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ABSTRACT

Misalignment of Productivity and Wages across Regions? Evidence from Belgian Matched Panel Data¹

This paper is one of the first to estimate how the region in which an establishment is located affects its productivity, wage cost and cost competitiveness (i.e. its productivity-wage gap). To do so, we use detailed linked employer-employee panel data for Belgium and rely on methodological approaches from both Hellerstein and Neumark (1995) and Bartolucci (2014) to estimate dynamic panel data models at the establishment level. Our findings show that interregional differences in productivity and wages are significant but vanish almost totally, both in industry and services, when controlling for a wide range of covariates, establishment fixed effects and endogeneity. Thus, our results suggest that wage cost and productivity differentials are *ceteris paribus* relatively well aligned across regions.

JEL Classification: C33, J24, J31, R30

Keywords: regions, productivity, labour costs, linked panel data

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1. Introduction

According to competitive labour market theory, wage differences across workers reflect only variation in individual ability and/or differences in working conditions (Mortensen, 2003; Rosen, 1974). This simple description of the wage-setting system is, however, challenged by numerous alternative explanations. For instance, non-competitive models of wage determination, including collective bargaining, rent-sharing, discrimination or monopsony, find some support in the empirical literature (Baert et al., 2015; Cahuc et al., 2014; Dobbelaere and Mairesse, 2015; Manning, 2011; McGuinness et al., 2010; Russo and Hassink, 2012). Hence, equally productive workers with similar working conditions do not always receive the same wages. Put differently, there might be some misalignment between productivity and wages.

Recent studies have shown that these productivity-wage gaps may discourage firms from employing specific categories of workers, such as the lower educated or older ones (Cardoso et al., 2011; Cataldi et al., 2011, 2012; Hellerstein and Neumark, 2004; Ilmakunnas and Maliranta, 2005; Lebedinski and Vandenberghe, 2014; Pfeifer and Wagner, 2012; Rycx et al., 2015; Saks, 2014; Vandenberghe, 2011, 2013). It is also often emphasized that productivity-wage gaps may be at the root of large and persistent differences in unemployment rates across regions (Dejemeppe and Van der Linden, 2006; Konings and Marcolin, 2014; Martin et al., 2011; Pereira and Galego, 2014; Rusinek and Tojerow, 2014; Simon et al., 2006). The standard argument is that wage-setting mechanisms may not be flexible enough to account for the diversity of productivity patterns across regions. This would create regional productivity-wage gaps and lead to the destruction of employment in regions where productivity is lagging behind. Yet, the accurateness of this explanation is still highly controversial (Elhorst, 2003; Zeilstra and Elhorst, 2014). This is due to the fact that the relationship between regions, wage costs and productivity is still not well understood. In particular, it remains unclear whether wage cost and productivity differentials are well aligned across regions.

Belgium is an interesting case study to test for the presence of regional productivity-wage gaps. Differences in labour market performance across Belgian regions are substantial and long-lasting. Figures for 2014 show for instance that the unemployment rate is equal to 5% in Flanders, 12% in Wallonia and 18% in Brussels. As regards the employment rate, it reaches 54% in Brussels, 57% in Wallonia and 66% in Flanders (Eurostat, 2016). Moreover, Belgium is characterised by a relatively centralised and coordinated wage-setting process. As in many European countries, collective bargaining is conducted at three levels (i.e. national, industry and firm). It is hierarchical and structured such that an agreement concluded at one level cannot

be less favourable than agreements reached at an upper level. The heart of wage bargaining lies at the sectoral level.² However, 25 to 30% of private sector workers see their working conditions collectively re-negotiated at the firm level (du Caju et al., 2012; Lopez and Sissoko, 2013). Additionally, Belgium is characterized by a coverage rate of more than 90% (OECD, 2012). This stems from the fact that non-unionized workers, like employers who are not members of an employers' organization, are generally covered by a collective labour agreement.³ Overall, Belgium appears to be a typical example of a European country for which it could be argued that its wage-setting system is too rigid to account satisfactorily for regional productivity shocks and that regional unemployment differentials are fostered by this rigidity (OECD, 2013).

Yet, the validity of this hypothesis remains to be demonstrated. Indeed, micro-econometric evidence regarding the potential misalignment of wages to regional productivity differentials in advanced economies is rare and very inconclusive (Dejemeppe and Van der Linden, 2006; Konings and Marcolin, 2014; Pereira and Galego, 2014; Rusinek and Tojerow, 2014; Simon et al., 2006). Moreover, findings must often be interpreted with caution because of methodological and/or data limitations. Last but not least, very little is known on whether the region-productivity-wage nexus is influenced by specific work environments. This is problematic as the latter is likely to depend on the characteristics of the production unit, for instance the economic activity of the firm.

Our paper aims to unravel productivity-wage gaps from a regional perspective. More precisely, we examine how the region in which an establishment is located affects its productivity, wage cost and cost competitiveness (i.e. its productivity-wage gap). We also investigate whether the region-productivity-wage nexus varies across work environments defined by the sectoral affiliation of the establishments. To do so, we use detailed Belgian linked employer-employee panel data for the years 1999-2010. These data offer several advantages. The panel covers a large part of the private sector, provides accurate information on average productivity and wages within establishments and allows us to control for a wide range of worker, job and establishment characteristics. It also enables us to address important econometric issues that are generally not accounted for in this literature (such as establishment-level fixed effects, endogeneity and state dependence).

² There is scope for industry agreements to be set at the regional level. However, in practice this is not common.

³ Two additional mechanisms regulate the system as a whole: automatic indexation and the 'wage norm'. The indexation mechanism implies that all gross wages automatically rise with consumer prices, i.e. the so-called 'health index'. In practice, it imposes a wage floor for wage increases. Since 1996, the so-called 'wage norm' complements the automatic indexation system. Fixed by the social partners, the norm sets an overall maximum margin for labour cost increases for a two-year period. It is based on the weighted average of the expected labour cost increases in Belgium's three main neighbouring countries: Germany, the Netherlands and France.

The remainder of this paper is organised as follows. A review of the literature is presented in the next section. Sections 3 and 4 respectively describe our methodology and data set. The impact of regions on productivity, wages and productivity-wage gaps across work environments is analysed in section 5. The last section discusses the results and concludes.

2. Background

Many papers estimate wage differentials between regions (some in relation to local specificities such as product market competition), but very few directly test whether these differentials are aligned with regional productivity differences.⁴

The traditional approach, in this literature, boils down to estimate Mincer (1974) type wage equations and to decompose inter-regional wage differentials, using e.g. the Oaxaca-Blinder technique (Blinder, 1973; Oaxaca, 1973), so as to get a better understanding of their magnitude and causes. Empirical results vary across countries. Blackaby and Murphy (1995), for instance, investigated wages differentials between the north and south of Britain. The authors were able to control for many covariates. However, as in most studies, they had no direct information on productivity and hence couldn't directly test for regional productivity-wage gaps. Nevertheless, their results show that the wage gap between northern and southern regions in Britain is largely due to compositional effects (such as regional differences in human capital, occupations and industries). They also highlight that the gap that can be explained by differences in returns to workers with the same level of skills stands at 2,4% in favour of the south, an outcome that is 'not too far from the neoclassical equilibrium' (Pereira and Galego, 2014: 1531). In a more recent paper concerning the UK, Monastiriotis (2002) also found that inter-regional wage differentials are small controlling for standard covariates. His decomposition exercise, based

⁴ Another strand of the literature, indirectly related to our topic, focuses on wage curves, i.e. on the elasticity of individual wages to regional unemployment rates. Ammermüller et al. (2010), for instance, adopt this strategy to investigate the functioning of regional labour markets in Germany and Italy. Their findings show a steeper wage curve in Germany than in Italy, for (German) females and for people in the middle of the wage distribution. According to Lucifora and Origo (1999), the 'flatness' of the Italian wage curve could be explained by the collective bargaining structure (which may limit the scope for wage differentiation at the local level) and/or the large size of the informal economy (which may imply that adjustments occur outside the regular economy). In similar vein, Brunello et al. (2001) report that wage setting in Italy is mainly influenced by economic conditions in the north and centre of the country, i.e. in the leading economic areas. Evidence regarding the Belgian wage curve is notably provided by Janssens and Konings (1998). Using household data for the years 1985, 1988 and 1992, they show that the elasticity of wages to regional unemployment stands at around -0.1 for men (a figure equivalent to that estimated for the Anglo-Saxon countries (Blanchflower and Oswald, 1994) and slightly bigger in absolute terms than for Germany (Blien et al., 2013)) and is not significantly different from zero for women. Accordingly, the authors conclude that unions do take local unemployment rates into account while bargaining over wages (especially for men) and that the labour market seems to be more competitive for women.

on Juhn et al. (1993), highlights that regions account on average for less than 2% of overall wage inequality. In addition, he shows that inter-regional differences in wage distributions are essentially explained by differences in the occupational composition of the workforce and in the returns to occupations.

Spanish wage differentials appear to be more pronounced *ceteris paribus* than in the UK (Simon and Russell, 2004). Moreover, differences in both characteristics and in their returns are found to play an important role in their explanation (Garcia and Molina, 2002). Simon et al. (2006) further suggest that regional wage differentials in Spain are related to non-competitive factors, such as product market competition and collective bargaining institutions. In similar vein, Bande et al. (2008) conclude, on the basis of industry-level wage regressions run for different groups of regions, that Spanish earnings differences do not seem to reflect local conditions fully. They attribute this outcome to a phenomenon of inter-regional wage imitation within industries.

