories assume workers with comparable characteristics. Hence, conditional indicators should be used to test these theories.

A similar logic holds regarding the different outcomes on which pay variation has been tested. More precisely, a multitude of outcomes have been studied at the individual (e.g. individual perceptions), team (e.g. workforce performance) and organizational levels (e.g. financial performance, profits or productivity) (Guta, Conroy and Delery, 2012). Even though some of these outcomes might be closely linked, one should expect different impacts of pay variation on each of them. Besides, many studies consider financial values (e.g. sales, value-added, profits) as proxies for firm productivity. As shown by Mahy, Rycx and Volral (2011), this choice may potentially raise the problem of simultaneity in the relation between wage dispersion and firm productivity. That is, if well performing firms pay larger wages (through bonuses) to their most productive workers, which further increases wage dispersion; this may therefore create endogeneity issues, from reverse causality and bias the estimates.

3. Methodology

3.1. The wage-level equation

Many different measures are used throughout the literature to assess wage dispersion. Gupta et al (2012) focuse on pay variation and show that many studies have confusingly used different types of measures to test identical theoretical arguments. To sweep ambiguity away and to make sure not to produce the same mistake, let us clarify the concept. Three kinds of pay variation can be identified throughout the literature (Gupta, Conroy and Delery 2012). First, vertical variation concerns pay variation across jobs, that is the wage gap between different kinds of jobs within the same firm. A greater level of vertical pay variation will reflect higher differentiation across jobs. Second, horizontal variation refers to pay discrepancy among people holding the same job, or people who perform similar activities for an organization. If workers are to do the exact same job, individuals' characteristics will presumably be responsible for differences in pay. Such differences include age, seniority, accumulated skills, bargaining ability, and others aimed at explaining pay variations within the same job. Finally, a third type of pay variation, called overall variation, accounts for the wage variance attributable to vertical variation, horizontal variation, and other factors typically considered error variance (Gupta et al, 2012). As Shaw (2015, p7) emphasizes, relevant dispersion-

[1] Eriksson (1999), Leonhard (1990) Main, O'Reilly and Wade (1993)
[2] Harder (1992), Bloom (1999), Depken (2000), Frick et al. (2003), DeBrock et al. (2004)
[3] Pfeffer and Langton (1993)

creating practices do not always explain highly dispersed pay. Put differently, there might be other factors such as organizational politics, lack of formal or inconsistently applied procedures, nepotism, and game-playing which can cause employees who do similar work and have identical profiles, to be paid differently (Kepes, Delery and Gupta, 2009).

Even though the distinction between horizontal and vertical pay enables to study very specific mechanisms of workers' behavior, such analysis requires detailed data bases and lies primarily on how job is defined (i.e. what differentiates two jobs). Unfortunately, the data used in this paper do not contain such variables to differentiate pay variation between and within jobs. It is important to acknowledge this fact and be aware that the measure of wage inequality hereunder, contains both horizontal and vertical variation in firm's pay.

Unconditional wage dispersion indicator

Initially, a classic and rather simple approach used in this literature was to compute the standard deviation of wages in over each firm, to obtain an overall measure of firm wage spread. Below the identical technique is composed and the resulting indicator each firm and for each year.

$$\sigma_{U;\,j,t} = \sqrt{\frac{1}{N_{j,t}} \sum_{j=1}^{N_{j,t}} \left(\ln\left(w_{i,j,t}\right) - \ln\left(\overline{w_{J,t}}\right)\right)^2} \tag{1}$$

where σ_U captures the overall wage dispersion within each firm for each year, $N_{j,t}$ and $\overline{w_{J,t}}$ is the number of workers and the mean wage in firm j at time t, respectively, and $w_{i,j,t}$is the wage of worker i of firm j at time t.

Yet, theories such as tournament or fairness refer to wage differentials between comparable workers. More precisely, σ_U as defined above, captures variation in wages between workers that may have extremely different characteristics. However, the effects of tournament, for example, will typically take place between workers who consider themselves approximately equals. Accordingly, higher wage dispersion between comparable workers will foster their motivation, because they believe that the prize, i.e., the highest salary, is within their reach. Hence, this will increase competition and further increase their productivity. Therefore, another distinction is relevant for the subsequent analysis. Conditional wage dispersion, as opposed to unconditional dispersion, uses individuals' characteristics to determine wage differentials between observationally equal workers. In the past decades, the literature has headed towards this type of indicator, more appropriate for such analysis. A famous method was first introduced by Winter-Ebmer and Zweimüller (1999) and rests on a two-step estimation procedure. This is the method used in the analysis below.

Conditional wage dispersion indicator

The first step is to obtain the conditional wage dispersion indicator, thereby the following wage equation is estimated by POLS:

$$\ln w_{ijt} = \alpha_0 + x_{ijt}\alpha_1 + \epsilon_{ijt} \tag{2}$$

where w_{ijt} is the quarterly gross wage for worker i of firm j at time t, x_{ij} is a vector that includes individual characteristics including age (and its squared value), a dummy for the worker type (blue or white collar), the sector of activity, working time over the quarter and ϵ_{ij} is the error term. The wage dispersion measure is obtained by taking the standard deviation of the residuals of this equation, firm by firm and year per year. This measure is named σ_C and is aimed at representing the variation in wage within each firm, that is not explained by individual characteristics. It is computed through the following equation:

$$\sigma_{C;\,j,t} = \sqrt{\frac{1}{N_{j,t}}\sum_{j=1}^{N_{j,t}}\left(\epsilon_{i,j,t} - \overline{\epsilon_{j,t}}\right)^2} \tag{3}$$

where the notations are identical to the ones of equation (1), except ϵ, the standard errors of equation (2) replaces w, the wage.

Controlling for observable individual characteristics in equation (2) allows to filter out all variation in pay that are explained by individual characteristics. Or put differently, σ_C excludes all variation in pay that is due to worker endowment, which is essentially the accumulation of human capital. Consequently, the resulting σ_C will account for all reasons, other than worker characteristics. Theoretically, this will provide an indicator for the amount of pay variation desired in each firm, or in other words, an indicator of firms wage policy towards pay dispersion. In practice, however, the interpretation of σ_C may be challenged for several reasons.

First, the conditional indicator aim to control for all wage variation for which worker characteristics are responsible. Unfortunately, the data used in the following analysis do not contain measures neither for individuals' level of education nor employees' seniority. However, human capital and especially seniority, are both important driving factors of productivity in the Belgian labor market. Within a same firm, workers that are more educated and who have longer experience will typically earn higher wages than another similar worker who are less educated or experienced.

Therefore, the absence of such measures creates a risk that the conditional wage dispersion estimates, σ_C, is biased for not controlling education and experience. To illustrate, consider how a firm of two identical workers, except for their educational achievements, who earn different wages influences equation (2). Based on the available information, these two individuals will be considered identical and hence, the wage gap between these two will be treated as the unexplained error term, which will reflect in a σ_C larger than it should be if we had controlled for education. Our estimations of conditional wage dispersion will therefore suffer from the lack of these and other explanatory variables at the individual level.

Nonetheless, one should not underestimate the richness of the explanatory variables contained in the data set, which in fact, may partially control for variables such as education and seniority. More precisely, variables controlling for age and the type of worker (whether blue or white collar) appear to be good proxies for experience and education, respectively. More precisely, it is fair to expect that older workers, 45-years-old for instance, typically have more experience than younger ones, such as young graduates. Similarly, white collar workers usually perform tasks that require a certain level of skill, which in turn implies this type of worker will generally be more educated. Because such omitted variables are probably correlated with other explanatory variables present in equation (2), most of the variation in wages due to individual characteristics is somehow excluded from σ_C. Hence, we can confidently rely on σ_C for the analysis hereunder, and consider it as a powerful indicator of wage variation conditional on worker characteristics.

Second, in practice, σ_C is unable to perfectly control for all the workers' characteristics, even with an extremely informative data set. Some of them, such as worker ability to bargain or social skills, are simply unobservable. However, even though these unobservable characteristics may explain why two identical workers have different wages, they usually account for a very small part of the wage dispersion. Third, σ_C may be the result of other determinants than worker characteristics and firm wage policy. For instance, the state of the labor market itself and its regulations may certainly influence how wage varies among workers. A high minimum wage established in one sector will certainly compress the overall wage dispersion in that sector.

With all that said, the conditional wage dispersion measure remains the most appropriate indicator for the following analysis. As shown earlier, the theory of tournament, equity and fairness best applies to workers who have similar characteristics. How can we then interpret the difference between the conditional and unconditional pay dispersion measures in the analysis below? Let us use a simple example to compare their meanings. To illustrate, imagine the case of a large corporation where there are two types of workers and where we suspect the existence of tournament effects. The first category of worker, say 'the managers', earn far more than the other category of workers, who perform tasks that do not require as much skill (e.g. secretary, manual job). If we consider that the lower skilled workers do not believe in any chance of being promoted to a manager position, a raise in overall manager salary will not produce any tournament effects, i.e., the raise will not affect lower skilled workers' productivity. Yet, the two wage dispersion indicators will be differently affected by such a raise.

A raise in the managers' pay will produce a larger overall firm wage dispersion, σ_U, because of the higher wage spread between them and all the other workers, including the lowest skilled workers. On the other hand, because we expect managers to have specific worker characteristics (e.g. most probably a highly educated white collar worker and older, highly experienced, etc.), it should not substantially affect the conditional wage dispersion indicator σ_C. Such characteristics will be controlled for in equation (1) and hence, will only moderately affect σ_C. Consequently, because most theories apply to comparable workers, the conditional wage dispersion indicator, σ_C, is the most appropriate indicator for the purpose of this paper.

In the early ages of the wage inequality related literature, the unconditional indicator was usually used to test the theories of tournament and fairness. The appearance of the much more accurate tool of the conditional wage dispersion indicator allowed scholars to address these theories more appropriately. Does that mean that the unconditional indicator should be vanished for all that? According to Winter-Ebmer and Zweimüller (1999) unconditional wage dispersion measures also have appeal, especially when it comes to the influence of CEO's pay on work morale of the rest of the workforce. In general, too high levels of wage dispersion may create a feeling of "unfairness" among the employees. Also, the unconditional wage inequality measure may be relevant if workers believe that each wage level in a firm can be reached by high performance. In this scenario, greater wage inequality may create larger incentives, and hence, improve overall performance. This joins the idea of tournament theories. However, to apply such theories on the impact of unconditional measure of wage dispersion on firm productivity requires strong conditions (e.g. regarding workers' beliefs) to be satisfied.

Hence, to test the theoretical predictions exposed above, the use of the conditional wage dispersion indicator, σ_C, will be preferred. Nevertheless, for a sensitivity test, σ_U is also included in the most basic form of the specification below. Comparing the effect of overall and conditional wage dispersion coefficients may help to see to what extent firm productivity is explained by individual/worker characteristics.

3.2 The firm-level equation

3.2.1 Basic specification

In the second step, the following firm level equation is estimated:

$$\ln\left(productivity_{jt}\right) = \beta_0 + \sigma_{jt}\beta_1 + z_{jt}\beta_2 + y_{jt}\beta_3 + \theta_t + \omega_{jt} \quad (4)$$

where $productivity_{jt}$ is, the value added per worker for firm i at time t, σ_{jt} is the wage dispersion indicator of intra-firm wage dispersion, z_{jt} contains firm characteristics, y_{jt} captures aggregated characteristics of firms' workforces, θ_t, is a set of year dummy and interactions of year dummy with sectorial dummy, ω_j is the error term. The explanatory variable of interest in equation (2) is the conditional wage dispersion (σ_{jt}) estimated in the first step. Firm productivity is measured by value added per worker, the difference between the quantity of output and the quantity of input used to generate that output. This way, it can be thought as the wealth generated by the combined efforts of firms' employees and employers. Equation (4) contains numerous control variables for the composition of the workforce including the share of female, blue collar workers, young (less than 25 years old) and old workers (more than 50 years old) as well as the share workers who started in year t. Another set of variables control for firm characteristics including the amount of capital per worker, the firm size (number of workers) and the sectorial affiliation. θ_t contains both year dummies, to account for annual fluctuations in productivity that are not due to any of the explanatory variables (time varying effects), and a set of interaction term capturing sectoral productivity shocks over time[4]. The exact same equation is estimated as well, replacing the conditional dispersion measure by the coefficient of variation.

