Rigid labour compensation and flexible employment?

Firm-level evidence with regard to productivity for Belgium

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Abstract:

Using firm-level data for Belgium over the period 1997-2005, we evaluate the elasticity of firms' labour and real average labour compensation to total factor productivity (TFP). Our results may be summarised as follows. First, we find that the short-run elasticity of average labour compensation and that of labour are positive but of a small order of magnitude. However, the long-run elasticity of labour is much higher than that of average labour compensation, consistent with real wage rigidity. Second, while the elasticity of average labour compensation to idiosyncratic firm-level TFP is close to zero, the elasticity with respect to aggregate sector-level TFP is high. Our results indicate that adjustment to aggregate TFP occurs through coordinated wage decisions embodied in sector-level collective agreements.

Keywords: labour compensation, employment, hours, Total Factor Productivity

JEL: J30, J60

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1. Introduction

This paper examines the response of the components of firms' total labour compensation to Total Factor Productivity (TFP) at the microeconomic level. More specifically, we investigate the impact of TFP on firms' real wage bill per employee (average labour compensation), firms' employment, total hours worked, as well as real wage bill per hour (hourly labour compensation). We distinguish between idiosyncratic firm-level TFP and aggregate sector-level TFP. Comparing the elasticity of average labour compensation and labour to both firm-specific TFP and to sector-level TFP, we also discuss the role of centralised wage bargaining.

First, we compare the elasticity of average labour compensation and labour to firm-specific TFP. This can be related to the existence of real wage rigidity and employment adjustment costs. There are several reasons for wage rigidity and it can manifest itself in various ways.[1] Recent microeconomic research highlights the existence of various forms of wage rigidity.[2] These papers point to high downward real wage rigidity in Belgium. This is attributable mainly to the full automatic indexation of base wages. We therefore focus on adjustment of real labour compensation. Models with real wage rigidity typically find that wages have a smaller and more sluggish response to economic shocks while employment exhibits larger variability in response to productivity shocks, as compared to the flexible wage scenario (see, for example, Boldrin and Horvath (1995) or Hall (2005)). In addition to wage rigidities, other frictions alter the functioning of labour markets. Hiring and firing costs together with training expenses may generate considerable employment adjustment costs that impede labour adjustment. Which of the two constraints - wage rigidity or employment adjustment costs - is more binding has to be determined on empirical grounds.

This question is also relevant for inflation dynamics and monetary policy, as shown in the most recent strand of New Keynesian models. In the absence of wage rigidity, these models predict that the central bank should fully stabilise inflation at all times and at any cost (Goodfriend and King (1997)). On the contrary, price lumpiness (Christiano et al. (2005)) and real wage rigidity (Blanchard and Galí (2007, 2008)) generate inflation inertia and persistence of fluctuations in hours and output. Therefore, following an adverse economic shock, the monetary authority must decide whether to accommodate a higher level of inflation or, instead, keep inflation constant but allow for a larger decline in the output gap and employment. Pure inflation targeting is no longer the optimal monetary policy, which should rather aim at reducing, but not eliminating, the volatility of both inflation and unemployment.

[1] Multi-period contracts, implicit contracts, efficiency wages etc. may imply that wages do not respond to contemporaneous shocks. The resistance to wage cuts may imply reduced sensitivity to adverse shocks. This so-called downward wage rigidity may even reduce the sensitivity of wages to favourable shocks (Elsby (2006)). A sluggish response of wages may also be the outcome of wage bargaining between risk-averse workers and risk-neutral firms, leading to "wage insurance" (Azariadis (1975)).

[2] Firstly, Guiso et al. (2005), Cardoso and Portela (2005) and Katay (2007) provide microeconomic evidence that firms do insure workers against temporary firm-specific shocks to productivity. Second, recent evidence on downward wage rigidity in Belgium can be found in Dickens et al. (2006, 2007), Du Caju et al. (2007), Holden and Wulfsberg (2008) and Knoppik and Beissinger (2005).