Görzig et al. (2005) examined the situation in Germany. Their results show that regional wage differences are particularly marked between the western and eastern parts of the country. Moreover, using Nopo's (2008) non-parametric decomposition technique, they found that the east-west wage gap is essentially driven by the shift of the East German economic structure towards low-paying types of companies. In contrast, the role of collective bargaining characteristics (i.e. a lower bargaining coverage and a more intensive use of opt-out clauses in East German establishments) appears to be more limited. Pereira and Galego (2012) applied Machado and Mata's (2005) quantile-based decomposition technique to Portuguese data. Their results show that wage differences across regions (both conditional and unconditional) increase almost linearly over the wage distribution. This implies that policies reducing inter-regional inequalities in human capital are likely to be more efficient in eliminating inter-regional wage gaps at the bottom than at the top of the earnings' distribution. Price effects (i.e. regional differences in returns for workers with the same level of skills) are indeed found to become larger as wages increase.

Evidence regarding inter-regional wage differentials in Belgium is notably reported in Plasman et al. (2007). The latter estimate wage regressions with micro-data including a large set of covariates. Their results, for the years 1995, 1999 and 2002, show that hourly wages are highest in Brussels, intermediate in Flanders and lowest in Wallonia. However, conditional wage differences across regions are found to be modest and to fluctuate between 0 and 4 percent depending on the period under investigation.

Konings and Marcolin (2014) brought the analysis a step further. They used Belfirst data from 2005 to 2012 to investigate the presence of regional productivity-wage gaps in the Belgian private sector. Taking Flanders as a benchmark, their estimates (in level) indicate that wage costs are ‘too high’ with respect to productivity in Wallonia and Brussels. Their findings also suggest that a catching up process is going on and that firms’ financial incentives to locate in Flanders are actually not that large (especially compared to Brussels) when outcome variables are expressed in growth rates. This said, their results should to be taken with caution as they are likely to suffer from an omitted variable bias. Indeed, their firm-level regressions essentially control for industry, firm size and age, capital stock and year dummies. Many important determinants of productivity and wages (such as the composition of the workforce in terms of human capital and other demographics) are thus omitted. Moreover, core findings do not control for potential time-invariant unobserved firm heterogeneity.

The moderating role of the collective bargaining structure in the relationship between regional wage and productivity differentials has been investigated by Rusinek and Tojerow (2014). Using Belgian linked employer-employee data for the year 2003, they find that the more an industry is decentralized in terms of wage setting, the more regional differences in productivity are reflected in wages. The authors conclude that the Belgian wage-setting system already contains a mechanism (i.e. the possibility to bargain wages at the firm level) that allows wages to reflect local specificities. Yet, their results are limited by the fact that they rely on data for a single year.

In sum, micro-econometric evidence regarding the potential misalignment of wages to regional productivity differentials in advanced economies is scarce, subject to econometric biases and ambiguous. The objective of this paper is to improve our understanding of this key issue taking advantage of access to linked employer-employee panel data (with direct information on establishment-level productivity and wage costs alongside many covariates) and following both the methodological approaches developed by Hellerstein and Neumark (1995) and Bartolucci (2014).

3. Methodology

Our baseline empirical approach is based on the separate estimation of a value added function and a wage cost equation at the establishment level. The former provides parameter estimates for productivity differentials across regions, while the latter estimates the relative impact of each region on the wage bill paid by the establishment. Given that both equations are estimated

on the same sample with identical control variables, the parameters for marginal products and wage costs can be compared and conclusions can be drawn on the existence and magnitude of regional productivity-wage gaps. This technique was pioneered by Hellerstein and Neumark (1995) and refined/applied by Hellerstein et al. (1999), Hellerstein and Neumark (2004), Cardoso et al. (2011), van Ours and Stoeldraijer (2011), Vandenberghe (2013), Garnero et al. (2014a,b) and Devicienti et al. (2015) among others.

The estimated establishment-level productivity and wage cost equations are the following⁵:

$$\log\left(\frac{Value\ Added}{Hours}\right)_{i,t} = \alpha + \sum_{j \neq \{0\}}^J \beta_j Region_{j,i,t} + \lambda X_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$\log\left(\frac{Wage\ Cost}{Hours}\right)_{i,t} = \alpha^* + \sum_{j \neq \{0\}}^J \beta_j^* Region_{j,i,t} + \lambda^* X_{i,t} + \varepsilon_{i,t}^* \quad (2)$$

The dependent variable in equation (1) is establishment i 's hourly value added, obtained by dividing the total value added (at factor costs) of the establishment i in period t by the total number of working hours (taking into account overtime hours) that have been declared for the same period. The dependent variable in equation (2) is the establishment i 's hourly wage cost (including fixed and variable pay components, in kind benefits, employer-funded extra-legal advantages related e.g. to health, early retirement or pension, and payroll taxes net of social security payroll tax cuts). It is obtained by dividing the establishment's total wage bill by the total number of work hours. Hence, the dependent variables in the estimated equations are establishment averages of value added and wage cost on an hourly basis.

The main independent variables, $Region_{j,i,t}$, are dummies identifying the region j in which the establishment i is located at time t . Establishments are split in three regions (i.e. Brussels,

⁵ As shown by van Ours and Stoeldraijer (2011), equation (1) can be derived from a standard Cobb-Douglas production function augmented to include firm-specific characteristics (notably the region in which an establishment is located). It relies on the assumption that substitution elasticities are equal to one and that establishments operate at the efficiency frontier. This restriction is standard in the corresponding literature and appears to be unproblematic as previous firm-level studies have shown that productivity coefficients obtained with a Cobb-Douglas production function are robust to alternative functional specifications (see e.g. Hellerstein and Neumark, 2004). Equation (2) is the establishment-level equivalent of a standard wage equation estimated with worker data. Individual and job characteristics generally accounted for in worker-level regressions show up as shares of the corresponding characteristics at the establishment level and establishment-level characteristics, such as the region, enter the equation untransformed (Cardoso et al., 2011). As noted by Haegeland and Klette (1999), equations (1) and (2) can be interpreted in a simple descriptive way with no behavioural content. Both relate average productivity and wage costs to establishment-level characteristics and the composition of the labour force within the latter.

Flanders and Wallonia) according to the NUTS one-digit nomenclature. Flanders is the reference category. In addition to regional dummies, equations (1) and (2) also include the vector $X_{i,t}$. It contains a large set of variables controlling for worker, job and establishment characteristics. More precisely, it includes the share of the workforce within an establishment that: (i) has at most higher secondary education and tertiary education, respectively⁶, (ii) has at least 10 years of tenure, (iii) is younger than 30 and older than 49 years, respectively, (iv) is female, (v) works part-time, (vi) occupies blue-collar jobs, (vii) has a fixed term contract, and (viii) is apprentice or under contract with a temporary employment agency. $X_{i,t}$ also comprises the log of establishment size (i.e. the number of full-time equivalent workers), the log of capital stock per worker⁷, the level of collective wage bargaining (1 dummy), the sectoral affiliation (8 dummies), and 11 year dummies.⁸

Estimating equations (1) and (2) allows gauging the effects of regions on establishment productivity and wage costs, but it does not allow to test directly whether the difference between the value added and wage cost coefficients for a given region is statistically significant. A

⁶ The share of workers with at most lower secondary education serves as reference category.

⁷ It has been estimated through the ‘perpetual inventory method’ (or PIM). The intuition of this method is as follows (Berleermann and Wesselhöft, 2014; OECD, 2009). The net capital stock at time t (K_t) can be written as a function of the net capital stock in the previous period (K_{t-1}), gross investment (I_{t-1}) and consumption of fixed capital (D_{t-1}): $K_t = K_{t-1} + I_{t-1} - D_{t-1}$. Assuming geometric depreciation at a constant rate α , we can re-write capital stock as: $K_t = (1 - \alpha) K_{t-1} + I_{t-1}$. Or, alternatively, it can be shown that: $K_t = (1 - \alpha)^{t-1} K^* + \sum_{i=0}^{t-1} (1 - \alpha)^i I_{t-(i+1)}$. The implementation of the PIM thus requires: a) time series data on investments, b) the value of the initial capital stock at the time when the investment time series begins (K^*), and c) information on the rate of capital stock depreciation. To estimate K^* , we relied on the steady state approach suggested by Harberger (1978). Accordingly, capital stock is assumed to grow at the same rate as output (θ). Put differently: $\theta = \frac{K_t - K_{t-1}}{K_{t-1}} = \frac{I_{t-1}}{K_{t-1}} - \alpha$. Solving

this equation for the stock of capital in $t-1$, we find: $K_{t-1} = \frac{I_t}{\theta + \alpha}$. This expression shows that the value of capital

stock in $t-1$ can be estimated by dividing investments at time t by the sum of the long term growth rate of nominal GDP and the capital depreciation rate. Following standard practice, we assumed a 5 percent annual rate of depreciation for capital and fixed the value of θ at 4 percent. Data on investments have been taken from the SBS. More precisely, we subtracted sales of tangible goods from gross investments in tangible goods at the establishment level. These variables are expressed on a per capita basis. As highlighted in footnote 5, equation (1) is derived from a Cobb-Douglas production function with labour input in hours worked. Ideally, capital stock should thus also be included on an hourly basis. For confidentiality issues, we could only have access to information on investments (and thus on capital stock) per worker. Yet, this limitation should be at least partially accounted for by the fact that the share of part-timers at the establishment-level is included among the covariates (see footnote 8).