An important problem to consider is the potential simultaneity between productivity and wage dispersion. As noted by (Lallemand et al, 2004), it may be argued that highly productive firms pay larger wages to their most productive workers, which in turn may lead to more wage dispersion (e.g. through bonus payments). Additionally, Braakmann (2008) claims that negative shocks in sales may incite firms to hire more qualified personal in response, which in turn leads to simultaneity problems. Scholars have dealt differently with the simultaneity issue either using IV techniques (Lallemand et al, 2004) or Arellano-Bond dynamic panel estimator (Braakmann, 2008). In the analysis below, we treat this issue by regressing productivity on both the conditional wage dispersion indicator, $\sigma_{C,t}$, and $\sigma_{C;\,t-1}$, its lagged value separately. Because productivity in period t cannot affect conditional wage dispersion in period t-1, comparing regression results for the wage dispersion coefficient and its lagged counterpart permits to investigate the existence of potential simultaneity. There may be signs of simultaneity in case the corresponding coefficients in the two regressions differ greatly.

Equation (2) is estimated using the panel extension of the standard ordinary least squared (OLS) regression, namely Pooled OLS. However, this model, whilst of the simplest form econometrically, has some drawbacks. The risk of the coefficients being correlated to the error term is hard to invalidate in a panel data setting, henceforth, the reported standard errors cannot be considered. Robust standard errors must hence be computed (i.e., clustering firm ID). Unfortunately, while the POLS estimates are efficient by definition, there is a risk that these coefficients are inconsistent. As the name of the inference method implies, all firms are pooled together and hence, are no longer distinguished. The single constant, β_0, is the same for all firms.

However, productivity may be caused by unobserved firm heterogeneity (e.g. firm culture or synergy), which in turn may lead to an overestimation of the effect of wage dispersion on firm performance. As an example, highly productive firms might comprise individuals that have higher (unobserved) ability, and therefore offer wages that are higher and more dispersed. If a firm selects workers that are particularly efficient for teamwork in its hiring process, one may expect the overall productivity of this firm to be higher, comparatively to other firms, because

[4] This phenomenon is known as Baumol's cost disease or Baumol effect and describes an economy in which some sectors experience great productivity gains while other do not. Beaumol observes a rise of salaries in jobs that have experienced no increase of labor productivity, in response to rising salaries in other jobs that have experienced the labor productivity growth (Heilbrun, 2003).

of the synergy created from combined workers' efforts. However, such firm characteristics can hardly be observed and quantified. Hence, panel data techniques can be used to deal with this issue of unobserved firm heterogeneity that typically leads to omitted variable bias in the POLS estimates. As a result, OLS may not be able to grasp the relationship between intra-firm wage dispersion and productivity properly. To take these differences between firms into account, we turn towards another classic inference method used for panel data settings, namely the fixed effects (FE) estimation technique.

FE permits to measure the relationship between wage dispersion and productivity by including a dummy for each separate entity, which controls for cross-firm variation. This has the advantage of greatly reducing the threat of omitted variable bias present in POLS. The choice to prefer FE over POLS may also depend on how we consider the relationship from an economic point of view. To see which of the two techniques is more appropriate to our analysis, let us dissect how POLS and FE are both affected by wage dispersion variations.

In POLS, productivity is affected both, by wage dispersion variations within and between firms. These variations may either occur over time or be the result of persistent differences between the firms, i.e. time-variant and invariant differences between firms. FE, on the other hand, exploits the within-firm variations over time, excluding all cross-firm variation. However, to assess the effect of within-firm variation in wage inequality on productivity over time, the fixed effects model requires a reasonable amount of variation of wage dispersion, the variable of interest, within each firm. Put differently, if wage dispersion has too little within-firm variation, FE will not be able to assess the relationship.

In our case, it is reasonable to assume that large variations in the wage structure are unlikely to occur from year to year. Even in case of sudden and total restructuration, firms usually modify their pay structure very slowly over time. Imagine a firm that would like to decrease its salary expenses. Such a strategic managerial decision would be smoothed out over time to avoid that all the workers move towards another company. Consequently, short term changes in wage dispersion within firms will typically be so small that they will not affect workers' productivity in any way. As a result, FE estimates in this analysis can be expected to be quite small if not null.

Having acknowledged that FE will probably lead to small and weak results, we include the estimates for the model next to POLS in the analysis hereunder. To control for fixed (persistent) differences between firms, the alternative equation is estimated:

$$\ln(productivity_{jt}) = \beta_0 + \sigma_{jt}\beta_1 + z_{jt}\beta_3 + y_{jt}\beta_4 + \theta_t + \mu_j + \omega_{jt} \tag{5}$$

where μ_j is the fixed effect dummy variable that captures time-invariant characteristics for each firm.

Alternatively, between estimators is another technique that may be used in the context of panel data analysis. Averaging each variable over time and that, for each individual, may particularly be interesting to capture long term relationships, especially for a panel with a great number of individuals. However, an important shortcoming with the between estimation is that the panel must be balanced. Otherwise, it produces incomparable means.

3.2.2 The Hump-shaped relationship

As the existence of a hump-shaped relationship is suspected for this relationship, the quadratic form of the wage dispersion measure can be included in the equation, giving:

$$\ln(productivity_{jt}) = \beta_0 + \sigma_{jt}\beta_1 + \sigma_{jt}^2\beta_2 + z_{jt}\beta_3 + y_{jt}\beta_4 + \theta_t(+\mu_j) + \omega_{jt} \qquad (6)$$

3.3 Difference between white and blue collars

Several scholars (Winter-Ebmer and Zweimüller, 1999; Lallemand et al, 2004) have investigated whether the relationship between intra-firm wage dispersion and firm productivity would differ as a function of the working environment. As outlined in the above section, some worker characteristics may explain why some workers react differently to wage dispersion. Lazear (1995) suggests that the elasticity of firm productivity with respect to inequality is influenced by the composition of the workforce and that as a result, firms should adapt their compensation scheme to the characteristics of the workforce (e.g. level of skills), or the hierarchical level. Consequently, a popular exercise in the literature is to investigate which theory (tournament vs fairness or equity theory) would dominate the other for different types of workers. According to Milgrom (1988) and Milgrom and Roberts (1990), one of the key differences that may lead to different mechanisms among the two types of workers lies in the monitoring costs. Because white collar workers are much more costly to monitor, firms should reduce the dispersion between their wages to avoid rent seeking activities. Consequently, firms where white collars wages are largely dispersed, may suffer from managers taking personal interest decisions, thereby reducing overall productivity. Additionally, Lazear (1989) theory of the 'Hawks and Doves' suggests a positive relationship between wage dispersion and productivity, especially at higher positions in firms. While these theories predict the occurrence of different mechanisms among certain types of workers, they all seem to agree on the fact that the relationship is dependent on certain workers' characteristics. In this paper, the focus is put on the difference between white and blue collar workers. We further tested the following hypotheses:

Hypothesis 1: The relationship between intra-firm wage dispersion and firm productivity depends on which type of worker, blue or white collar, predominates in a firm.

To test this assertion, an interaction variable is introduced into the model hereunder. More precisely, the share of blue collar workers for each firm and for each year is interacted with the variable of interest, the conditional wage dispersion indicator. The model therefore interacts two continuous variables, the share of blue collar workers with the conditional wage dispersion, which will offer precise estimates for how the effect of wage dispersion on productivity varies with different types of working force. Although this method differs from Winter-Ebmer & Zweimüller (1999) who perform two regressions separately for each type of worker, results should be similar while producing more precise relationship estimates. The model also investigates the existence of a hump-shaped relationship (adding the parenthesis content):

$$\ln(productivity_{jt}) = \beta_0 + bcol_{j,t}\,\beta_1 + \sigma_{C;\,j,t}\beta_2 * bcol_{j,t} + \sigma_{jt}^2\beta_3 * bcol_{j,t}$$
$$z_{jt}\beta_4 + y_{jt}\beta_5 + \theta_t(+\mu_j) + \omega_{jt} \quad (7)$$

where $bcol_{j,t}$ is the share of blue collar workers in firm j at time t. If hypothesis 1 is to be confirmed, the examination can even be pushed further to investigate which of the above theories best applies to each type of worker.

3.4 Differences across the regions

So far, this paper has done nothing more than replicating what has been done in the existing empirical literature. Indeed, many scholars have investigated how the relationship between intra-firm wage dispersion and productivity changes in different working environments. Among these, some of them (Lallemand, Plasman and Rycx, 2004; Mahy, Rycx and Volral, 2009; 2011) have used data from the Belgian private sector. Interestingly, these studies find mixed results for the influence of wage dispersion on productivity. Although they differentiate between certain working environments[5] and worker characteristics, they all consider the Belgian private sector as a whole. However, some factors that vary differently among Belgian regions may influence workers' behavior and affect their productivity. Hence, in this section, the analysis of the effect of intra-firm wage dispersion on productivity is pushed further to see whether some differences across regions can influence the above specification. Belgium counts three different regions (Flanders, Wallonia and Brussels) that differ in many aspects, be it politically or economically.

There are several reasons that explain why regions vary economically. First, some regions may simply be more prosperous than others and have higher levels of productivity. Second, sectors are not equally represented in each region. If a sector, that typically contains workers who are motivated by competition, is more represented in one region, then there will be a higher proportion of workers who prefer higher levels of wage dispersion in that region. Moreover, this will also positively influence the relationship between wage dispersion and productivity in that region. Another reason that may also influence the economic situation of a region could be demographic differences. For instance, we may consider that older workers, who only have a few years left before retiring, are less responsive to competition. If one of the region's workforces is populated by older workers, the relationship for that region will be negatively affected.

Alternatively, regions also differ politically. More specifically, preferences towards wage dispersion may partly be determined by ideological visions that differ within each region. Such

[5] e.g. Mahy, Rycx and Volral (2009) examines different levels of uncertainty in firm economic environment.

an ideological perspective may in turn be reflected through political preferences. Put differently, if for example, an egalitarian political party is more popular in one region, this may reveal voters' preference for redistribution in that region. In that case, workers of this region will probably behave according to the fairness/equity theory and pay dispersion will negatively affect their productivity. The case of Belgium is of particular interest with regard to political preferences. The two main regions of the country, Wallonia and Flanders, often oppose each other on the political scene. In what follows, the focus is put on these political differences. We first explore the political views shared in each region. Then, we elaborate on the argument that different political attachments may explain different workers' reactions towards wage dispersion. Lastly, a new equation is specified to evaluate whether the above specification differs across the regions.

An important question to ask is whether different levels of wage dispersion vary across the regions. Appendix B shows the difference in pay variation across regions. In the above specification, the conditional wage dispersion is computed by filtering out all variations explained by individual characteristics. What is 'left' is then considered essentially driven by firms' decisions. In other words, the differences in conditional pay variation are mostly explained by firms' managerial/structural policies. Nevertheless, there could be other factors that affect pay dispersion differently across the regions. For instance, some sectors with specificities (e.g. for which piece rate is more widespread) that lead to a different relationship between wage dispersion and productivity may be more predominant in some region.

How do political views relate to within-firm wage dispersion and productivity? A first element to consider to answer this question concerns the role of trade unions in Belgium. Trade unions have a great influence over working conditions and wage setting, both in the private and the public sector. Their role is to act at the three different levels where wage bargaining occurs: the national (inter-professional) level, the sectoral level and the firm level. The process is renewed every two years and starts at the national level. At this stage, a national collective agreement defines a minimum wage level. This national agreement is then renegotiated within every sector. Lastly, negotiations take place within each firm, which result in collective agreements setting wages that can only be greater or equal to the wages set at the sectoral and national agreements (Lallemand et al, 2007). Hence, trade unions can have a real influence on firms' wage setting policies. For example, a more compressed wage structure can be attained if minimal wage level is increased. As shown below, Belgian trade unions have political orientations. This may then explain the wage gap that exists between the regions. The following paragraph offers a glimpse of the support received by the main Belgian trade unions.