Further, examining jointly real wage rigidity and employment protection, Christoffel and Linzert (2005) show that, on the one hand, real wage rigidity causes a bigger adjustment via the employment margin and explains inflation persistence. On the other hand, employment protection tends to smooth out labour flows, raise the volatility of wages following a monetary policy shock, increases the response of inflation, and thus lowers the persistence of inflation. Matching frictions, on the contrary, tend to reduce the response of inflation to monetary policy shocks (Christoffel et al. (2006)). According to a recent paper by Christoffel et al. (2009), real wage rigidity is more relevant for monetary policy effectiveness, i.e. the speed of transmission of monetary policy shocks to inflation, than other labour market rigidities.

Second, we compare the elasticity of average labour compensation to idiosyncratic (firm-specific) TFP and to aggregate (sector-level) TFP. To our best knowledge, there is no other paper that compares the response of labour compensation and employment to idiosyncratic as opposed to aggregate TFP. The economic and institutional structures of the labour and product markets may affect the wage responsiveness to productivity developments. In particular, stronger competition on the product and labour markets may reduce the sensitivity of wages to firm-level TFP. Indeed, isolated wage cuts may not be desirable if firms compete for workers on the labour markets, due to efficiency wage considerations and efforts to minimise the risk of on-the-job shirking or job quits. Furthermore, isolated wage increases may not be feasible in a competitive product market environment because companies are not able to raise output prices unless all other firms do so. However, the elasticity of wages to sector-level TFP may be high because, in the event of common TFP variations, coordinated wage actions make it possible to internalise the externalities of wage changes and alleviate the above-mentioned impact of competition.[3] Coordination, in turn, is facilitated in economies with centralised collective wage bargaining, as is the case in Belgium where sector-level collective wage agreements play a major role in wage-setting.

With respect to the above discussion, note that Belgium is typically characterised as a country with real wage rigidity and where sector-level collective bargaining plays a major role in wage-setting. According to the OECD Employment Protection Legislation indicator, employment protection for permanent workers in Belgium is lower than average, and although it is higher for temporary employment, this only concerns a small fraction of the workforce compared to other European countries.

In order to estimate the elasticities discussed above, we estimate dynamic equations for average labour compensation, employment, total hours worked, as well as hourly labour compensation. Among others, the equations include TFP measures together with variables that capture sector-level fluctuations. The main variables are obtained from companies' annual accounts and social balance sheets recorded in Belgium over the period 1997-2005. TFP is measured through the growth accounting framework of Ackerberg et al. (2006) and corrected for fluctuations in hours per worker to account for variable utilisation of production factors (Basu and Kimball (1997)). Note that we use firm-level information on average labour compensation rather

[3] This argument can be traced back to Bruno and Sachs (1985) who find that countries with more centralised wage bargaining find it easier to adjust real wages to adverse macroeconomic shocks.

than individual earnings data. The advantage of using individual earnings data is that changes in wages cannot be confused with changes in the workforce composition. The main drawback is that wage changes can only be constructed for job stayers, while our approach also takes into account newly hired workers and workers that leave the firm together with permanent job stayers when measuring average labour compensation changes. We believe that from the point of view of a firm, the relevant adjustment variable following a TFP shock is the average labour compensation rather than workers' individual wages, although changes in the composition of the labour force might have an impact on firm's productivity. We acknowledge this point by including control variables for labour force composition in our labour compensation models.

Our results may be summarised as follows. First, we examine the relative sensitivity of average labour compensation and labour to firm-specific TFP changes. Our estimates indicate that the short-run elasticity of average labour compensation to TFP is close to zero, while the elasticity of labour is positive. However, both are fairly low. In the long run, the response of labour to firm-specific TFP is much larger than that of labour compensation, in line with the existence of real wage rigidity. Second, we contribute to the literature by comparing the elasticity of average labour compensation to firm-specific and sector-level TFP. We find that the elasticity of average labour compensation to sector-level TFP is much higher than that to firm-level TFP. We relate this finding to the fact that wage dynamics in Belgium is mostly driven by sector-level collective agreements.

This paper is organised as follows. Section 2 provides a brief overview of the Belgian labour market institutions, introduces the data and describes the methodology. Section 3 presents our main results. Robustness tests with respect to alternative measures of TFP and specifications are discussed in Section 4, while Section 5 concludes.