⁸ All independent variables are measured in terms of shares in total work hours. For instance, the fraction of part-time workers is computed on the basis of the proportion of hours worked by employees working less than 30 hours per week over the total amount of hours worked within the establishment. The control variables that have been included in our regressions are in line with existent literature (for a review of the set of covariates that should be included in this type of analysis see e.g. Göbel and Zwick, 2009). As highlighted by Mahlberg et al. (2013: 10): ‘by including a rather broad set of independent variables, we account for heterogeneity among firms, in order to mitigate the bias that could be caused by omitted variables’.

simple method to obtain a test for the significance of productivity-wage gaps has been proposed by van Ours and Stoeldraijer (2011). This method boils down to estimating equation (3):

$$\left[\log\left(\frac{Value\ Added}{Hours}\right)_{i,t} - \log\left(\frac{Wage\ Cost}{Hours}\right)_{i,t} \right] = \alpha^{**} + \sum_{j \neq \{0\}}^J \beta_j^{**} Region_{j,i,t} + \lambda^{**} X_{i,t} + \varepsilon_{i,t}^{**} \quad (3)$$

in which the gap between establishment i 's log hourly value added and log hourly wage costs (i.e. the log of the ratio between value added and wage costs) is regressed on the same set of explanatory variables as in equations (1) and (2). This produces coefficients for the regional dummies and directly measures the size and significance of their respective productivity-wage gaps. The dependent variable in equation (3) measures how much value added an establishment produces per hourly wage cost. It is often used as a measure of cost competitiveness (European Commission, 2009; OECD, 2008).⁹

Equations (1) to (3) have been first estimated with pooled ordinary least squared (OLS). However, pooled OLS estimates suffer from a potential heterogeneity bias because establishment productivity and wages can be related to establishment-specific, time-invariant characteristics (such as the quality of management, ownership of a patent or other establishment idiosyncrasies) that are not measured in micro-level surveys. The traditional way to remove unobserved establishment characteristics that remained unchanged during the observation period is by estimating a fixed effects (FE) model. This boils down to estimate a within differentiated model, i.e. a model where the mean of each variable has been subtracted from the initial values. Given that our variable of interest, i.e. the region in which an establishment is located, is (almost) time-invariant, this approach cannot be applied. Hence, we relied on the system generalized method of moments (SYS-GMM), proposed by Arellano and Bover (1995) and Blundell and Bond (1998). This estimator is widely used in the literature to obtain consistent estimates of time-invariant regressors while controlling for establishment fixed effects (Roodman, 2009). It implies to simultaneously estimating a system of two equations (one in level and one in first differences) and to use 'internal instruments' to control for endogenous regressors.¹⁰ Interestingly, the SYS-GMM approach does not only enable to

⁹ Given that the cost of capital is not taken into account in the computation of the dependent variable, the latter does not reflect overall competitiveness. If wage costs increase faster than productivity, overall competitiveness will be deteriorated only if other costs are not adjusted in compensation (OECD, 2008).

¹⁰ All explanatory variables, except regions, industries, the level of collective wage bargaining and time, have been considered as endogenous in our SYS-GMM regressions. Put differently, variables showing very little or no variability over time have not been instrumented so as to avoid inconsistent estimates due to weak instrumenting. SYS-GMM estimates thus control for establishment fixed effects as well as for the endogeneity of time-varying

include time-invariant explanatory variables among covariates (which typically drop out in a FE or difference GMM model), but also to account for the persistency in establishment-level productivity, wages and profits by adding the lagged dependent variable among regressors. This is important because the estimation of a static model would generate an omitted variable bias and cause autocorrelation in the idiosyncratic errors (i.e. lead to inconsistent estimates) if the adjustment process of dependent variables is dynamic (Wooldridge, 2010) as suggested by the literature.¹¹ To examine the validity of our estimates, we applied Hansen's (1982) and Arellano-Bond's (1991) tests. The first is a test of over-identification which allows to test the validity of the instruments. The second is a test for autocorrelation, where the null hypothesis assumes no second order autocorrelation in the first differenced errors. The non-rejection of these two tests is required to assume that our estimates are reliable. In order to be as parsimonious as possible, we choose the model with the minimum number of lags that passes both tests.

4. Data and descriptive statistics

Our empirical analysis is based on a combination of two large data sets covering the period 1999-2010. The first, carried out by Statistics Belgium, is the 'Structure of Earnings Survey' (SES). It is representative of all establishments operating in Belgium which employ at least 10 workers and with economic activities within sections C to K of the NACE Rev.1 nomenclature.¹² The survey contains a wealth of information, provided by the management of establishments, both on the characteristics of the latter (e.g. sector of activity, number of employees, region where is establishment is located) and their workers (e.g. age, education,

explanatory variables (in addition to persistency in dependent variables and a large set of covariates). The potential non exogenous character of regions is addressed in the robustness tests' section.

¹¹ From a theoretical perspective, competitive forces should eliminate abnormal profits (McMillan and Wohar, 2011). Yet, a large literature (see e.g. Shepherd (1975) and McGahan and Porter (1999)) suggests that profit persistence is large and inconsistent with the competitive framework. More recent papers further show that firms with above (below) normal profits have high (low) barriers to entry and exit (McMillan and Wohar, 2011). In light of this so-called 'persistence of profits literature', there are strong arguments for modelling profits in a dynamic way, i.e. for including the lagged dependent variable among covariates in Equations (1) to (3). The assumption of persistent productivity both at the industry and firm level also finds some support in the literature (see e.g. Bartelsman and Doms, 2000). Researchers 'documented, virtually without exception, enormous and persistent measured productivity differences across producers, even within narrowly defined industries' (Syverson, 2011: 326). Large parts of these productivity differences are still hard to explain. The persistence of wage costs is also highlighted in the literature (see e.g. Fuss and Wintr, 2009; Heckel et al., 2008). Wage stickiness is notably the outcome of labour market institutions, adjustment costs and efficiency wages' motives.

¹² It thus covers the following sectors: (i) mining and quarrying (C), (ii) manufacturing (D), (iii) electricity, gas and water supply (E), (iv) construction (F), (v) wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods (G), (vi) hotels and restaurants (H), (vii) transport, storage and communication (I), (viii) financial intermediation (J), and (ix) real estate, renting and business activities (K).

sex, tenure, gross earnings, working hours, occupations).¹³ The SES provides no financial information. It has therefore been merged with a firm-level survey, the ‘Structure of Business Survey’ (SBS). The SBS, also conducted by Statistics Belgium, provides information on financial variables such as investments, value added and gross output. The coverage of the SBS differs from that of the SES in that it does not cover the whole financial sector (NACE J) but only Other Financial Intermediation (NACE 652) and Activities Auxiliary to Financial Intermediation (NACE 67). The merger of the SES and SBS datasets has been carried out by Statistics Belgium using firms’ social security numbers.

The computation of our explanatory variables (especially, those reflecting the composition of the labour force) requires a sufficient number of individual observations per establishment. We therefore eliminate (a very small number of) establishments with less than 10 observations in a given year.¹⁴ We also exclude workers and/or establishments for which data are missing or inaccurate.¹⁵ Next, the estimation of capital stock through the ‘perpetual inventory method’ (OECD, 2009) requires to have information on investments for minimum two successive periods. This restricts our sample to establishments that are observed in at least two consecutive years. It leads to the over-representation of medium-sized and larger establishments since sampling percentages of establishments in our sample increase with the size of the latter.¹⁶

¹³ The SES is a stratified sample. The stratification criteria refer respectively to the region (NUTS-groups), the principal economic activity (NACE-groups) and the size of the establishments. The sample size in each stratum depends on the size of the establishment. Sampling percentages of establishments are respectively equal to 10, 50 and 100 percent when the number of workers is lower than 50, between 50 and 99, and above 100. Within an establishment, sampling percentages of employees also depend on size. Sampling percentages of employees reach respectively 100, 50, 25, 14.3 and 10 percent when the number of workers is lower than 20, between 20 and 50, between 50 and 99, between 100 and 199, and between 200 and 299. Establishments employing 300 workers or more have to report information for an absolute number of employees. This number ranges between 30 (for establishments with between 300 and 349 workers) and 200 (for firms with 12,000 workers or more). To guarantee that establishments report information on a representative sample of their workers, they are asked to follow a specific procedure. First, they have to rank their employees in alphabetical order. Next, Statistics Belgium gives them a random letter (e.g. the letter O) from which they have to start when reporting information on their employees (following the alphabetical order of workers’ names in their list). If they reach the letter Z and still have to provide information on some of their employees, they have to continue from the letter A in their list. Moreover, firms that employ different categories of workers, namely managers, blue- and/or white-collar workers, have to set up a separate alphabetical list for each of these categories and to report information on a number of workers in these different groups that is proportional to their share in the firm’s total employment. For example, a firm with 300 employees (namely, 60 managers, 180 white-collar workers and 60 blue-collar workers) will have to report information on 30 workers (namely, 6 managers, 18 white-collar workers and 6 blue-collar workers). For more details see Demunter (2000).