Belgian trade unions are divided between competing confederations, which have clear political traditions. The three most popular trade unions in Belgium are the CSC/ACV[6], FGTB/ABVV[7] and a smaller one, the CGSLB/ACLVB[8]. The figure hereunder provides the results of the 2012

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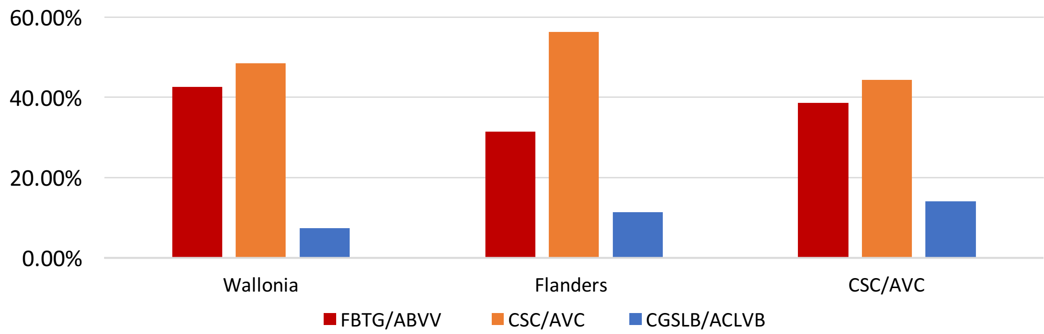
[6] French: Confédération des syndicats chrétiens (CSC); dutch: Algemeen Christelijk Vakverbond (AVC)
[7] French: Fédération générale du travail de Belgique (FGTB); Dutch: Algemeen Belgisch Vakverbond (ABVV)
[8] French: Centrale générale des syndicats libéraux de Belgique (CGSLB); Dutch: Algemene Centrale der Liberale Vakbonden van België (ACLVB)

trade unions elections by region. The CSC/AVC is linked to the Christians movement, the FBTG/ABVV shares socialist party ideas (PS), and the third trade union is linked to the liberals. Interestingly, the popularity of the main confederations is not spread evenly across the regions. Even though the CSC/ACV has more seats and votes than the FGTB/ABVV in each of the three regions, the Christians democrats oriented trade union (CSV/ACV) has its strongest support in Flanders while for the socialist oriented trade union, the strongest support is in Wallonia. Trade union membership obviously cannot reflect the overall political framework of Belgian politics, which is much more nuanced and involves other issues besides the labor market. However, as social democrats are usually considered at the center of the political scene and socialists on the left, it shows a tendency of the French speaking region to be more oriented towards left-socialist then Flanders, its regional counterpart. This is confirmed by figure 1 hereunder.

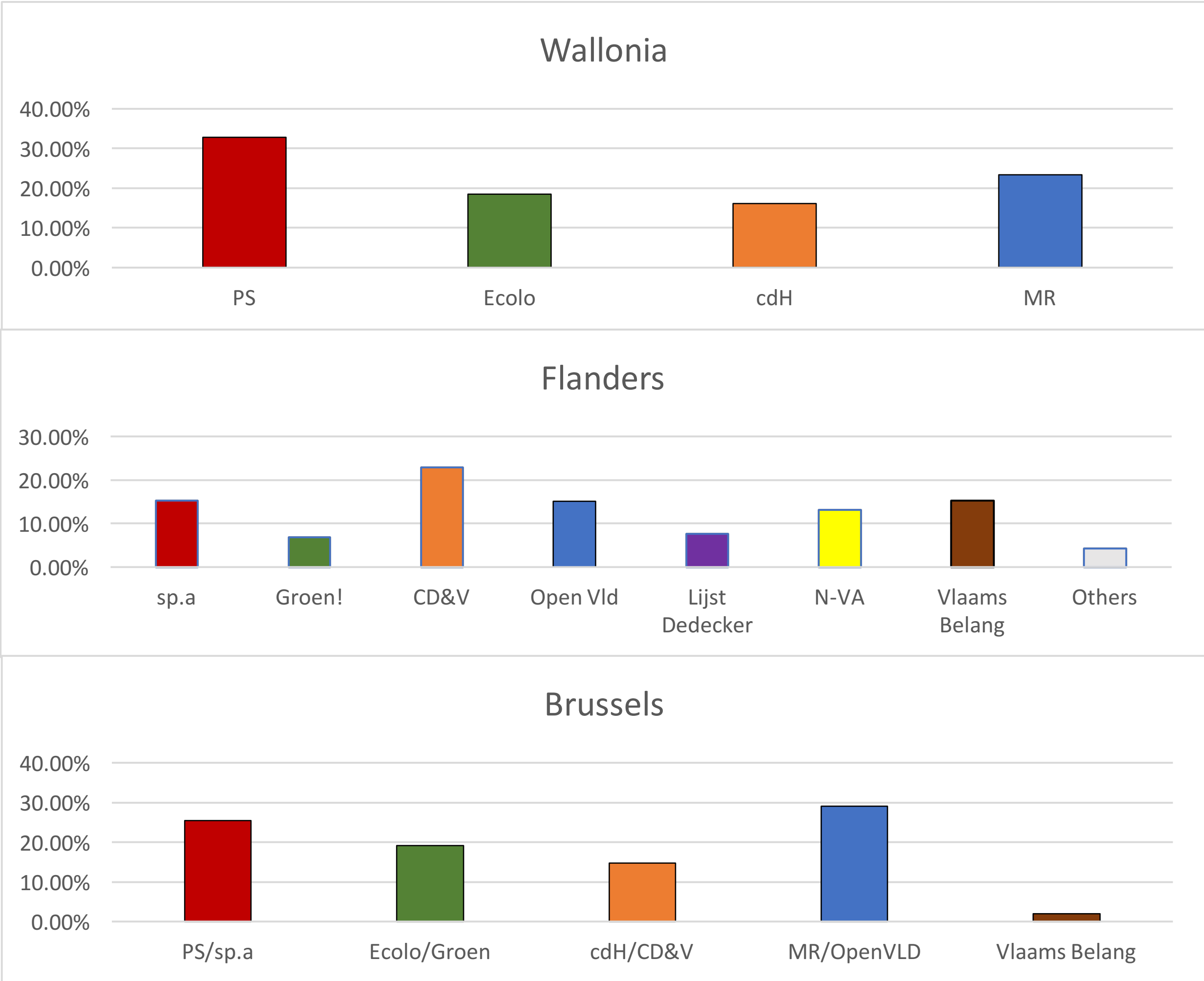
Figure 1. *Results of the Belgian trade unions elections in 2012 by region*



Notes: FGTB: Fédération générale du travail de Belgique; ABVV: Algemeen Belgisch Vakverbond; CSC: Confédération des syndicats chrétiens; AVC: Algemeen Christelijk Vakverbond; CGSLB: Centrale générale des syndicats libéraux de Belgique; ACLVB: Algemene Centrale der Liberale Vakbonden van België. These results originate from the "Service Public Fédéral intérieur" website (https://ibz.be/).

The picture of the trade union support described above provides a first element to explain ideological differences across the regions. Obviously, trade union election results alone do not suffice to explain overall political preferences for the regions. To measure the political preferences by region is a complex task. As emphasized by Castanheira and Noury (2007), to identify the position each political family has can be very intricate and may require different methods. More precisely, the political sphere debates on many issues. Two political parties may agree on some issues while they might diametrically oppose each other on others. However, it is possible, using the left-right opposition shortcuts (i.e. where the left ideology rests primarily upon egalitarianism and solidarity and the right, on liberalism and order), to obtain a broader picture of the overall political preferences by region. This is what figure 2 below aims at. It can surely be criticized for its simplicity and subjectivity (e.g. one may consider some of the main political parties differently). For instance, the CD&V is situated at the center of the political scene notwithstanding that some might describe it as a party of the center-right. Furthermore, elections take place at several responsibility levels in Belgium (i.e., federal, regional, community, provincial). The figure provides results for the regional elections only, which may differ from poll outcomes at other levels. It is therefore important to stress that accuracy is certainly not the purpose of this figure. Rather, it is intended to offer a broader vision of the Belgian political framework in each region. Although it is hard to point out at a 'center' among those political parties, one may think of the orange, Christian-democrats, families as being at the center of the political scheme, considering a simplistic left-right wing opposition.

Figure 2*. Results of the Belgian regional elections in 2009 by region*



Notes: From left to righ-wing parties, PS: Parti socialiste; sp.a: Socialistische Partij Anders; Ecolo/Groen; cdH: centre démocrate Humaniste; CD&V: Christen-Democratisch en Vlaams; openVLD: Open Vlaamse Liberalen en Democraten; MR: Mouvement réformateur; Lijst Dedecker; N-VA: Nieuw-Vlaamse Alliantie; Vlaams Belang. These results can be found on the "Service Public Fédéral intérieur" website (http://elections2009.belgium.be/en/).

Figure 2 shows the main political families that are supported in each region. For simplicity, parties from Wallonia have been matched with their Flemish counterparts for the regional elections in Brussels. Although some of them are totally independent from each other (e.g. the cdH and the CD&V) and hence, do not have the exact same position on every issue, they tend to aspire to similar values. The difference between Wallonia and Flanders is clearly the most striking. About two third of the parties from the center to the left dominate in Wallonia. This is mostly attributable to the socialist party, holding 32.77% of the votes alone and being the most popular family of this region. In Flanders, the situation is reversed. The CD&V is the most popular party and is situated at the center (although it is considered slightly more on the right than its 'Walloon counterpart', the cdH). Unlike in Wallonia, the socialist and ecologist parties are much less popular in Flanders. More than fifty percent of the votes goes to the four right-wing-oriented parties that share liberalist values although they strongly oppose each other on many issues. The center-right party, the openVLD, is for example to be distanced from nationalist/separatist parties such as the Vlaams Belang, which is clearly a far-right movement.

On the other hand, the picture is different in the capital region, where the distribution of votes is more balanced between the left, the center and the right of the political sphere.

With the observations drawn from figure 2 in mind, on could imagine that the political preferences in the regions may be observable through workers' behavior. More precisely, as political parties bear ideological values that reflect in their actions, people who vote for these parties should, in principle, share identical values and opinions. Hence, it could be that these political preferences affect the workers' reaction to different levels of wage dispersion. For example, regions where workers vote essentially for left/socialist political families will logically be more inclined to adhere to an egalitarian ideology, which advocates equal distribution of income and thus, a more compressed wage structure. On the other hand, regions dominated by right/liberal parties may be in favor of competition implemented through higher wages, aimed at stimulating workers' effort. Therefore, divergences in political opinions may not only affect wage dispersion and productivity, but also the elasticity between productivity and intra-firm wage dispersion in each region. Of course, it would be eroded to talk about a causality here. What is tested later is more of a supposition. There are indeed other external factors that will influence productivity other than wage dispersion, political preferences and the control variables described earlier (e.g. randomness and other unobservable factors such as managers' ability). In this line of reasoning, the second hypothesis is formulated:

Hypothesis 2: The political preferences result in different relationship between intra-firm wage dispersion and worker productivity in each region.

Building on this hypothesis, one could go one step further and predict that if ideological preference is so different between Wallonia and Flanders, not only the effect of wage dispersion differs but also the sign. To capture whether the elasticity of firms' productivity with respect to inequality differs across the regions, a region dummy is introduced to interact with the variables of interest. The inclusion of a simple dummy into the basic specification allows to test whether differences in the effect of wage dispersion on productivity across the regions are significant. This gives the following equation:

$$\ln(productivity_{jt}) = \beta_0 + Region\,\beta_1 + \sigma_{C;\,jt}\,\beta_2 * Region + \sigma^2_{C;\,jt}\,\beta_3 * Region + z_{jt}\beta_4 + y_{jt}\beta_5 + \theta_t(+\mu_j) + \omega_{jt} \quad (8)$$

where β_1 captures the intercept for each region, β_2 and β_3 represents the multiple coefficient showing the effects of conditional wage dispersion on productivity for each region, with Flanders as the baseline region, z_{jt} contains firm characteristics, y_{jt} captures aggregated characteristics of firms' workforces, θ_t, is a set of year dummy and interactions of year dummy with sectorial dummy, ω_j is the error term. By controlling for firm and worker characteristics as well as the sector of activity in the firm's region we also control for economic differences across the regions. Hence, equation (8) should offer an estimate of how the relationship between intra-firm wage dispersion and worker productivity varies across the regions, controlling for most of the variation due to economic differences.

4. Data

This analysis is based on a Belgian linked employer-employee unbalanced panel data that contains information on Belgian firms and their employees for the period 2002 to 2010. This panel was obtained by combining two data sets. One of them provides information about the employees. It was retrieved from Bel-first (Bureau Van Dijk), a tool that regroups worker characteristics such as age, gender, wage, working type (whether blue or white collar), the industry they work in (via the Statistical classification of economic activities in the European Community, NACE Rev. 2 nomenclature) and the year in which they joined the firm. The other set contains data at a firm/employer level. These were publically available by the 'SPF Economy, SMEs, Self-Employed and Energy', a Belgian public service that provides information about firms registered at the 'Banque-Carrefour des Entreprises (BCE). The data set contains several performance numbers (profits, cash flow, turnover, value added per worker), firm's capital, the number of workers, overall wage and the industry in which the firm operates (indicated by the NACE code). The unique firm identifier present in both data sets is used to match the individuals to firm-level data.