2. Institutions, data and methodology

2.1 Institutional features of the Belgian labour market

In this section, we briefly introduce the main features of the Belgian labour market that are relevant for the interpretation of our results. Notable characteristics of the wage formation process in Belgium include the minimum wage, automatic indexation, a cap on average wage increases, and sectoral collective wage bargaining. As far as employment is concerned, strict employment protection may be eased by early retirement, temporary unemployment, as well as overtime work.

Wage-setting in Belgium may be described as the outcome of three mechanisms. First, a prominent feature of the Belgian labour market is full automatic indexation of nominal gross wages to the so-called health index, which is basically the consumer price index excluding alcoholic beverages, tobacco and motor fuels. This impedes real wage reductions for job stayers through the pace of inflation. Second, the so-called wage norm, set at the national level, is a recommendation for a maximum nominal hourly labour compensation increase. It is set by an interprofessional agreement for two years and takes into account, among others, the predicted indexation and evolution of labour costs of Belgium's main trading partners (namely Germany, France and the

Netherlands). Third, sector-level collective wage bargaining between trade unions and employers' representatives plays a major role in the wage formation process and concerns the vast majority of firms.[4] These agreements are typically organised separately for white-collar workers and blue-collar workers and set real wage increases. These features explain why Belgium has substantial real wage rigidity. However, it should be noted that labour compensation involves extra-wage components such as bonuses, premiums and overtime hours, which make total compensation more flexible than the base wage. On top of this, some companies engage in firm-level wage bargaining. These individual agreements are not common in Belgium except for large firms in which they usually lead to higher earnings.[5] Note that union representation and worker involvement within the firm is compulsory for companies with 50 or more employees, and they also have to have works councils, among others.[6] Trade union participation is stronger and better structured in firms employing 100 or more people.[7]

Employment developments over the last decade have been characterised by changes in the labour force composition. Trends include a smaller proportion of blue-collar workers in private sector employment (from 54% in 1990 to 49% in 1997 and 46% in 2005 according to social security statistics), an increasing fraction of part-time workers (accounting for 13.5% of employment in 1990, 16.3% in 1997 and 18.1% in 2005 (OECD (2002, 2004, 2006)), fewer hours worked per employee (the annual number of hours worked per employee fell from 1,546 in 1999 to 1,534 in 2005 (OECD (2004, 2006))) and a slightly higher number of employees with fixed-term contracts. Fixed-term contracts represent only a small proportion of wage earners in Belgium, 6.3% in 1997 and 8.8% in 2005, in comparison with EU average of 12% in 1997 and 14% in 2005 (Eurostat's New Cronos database).

Among the OECD member states, Belgium has a slightly higher than average degree of employment protection legislation. This results from below average protection of regular employment and above average protection of temporary jobs and specific requirements for collective dismissals (see OECD (2004)). On the other hand, flexibility of the labour market is enhanced by early retirement and temporary unemployment. For firms in distress or in the process of restructuring, early retirement is possible under specific conditions for workers aged 50 and over. For short periods, temporary unemployment allows firms to temporarily interrupt, but not breach,

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4 According to the Belgian survey conducted in the framework of the Wage Dynamics Network (Druant et al. (2008)), bargaining at sectoral level concerns 98% of all firms. Sector-level collective bargaining determines various aspects of compensation, such as pay scales and real wage increases, which often consist of an absolute rise in the minimum pay scale, as well as other aspects, such as training or mobility. Pay scales set a minimum wage by sector and occupation and vary with age or tenure for white-collar workers and some blue-collar workers.

5 From the Structure of Earnings Survey data for the years 1999 to 2005, in the manufacturing, construction and business service sectors, 16% of companies have a firm-level agreement (either for blue-collar workers, or for white-collar workers, or for both). Companies with firm-level collective wage agreements tend to pay 15% higher wages than firms with no firm-level collective wage agreement. This figure rises to 20% if one includes irregular payments such as bonuses and premiums.

6 The works council is jointly composed of employee representatives and management staff. Its aim is to provide a forum for consultation and negotiation between employers' and employees' representatives.