¹⁴ Theoretically, the characteristics of the SES data set should guarantee that the minimum number of individual observations per establishment and per year is equal to 10 (see footnote 13). However, in practice, in less than 2 percent of cases this minimum number of data points is not reached. This could be explained for instance by the fact that some establishments did not fill in the questionnaire for a sufficient number of their employees or because some questionnaires have been lost or not encoded by the administration. The average number of observations per establishment in each year is equal to 34 in our final sample.

¹⁵ For instance, we eliminate a (very small) number of establishments for which the recorded value added was negative.

¹⁶ See footnote 13.

Finally, we restricted our sample to single-establishment firms (SEF). The rationale for doing this is that information on dependent variables (taken from the SBS) is at the level of the firm, while explanatory variables (taken from the SES) are measured at the establishment-level. Put differently, the dependent variable takes the same value for all establishments (potentially located in different regions) belonging to the same multi-establishment firm (MEF). To avoid this aggregation bias, we focus on SEF only.¹⁷ Our final sample consists of an unbalanced panel of 7,418 establishment-year observations from 2,439 establishments.¹⁸ It is representative of all medium-sized and large establishments employing at least 10 employees in the Belgian private sector, with the exception of large parts of the financial sector (NACE J) and the electricity, gas and water supply industry (NACE E).

[Insert Table 1 about here]

Table 1 presents summary statistics of the main variables broken down by region.¹⁹ Results show that labour productivity is significantly higher in Brussels than in the two other regions. Moreover, they show that establishments in Flanders create on average more value added per hour of work than in Wallonia. The same hierarchy is found for hourly wage costs. However, the distribution of wage costs across regions is found to be more compressed than productivity differentials. Accordingly, descriptive statistics also show that cost competitiveness (i.e. the value-added wage gap) is greatest in Brussels, intermediate in Flanders and smallest in Wallonia. This is coherent with previous evidence and official regional accounts data (see e.g. ICN (2015), OECD (2015) and Rusinek and Tojerow (2014)). It is also in line with urban economics literature showing that areas in which economic activity is more concentrated (i.e. large and dense urban areas) tend to produce more value added per capita and to pay higher wages (see e.g. Ciccone and Hall (1996), Puga (2010) and Behrens et al. (2014)). Konings and Torfs (2011) show indeed that concentration of economic activity (i.e. the number companies per km²) is respectively bigger in Brussels than in Flanders and in Flanders than in Wallonia.

¹⁷ This restriction reduces the number of establishments by approximately 24% (from 3,225 to 2,439 establishments). The effect is more pronounced in Brussels (where the sample is trimmed by around 35%) than in Flanders and Wallonia (where the loss of establishments reaches respectively 23 and 20%). Descriptive statistics by regions are not very much affected by this restriction. Those for SEF (reported in Table 1) are indeed quite similar to those obtained for our initial sample, including both single- and multi-establishment firms (see Appendix 1).

¹⁸ Our data enable to follow establishments over time but not workers.

¹⁹ All variables measured in monetary terms have been deflated to constant prices of 2004 by the consumer price index take from Statistics Belgium. Moreover, we notably control for year and sector dummies. As highlighted by Vandenberghe (2013: 34): ‘the introduction of these dummies can control for asymmetric variation in the price of firms’ outputs at sectoral level’.

Productivity and wage premia associated to more concentrated economic areas are notably explained by selection (i.e. more talented workers choose to locate in areas where economic density is bigger), sorting (i.e. competition among firms is stronger in more concentrated areas so that only the most productive ones survive) and agglomeration effects (i.e. the benefits that companies obtain by locating close to each other, such as labour market pooling, input-output linkages and knowledge spillovers).

Table 1 further compares the average composition of the labour force within establishments across regions. Results notably show that the share of tertiary educated workers is substantially larger in Brussels than in the two other regions. This is most likely due to Brussels' status as a metropolitan centre, capital of Belgium and seat of various international institutions (e.g. European Union and NATO). Establishments located in Brussels also tend to employ more women and especially white-collar workers. This can be directly related to the sectoral distribution of establishments within regions. The share of establishments operating in services (particularly in wholesale and retail trade, hotels and restaurants, financial intermediation, and real estate, renting and business activities) is indeed much higher in Brussels. Put differently, the incidence of establishments operating in the manufacturing industry is substantially bigger in Flanders and Wallonia.

Overall, descriptive statistics show that worker, job and establishment characteristics vary substantially across regions. Moreover, while inter-regional differences exist in both hourly wage costs and productivity, differences in productivity are found to be more important. What is the origin of these productivity and wage cost differentials? Can regional heterogeneity in worker, job and establishment characteristics alone account for these differentials? If the answer is no, are productivity and wage cost differentials well aligned across regions? These key questions concerning regional cost competitiveness are analysed in the remainder of this paper.

5. Results

5.1. Benchmark estimates

We first estimated equations (1) to (3) with pooled OLS. Results, presented in columns (1) to (3) of Table 2, show the impact of the region in which an establishment is located on its average hourly productivity, wage bill and cost competitiveness (i.e. productivity-wage gap) controlling

for a wide range of observable characteristics.²⁰ Estimates highlight that establishments located in Brussels are still significantly more productive than those in Flanders and Wallonia after controlling for compositional effects. The regression coefficient associated to Brussels is equal to 0.091 (see column (1)). It means that, all else remaining constant, productivity in Brussels' establishments is on average 9.5% higher than in Flanders.²¹ In contrast, labour productivity in Wallonia is estimated to be 2.8% lower than in Flanders. As regards wage cost differentials (see column (2)), they are found to be significant but smaller than differences in productivity after controlling for covariates. With respect to Brussels, the discount in average wage cost is measured at around 3.5% in both Flanders and Wallonia.²² As a consequence, cost competitiveness is found to be on average 2.4% lower in Wallonia than in Flanders and 5.9% higher in Brussels than in Flanders (see column 3).

[Insert Table 2 about here]

Yet, caution is required as these findings do neither control for establishment fixed effects nor for persistency in dependent variables. To take these issues into account, we re-estimated equations (1) to (3) with the SYS-GMM estimator.²³ Corresponding estimates are reported in columns (1') to (3') of Table 2. To examine their reliability, we applied the Hansen's (1982) and Arellano-Bond's (1991) tests. For all regressions, they do not reject respectively the null hypotheses of valid instruments and of no second order auto-correlation in first differenced errors. Regression coefficients confirm that establishments located in Brussels are significantly more productive than those in Flanders and Wallonia. Yet, the productivity gap drops at below 5%. Moreover, average productivity is no longer found to be statistically different in Flanders and Wallonia. As regards wage costs differentials, they also become more compressed than in the OLS specification. Regional wage costs differentials reach less than 2 percent and are only weakly statistically significant between Brussels and Flanders. Overall, this leads to regression results reported in column (3') which suggest that establishments located in Brussels are significantly more competitive (by around 3.5%) than those in the two other regions. They also

²⁰ Detailed OLS estimates (including regression coefficients associated to the control variables) are reported Appendix 2.

²¹ Technically, this figure is obtained by taking the antilog (to base e) of the estimated coefficient from which 1 is subtracted ($\times 100$). As demonstrated by Halvorsen and Palmquist (1980), this transformation is required when interpreting a dummy variable in a log-linear model.

²² No significant wage cost differential is observed between Flanders and Wallonia.

²³ Apart from regions, industries, the level of collective wage bargaining and time dummies, all explanatory variables have been treated as endogenous.

indicate that the productivity-wage gap between Flanders and Wallonia is quite small and non-significant.

5.2. Estimates across industries

To investigate whether these results are sensitive to establishments' sectoral affiliation, we re-estimated equations (1) to (3) separately for industry and services.²⁴ SYS-GMM estimates, reported in Table 3, are quite interesting. They basically show that previous results only hold for services. In the industry, regression coefficients associated to regions are all statistically insignificant. Regional productivity and wage cost differentials are thus found to vanish once dynamics and establishment fixed effects are accounted for. For services, results are quite different. On the one hand, they show that productivity of Brussels' establishments is approximately 14% higher than that of those located in the two other regions (for which results are not statistically different). On the other, they suggest that regional wage cost differentials are much smaller and only statistically significant between Brussels and Flanders. Overall, this suggests (as highlighted by estimates in column (3')) that cost competitiveness is approximately 5% higher in Brussels than in the two other regions. The productivity-wage gap between Flanders and Wallonia stands at around 1.6% (in favour of the former) but turns out to be statistically insignificant at conventional probability levels.

[Insert Table 3 about here]

5.3. Further robustness tests

To test the robustness of these findings, we first examined whether results for services still hold if establishments operating in the financial intermediation sector (i.e. NACE code J) are excluded from the analysis. The rationale for doing this is that this sector of activity is somewhat over-represented in Brussels (see Table 1) and known for generating/providing remarkably above-average value-added, wages and profits (see e.g. du Caju et al., 2011, 2012). Hence, although industry dummies are included as covariates in our regressions, it could be questioned

²⁴ Industry sectors refer to NACE codes C (Mining and quarrying), D (Manufacturing), E (Electricity, gas and water supply) and F (Construction). Services sectors include NACE codes G (Wholesale and retail trade; repair of motor vehicles, motorcycles and household goods), H (Hotels and restaurants), I (Transport, storage and communication), J (financial intermediation) and K (Real estate, renting and business activities).

whether results are robust to the exclusion of this sector. Results, reported in Table 4, confirm the higher productivity and cost competitiveness of Brussels' establishments operating in services even when dropping NACE code J. However, the magnitude of the effects are smaller than before. While the productivity differential in favour of Brussels drops to 4.3%, regional wage gaps all become statistically insignificant. Overall, this still leads to a competitive advantage of 3.7% for establishments located in Brussels with respect to Flanders and Wallonia.