The computation of both indicators of wage dispersion requires a minimum number of observations per firm. Theories of tournament and fairness do not really apply to firms with few employees. Comparing large corporations with small start-ups, for example, would not be meaningful as they differ too much from each other (e.g. they are not managed the same way). Hence, there might be organizational differences between small and large firms that may bias the results. For this reason, the basic sample is restricted to firms with a 'minimum' size of at least 25 employee observations per year.

Unfortunately, this sample is not perfectly representative of the actual workforce in the Belgian private sector for several reasons. First, this sample only represents a tiny part of the workforce (377,778 employees). Statistics Belgium (pp.11, 2013) survey estimated the whole workforce of the private sector to contain 2,875,000 individuals in 2013. A large number of workers are therefore missing. Second, the representation of the prevailing sectors in this sample differ from the actual representation, some sectors being over- or under-represented, at least with respect to the number of firms represented in each sector. However, there exists different ways to evaluate which sector dominates another (e.g. in terms of the number of firms in each sector, number of workers, value added, etc.) and the broader picture seems to be roughly respected in terms of percentage of employers in each sector. More specifically, the four main sectors in this sample (77% of all observations) are manufacturing [C] (33.77%), Wholesale and retail trade; repair of motor vehicles and motorcycles [G] (24.46%), Construction [F] (12.70) and Transporting and storage [H] (8.95%). According to the report of SPF Economie (2012), the four-prevailing sectors of activity in 2010 were Wholesale and retail trade; repair of motor vehicles and motorcycles [G] (25.27%), Construction [F] (12.78%), Accommodation and food service activities [I] (10.21%) and manufacturing [C] (8.15%).

These differences are worth being mentioned as they may produce bias in the results presented above. Additionally, the data set is subject to many measurement errors, especially at an individual/worker level, that may produce a bias as well. The collection of this type of data usually relies on the person who reports the data. There are mainly two types of error that may appear. First, the data set may be incomplete. If for any reason, some people are omitted, the wage dispersion measured for some firms will differ from reality and bias the results. Second, some information may be inaccurate. If some of the individual characteristics are not correctly reported, this will again bias the wage dispersion measures. The problems raised above can potentially violate the exogeneity assumption, which in turn may affect the consistency of the parameter estimates in the next sections. Hence, the results should therefore be taken with cautious.

The resulting sample is described in Appendix B and consists of 377,778 employees working in 2,354 different firms that comprise at least 25 employees and which are observed between 2002 and 2010. Table i and ii in Appendix B depict the descriptive statistics (means and standard deviations) of the variable used at the employee and employer level respectively. The latter presents the results for each region. The tables indicate that, on average, firms have 160 workers and that these workers earn a quarterly gross wage of €7,903 (or €2,364 per month). The mean age of the workers is about 38 years old, approximately 72.5% of them are men, and 52% are blue-collar workers. Worker productivity is approximated using the logarithm of annual value added per worker in thousands of euros. On average, every worker produces €86.621 every year.

Appendix B also displays descriptive statistics of the wage dispersion measures. To understand the meaning of each of these measures economically, it is important to see how they are represented in the data and to compare them. As expected, the unconditional measure of wage dispersion, sigma is on average much lower and the unconditional measure (i.e. mean value of 0.28), the coefficient of variation in wages (i.e. mean value of 0.35). The difference between these two indicators can be thought of as the variation in wages that is due to individual characteristics. Above, the main sectors represented by the data have been discussed. What about the difference between these sectors? More precisely, some sectors may be characterized by large wage dispersion. For example, if in a specific sector, the workers are mainly remunerated through piece rates (e.g. there is potentially a large number of assembly-line workers in the manufacturing sector), wage dispersion will be higher in this specific sector.

This argument was suggested by Winter-Ebmer and Zweimüller (1999) who stated that the implementation of piece rate typically encourages workers to increase their effort and therefore increase both wage dispersion and productivity. Consequently, it is worth looking at how both measures of wage dispersion vary between the different sectors.

Table 1. *Descriptive statistics for the main variables of interest by sector*

Sector	Representation[a]	σ_C[b]	Productivity[c]
Manufacturing [C]	*33.77%*	*0.23*	*78.643*
Construction [F]	*12.70%*	*0.28*	*58.964*
Wholesale and retail trade; repair of motor vehicles and motorcycles [G]	*24.47%*	*0.28*	*93.921*
Transporting and storage [H]	*8.95%*	*0.23*	*86.467*
Information and communication [J]	*4.20%*	*0.31*	*98.043*
Professional, scientific and technical activities [M]	*5.15%*	*0.32*	*93.212*
Others	*10.76%*	*0.38*	*120.023*
Total/Average	*100.00%*	*0.27*	*86.621*

Notes: [a] Representation over the whole sample; [b]Conditional wage dispersion indicator; [c]Value-added per worker (annual, in th. of €)

Appendix B also displays the variables' mean for each region. Wallonia is the region where, on average, the workers earn the lowest wages. Firms in Brussels on the other hand offer the highest average wage. Such differences might be caused by several factors. For instance, as raised earlier, some more productive sectors may be predominant in Brussels, and not in Wallonia or Flanders. Moreover, these may attract workers with higher levels of skills, which in turn could justify a higher salary. The second table shows how the value added per worker differs across the regions. On average, the annual value added per worker amounts to €86,621. However, the gap between the value added of workers in Brussels and Wallonia is considerably large (€71,378 in Wallonia against €116,141 in Brussels). The average productivity of workers in Flanders is situated in the middle of this gap. Such regional differences are important for the analysis below.

5. Results

In the following, the results of the equations previously established are presented and interpreted. Several models are analyzed and tested. Also, some further tests are performed to check the robustness of the results.

5.1. Basic specification

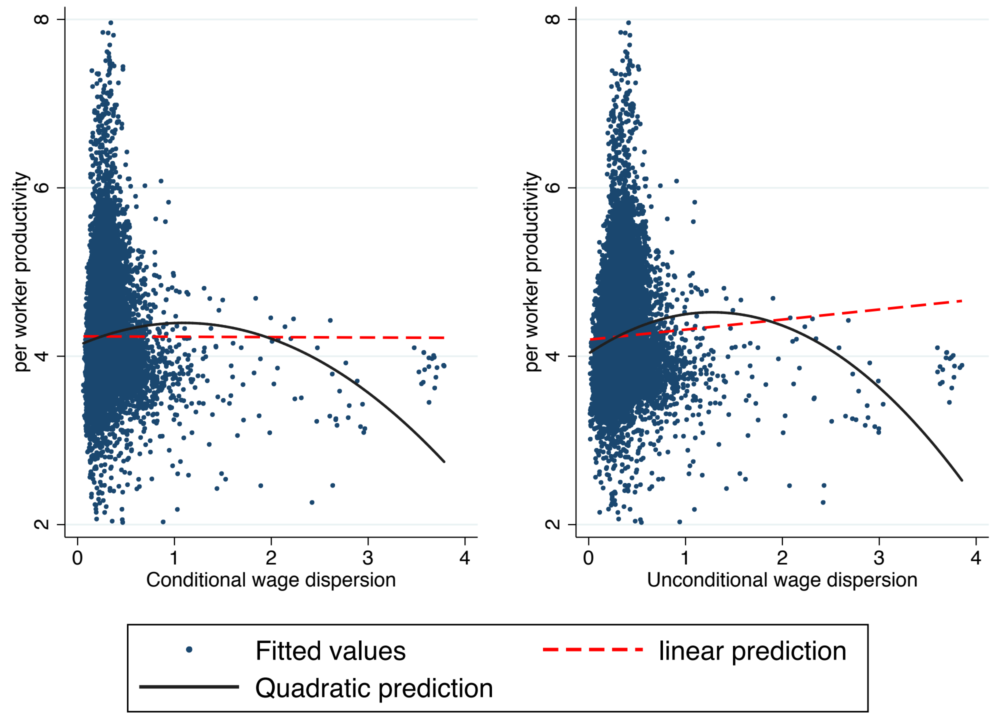
Before the results are analyzed, we first test for serial correlation and heteroskedasticity. Also, we review the different estimation methods applied to this study. In this regard, additional tests are performed to ensure that the most appropriate model is used.

Pre-tests

Figure 4 hereunder helps picture the correlation between wage dispersion and value added per worker. On the left-hand side graph of the figure, σ_C is set on the horizontal axis while σ_U is plotted against productivity on the right-hand side graph. The two scatterplots and corresponding prediction lines already indicate that the two indicators seem to correlate similarly with productivity, with σ_U suggesting a slightly more positive relationship. Furthermore, the figure reveals the potential issue of heteroskedasticity and confirms the need for some pre-tests.

First, pooled OLS constructs standard errors and p-values based on the assumption that the observations are independent, which by definition, is wrong in a panel framework. Because firms are observed at multiple points in time, serial correlation represents an issue that may potentially alter the efficiency of the parameters below. The test discussed by Woolridge (2002) and Drukker (2003) confirms the high probability of first-order autocorrelation. Furthermore, another problem that may invalidate the statistical tests of significance of the estimators is the presence of heteroskedasticity. The Breusch-Pagan/Cook-Weisberg test for heteroskedasticity performed on the basic specification strongly rejects constant variance of the errors. Hence, the cluster(ID) option in STATA is used to produce standard errors, of both POLS and FE, that are robust to cross-sectional heteroskedasticity and serial correlation.

Figure 4. *Scatterplots and prediction lines of wage dispersion indicators against productivity*



Notes: Scatter plots and prediction lines of each dispersion indicator against value added per worker. X-axis graph on the left: σ_C (conditional wage dispersion); x-axis graph on the right: σ_U, the within-firm standard deviation of wages (unconditional wage dispersion).

Earlier, we considered two famous models for the analysis, POLS and FE. Between estimation is omitted in the analysis as the panel used is unbalanced. Although it may help to look for the existence of potential long-term relationships, this method would produce incomparable means. Therefore, we turn to POLS and FE and see how accurate they are in predicting the model parameters. Table 2 presents the estimates for the basic specification as in equation (4), (5) and (6). The reported coefficients and standard errors are corrected for both serial correlation and heteroskedasticity.

Estimation Results

We first estimate the most basic specification using each wage dispersion indicator in turn. The left-hand side of table 2 below presents the effect of the conditional wage dispersion indicator, σ_C as defined above, on productivity. The right-hand side displays the same model except the conditional indicator is replaced by its unconditional counterpart, σ_U. These results help to compare the influence of each wage dispersion indictor on productivity. As can be observed from column 2 and 4, the slope of the hump-shaped relationship suggested by σ_U is higher, which implies that σ_U has a larger effect on productivity then σ_C. This is no surprise as σ_U captures the variation in pay among all workers, which implies that part of the effect of σ_U on productivity is attributable to wage dispersion between workers of different characteristics as well as the wage dispersion between similar workers. Therefore, the results in table 2 come as no surprise.

Table 2*. OLS Results for the basic specification using both the conditional and the unconditional wage dispersion indictor*

	Dependent variable: value added per workers (log of)			
	Conditional wage dispersion (σ_C)		Unconditional wage dispersion (σ_U)	
σ_t	*-0.0468* *(0.0292)*	*0.122** *(0.0596)*	*-0.0126* *(0.0309)*	*0.189**** *(0.0554)*
σ_t^2		*-0.0749**** *(0.0220)*		*-0.0912**** *(0.0215)*
Intercept	*3.518**** *(0.0553)*	*3.474**** *(0.0574)*	*3.510**** *(0.056)*	*3.452**** *(0.057)*
Year Dummy	*Yes*	*Yes*	*Yes*	*Yes*
Interaction year * sector	*Yes*	*Yes*	*Yes*	*Yes*
Sector Dummy	*Yes*	*Yes*	*Yes*	*Yes*
Firm Characteristics	*Yes*	*Yes*	*Yes*	*Yes*
Worker Characteristics	*Yes*	*Yes*	*Yes*	*Yes*
N	*16848*	*16848*	*16848*	*16848*
R^2	*0.440*	*0.441*	*0.440*	*0.442*

Notes: Coefficients, robust (for heteroskedasticity & serial correlation) standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Equation (5): $ln(productivity_{jt}) = \beta_0 + \sigma_{jt}\beta_1 + \sigma_{jt}^2\beta_2 + z_{jt}\beta_3 + y_{jt}\beta_4 + \theta_t + \omega_{jt}$

As emphasized earlier the unconditional wage dispersion results do not bring much to our analysis, regarding the theories that are being tested. Above, it was shown that theories, such as tournament, especially apply to workers who have similar characteristics. The interpretation of σ_U is therefore 'limited'. That is, although we observe that higher overall variation in pay increase worker productivity, we cannot identify which type of variation creates more productivity. Some of this variation may be horizontal (among workers holding similar jobs/characteristics) but also vertical (between different jobs/positions within the firms). Despite this limitation, it can be said that a larger overall pay variation within firms correlates with higher average level of productivity per worker. At this stage, we simply cannot figure out why. For this reason, the rest of the analysis uses σ_C, the conditional indicator of within-firm wage dispersion as the variable of interest.