7 In firms with a workforce of more than 100, employees' representatives in the works council have to be elected every four years; in smaller firms, the representatives' mandate is simply renewed.

labour contracts. Workers then receive unemployment benefit for a defined period and are later re-employed by the same firm under the initial contract terms. Together with changes in the number of hours (e.g. due to overtime hours), temporary unemployment makes it possible to reduce the number of hours worked, and avoid costly layoffs, as does early retirement.

2.2 Data

The main variables of interest related to labour compensation (total wage bill, number of employees, total hours worked) are taken from firms' annual accounts. Almost all firms in Belgium have to file their annual accounts with the Central Balance Sheet Office. However, we focus on the manufacturing, construction and market services sectors, and we consider only firms with at least 50 employees[8]; which account for the vast majority of jobs. We perform a range of consistency checks to identify possible data issues and exclude extreme observations as outliers. In our analysis, we estimate equations of employment, labour compensation, hours etc. by System GMM. To make sure that sufficient history is available to build lagged instruments, we consider only trajectories with at least 6 consecutive observations per firm. Last, we exclude sectors with either too few observations to estimate the production function, from which our measure of TFP is derived, or sectors with production function coefficients substantially different from their income shares. Altogether, the dataset contains 10,771 firm-year observations on 1,518 firms with more than 50 employees over the period 1997-2005. Descriptive statistics on the variables used in the paper are reported in Table A.1 in the Appendix. Technical details, information on the composition of the dataset across the sectors are discussed in the Appendix to Fuss and Wintr (2009).

The real wage bill of firm *i* at time *t* is denoted as WB_{it} and includes total remuneration and direct social benefits deflated by sector-specific value added prices. Employment, abbreviated as L_{it}, is measured as the average number of employees in full-time equivalent positions over the year. Average labour compensation per firm (W_{it}) is simply calculated as the ratio of the total real wage bill to the average number of employees over the year in full-time equivalents. Total hours worked over the year for each firm are denoted as H_{it}. Value added of sector *s* at time *t*, VA_{st}, was obtained from national accounts statistics. Variables related to workforce composition, like the percentage of blue-collar workers ($\%BLUE_{it}$), the percentage of women ($\%WOMEN_{it}$) and the proportion of workers with fixed-length contracts ($\%TEMP_{it}$) are provided in the so-called social balance sheet, which forms part of firms' annual accounts. The construction of capital stock (K_{it}) is based on the perpetual inventory method. Variables mentioned below in lower case designate log transformation.

We measure average labour compensation per firm as its total labour compensation divided by the number of employees in full-time equivalent positions. This contrasts with empirical research based on individual wages (such as Cardoso and Portela (2005), Guiso et al. (2005)). These

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[8] We prefer to disregard smaller firms because they may have different employment dynamics. Our own preliminary estimates, although not reported here, indicate that the elasticity of labour to TFP is higher for larger firms. This is also supported by the results of the WDN survey for Belgium (Druant et al. (2008)).

studies focus on job stayers. Such analyses may underestimate the sensitivity of wages if the wages of job stayers are less flexible than those of newly recruited workers[9], for example because they are (partly) set by multi-period contracts. One advantage of our measure is that it also includes employees whose wages might be more easily adjusted than those of permanent job stayers, such as newly hired workers or workers on fixed-term contracts. A potential disadvantage of our measure of average labour compensation is that it may vary with changes in the composition of the labour force. We account for this by including control variables related to workforce composition in our equations, namely the percentage of blue-collar workers, women, and workers under fixed-term contracts. Note also that our measure of average labour compensation, i.e. the firm's average labour compensation per employee, may be more flexible than the base wage because it includes extra-wage components such as overtime hours, bonuses and premiums.[10] Because fluctuations in hours per worker imply variation in labour compensation due to overtime hours or temporary unemployment in addition to the reaction of the wage, we also estimate an equation for hourly labour compensation defined as total labour compensation over total hours worked.