[Insert Table 4 about here]

Estimates reported so far are unbiased under the hypothesis that establishments' choice of location is independent of the latter's average productivity and wage cost. However, if we assume that high productivity establishments prefer to settle down in locations where average productivity of their peers is highest, than regression coefficients associated with the most productive region will be upward biased. Konings and Marcolin (2014) argue and provide some empirical evidence suggesting that this self-selection issue is limited in Belgium because of linguistic and cultural barriers, especially between Flanders, on the one hand, and Brussels and Wallonia, on the other. Their argument, in line with Lazear (1999), is that economic success depends crucially on language proficiency and cultural proximity, as it reduces communication costs and fosters social interactions. Persyn and Torfs (2012) also suggest that regional borders are important to explain labour market dynamics in Belgium. The authors develop a gravity model to analyse the determinants of the spatial structure of commuting. Using data on 580 municipalities, their results show that regional borders act as a strong barrier to commuting. Hence, they also suggest that self-selection issues should be limited in our econometric investigation.

[Insert Table 5 about here]

Anyway, to examine whether our results are affected by this potential bias, we re-estimated equations (1) to (3) for older establishments, i.e. establishments existing since at least 10 years. The rationale for doing this is that the benefits from settling down in a particular region should be especially important in the early life of a company, soon after its creation (Konings and Marcolin, 2014). Put differently, self-selection is expected to be less of a concern for older establishments. SYS-GMM estimates for older establishments, operating respectively in

industry and services, are reported in Table 5.²⁵ Results for the industry are in line with our benchmark specification (see Table 3) as they all remain statistically insignificant. Regarding services, as expected, we find that the coefficient associated to Brussels in the productivity regression was somewhat upward biased in Table 3. It indeed decreases from 0.133 to 0.115 when focusing on older establishments. Yet, it remains highly significant. Concerning labour costs, the coefficient associated to Brussels decreases from 0.025 to 0.015 and becomes statistically insignificant. In the end, estimates for older establishments still suggest that cost competitiveness in services is approximately 5% higher in Brussels than in the two other regions. The productivity-wage gap in services between Flanders and Wallonia stands at almost 2% (in favour of the former) but is again statistically insignificant.

[Insert Table 6 about here]

An alternative approach to test for productivity-wage gaps with establishment-level data has been recently proposed by Bartolucci (2014). The author suggests to estimate a wage equation, similar to the one specified by Hellerstein and Neumark (1995) (see equation (2)), and to include average establishment-level productivity as an additional control variable. This method has been shown to be somewhat more flexible than that of Hellerstein and Neumark (1995) notably because it doesn't impose that the elasticity of wages with respect to productivity is equal to 1. Moreover, it avoids the estimation of a production function and hence the choice of an appropriate functional form for the latter. To examine the robustness of our findings to this alternative strategy, we estimated a Bartolucci-type wage equation using a SYS-GMM estimator. Results are reported in Table 6. When considering all establishments, irrespective of their age, estimates (see columns (1) and (2)) suggest that regions generate no significant productivity-wage gap, neither in industry nor in services. Moreover, if we focus on older establishments so as to account for potential self-selection issues, results then become perfectly in line with earlier findings based on the Hellerstein and Neumark (1995) approach. Indeed, as shown in columns (1') and (2'), estimates remain statistically insignificant for the industry, while those for services indicate that mean labour costs are approximately 4% lower in Brussels than in the two other regions after controlling for differences in productivity and other covariates. Put differently, results again suggest that cost competitiveness in services is

²⁵ Comparing estimates according to establishments' age is a convenient way to examine the sensitivity of our results to a potential self-selection issue. Yet, it does not constitute a formal statistical test for the existence of such phenomenon.

significantly higher in Brussels than in the two other regions (which in turn are found to be equally competitive).

6. Conclusion

This paper estimates the impact of the region in which an establishment is located on its average hourly productivity, wage bill and cost competitiveness (i.e. productivity-wage gap). It contributes significantly to the existing literature as it is one of the first to: (1) extend the traditional analysis of inter-regional wage differentials to productivity and productivity-wage gaps using large representative micro-data (i.e. Belgian linked employer-employee panel data covering most private-sector establishments over the period 1999-2010); (2) rely on both the Hellerstein and Neumark (1995) and Bartolucci (2014) methodological approaches; (3) control for a wide range of covariates and address important econometric issues (such as establishment-level fixed effects, endogeneity and state-dependence); and (4) investigate the moderating role of the establishment's sectoral affiliation in the region-productivity-wage nexus.

Descriptive statistics show that hourly productivity is highest in Brussels, intermediate in Flanders and lowest in Wallonia. The ranking of regions in terms of hourly wage cost is similar. Yet, given that gross regional wage differentials are more compressed than differences in productivity, cost competitiveness is also found to be greatest in Brussels, middle in Flanders and smallest in Wallonia. These descriptive statistics, coherent with official regional accounts data (ICN, 2015; OECD, 2015), are in line with urban economics literature showing that areas in which economic activity is more concentrated (i.e. large and dense urban areas) tend to produce more value added per capita and to pay higher wages (see e.g. Ciccone and Hall (1996), Puga (2010) and Behrens et al. (2014)).

To get a better understanding of the drivers of these gross inter-regional differences in productivity and wages, we first run simple OLS regressions controlling for a large set of worker, job and establishment characteristics. Results interestingly show that compositional effects (i.e. regional differences in human capital, labour contracts, occupations, sectors, establishment size and capital intensity, among other variables) account for a substantial part of the variability in productivity and wages across regions. Yet, the same inter-regional pattern is still obtained. Cost competitiveness is indeed found to be on average 2.4% lower in Wallonia than in Flanders and 5.9% higher in Brussels than in Flanders. Estimated differences in productivity across regions thus remain somewhat bigger than those in terms of wages even after controlling for observed heterogeneity. Konings and Marcolin (2014) ran similar OLS

regressions, albeit with a smaller set of covariates (human capital variables were notably not included in their analysis). Our estimates back up their conclusion according to which cost competitiveness is somewhat smaller in Wallonia than in Flanders. However, the magnitude of the estimated effect is smaller in our setup which is not surprising given the larger number of covariates. In contrast, results for Brussels differ in both studies. While Konings and Marcolin (2014) suggest that the productivity-wage gap is significantly smaller in Brussels than in Flanders, we find the reverse outcome. Differences in sampling characteristics may provide an explanation for this discrepancy. Indeed, while descriptive statistics in Konings and Marcolin (2014) suggest that productivity and, to a lesser extent, wages are higher in Flanders than in Brussels, our data show the opposite (which, as highlighted earlier, is more in line with official regional accounts data (ICN, 2015; OECD, 2015)).

This said, OLS estimates should be considered with great caution as they are subject to a range of measurement issues (i.e. establishment fixed effects, endogeneity and persistence in dependent variables). To address these issues, we relied on a dynamic SYS-GMM estimator and had a specific focus on older establishments (for which self-selection is likely to be less of a concern). SYS-GMM estimates show that differences between Flanders and Wallonia in terms of productivity, wages and cost competitiveness are statistically insignificant both in the industry and services. The same outcome is obtained when using a static SYS-GMM specification (i.e. not controlling for persistence)²⁶ and when focusing on all establishments (i.e. not accounting for potential self-selection). This suggests that the higher performance (i.e. productivity and competitiveness) of Flanders with respect to Wallonia reported in our OLS regressions can actually be attributed to regional differences in time-invariant unobserved establishment characteristics (e.g. specific workers' skills, management talent, patents or other establishment idiosyncrasies that are not observed in our data).

As regards Brussels, SYS-GMM estimates indicate that conclusions vary according to establishments' sectoral affiliation. In the industry, results show no significant difference between Brussels and the two other regions in terms of productivity, wages and competitiveness.²⁷ In services, findings are quite different. Indeed, SYS-GMM estimates show a significant premium for establishments located in Brussels (with respect to Flanders and Wallonia) both in terms of productivity and cost competitiveness. When excluding the financial intermediation sector (over-represented in Brussels and known to generate above-average

²⁶ Though (as expected) the p-value associated to the AR(2) test is below 5 per cent with the static estimator.

²⁷ The discrepancy between OLS and SYS-GMM estimates for establishments operating in Brussels' industry can also be ascribed to regional differences in establishment fixed effects.

valued added and profits), this premium still reaches around 4 percent. This result suggests that establishments operating in services benefit from agglomeration effects when they choose to locate in Brussels.²⁸ The absence of a similar effect in the industry is not surprising as Brussels, like most global cities (Sassen, 1991), is essentially offering relatively high-skilled jobs in the tertiary sector.^{29, 30, 31}

To sum up, our findings show that inter-regional differences in productivity and wages vanish almost totally when controlling for a large set of covariates, establishment fixed effects and endogeneity. The only significant (and positive) productivity-wage gap is encountered in the Brussels' tertiary sector. Overall, estimates thus suggest that wage cost and productivity differentials are *ceteris paribus* relatively well aligned across regions.³²

Further investigation is required to provide a better understanding of the regional productivity-wage nexus in other advanced economies with marked differences in unemployment rates across regions (e.g. Italy, Spain or the UK). Extending the approaches offered by Hellerstein and Neumark (1995) and/or Bartolucci (2014) to account for differences in latent productivity and wage costs of unemployed people would also be a compelling avenue for future research.