We then turn towards the estimation of the basic specification using both OLS and FE models. Results are presented in the first four columns in table 3 while the fixed effects estimates, controlling for time-invariant firm characteristics, are displayed in the last two columns. The detailed regression results can be found in table i of Appendix C, and reports the joint hypotheses tests on the explanatory variables. Sectors, year dummies, interaction year*sector and workforce characteristics indicators are each jointly significant.

Two main observations may be pointed out from Table 2. First, the coefficient estimates of wage dispersion and its lagged measures do not seem to differ much. This implies that our model does not suffer from the simultaneity issue. Second, and as expected, the FE coefficients are much lower than those of pooled OLS and are all insignificant. Below, we investigate each of these two observations.

Table 3. *OLS/FE results of firm level wage regression*

	Dependent variable: value added per workers (log of)					
	OLS		OLS		FE	
$\sigma_{C;\,t}$	-0.0468 (0.0292)	0.122* (0.0596)			-0.00304 (0.0215)	-0.0450 (0.0356)
$\sigma^2_{C;t}$		-0.0749*** (0.0220)				0.0268 (0.0242)
$\sigma_{C;\,t-1}$			-0.0288 (0.0277)	0.134* (0.0527)		
$\sigma^2_{C;t-1}$				-0.076*** (0.0209)		
Intercept	3.518*** (0.0553)	3.474*** (0.0574)	3.515*** (0.0556)	3.470*** (0.0577)	3.980*** (0.0741)	3.990*** (0.0735)
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Interaction year * sector	Yes	Yes	Yes	Yes	Yes	Yes
Sector Dummy	Yes	Yes	Yes	Yes	No	No
Firm Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Worker Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
N	16848	16848	16848	16848	16848	16848
adj. R^2	0.440	0.441	0.440	0.441	0.142	0.142
SD of individual Component					0.455	0.456
SD of idiosyncratic Component					0.212	0.212
rho					0.822	0.822
Hausman p-value					0.000	0.000
F test: $\mu_j = 0$ (p-value)					0.000	0.000
Breusch-Pagan LM Test					0.000	0.000

Notes: Coefficients, robust (for heteroskedasticity & serial correlation) standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Equation 5: $ln(productivity_{jt}) = \beta_0 + \sigma_{jt}\beta_1 + \sigma^2_{jt}\beta_2 + z_{jt}\beta_3 + y_{jt}\beta_4 + \theta_t(+\mu_j) + \omega_{jt}$

First, the point estimates in column 2 and 4 of table 3 indicate small differences in the coefficients using the wage dispersion or its lag. However, this difference does not seem to be caused by simultaneity. More precisely, if productivity and wage dispersion influence each other at the same time, higher coefficient magnitudes should be observed in column 3 and 4. Hence, simultaneity should not be a concern for our estimates. Yet, from an economic perspective, it is hard to say why the relationship between the lag of conditional dispersion and productivity is higher than the one observed in the first two columns. What matters though, is that, despite these small differences, all four columns tend to explain a similar relationship.

Ruling out our suspicions regarding simultaneity, we can interpret what the coefficients in table 3 suggest. The second column seems to indicate the existence of a weak but significant hump-shaped relationship between σ_C and productivity. The curve of this relationship has its maximum when conditional wage dispersion reaches 0.81, which is quite far off from its mean of 0.28 with a standard deviation of 0.20. More accurately, only 6.4% of the firms report a σ_C higher than 0.81. Hence, the POLS estimates in column 2 suggest that within-firm conditional wage dispersion positively and significantly influences firm productivity. At a certain point though, the slope of the hump-shaped curve becomes negative and hence, higher levels of σ_C are associated with lower productivity.

To illustrate the effect of σ_C on productivity, the estimates from the table can be used to predict worker productivity at different levels of conditional wage dispersion. For instance, on average, the employees in a firm will be expected to be 1.3 % more productive if the conditional dispersion in wage for this firm is one standard deviation above the mean. Inversely, on average, the employees are expected to be 1.9% less productive if the conditional wage dispersion in this firm is one standard deviation below the mean.

Second, FE estimates reported in table 3 are much lower than those estimated through OLS. Not only the magnitude of the effect of conditional wage dispersion on productivity is extremely low, but the coefficients are also insignificant. In addition to being low and insignificant, the coefficients indicate a mostly negative relationship, which somehow contradicts the OLS findings. Table 3 displays rho, the share of the total residual variance accounted for by the individual effect. Correspondingly, the individual/firm effect accounts for about 82% of the variance in the overall error variance, which partly explains the weak coefficient estimates.

Post-estimation

Why are the OLS and FE coefficients so different? And more importantly, which model produces the best estimates? To answer these questions, one need to combine the economic to the statistical reasoning. From an econometric point of view, POLS is the method that pools all observations into a single cluster. Hence, for this estimation technique to be appropriate, it requires each observation to be independent from any other. This constitutes a key difference, economically, between the POLS, that does not differentiate between firms, and panel data, which has the advantage of accounting for firm heterogeneity. Hence, the condition for POLS to produce good estimates, is for the firm's unobserved fixed effects, μ_j, to be near zero. The F-test results, testing the null hypothesis that $\mu_j = 0$ (see bottom of table 3) on the basic specification, confirm that individual fixed effects are jointly significant, which implies that the POLS coefficient presented hereunder will be biased by omitting the control of these firm fixed effects, μ_j.

Additionally, table 3 also reports the results of the Hausman test, which checks a more efficient model (POLS) against a less efficient but consistent model (fixed effects). A p-value of zero suggests that fixed effects should be preferred to random effects estimators, which further advocates for the use of FE among other panel estimation methods.

Furthermore, the Breusch and Pagan Lagrangian multiplier test, at the bottom of table 3, strongly reject that the variance of the individual effects is zero, which confirms that the 'poolability' should be rejected. This is consistent with the large differences observed between the POLS and FE coefficients, which are partly explained by the control of unobserved firm heterogeneity in FE. In fact, the OLS estimates reflect a mixture of between and within firm effects. Because within firm variation in σ_C over time is extremely small compared to the variation between firms, it is not surprising that fixed effects results are drastically smaller from the POLS results. It was pointed out earlier that, from an economic point of view, there no reasons to expect large variations in the conditional wage dispersion over time. Hence, in this regard, the results in table 3 match our expectations.

To sum up, the tests described above suggest the use of FE over POLS because of large firm heterogeneity. However, FE estimates are highly limited by the low within firm variation over time. As a result, even though POLS estimates are probably biased they seem to offer the best estimation for this study. Overall, the relationship between conditional wage dispersion, σ_C, and firm productivity appears to be positive.

Other issues

Additionally, another issue that may alter the results in table 2 and 3 above is the potential state dependence of the dependent variable, the value added per worker. More precisely, productivity in preceding periods may affect productivity in the future because productive firms are indeed likely to be persistently productive over time. As Braakmann (2008) notes, factors that affected productivity in the last period, such as the motivation of the workforce, are expected to adjust slowly. Consequently, the estimated coefficients above may be biased by not accounting for past productivity values. Including a state dependence parameter γ, capturing the effect of (one year) lagged productivity measure, in the equation (4) allows for the influence of past on present productivity:

$$\ln(productivity_{jt}) = \beta_0 + \gamma \ln(productivity_{jt-1}) + \sigma_{jt}\beta_1 + z_{jt}\beta_2 + y_{jt}\beta_3 + \theta_t(+\mu_j) + \omega_{jt} \quad (9)$$

However, adding the lagged dependent variable in the repressors potentially leads to endogeneity issues. More specifically the problem known as Nickell bias arise because the lagged dependent variable is correlated with the fixed effect μ_j of the composite error term $(\theta_t + \mu_j + \omega_{jt})$. Such bias, in turn, leads to overestimation of γ in POLS and underestimation in FE. The true value is thus likely between the POLS and FE estimates. To deal with this issue the use of dynamic system (GMM) estimator is more appropriate. Many studies use these models as for instance Beaumont and Harris (2003) or Mahy, Rycx and Volral (2011). However, the use of GMM appears to be a complex method where the choice of appropriate instruments is a difficult issue considering that the 'overidentification' and the proliferation of instruments play an important role. As a result, we simply acknowledge that the coefficients estimated in this study are probably biased because of state dependence in the dependent variable.

5.2. Results for white and blue collar workers

Many studies (Winter-Ebmer & Zweimüller, 1999; Lallemand, Plasman and Rycx, 2009) suggest that the relationship between wage dispersion and firm productivity is influenced by the workforce composition in firms. More specifically, the proportion of blue and white collar workers within a firm has been shown to be an important determinant of the elasticity of firm performance with respect to pay inequality. In this section, the previous specification is put to the test for different compositions of the workforce. Table 4 below offers the main variable statistics for firms with different proportions of blue and white collar workers.

Table 4. *Descriptive statistics on firms with different proportions of blue and white collar workers*

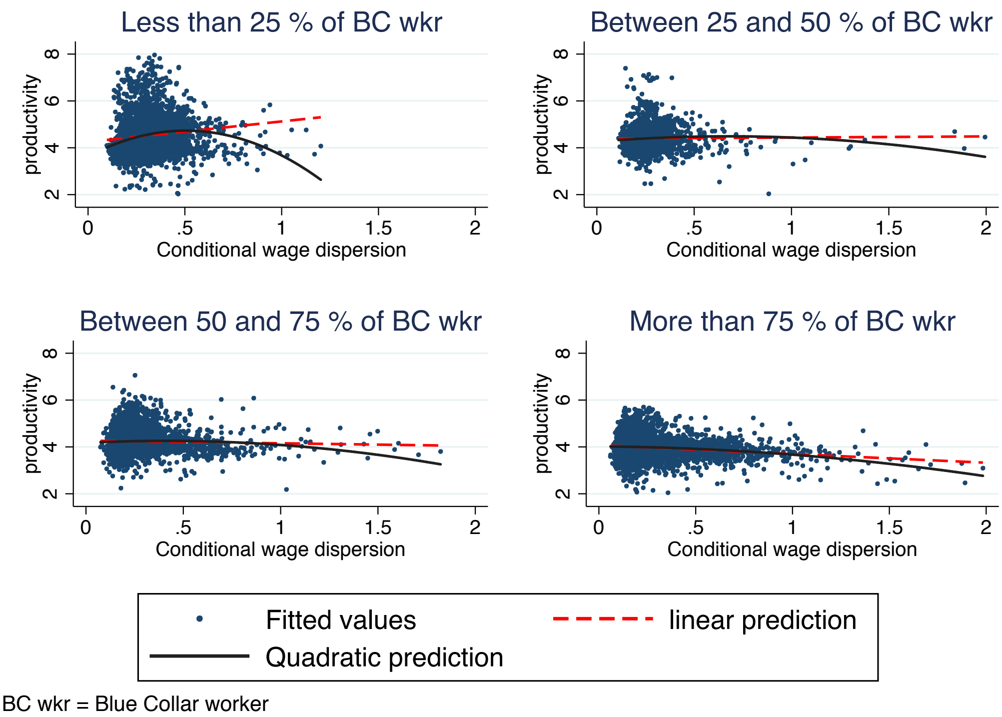
Share of blue collar workers	< 25%	25% - 50 %	50 % - 75 %	> 75 %
Number of firms	*27.22 %*	*11.26 %*	*25.00 %*	*36.52 %*
Wages[a]	*9262.872*	*7932.995*	*7230.981*	*6283.513*
σ_C[b]	*0.31 (0.11)*[c]	*0.28 (0.15)*[c]	*0.28 (0.27)*[c]	*0.25 (0.21)*[c]
Productivity[d]	*127.471*	*96.740*	*78.620*	*58.535*

Notes: [a] quarterly wages, in thousands of €; [b]Conditional wage dispersion; [c]Standard deviation in parentheses; [d]Value-added per worker (annual, in th. of €)

It can first be pointed out that, overall, the firms in this sample contain more blue than white collar workers. This is important to consider in the above findings. If the effects of conditional wage dispersion drastically differ for blue and white collar workers, the positive relationship found earlier may over represent one type of worker rather than the other. Additionally, the table reveals typical characteristics of the sample that represent the Belgian labor markets. For instance, it confirms the expectations that on average, white collar workers receive higher pay and are much more productive. Moreover, the wage structure for blue collar workers is more compressed.