We estimate TFP through the method recently proposed by Ackerberg et al. (2006), who improve on several grounds the estimation procedures used by Olley and Pakes (1996) and Levinsohn and Petrin (2003). We take into account two important problems related to measures of TFP based on the residual of a production function. The first is a simultaneity bias arising from the fact that productivity shocks are likely to affect factor demand. Second, productivity shocks may affect the rate of utilisation of production factors in addition to their impact on the demand for factors (Basu and Kimball (1997)).

Olley and Pakes (1996), Levinsohn and Petrin (2003) and Ackerberg et al. (2006) correct for the simultaneity bias by augmenting the production function equation with a proxy of technological shocks (based on capital and either investment or intermediate inputs). The procedures by Olley and Pakes (1996) and Levinson and Petrin (2003) are based on a two-step estimate. In the first step, the production function is estimated including the proxy for unobserved productivity to solve the simultaneity problem. Because capital appears twice in the equation, once to proxy for productivity and again as a production factor, it is not identified. However, the equation provides an estimate of the labour coefficient. In the second step, the coefficient on capital is estimated, given the first-step estimate of the labour coefficient. The identification is based on the assumption that the current capital stock was built in the previous period and is independent of current productivity innovations.

Ackerberg et al. (2006) point out that when intermediate inputs are used to proxy unobserved productivity, as in the Levinsohn and Petrin (2003) methodology, the labour production coefficient cannot be identified in the first step if labour and intermediate input decisions are taken

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9 Evidence that the wages of new hires or movers is more flexible than those of job stayers is provided by Carneiro et al. (2008), Fehr and Goette (2005) and Haefke et al. (2008).

10 Survey evidence, reported in Bertola et al. (2008) for European countries and Druant et al. (2008) for Belgium, shows that this is the main adjustment margin of labour compensation.

simultaneously. The problem is similar but less severe when investment is used to proxy unobserved productivity, as in Olley and Pakes (1996). Ackerberg et al. (2006) then propose an alternative estimation procedure in which all production function parameters are estimated in the second stage. Identification of the capital parameter is the same as in the Olley-Pakes and Levinsohn-Petrin procedures. Identification of the labour parameter is achieved under the assumption that lagged labour does not respond to current productivity shocks.

In this paper, we adopt the Ackerberg et al. (2006) procedure.[11] In addition, we correct the obtained measure of TFP for variable capacity utilisation. In order to deal with this problem, Basu and Kimball (1997) develop a structural model in which the rate of utilisation of labour can be proxied by hours per worker. Furthermore, we decompose TFP into a firm-specific or idiosyncratic TFP component, TFP_{it}, and a sector-level or aggregate TFP component, TFP_{st}. In short, we regress the Ackerberg et al. (2006) measure of TFP on hours per worker and a full set of interactive sector and year dummies. The firm-level TFP corrected for variable utilisation rate, TFP_{it}, is obtained as the residual of this equation, and sector-level TFP, TFP_{st}, as the estimated values of the sector-specific time dummies.

Last, we attempt to capture the impact of sector-level collective bargaining agreements on each firm's average labour compensation. This is motivated by the considerable importance of sector-level collective agreements in the wage-setting process in Belgium and our estimates confirm their relevance for firms' average labour compensation. The variables are constructed as follows. The nominal index of collectively agreed nominal wage increases at the sector level for blue-collar workers and white-collar workers, respectively, is published by the Ministry of Labour.[12] We deflate these by the corresponding sector-level value added deflator to obtain the real measure. We use the logarithm of the real index of collectively agreed wage increases for blue-collar workers and white-collar workers, I^{B}_{st} and I^{W}_{st} and multiply these by the percentage of blue-collar workers and white-collar workers, respectively, in each firm. The measure is not perfect because collectively agreed wage increases are set on a more detailed scale (in terms of sectors, occupation and age or tenure).[13] Discrepancies with respect to the average labour compensation may capture the firm-specific pay policy but also reflect the fact that collective agreements do not apply to more flexible components of labour compensation, such as bonuses and premiums.