²⁸ Selection and sorting effects are likely to be controlled for by our focus on older establishments and the use of a SYS-GMM estimator. Yet, caution is required because distinguishing sorting from agglomeration effects is not straightforward. This said, our interpretation is in line with Combes et al. (2012) who show that French establishments are more productive in larger cities due to agglomeration rather than sorting effects.

²⁹ The phenomenon of congestion may also account for this outcome (Graham, 2007). Indeed, it typically disfavours agglomerations (such as Brussels) and is clearly more relevant for industry (relying more on transport) than services.

³⁰ Given that economic density is on average bigger in Flanders than in Wallonia (Konings and Torfs, 2011), one might also wonder why agglomeration effects do not show up in the former region. As highlighted by Brakman et al. (2009), this is likely due to the fact that the geographical delimitation of pooled labour markets (i.e. clusters) does usually not coincide with administrative frontiers. Put differently, agglomeration effects are probably only observed in Brussels' tertiary sector because the matching between pooled labour markets and Belgian administrative regions is imperfect (as suggested by e.g. Dujardin et al, 2007; Konings and Torfs, 2011; Riguelle et al., 2007; Tannier and Thomas, 2013).

³¹ Our paper aims to assess whether productivity-wage gaps exist among Belgian administrative regions. The investigation of employment clusters and agglomeration effects at a more disaggregated level is thus beyond the scope of the latter.

³² Interestingly, other variables have been found to generate much larger and significant productivity-wage gaps than regions. Rycx et al. (2015) for instance highlight that establishments located in the Belgian private sector face financial disincentives to employing lower-educated workers. More precisely, they show that establishments employing a larger share of low-educated workers tend, all else being equal, to be less profitable (i.e. to report significantly smaller productivity-wage gaps). Workers' age has also been found to generate productivity-wage gaps in the Belgian private economy. Indeed, multiple studies (Cataldi et al., 2011, 2012; Lallemand and Rycx, 2009; Vandenberghe, 2011, 2013) have shown that older workers tend to be 'over-paid' (at given productivity) with respect to their younger co-workers.

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Table 1: Descriptive statistics at the establishment-level by region, 1999-2010

Variables	Flanders		Brussels		Wallonia	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Value-added per hour (ln) ^a	3.78	0.46	3.95	0.84	3.75	0.49
Wage cost per hour (ln) ^a	3.39	0.31	3.48	0.43	3.36	0.38
Value added-wage gap (ln) ^{a,b}	0.40	0.32	0.47	0.60	0.39	0.29
Share of workers with primary or lower secondary education	0.32	0.31	0.28	0.32	0.35	0.31
Share of workers with higher secondary education	0.45	0.29	0.33	0.26	0.41	0.28
Share of workers with tertiary education	0.23	0.22	0.39	0.34	0.24	0.25
Share of workers with 10 years of tenure or more	0.39	0.22	0.32	0.23	0.38	0.24
Share of workers < 30 years	0.22	0.13	0.21	0.15	0.21	0.14
Share of workers > 49 years	0.16	0.12	0.18	0.15	0.17	0.13
Share of women	0.24	0.22	0.29	0.22	0.22	0.21
Share of part-time workers (less than 30 hours per week)	0.10	0.12	0.09	0.14	0.12	0.15
Share of blue-collar workers	0.62	0.30	0.36	0.37	0.61	0.31
Share of workers with fixed-term contracts	0.02	0.06	0.03	0.11	0.04	0.09
Share of apprentices	0.00	0.00	0.00	0.01	0.00	0.01
Share of temporary agency workers	0.00	0.03	0.00	0.03	0.01	0.05
Industry:						
Mining and quarrying (C)	0.00	0.05	0.00	0.00	0.02	0.14
Manufacturing (D)	0.61	0.49	0.35	0.48	0.61	0.49
Electricity, gas and water supply (E)	0.00	0.02	0.00	0.05	0.00	0.02
Construction (F)	0.12	0.33	0.11	0.31	0.11	0.31
Wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods (G)	0.10	0.30	0.15	0.36	0.11	0.31
Hotels and restaurant (H)	0.01	0.10	0.04	0.20	0.01	0.09
Transport, storage and communication (I)	0.06	0.24	0.04	0.20	0.06	0.24
Financial intermediation (J)	0.01	0.09	0.04	0.20	0.02	0.14
Real estate, renting and business activities (K)	0.08	0.28	0.25	0.43	0.06	0.24
Firm-level collective agreement	0.29	0.45	0.12	0.33	0.26	0.44
Employment (ln)	5.00	1.00	4.37	1.13	4.64	1.07
Establishment age >= 10 years ^c	0.94	0.25	0.85	0.36	0.89	0.32
Capital stock per worker (ln) ^a	10.84	1.46	10.51	1.96	10.79	1.40
Number of establishment-year observations	4,215		1,009		2,194	
Number of establishments	1,385		332		722	

Notes: ^a All variables measured in monetary terms have been deflated to constant prices of 2004 by the consumer price index taken from Statistics Belgium. ^b Value added-wage cost gap (ln) = ln(value added per hour) – ln(wage cost per hour). ^c Our data set does not provide direct information on the age of the establishment. This variable has been proxied with the seniority of the establishment's most senior employee.

Table 2: OLS and GMM-SYS estimates, 1999-2010

	OLS			SYS-GMM		
	Value added per hour worked (ln)	Wage cost per hour worked (ln)	Value added-wage gap (ln) ^a	Value added per hour worked (ln)	Wage cost per hour worked (ln)	Value added-wage gap (ln) ^a
	(1)	(2)	(3)	(1')	(2')	(3')
Flanders	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Brussels	0.091*** (0.020)	0.034*** (0.012)	0.057*** (0.016)	0.046** (0.022)	0.018* (0.010)	0.034** (0.017)
Wallonia	-0.028*** (0.011)	-0.004 (0.007)	-0.024*** (0.008)	0.002 (0.011)	0.006 (0.006)	-0.009 (0.008)
Lagged dependent variable (ln)				0.584*** (0.050)	0.767*** (0.036)	0.532*** (0.065)
Worker and job characteristics ^b	YES	YES	YES	YES	YES	YES
Establishment characteristics ^c	YES	YES	YES	YES	YES	YES
Year dummies (11)	YES	YES	YES	YES	YES	YES
R-squared	0.399	0.451	0.235			
F-stat (joint significance)	90.20***	155.37***	36.09***			
Hansen over-identification test, p-value				0.535	0.367	0.410
Arellano-Bond test for AR(2) ^d , p-value				0.189	0.132	0.100
Number of establishment-year observations	7,418	7,418	7,418	7,418	7,418	7,418
Number of establishments	2,439	2,439	2,439	2,439	2,439	2,439
F- / Chi-squared statistic for equality of regression coefficients, H ₀ : Brussels = Wallonia	16.10***	4.76***	14.00***	4.45**	1.63	6.04**
Conclusion ^e	B > F > W	B > (F = W)	B > F > W	B > (F = W)	B > F B = W F = W	B > (F = W)

Notes: *** p<0,01, ** p<0,05, * p<0,1. Robust standard errors are reported between brackets ^a Value added-wage cost gap = ln(value added per hour) – ln(wage cost per hour). ^b Share of the workforce at establishment-level that: (i) has at most higher secondary education and tertiary education, respectively, (ii) has at least 10 years of tenure, (ii) is younger than 30 and older than 49 years, respectively, (iii) is female, (iv) works part-time, (v) occupies a blue-collar job, (vi) has a fixed term contract, and (vi) is apprentice or under contract with a temporary employment agency. ^c Sectoral affiliation (8 dummies), establishment size (ln of full-time equivalent workers), capital stock per worker (ln), level of collective wage bargaining (1 dummy). ^d AR(2) refers to second-order autocorrelation in first-differenced errors. ^e '>' ('=') indicates when regression coefficients are (not) statistically different at the 10 percent level. B, F and W stand respectively for Brussels, Flanders and Wallonia. Models (1') and (2') include second and third lags of endogenous explanatory variables as instruments. Model (3') includes first and second lags of endogenous explanatory variables as instruments.