The scatterplots below offer a picture of the correlation between wage dispersion and productivity for firms with different proportions of blue and white collar workers. The most striking difference is indeed between the firms that are essentially composed of white collar workers (upper left) and those mainly composed of blue collar workers (lower right). While the former indicates a positive correlation, the latter shows a less clear but negative relationship. However, these graphs only display the correlation between wage dispersion and productivity alone. For more accuracy on the effect of conditional wage dispersion on productivity, let us estimate the regression taking other factors into account, as described in section 3

Figure 5. *Scatterplots and prediction lines of conditional wage dispersion indicators against productivity for blue and white collar workers*



Notes: Scatterplots of conditional wage dispersion, σ_C, against productivity for firms with i) less than 25% of blue collar workers; ii) between 25 and 50 % of blue collar workers; iii) between 50 and 75 % of blue collar workers and iv) more than 75 % of blue collar workers. The dashed-red line displays the linear prediction while the black one shows the best fit of the wage dispersion measure indicator along with its squared value.

Estimation results for the equation (7) can be found in the table ii of Appendix C. The table is divided in six columns. As in table 3, the first two columns report the estimation (both linear and hump-shaped) of equation (7) using pooled OLS. Column 3 and 4 reproduce the same estimation except the wage dispersion indicator is replaced by its one year lag counterpart, to check for simultaneity. The last two columns show the estimates of equation (7) including the firm fixed effects, μ_j, that is the FE model. The OLS coefficients in table ii in Appendix C confirm hypothesis 1, i.e., there are significant differences in the influence of conditional wage dispersion on the productivity of firms differently composed of blue or white collar workers. Once again, the estimation of the FE model shows extremely low and insignificant coefficients due to the lack of conditional wage dispersion variations over time within each firm.

Including several interaction terms of continuous variables into equation (7) however leads to a table of coefficients somewhat difficult to interpret. To better capture how conditional wage dispersion influences productivity for blue and white collar workers, we focus on table 5 and figure 6 hereunder. Table 5 displays the marginal effects of conditional wage dispersion on productivity for different proportions of white and blue collar workers within firms. In other words, it shows the slope of the prediction lines for different values of the $bcol_{j,t}$ variable, the share of blue collar workers in equation (7). The table is constructed using the 'dydx()" option of the 'margins' command in STATA. Similarly, figure 6 shows the linear and quadratic prediction lines for the effect of conditional wage dispersion on productivity as estimated by the models. In this way, table 5 displays the slope at different points of the curves shown in figure 6. It is important to emphasize that figure 6 displays unequal scales in the different graphs. Using larger scales for the graphs showing the prediction of the FE model permits to visualize better the difference between the different types of firms. However, one should not make the mistake to overestimate what the FE model really suggests, i.e., a very small and insignificant effect $\sigma_{C;\,t}$ on productivity.

Table 5. *Marginal effect of conditional wage dispersion on productivity for different proportions of white and blue collar workers within firms*

Share of blue collar workers		OLS ($\sigma_{C;\,t}$)		OLS ($\sigma_{C;\,t-1}$)		FE ($\sigma_{C;\,t}$)	
		Linear prediction	Quadratic prediction	Linear prediction	Quadratic prediction	Linear prediction	Quadratic prediction
0 %	σ_C	*0.313***	*0.724****	*0.251***	*0.526***	*-0.046*	*-0.162*
		(0.120)	*(0.210)*	*(0.084)*	*(0.172)*	*(0.061)*	*(0.103)*
	σ_C^2		*-0.331****		*-0.173**		*0.108*
			(0.101)		*(0.074)*		*(0.077)*
25 %	σ_C	*0.185**	*0.495****	*0.145**	*0.368***	*-0.031*	*-0.122*
		(0.083)	*(0.147)*	*(0.058)*	*(0.119)*	*(0.043)*	*(0.074)*
	σ_C^2		*-.238****		*-0.133***		*0.082*
			(.072)		*(0.051)*		*(0.057)*
50 %	σ_C	*0.057*	*0.267***	*0.040*	*0.211***	*-0.015*	*-0.083*
		(0.048)	*(0.088)*	*(0.034)*	*(0.071)*	*(0.028)*	*(0.049)*
	σ_C^2		*-0.145****		*-0.093***		*0.056*
			(0.043)		*(0.030)*		*(0.038)*
75 %	σ_C	*-0.071**	*0.038*	*-0.066***	*0.052*	*0.00001*	*-0.043*
		(0.028)	*(0.053)*	*(0.024)*	*(0.046)*	*(0.021)*	*(0.025)*
	σ_C^2		*-0.051**		*-0.054***		*0.030*
			(0.021)		*(0.019)*		*(0.024)*
100 %	σ_C	*-0.199****	*-0.189**	*-0.171****	*-0.105*	*0.016*	*-0.003*
		(0.049)	*(0.081)*	*(0.040)*	*(0.074)*	*(0.030)*	*(0.036)*
	σ_C^2		*0.041*		*-0.014*		*0.004*
			(0.030)		*(0.031)*		*(0.024)*

Notes: Coefficients, robust standard errors in parentheses. White-corrected for heteroskedasticity standard errors.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Equation (7): $\ln(productivity_{jt}) = \beta_0 + bcol_{j,t}\,\beta_1 + \sigma_{C;\,j,t}\beta_2 * bcol_{j,t} + \sigma_{jt}^2\beta_3 * bcol_{j,t} + z_{jt}\beta_4 + y_{jt}\beta_5 + \theta_t(+\mu_j) + \omega_{jt}$

Table 5 also confirms hypothesis 1 but allows to go one step further and estimate the effect of conditional wage dispersion on productivity for firms with specific proportions of blue and white collar workers. As in table 3, OLS coefficients are mostly significant while FE ones are low and insignificant. This happens, once again, because of the too small within-firm variations over time. However, unlike table 3, the magnitude of the coefficients showing the relationship between lagged wage dispersion in column 3 and 4, $\sigma_{C,t-1}$, and productivity are now lower than those in column 1 and 2 using conditional wage dispersion in year t, $\sigma_{C;\,t}$. This clearly indicates potential simultaneity, which may further bias the estimates. Additionally, it seems that this pattern especially holds for firms with higher proportions of white collar workers, where the intensity of the relationship is higher for $\sigma_{C,t-1}$, compared to $\sigma_{C,t}$. This observation could make sense if we consider that firms mostly composed of white collar workers compensate their employees more easily with bonuses or raises, in case of positive productivity shocks. Hence, because we suspect the coefficients on $\sigma_{C,t}$ to be upward biased, it will be more prudent to interpret those of $\sigma_{C,t-1}$ as well.

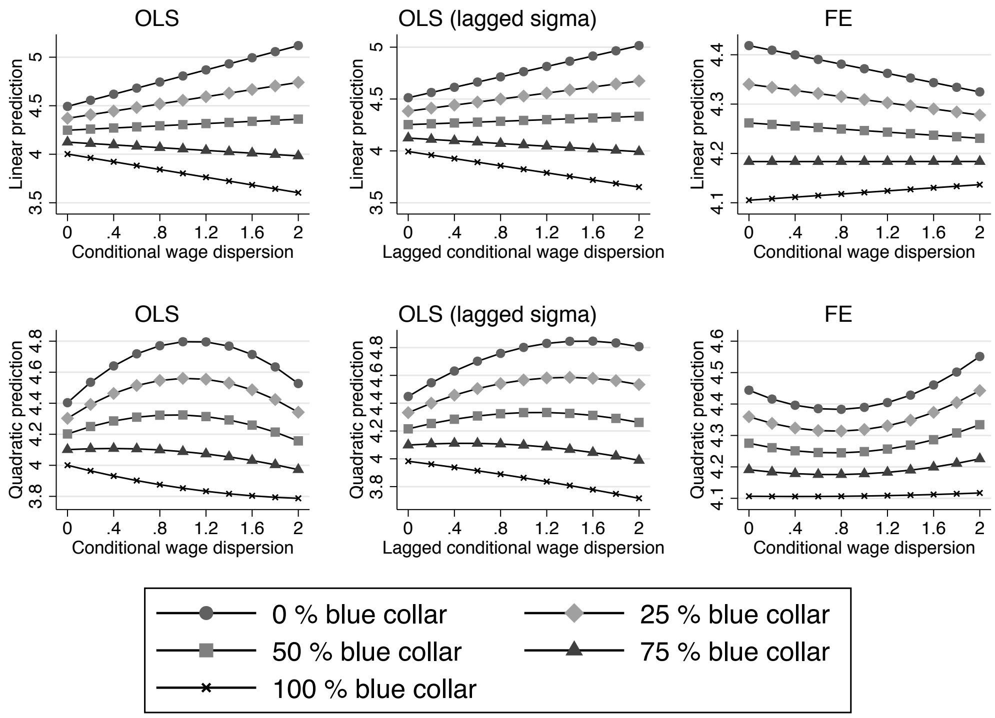
Table 5, along with figure 6, suggest that different mechanisms occur in different working environments, depending on the composition of blue and white collar workers that constitutes each firm. Let us examine how the effect of conditional wage dispersion on productivity varies when the variable $bcol_{j,t}$ takes on different values. For a firm entirely composed of white collar workers (that is, $bcol_{\,t} = 0$ %), figure 6 suggests that the relationship is positive. In this extreme case, the gains in productivity from increasing the conditional wage dispersion are at their highest. According to the estimates of column 4 in table 5, such firms, that move one standard deviation (0.20) away from the sample average conditional wage dispersion of 0.28, can increase their productivity by 7.89 % in the next year. As shown in figure 7, the intensity of the relationship between conditional wage dispersion and productivity then tumbles down as the proportion of blue collar workers increases, and finally becomes negative. To illustrate using the estimates of column 4 in table 5 once more, a firm entirely composed of blue collar workers that moves one standard deviation (0.20) away from the sample average conditional wage dispersion of 0.28 will typically decrease its employees' productivity by 2.31 % in the next year. Therefore, the picture is much more different for firms outnumbered by blue collar workers. Compared to white collar workers, not only the overall magnitude of wage dispersion coefficients is lower, but the relationship also becomes negative.

Interestingly, FE estimates suggest that the impact of conditional wage dispersion on productivity goes in the opposite direction than ones indicated by OLS estimates. More precisely, the FE model predicts that firms with higher proportions of white collar workers reduce their employees' productivity by increasing the wage gap between similar workers, or $\sigma_{C,t}$. As the proportion of blue collar worker increases, the relationship weakens and converges towards a slope of zero. However, as mentioned earlier, the relationship between $\sigma_{C,t}$ and productivity suggested by FE is much lower than that of OLS and foremost, insignificant. Hence, it seems that we should rely on OLS for the economic interpretation of the results.

According to POLS estimates, the incentives of white collar workers to put effort into their job seem to be lowered at low levels of wage dispersion. In this case, increasing wage dispersion might help increase the productivity of these workers. However, the hump-shaped relationship further implies productivity gains at a decreasing rate. Comparing figure 6 and the scatterplots of figure 5 above, the estimated curves for firms that are mostly composed of white collar workers generally attain their maximum at large values of conditional wage dispersion (between 0.9 and 1.1, and 1.1 and 1.5 for $\sigma_{C,t}$ and $\sigma_{C,t-1}$ respectively). Hence, one may wonder why firms do not aim for this optimum. According to the model estimates, firms could increase their workers' productivity and increase their profit by converging towards these levels of conditional wage dispersion. However, there may be several reasons for which some firms are not at their optimum. More specifically, a series of constraints may prevent firms from freely adjusting their level of wage dispersion. As developed earlier, the minimum wage is bargained at three different levels in Belgium. If high minimum wages along with rigid working conditions are negotiated in certain sectors, firms may then be constrained when trying to implement wage dispersion between comparable workers.