11 Estimates of production function coefficients are reported in Table A.2 in Appendix.

12 Federal Public Service Employment Labour and Social Dialogue (FPS ELSD).

13 Note that collectively agreed nominal wage increases in Belgium are the result of two mechanisms: indexation and collective agreements concerning real wage increases. We do not attempt to estimate the latter, i.e. we do not try to discriminate between indexation and real wage increases negotiated under sectoral collective agreements. Rather, we evaluate the impact on the firm's labour compensation of wage increases triggered by the sector-level collective agreement that is decided outside the firm. From the point of view of the company, these costs have to be compared to the firm's real output prices. Therefore, we deflate the collectively agreed nominal wage increases by the value added deflator.

2.3 Specifications

We adopt a dynamic specification for each component of the wage bill and we also provide estimates for total hours worked and the wage bill per hour worked. A dynamic specification is standard in employment equations due, for instance, to adjustment costs (see Arellano and Bond (1991), Nickell and Nicolitsas (1999), Nickell and Wadhwani (1991)). In the case of labour compensation equations, the inclusion of lags in the endogenous variables may be motivated by multi-period contracts, wage smoothing, wage rigidity or the existence of reference norms for example. In addition, from an empirical point of view, omitting lags in endogenous variables leads to serially correlated residuals.

In the labour compensation equation, we control for the composition of the labour force by including the percentage of blue-collar workers, $\%BLUE_{it}$, the percentage of women, $\%WOMEN_{it}$, and the percentage of workers with fixed-term contracts, $\%TEMP_{it}$.[14] In order to take into account the impact of firm size in our regressions, we include a dummy that is equal to one for firms with more than 100 employees, "$L>100_{it}$". This threshold is motivated by the fact that union participation may be considered as more structured in firms with 100 employees or more (see section 2.1). It is close to the median firm size in our sample.[15] Our labour equations follow standard labour demand specifications, including installed capital and average labour compensation per firm, increased by TFP.[16]

Equation (1a) and (1b) show the baseline model that we estimate in Section 3 for labour compensation and labour respectively:

$$\text{dep.var}_{it} = \rho_1\,\text{dep.var}_{it-1} + \rho_2\,\text{dep.var}_{it-2} + \beta_1\,\text{tfp}_{it} + \beta_2\,\%\text{BLUE}_{it} + \beta_3\,\%\text{TEMP}_{it} + \beta_4\,\%\text{WOMEN}_{it} + \beta_5\,\text{L>100}_{it} + \delta_i + \delta_{st} + \varepsilon_{it} \quad (1a)$$

$$\text{dep.var}_{it} = \rho_1\,\text{dep.var}_{it-1} + \rho_2\,\text{dep.var}_{it-2} + \beta_1\,\text{tfp}_{it} + \beta_2\,\text{k}_{it} + \beta_3\,\text{w}_{it} + \delta_i + \delta_{st} + \varepsilon_{it} \quad (1b)$$

Variables in lower case are expressed in logs and ρ_js and β_js are the coefficients to be estimated. Firm-fixed effects, δ_i, capture unobserved firm characteristics; while sector-level conditions, such as aggregate demand or prices, are taken into account by interactive year and sector dummies as δ_s. In equation (1a), dep.var_{it} denotes the dependent variable, which can be average labour

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14 Due to the lack of data, our specification omits education, a typical worker characteristic of individual wage equations. Provided that higher human capital is captured by our measure of TFP and translates into higher wages, this may induce an upward bias in the TFP coefficient. This does not affect our main qualitative finding that the wage elasticity with respect to firm-specific TFP is very small.

15 In Section 4, we report robustness test with respect to the use of employment as a measure of firm size.

16 As reported in the robustness section 4, we also consider a specification that involves changes in labour compensation and lags of labour compensation to take into account efficiency wage mechanisms (Nickell and Wadhwani, 1991). However, these terms are insignificant. What is missing with respect to wage bargaining models is the outside wage option. To the extent that unemployment benefits are proportional to wage payments, this term will be taken into account by labour compensation.

compensation (w_{it}) or hourly labour compensation ($wb\text{-}h_{it}$). In equation (1b), y_{it} stands for employment (l_{it}) or hours (h_{it}).