Table 3: SYS-GMM estimates, industry vs. services, 1999-2010

	Industry ^a			Services ^b		
	Value added per hour worked (ln)	Wage cost per hour worked (ln)	Value added-wage gap (ln) ^c	Value added per hour worked (ln)	Wage cost per hour worked (ln)	Value added-wage gap (ln) ^c
	(1)	(2)	(3)	(1')	(2')	(3')
Flanders	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Brussels	0.018 (0.031)	0.009 (0.012)	-0.002 (0.022)	0.133*** (0.042)	0.025** (0.013)	0.050** (0.020)
Wallonia	-0.004 (0.012)	0.003 (0.005)	-0.011 (0.010)	-0.001 (0.034)	0.005 (0.015)	-0.016 (0.013)
Lagged dependent variable (ln)	0.580*** (0.049)	0.749*** (0.052)	0.524*** (0.059)	0.310*** (0.083)	0.791*** (0.059)	0.595*** (0.107)
Worker and job characteristics ^d	YES	YES	YES	YES	YES	YES
Establishment characteristics ^e	YES	YES	YES	YES	YES	YES
Year dummies (11)	YES	YES	YES	YES	YES	YES
Hansen over-identification test, p-value	0.327	0.806	0.539	0.426	0.588	0.425
Arellano-Bond test for AR(2) ^f , p-value	0.938	0.083	0.292	0.465	0.366	0.168
Number of establishment-year observations	5,198	5,198	5,198	2,219	2,219	2,219
Number of establishments	1,490	1,490	1,490	949	949	949
Chi-squared statistic for equality of regression coefficients, H ₀ : Brussels = Wallonia	0.53	0.38	0.14	7.21***	1.38	7.89***
Conclusion ^g	B = F = W	B = F = W	B = F = W	B > (F = W)	B > F B = W F = W	B > (F = W)

Notes: *** p<0,01, ** p<0,05, * p<0,1. Robust standard errors are reported between brackets. ^a Industry sectors refer to NACE codes C (Mining and quarrying), D (Manufacturing), E (Electricity, gas and water supply) and F (Construction). ^b Services sectors include NACE codes G (Wholesale and retail trade; repair of motor vehicles, motorcycles and household goods), H (Hotels and restaurants), I (Transport, storage and communication), J (Financial intermediation) and K (Real estate, renting and business activities). ^c Value added-wage cost gap = ln(value added per hour) – ln(wage cost per hour). ^d Share of the workforce at establishment-level that: (i) has at most higher secondary education and tertiary education, respectively, (ii) has at least 10 years of tenure, (ii) is younger than 30 and older than 49 years, respectively, (iii) is female, (iv) works part-time, (v) occupies a blue-collar job, (vi) has a fixed term contract, and (vi) is apprentice or under contract with a temporary employment agency. ^e Sectoral affiliation (8 dummies), establishment size (ln of full-time equivalent workers), capital stock per worker (ln), level of collective wage bargaining (1 dummy). ^f AR(2) refers to second-order autocorrelation in first-differenced errors. ^g '>' ('=') indicates when regression coefficients are (not) statistically different at the 10 percent level. B, F and W stand respectively for Brussels, Flanders and Wallonia. Models (1) and (2) include second and third lags of endogenous explanatory variables as instruments. Model (3), (1'), (2') and (3') include first and second lags of endogenous explanatory variables as instruments.

Table 4: SYS-GMM estimates for services, excluding NACE J^a, 1999-2010

	Value added per hour worked (ln)	Wage cost per hour worked (ln)	Value added- wage gap (ln) ^b
	(1)	(2)	(3)
Flanders	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Brussels	0.042* (0.024)	0.006 (0.012)	0.036** (0.046)
Wallonia	-0.009 (0.020)	-0.007 (0.015)	-0.008 (0.014)
Lagged dependent variable (ln)	0.682*** (0.079)	0.816*** (0.040)	0.599*** (0.108)
Worker and job characteristics ^c	YES	YES	YES
Establishment characteristics ^d	YES	YES	YES
Year dummies (11)	YES	YES	YES
Hansen over-identification test, p-value	0.818	0.692	0.916
Arellano-Bond test for AR(2) ^e , p-value	0.065	0.327	0.149
Number of establishment-year observations	2,102	2,102	2,102
Number of establishments	927	927	927
Chi-squared statistic for equality of regression coefficients, H ₀ : Brussels = Wallonia	3.75**	0.76	4.41**
Conclusion ^f	B > (F=W)	B = F=W	B > (F=W)

Notes: *** p<0,01, ** p<0,05, * p<0,1. Robust standard errors are reported between brackets. ^a Regression results for services (i.e. NACE codes G to K), except financial intermediation (i.e. NACE code J). ^b Value added-wage cost gap = ln(value added per hour) – ln(wage cost per hour). ^c Share of the workforce at establishment-level that: (i) has at most higher secondary education and tertiary education, respectively, (ii) has at least 10 years of tenure, (iii) is younger than 30 and older than 49 years, respectively, (iv) is female, (v) works part-time, (vi) occupies a blue-collar job, (vii) has a fixed term contract, and (viii) is apprentice or under contract with a temporary employment agency. ^d Sectoral affiliation (8 dummies), establishment size (ln of full-time equivalent workers), capital stock per worker (ln), level of collective wage bargaining (1 dummy). ^e AR(2) refers to second-order autocorrelation in first-differenced errors. ^f '>' ('=') indicates when regression coefficients are (not) statistically different at the 10 percent level. B, F and W stand respectively for Brussels, Flanders and Wallonia. Models (1), (2) and (3) include second and third lags of endogenous explanatory variables as instruments. Model (1), (2) and (3) include second and third lags of endogenous explanatory variables as instruments.

Table 5: SYS-GMM estimates, industry vs. services, only older establishments ^a

	Industry ^b			Services ^c		
	Value added per hour worked (ln)	Wage cost per hour worked (ln)	Value added- wage gap (ln) ^d	Value added per hour worked (ln)	Wage cost per hour worked (ln)	Value added- wage gap (ln) ^d
	(1)	(2)	(3)	(1')	(2')	(3')
Flanders	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Brussels	0.009 (0.030)	0.005 (0.013)	-0.003 (0.022)	0.115*** (0.032)	0.015 (0.010)	0.051** (0.021)
Wallonia	-0.009 (0.012)	0.003 (0.006)	-0.016 (0.012)	-0.002 (0.028)	0.005 (0.009)	-0.017 (0.015)
Lagged dependent variable (ln)	0.634*** (0.045)	0.874*** (0.045)	0.562*** (0.100)	0.509*** (0.076)	0.879*** (0.066)	0.619*** (0.118)
Worker and job characteristics ^e	YES	YES	YES	YES	YES	YES
Establishment characteristics ^f	YES	YES	YES	YES	YES	YES
Year dummies (11)	YES	YES	YES	YES	YES	YES
Hansen over-identification test, p-value	0.409	0.770	0.518	0.263	0.707	0.541
Arellano-Bond test for AR(2) ^g , p-value	0.733	0.380	0.224	0.079	0.465	0.174
Number of establishment-year observations	4,888	4,888	4,888	1,856	1,856	1,856
Number of establishments	1,451	1,451	1,451	824	824	824
Chi-squared statistic for equality of regression coefficients, H ₀ : Brussels = Wallonia	0.38	0.02	0.24	9.38***	0.66	7.21***
Conclusion ^h	B = F = W	B = F = W	B = F = W	B > (F = W)	B = F = W	B > (F = W)

Notes: *** p<0,01, ** p<0,05, * p<0,1. Robust standard errors are reported between brackets. ^a Older establishments are those that are operating since at least 10 years. Our data set does not provide direct information on the age of the establishment. This variable has been proxied with the seniority of the establishment's most senior employee. ^b Industry sectors refer to NACE codes C (Mining and quarrying), D (Manufacturing), E (Electricity, gas and water supply) and F (Construction). ^c Services sectors include NACE codes G (Wholesale and retail trade; repair of motor vehicles, motorcycles and household goods), H (Hotels and restaurants), I (Transport, storage and communication), J (Financial intermediation) and K (Real estate, renting and business activities). ^d Value added-wage cost gap = ln(value added per hour) – ln(wage cost per hour). ^e Share of the workforce at establishment-level that: (i) has at most higher secondary education and tertiary education, respectively, (ii) has at least 10 years of tenure, (ii) is younger than 30 and older than 49 years, respectively, (iii) is female, (iv) works part-time, (v) occupies a blue-collar job, (vi) has a fixed term contract, and (vi) is apprentice or under contract with a temporary employment agency. ^f Sectoral affiliation (8 dummies), establishment size (ln of full-time equivalent workers), capital stock per worker (ln), level of collective wage bargaining (1 dummy). ^g AR(2) refers to second-order autocorrelation in first-differenced errors. ^h '>' ('=') indicates when regression coefficients are (not) statistically different at the 10 percent level. B, F and W stand respectively for Brussels, Flanders and Wallonia. Models (1), (2) and (3) include second and third lags of endogenous explanatory variables as instruments. Model (1), (2') and (3') include first and second lags of endogenous explanatory variables as instruments.