Similarly, wage capping may also prevent managers from offering higher wages, thereby preventing firms from raising the wage gap. Another explanation may be that managers believe that the productivity gains from moving conditional wage dispersion towards the optimum are too small. This could especially be the case for firms that are already at large conditional wage dispersion levels. For these, the productivity gains become smaller and smaller as they approach the optimum level of wage gap, due to the concave shape of the curves in the lower part of figure 6, implying decreasing returns. Also, some managers may be misinformed or ignore the patterns observed in this paper. Hence, some managers are either constrained by regulations, or simply do not bother optimizing wage dispersion, which may explain the currently large gap between the conditional wage dispersion and its optimal level.

Figure 6. *Linear and quadratic predictions of value added per worker on conditional wage dispersion for firms with different proportions of blue and white collar workers*



Notes: Scatterplots of conditional wage dispersion against productivity for firms composed of 0% (dots), 25% (diamond-shaped), 50% (squares) 75% (triangle) and 100 % (crossed) of blue collar workers. The upper-graphs display the linear predictions while the lower-graphs show the quadratic predictions.

As demonstrated, the above results indicate different trends for the relationship between conditional wage dispersion and productivity depending on the composition of firms in blue and white collar workers. Are these results in line with the theoretical predictions concerning these two types of workers? As shown earlier, scholars have found inconclusive results for the effects of blue and white collar wage dispersion on productivity. Let us now see what can be concluded from the above estimations.

First, the negative relationship found for firms outnumbered by blue collar workers seems to match the theories of fairness and cohesiveness. Because workers compare their wages, a larger wage dispersion implies that some workers may consider their wages unfair compared to others. Larger wage dispersion between similar workers may induce some of them to withdraw some of their effort and thus, reduce their productivity. This mechanism occurs especially in working environments for which group cohesiveness is important. Hence, cohesiveness among blue collar workers may be an important factor of their productivity. Similarly, because some employees consider their colleagues' wage unfairly high, they may lose some of their intrinsic motivation and start to devote more time to unproductive activities. Together, these arguments alone explain in part the negative relationship observed above.

The pattern for white collar workers, on the other hand, seems to be more in line with theories of tournament in which an employee's motivation is driven by the lure of profit. More precisely, the theory predicts that, when wage dispersion is larger, white collar workers see their colleagues' higher salaries, within the same firm, as the attainable prize, which they might win. As a result, workers are encouraged to put more effort into their job, which increases the overall productivity of the firm.

Furthermore, the above findings are also in line with the expectancy theory, which predicts that larger rewards combined with closer relationships between pay and performance will result in greater motivation and higher firm performance (Downes and Choi 2014). As stated earlier, the expectancy theory argues that employee motivation is determined by three main factors. That is, higher motivation will result if i) employees consider a higher wage attractive, ii) they believe that putting more effort will lead to better performance and that iii) a better performance will be rewarded by a higher wage. In other words, because of the workers' belief that higher outcomes will be rewarded by higher pay, larger wage dispersion will encourage them to put more effort into their job as a means to achieve better outcomes. Hence, stronger motivation will result in higher productivity for these workers. One reason for which this mechanism seems to essentially apply to white collar workers may be due to the productivity gap between the two types of workers (as shown in table 4). Because an equal amount of effort put in by white collar workers, on average, leads to higher productivity gains compared to blue collar workers, large pay dispersion may produce more impact on white collar workers' productivity.

Nevertheless, findings for white collar workers seem to contradict the predictions of Milgrom (1988) and Milgrom and Roberts (1990) regarding the impact of monitoring costs, i.e., that these costs usually cause large wage dispersion among white collar workers to lower productivity. More specifically, monitoring costs may be so high for white collar workers, that firms are unable to properly monitor their employees. In that case, Milgrom (1988) and Milgrom and Roberts (1990) predict that large pay dispersion may produce undesirable outcomes. Because firms cannot prevent workers from adopting unproductive behavior, workers may adopt a selfish behavior, taking decisions for personal interest or shirking, because the threat of being sanctioned is low. Hence, large wage dispersion may reduce the productivity of these employees. However, the above findings indicate the contrary.

Additionally, the ‘Hawks and Doves’ theory developed by Lazear (1989) predicts that large pay dispersion among higher skilled workers will typically push some employees to adopt hawkish or non-cooperative behavior, e.g. sabotaging their colleagues’ work. Because white collar workers hold, on average, the best jobs that are characterized by more responsibility and better advancement prospect (Winter-Ebmer and Zweïmuller, 1999), the ‘Hawks and Doves’ theory was considered more appropriate to describe white collar behavior. Hence, Lazear’s (1989) predictions are at odds with the above results.

Are these findings regarding blue and white collars differences consistent with the existing empirical literature? As emphasized earlier, scholars have found various results. Hence, this paper simply adds up to an extensive list of mixed findings. Some similarities and dissimilitudes can however be pointed out. For instance, studies by Bingley and Eriksson (2001), Heyman (2005) and Grund and Westergaard-Nielsen (2008) also find a stronger relationship for white collar workers. Mahy, Rycx, and Volral (2008) also obtain identical findings to this paper, using a sample of large Belgian firms in 2003. All these studies seem to support what Prendergast (2002) and Barth et al. (2006) arguments suggesting that workers who achieve more complex tasks should be compensated as a function of their performance (performance-related pay system) because of the higher monitoring costs and the larger production-effort elasticity compared to other, lower skilled, workers. In fact, Mahy, Rycx and Volarl (2009) suggest that such large dispersion among white collar worker may take a monitoring role itself. Put differently, large wage dispersion may insure that white-collar workers act in an optimum way without forcing the firm to pay higher monitoring costs.

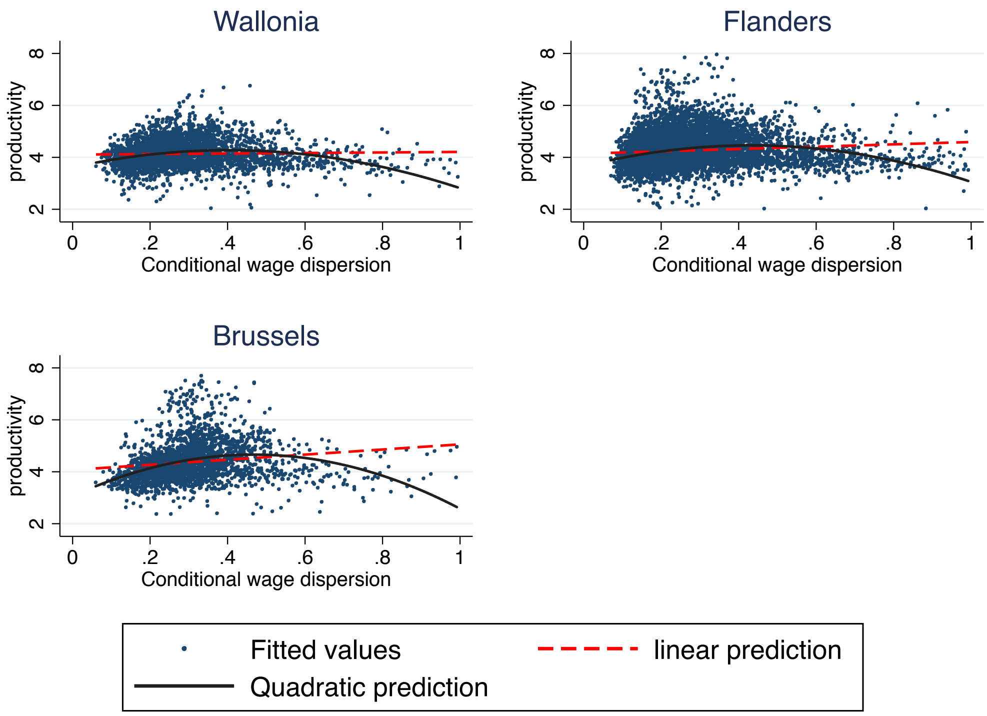
On the other hand, although this paper reproduces the method of Winter-Ebmer and Zweïmuller (1999) to measure conditional dispersion, results lead to completely different conclusions. More specifically, Winter-Ebmer and Zweïmuller (1999) find that higher dispersion leads to higher productivity levels (measured as wages) for blue collar workers and a hump shaped relationship (the curve’s maximum being near the dispersion mean) for white collar workers. As a result, it seems that other factors, aside from the blue/white collar worker differences influence the relationship between intra-firm wage dispersion and productivity. The inconclusive aspect of this empirical literature emphasizes the need for new studies that should be steered towards the investigation of these other factors. Unfortunately, the analysis in this paper is constrained by the limited amount of information.

5.3. Results across the regions

It was shown in the previous section that the impact of wage dispersion on productivity varies in different working environments. In this section, we take one step further and elaborate on the postulate that political preferences differ across the regions. First, we test hypothesis 2, i.e., that the elasticity of firm productivity with respect to wage dispersion differs across the regions. Next, we investigate whether political preferences match the empirical observations in each region.

Figure 7 below displays the scatterplot of conditional dispersion against productivity for each region. Comparing them should indicate how the correlation between the two variables of interest varies in the three regions. At first sight, there does not seem to be strong differences. Both in Wallonia and Brussels, the relationship seems weak and not too different from each other. In Brussels, on the other hand, productivity and conditional wage dispersion seem positively correlated. As described earlier, each region differs in many aspects economically. The right-hand side of table ii in Appendix B provides some descriptive statistics on the variables of interest as well as firm characteristic aggregates for each region. The analysis hereunder controls for these differences and hence, provides a more accurate estimate for the effect of conditional wage dispersion on productivity.

Figure 7. *Scatterplots and prediction lines of conditional wage dispersion indicators against productivity by region*



Notes: Scatterplots of conditional wage dispersion, σ_C, against productivity for firms by region. The dashed-red line displays the linear prediction while the black one shows the best fit of the wage dispersion measure indicator along with its squared value.

Table iii in Appendix C reports the estimation results for equation (7), for which Flanders is chosen as the baseline. This table aims to show whether significant differences exist in the influence of intra-firm wage dispersion on productivity between the three Belgian regions. More precisely, the table compares both Wallonia and Brussels to Flanders, which is set as the baseline. Results indicate that the relationship between σ_C and productivity differs across the regions, although insignificantly. As in the preceding section, the regression table offers results that are somewhat complicated to assess. To address the impact of intra-firm wage dispersion on productivity in each region, table 6 displayed below, presents the marginal effects of conditional wage dispersion on productivity in each region and for each model. This table permits to interpret each region's results in turn. To visualize the slope of each model's curve, figure 8 shows the prediction lines as estimated by the models.

Table 6. *Marginal effect of wage dispersion on productivity for each region*

Region	OLS ($\sigma_{C;\,t}$)		OLS ($\sigma_{C;\,t-1}$)		FE ($\sigma_{C;\,t}$)	
Wallonia	-0.036 (0.069)	0.467* (0.195) -0.526** (.188)	-0.007 (0.054)	0.463** (0.160) -0.477*** (0.140)	-0.036 (.028)	0.039 (.088) -0.074 (.076)
Flanders	-0.025 (.041)	0.153 (.093) -0.102* (.033)	-0.022 (0.040)	0.170* (0.082) -0.114** (0.041)	-0.006 (.022)	0.026 (.039) -0.021 (.0212)
Brussels	-0.071 (.043)	0. 426* (0.174) -0.149*** (0.046)	-0.040 (0.046)	0.452** (0.160) -0.150*** (0.041)	0.037 (.067)	-0.22* (.094) 0.103** (.032)

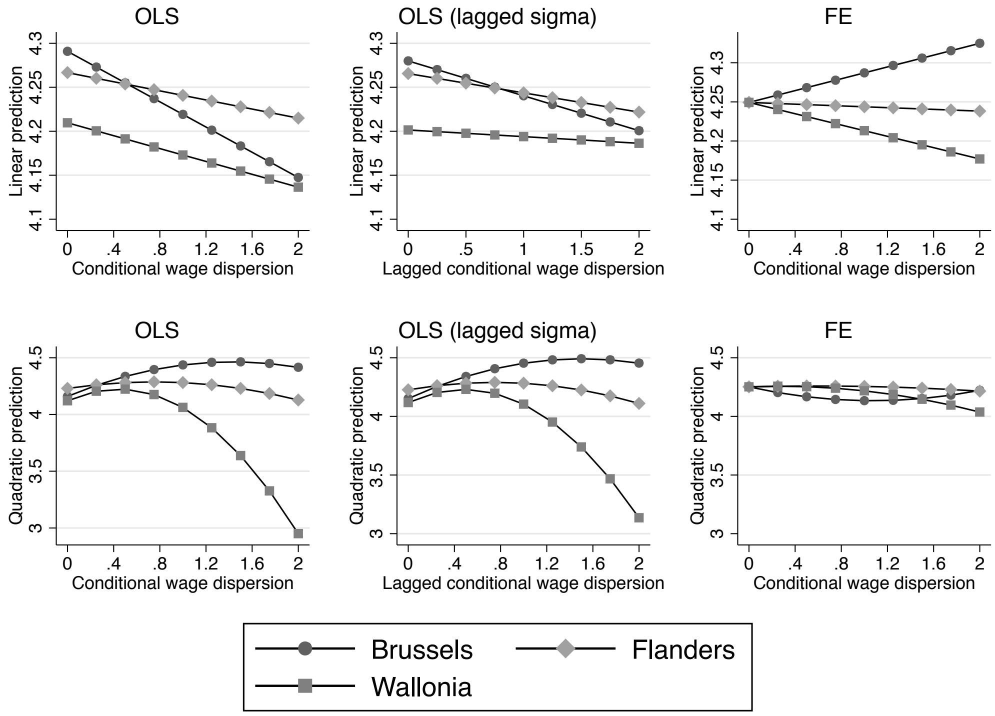
Notes: Coefficients, robust standard errors in parentheses. White-corrected for heteroskedasticity standard errors.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Equation (8): $\ln(productivity_{jt}) = \beta_0 + Region\,\beta_1 + \sigma_{C;\,jt}\,\beta_2 * Region + \sigma^2_{C;\,jt}\,\beta_3 * Region + z_{jt}\beta_4 + y_{jt}\beta_5 + \theta_t(+\mu_j) + \omega_{jt}$

A similar configuration, as presented in the last section, is used for table 6. The four first columns display the marginal effect of conditional wage dispersion (column 1 and 2) and its lag (column 3 and 4) on productivity estimated by the POLS model while the last two columns show the marginal effects of conditional wage dispersion on productivity using the FE model. Logically, numbers reported in this table reveal the slopes of the curves in figure 8. As for figure 6, one should interpret the graphs with extreme caution. The scales chosen for the productivity (y-)axis intend to provide a comparative picture of the slopes in the different regions. At first sight, one may over-interpret the slope of the linear predictions, which are shown to be extremely low in table 6.

Comparing results for Wallonia and Flanders in table 6 indicates some differences in both the OLS and FE models, although mostly insignificant. For both regions, the relationship between conditional wage dispersion and productivity seems to head in the same direction until a certain level of wage dispersion. This is, a concave hump-shaped relationship, with decreasing productivity gains, though much larger in Wallonia, from larger wage dispersion. For instance, estimates in column 4 suggest that moving conditional wage dispersion one standard deviation away from the mean (0.28 and 0.26 for Wallonia and Flanders, respectively) on average, to a 1.8% and 0.3% productivity raise in Wallonia and Flanders, respectively. It seems however, that at excessive levels of conditional wage dispersion, the relationship turns strongly negative for Wallonia. More accurately, results in column 4 suggest the optimum level of wage dispersion is at 0.75 and 0.49 for Flanders and Wallonia respectively. More intuitively, figure 8 below depicts these maximum values and the slope of the curves for each region. The maximum of the curve being at a much lower level of σ_C for Wallonia in figure 8 reveals an interesting point of divergence between the two regions. Let us now see how it relates to our previous expectations.

Interestingly, these results seem to be in line with our predictions. That is, political preferences between regions appear to be reflected in the workers' behavior towards conditional wage dispersion. It was shown earlier that comparatively, political preferences in Flanders are more oriented towards the right-wing while the opposite was true for Wallonia (see figure 1 and 2). Accordingly, because the most popular political families in Wallonia are those with egalitarian values, workers in Wallonia may be more sensitive to theories of fairness. Consequently, one may consider that the maximum of the hump-shaped relationship found above falls at the breaking point, where wage dispersion is optimized. Once a firm passes above this level, on average, the productivity of its workers starts declining. Different mechanism may then explain the negative relationship. For instance, fairness considerations may be at play. Hence, since workers compare their wages to ones of comparable colleagues, increasing the wage gap above the maximum would produce a negative effect on their productivity. On the other hand, the workers' productivity in Flanders seems to be mostly positively correlated with conditional wage dispersion. Such results may in part be explained by the fact that right-wing/liberal parties are more popular in Flanders, where the effects of the tournament theory seem to be at play even at larger levels of conditional wage dispersion.

Figure 8. *Linear and quadratic predictions of value added per worker on conditional wage dispersion for firms of the different Belgian regions*



Notes: Scatterplots of conditional wage dispersion against productivity for firms in Wallonia (squares), Flanders (diamond-shaped) and Brussels (dots). The upper-graphs display the linear predictions while the lower-graphs show the quadratic predictions.

Unlike the two other regions, Brussels does not seem to lean towards any sides of the political spectrum (see figure 1 and 2). Moreover, as the capital region and the largest city in Belgium, Brussels presents certain characteristics that may influence worker behavior differently. Table iii in Appendix C reveals such differences in the relationship between firms in Brussels and those in Flanders. It should be noted though, that the coefficients are insignificant.

Table 6 permits to assess the relationship between conditional wage dispersion and productivity for firms in Brussels, separately. As coefficients in column 2 and 4 suggest, the relationship is mostly positive and significant. Figure 8 also enables to compare the relationship for Brussels with other regions. The higher slope for the curve of Brussels compared to other regions implies that, on average, a firm with large dispersion will be more productive in Brussels than firms in other regions. What could explain such a difference between Brussels and the two other regions? There may be various reasons. For instance, the labor market in Brussels may be more competitive in Brussels compared to other regions, as it is the most populated city in Belgium. Moreover, the composition of its labor force may be much more diversified and qualified, which may partially explain a larger wage dispersion and productivity level. These reasons may account for the stronger positive relationship observed above.

Hence, as the case of Brussels illustrates, it is acknowledged that there may be various factors, other than political preferences, which influence the relationship between within-firm wage dispersion and productivity as well. However, to study the effects of these reasons, i.e. to quantify these factors and evaluate their effects by including them on our specification, goes beyond the scope of this paper.

It is worth mentioning that the observations drawn in this last section derive mainly from insignificant results, either too small or statistically insignificant (see table 6 and table iii in the Appendix C). Therefore, the results do not permit to establish any causal relationship. Rather, the above discussion aims at comparing observations of the political Belgian framework with some correlation results between wage dispersion and productivity found in the three regions

6. Conclusion

The objective of this paper was threefold. First, it examined the relationship between intra-firm wage dispersion and firm productivity in the Belgian private sector. Second, it investigated whether the relationship varies for blue and white collar workers. Blue and white collar differentiation helped to distinguish between two types of workers with generally different levels of human capital, which is likely to influence the relationship between wage dispersion and productivity. Lastly, we also took advantage of the sample to investigate the relationship between the different regions of Belgium and tried link these to the political preferences.

The methodology follows the one of Winter-Ebmer and Zweimüller (1999), based on a two-step estimation procedure. In the first step, the conditional wage dispersion indicator was measured controlling for worker characteristics. This measure was obtained by taking the standard errors of the wage regression run for each firm. Additionally, an unconditional indicator was also computed and included in the analysis to serve as a sensitivity test. It was measured by the standard deviation of wages for each firm and for each year. In the second step, firm productivity, measured as the value added per worker, was regressed against the wage dispersion indicators and other explanatory variables that may affect worker productivity. The quadratic forms of wage dispersion were also included in the equation to test for an eventual hump-shaped relationship. The equation was estimated by pooled OLS and fixed effects model. However, it was shown that the lack of within firm variation over time in our variable of interest, the conditional wage dispersion indicator, leads the FE model to produce extremely small estimates. Hence, conclusions are essentially drawn from POLS estimation. The problem of simultaneity was tackled. We also approached the potential issue of state dependence productivity, which may potentially produce a bias in the estimates.

The empirical analysis was based on a data set that was obtained by merging two panel data at employee and employer levels, thereby originating from two different sources (Belfirst, for the former and the SPF Economy for the later). The resulting unbalanced panel data covers 377,778 workers from 2,354 firms of at least 25 workers and that are unequally observed from 2002 to 2010.

We found a mostly positive relationship between conditional wage dispersion and worker productivity in the basic specification. Furthermore, the effect of conditional wage dispersion on productivity turns negative, at highly excessive levels of wage inequality between comparable workers. The gap found between the current wage dispersion and its optimum level may partly be explained by rigid Belgian regulations in the wage setting process that set high minimum wages, and hence, permit to pre-empt large income inequalities among workers. This finding illustrates the importance to take account of the country-specific labor market regulations when such a study is performed. As expected, the FE estimates were generally insignificant, and produced low estimates due to the low variation of wage dispersion within firms over time. Hence, the model estimated by OLS is preferred although it suffers from potential state dependence and omitted variable bias, by not accounting for unobserved firm heterogeneity.

Furthermore, the relationship also appeared to be different for white and blue collar workers. As the proportion of white collar workers increases within the firms, the effect of conditional wage dispersion on productivity become more important and positive. Inversely, at high proportions of blue collar workers, a larger level of wage dispersion leads, on average, to a lower productivity. These results suggest that the tournament and expectancy theories apply to white collar workers, while blue collar workers, on the other hand, seem more sensitive to fairness and cohesiveness. The fact that white collar workers can more easily raise their productivity than blue collar workers may partially accounts for this difference. Alternatively, because monitoring costs are typically higher for white collar workers, wage dispersion may act as a substitute of monitoring agents and help insure that white-collar workers act in an optimum way by creating competition between comparable workers.

Testing for differences across regions, the intensity of the relationship was also found to be stronger in Brussels compared to the other regions. Such differences may emanate from the fact that the region of Brussels is a more concentrated area containing a more diverse workforce and is surely more competitive in most sectors. Besides, the results reveal weak and mostly insignificant differences in the effect of wage dispersion on productivity between Wallonia and Flanders. It seems, however, that after a certain level of conditional wage dispersion, larger inequality strongly lowers worker productivity in Wallonia. In Flanders, the relationship between wage dispersion and productivity remains mainly positive. Interestingly, these observations support the argument that different ideologies and values, observed via political preferences (regional and trade union election results), may reflect the worker behavior at different levels of wage dispersion.

This paper presents interesting results, though often insignificant. The pooled OLS estimates provide good insights regarding the effect of conditional wage dispersion on productivity. However, it is subject to potential omitted variable bias for several reasons. Besides measurement errors that may arise in the data reporting process (e.g. the quality of the data can hardly be assessed), the threat of omitted variable bias from not accounting for firm fixed effects is real. Hence, there is no certainty concerning the consistency of the results, which may severely be affected by endogeneity. However, despite the doubts that one may emit concerning the accuracy of the results, the findings offer good insights into how conditional wage dispersion affects productivity in Belgium for different types of workers and in the different regions. What may be done to improve the results at hand? A larger sample containing more information on the individuals may help to circumvent the potential endogeneity issues raised above. For instance, it may improve on the quality of the computed conditional wage dispersion indicator, which suffers from the absence of crucial controls such as seniority and education. Also, besides the blue and white collar differences, it would be interesting to differentiate between other types of working environments and investigate how the relationship differs. For instance, different pay schemes, different monitoring environments, etc. all these may influence the impact of conditional within firm wage dispersion on productivity.

To conclude, this paper reinforces the argument that predicting the impact of intra-firm wage dispersion on productivity difficultly results in a consensus. The inconclusive findings reveal the complexity of this relationship and therefore call for further research to focus on more specific strands of the economy. As a matter of fact, this type of study may have great appeal for firms and public institutions. More specifically, having a clear vision about their wage structure and knowing precisely how different wage dispersion levels may influence their workers' productivity, may be crucial for firms to achieve higher its profits. Furthermore, public institutions may also find great interest in such researches. As the findings in this paper suggest, conditional wage dispersion may, in certain contexts (e.g. firms outnumbered by white collar worker and those in the region of Brussels), lead to large productivity gains among workers. Reforms that lower the minimum wage and reduce the constraints and conditions in the wage bargaining process may serve as powerful levers for policies oriented towards larger dispersion in pay. Hence, the Belgian government may consider the use of such levers, especially in the current times, at which the center-right, liberals and reformist political families govern the country and desperately look for new ways to improve the face of the Belgian economy.

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