Table 6: Bartolucci's (2014) approach, SYS-GMM estimates, industry vs. services, 1999-2010

	All establishments		Only older establishments ^a	
	Industry	Services	Industry ^b	Services ^c
	Wage cost per hour worked (ln)	Wage cost per hour worked (ln)	Wage cost per hour worked (ln)	Wage cost per hour worked (ln)
	(1)	(2)	(1')	(2')
Flanders	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Brussels	0.022 (0.014)	-0.017 (0.025)	0.022 (0.015)	-0.033* (0.018)
Wallonia	0.006 (0.007)	0.024 (0.018)	0.012 (0.008)	0.006 (0.011)
Value added per hour worked (ln)	0.287*** (0.041)	0.457*** (0.065)	0.294*** (0.046)	0.261*** (0.011)
Lagged dependent variable (ln)	0.327*** (0.093)	0.222** (0.088)	0.296*** (0.092)	0.617*** (0.094)
Worker and job characteristics ^e	YES	YES	YES	YES
Establishment characteristics ^f	YES	YES	YES	YES
Year dummies (11)	YES	YES	YES	YES
Hansen over-identification test, p-value	0.499	0.424	0.136	0.421
Arellano-Bond test for AR(2) ^g , p-value	0.120	0.702	0.794	0.520
Number of establishment-year observations	5,198	2,219	4,888	1,856
Number of establishments	1,490	949	1,451	824
Chi-squared statistic for equality of regression coefficients, H ₀ : Brussels = Wallonia	1.28	2.24	0.40	4.10**
Conclusion ^h	B = F = W	B = F = W	B = F = W	B < (F = W)

Notes: *** p<0,01, ** p<0,05, * p<0,1. Robust standard errors are reported between brackets. ^aOlder establishments are those that are operating since at least 10 years. Our data set does not provide direct information on the age of the establishment. This variable has been proxied with the seniority of the establishment's most senior employee.^b Industry sectors refer to NACE codes C (Mining and quarrying), D (Manufacturing), E (Electricity, gas and water supply) and F (Construction). ^c Services sectors include NACE codes G (Wholesale and retail trade; repair of motor vehicles, motorcycles and household goods), H (Hotels and restaurants), I (Transport, storage and communication), J (Financial intermediation) and K (Real estate, renting and business activities). ^d Value added-wage cost gap = ln(value added per hour) – ln(wage cost per hour). ^e Share of the workforce at establishment-level that: (i) has at most higher secondary education and tertiary education, respectively, (ii) has at least 10 years of tenure, (ii) is younger than 30 and older than 49 years, respectively, (iii) is female, (iv) works part-time, (v) occupies a blue-collar job, (vi) has a fixed term contract, and (vi) is apprentice or under contract with a temporary employment agency. ^f Sectoral affiliation (8 dummies), establishment size (ln of full-time equivalent workers), capital stock per worker (ln), level of collective wage bargaining (1 dummy). ^g AR(2) refers to second-order autocorrelation in first-differenced errors. ^h '>' ('=') indicates when regression coefficients are (not) statistically different at the 10 percent level. B, F and W stand respectively for Brussels, Flanders and Wallonia. All models include first and second lags of endogenous explanatory variables as instruments.

Appendix 1: Descriptive statistics at the establishment-level by region, MEF & SEF^a, 1999-2010

Variables	Flanders		Brussels		Wallonia	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Value-added per hour (ln) ^b	3.81	0.48	3.92	0.78	3.76	0.51
Wage cost per hour (ln) ^b	3.41	0.32	3.48	0.42	3.37	0.39
Value added-wage gap (ln) ^{b,c}	0.41	0.33	0.44	0.55	0.38	0.29
Share of workers with primary or lower secondary education	0.31	0.30	0.27	0.31	0.34	0.31
Share of workers with higher secondary education	0.45	0.28	0.35	0.27	0.42	0.28
Share of workers with tertiary education	0.25	0.24	0.39	0.33	0.25	0.25
Share of workers with 10 years of tenure or more	0.39	0.23	0.32	0.23	0.39	0.25
Share of workers < 30 years	0.22	0.14	0.21	0.16	0.20	0.14
Share of workers > 49 years	0.16	0.11	0.18	0.14	0.18	0.13
Share of women	0.25	0.22	0.31	0.23	0.22	0.22
Share of part-time workers (less than 30 hours per week)	0.11	0.12	0.09	0.14	0.11	0.14
Share of blue-collar workers	0.59	0.32	0.33	0.36	0.59	0.32
Share of workers with fixed-term contracts	0.02	0.07	0.03	0.11	0.04	0.09
Share of apprentices	0.00	0.00	0.00	0.01	0.00	0.01
Share of temporary agency workers	0.00	0.03	0.00	0.03	0.01	0.06
Industry:						
Mining and quarrying (C)	0.00	0.06	0.00	0.05	0.02	0.14
Manufacturing (D)	0.60	0.49	0.33	0.47	0.59	0.49
Electricity, gas and water supply (E)	0.00	0.02	0.00	0.05	0.00	0.05
Construction (F)	0.11	0.31	0.11	0.32	0.09	0.29
Wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods (G)	0.11	0.31	0.18	0.38	0.13	0.34
Hotels and restaurant (H)	0.01	0.10	0.05	0.21	0.01	0.11
Transport, storage and communication (I)	0.06	0.24	0.05	0.22	0.06	0.24
Financial intermediation (J)	0.01	0.09	0.05	0.21	0.02	0.14
Real estate, renting and business activities (K)	0.10	0.30	0.23	0.42	0.07	0.25
Firm-level collective agreement	0.30	0.46	0.17	0.37	0.28	0.45
Employment (ln)	5.10	1.09	4.56	1.21	4.66	1.11
Establishment age \geq 10 years ^c	0.93	0.25	0.86	0.35	0.90	0.31
Capital stock per worker (ln) ^b	10.85	1.50	10.52	1.92	10.83	1.43
Number of establishment-year observations	6,089		1,740		3,045	
Number of establishments	1,806		516		903	

Notes: ^a Establishments belonging to both multi- and single-establishment firms. ^b All variables measured in monetary terms have been deflated to constant prices of 2004 by the consumer price index taken from Statistics Belgium. ^c Value added-wage cost gap (ln) = ln(value added per hour) – ln(wage cost per hour). ^d Our data set does not provide direct information on the age of the establishment. This variable has been proxied with the seniority of the establishment's most senior employee.

Appendix 2: Detailed OLS estimates, 1999-2010

	Value added per hour worked (ln)	Wage cost per hour worked (ln)	Value added- wage gap (ln) ^a
	(1)	(2)	(3)
Flanders	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Brussels	0.091*** (0.020)	0.034*** (0.012)	0.057*** (0.016)
Wallonia	-0.028*** (0.011)	-0.004 (0.007)	-0.024*** (0.008)
Share of workers with primary or lower secondary education	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Share of workers with higher secondary education	0.011** (0.017)	0.032*** (0.009)	-0.021 (0.013)
Share of workers with tertiary education	0.707*** (0.038)	0.604*** (0.025)	0.103*** (0.027)
Share of workers with 10 years of tenure or more	0.197*** (0.031)	0.164*** (0.018)	0.034 (0.023)
Share of workers < 30 years	-0.164*** (0.047)	-0.270*** (0.022)	0.106*** (0.036)
Share of workers > 49 years	0.150*** (0.055)	0.115*** (0.029)	0.035 (0.045)
Share of women	-0.040 (0.026)	-0.177*** (0.016)	0.137*** (0.021)
Share of part-time workers (less than 30 hours per week)	-0.296*** (0.038)	-0.244*** (0.028)	-0.051* (0.027)
Share of blue-collar workers	-0.198*** (0.029)	-0.169*** (0.020)	-0.028 (0.020)
Share of workers with fixed-term contracts	-0.026 (0.061)	-0.068 (0.062)	0.042 (0.041)
Share of apprentices	-1.599*** (0.623)	-1.384*** (0.284)	-0.215 (0.479)
Share of temporary agency workers	-0.140 (0.100)	-0.224*** (0.056)	0.084 (0.076)
Industry:			
Mining and quarrying (C)	0.244*** (0.051)	0.093*** (0.028)	0.151*** (0.042)
Manufacturing (D)	<i>Reference</i>	<i>Reference</i>	<i>Reference</i>
Electricity, gas and water supply (E)	1.735*** (0.593)	0.235*** (0.062)	1.500*** (0.545)
Construction (F)	-0.061*** (0.012)	0.028*** (0.008)	-0.089*** (0.010)
Wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods (G)	-0.045** (0.020)	-0.025** (0.011)	-0.021 (0.015)
Hotels and restaurant (H)	-0.231*** (0.054)	-0.149*** (0.045)	-0.082*** (0.026)
Transport, storage and communication (I)	-0.123*** (0.023)	-0.066*** (0.021)	-0.057*** (0.016)
Financial intermediation (J)	0.284*** (0.088)	0.037 (0.068)	0.247*** (0.060)
Real estate, renting and business activities (K)	-0.108*** (0.024)	-0.016 (0.016)	-0.092*** (0.019)
Firm-level collective agreement	0.067*** (0.012)	0.051*** (0.007)	0.003 (0.007)
Employment (ln)	0.027*** (0.006)	0.066*** (0.003)	0.016*** (0.009)
Capital stock (ln)	0.124*** (0.005)	0.027*** (0.004)	0.097*** (0.004)

R-squared	0.399	0.451	0.235
F-stat (joint significance)	90.20***	155.37***	36.09***
Number of establishment-year observations	7,418	7,418	7,418
Number of establishments	2,439	2,439	2,439
F-statistic for equality of regression coefficients, H ₀ : Brussels = Wallonia	16.10***	4.76***	14.00***
Conclusion ^b	B > F > W	B > (F = W)	B > F > W

Notes: *** p<0,01, ** p<0,05, * p<0,1. Robust standard errors are reported between brackets. Regressions also include 11 year dummies. ^a Value added-wage cost gap = ln(value added per hour) – ln(wage cost per hour). ^b ‘>’ (‘=’) indicates when regression coefficients are (not) statistically different at the 10 percent level. B, F and W stand respectively for Brussels, Flanders and Wallonia.