In our alternative specification, the role of sector-specific variables is examined by replacing the sector-specific time dummies, δ_{st}, by a set of year dummies, δ_t, sector dummies, δ_s, and sector-level variables. These include sector-level TFP, and sector-specific value added in the labour compensation equations,[17] and the log change of sector-value added in the labour equations (as in Nickell and Wadhwani (1991)).

$$\text{dep.var}_{it} = \rho_1\, \text{dep.var}_{it-1} + \rho_2\, \text{dep.var}_{it-2} + \beta_1\, tfp_{it} + \beta_2\, tfp_{st} + \beta_3\, va_{st} + \beta_4\, \%BLUE_{it} + \beta_5\, \%TEMP_{it} + \beta_6\, \%WOMEN_{it} + \beta_7\, L{>}100_{it} + \delta_i + \delta_s + \delta_t + \varepsilon_{it} \quad (2a)$$

$$\text{dep.var}_{it} = \rho_1\, \text{dep.var}_{it-1} + \rho_2\, \text{dep.var}_{it-2} + \beta_1\, tfp_{it} + \beta_2\, tfp_{st} + \beta_3\, \Delta va_{st} + \beta_4\, k_{it} + \beta_5\, w_{it} + \delta_i + \delta_s + \delta_t + \varepsilon_{it} \quad (2b)$$

Lastly, to investigate the role of sector-level collective wage bargaining, we also estimate labour compensation equations that include weighted indices of wage increases for blue-collar workers and white-collar workers determined by sector-level collective agreements:

$$\text{dep.var}_{it} = \rho_1\, \text{dep.var}_{it-1} + \rho_2\, \text{dep.var}_{it-2} + \beta_1\, tfp_{it} + \beta_2\, (\%WHITE_{it} * i^W_{st}) + \beta_3\, (\%BLUE_{it} * i^B_{st}) + \beta_4\, va_{st} + \beta_5\, \%BLUE_{it} + \beta_6\, \%TEMP_{it} + \beta_7\, \%WOMEN_{it} + \beta_8\, L{>}100_{it} + \delta_i + \delta_s + \delta_t + \varepsilon_{it} \quad (3)$$

Equations (1) to (3) include firm-specific fixed effects, as it is common in the literature. This implies that instrumental variables should be used to take into account endogeneity of the lagged dependent variable. The dynamic panel equations are estimated by the System GMM procedure proposed by Arellano and Bover (1995) and Blundell and Bond (1998). We report the two-step estimates with standard errors corrected by the Windmeijer (2004) procedure. We assume that TFP, the firm-size dummy, labour force composition, sector-specific value added, and the impact of sector-level collective agreements on firms' wages are exogenous.[18] Other variables are used as instruments.

3. Results

3.1 Estimating the elasticity of average labour compensation and labour to firm-specific TFP

In this section, we compare the elasticity of labour compensation with respect to firm-specific TFP to that of labour. We estimate equation (1a) for average labour compensation and hourly labour compensation, and equation (1b) for employment and hours worked. The results are reported in

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17 Unemployment is often used as a determinant of wages. Because unemployment rates are not available at the sector level, we use a proxy for sector-level business conditions.

18 In the Appendix, we report robustness tests with respect to some of these assumptions.

Table 1. The coefficients on control variables have the expected sign. Firms with a higher percentage of blue-collar workers and women have significantly lower average labour compensation, all else equal. Also, firms with a higher percentage of workers under fixed-term contracts have *ceteris paribus* lower average labour compensation. The capital stock has a positive coefficient in the employment equation, suggesting complementarities between the two production factors, capital and labour. Labour compensation appears insignificant in labour equations.

Our estimates indicate that the contemporaneous elasticity of average labour compensation to TFP is small, but significantly larger than zero at the 15% significance level only, while the elasticity of employment is positive and significant at 10% level. The contemporaneous elasticity with respect to TFP for average labour compensation (0.02) is at least three times smaller than the elasticity of employment (0.06) and total hours (0.08). More strikingly, the long-run impact of firm-level TFP on employment (1.46) is ten times larger than that based on labour compensation (0.12).[19]

Our estimates point to a positive relationship between hours and TFP. The elasticity of total hours worked, which accounts both for changes in hours per worker and changes in the number of employees, is positive. Further, it is slightly larger than that of employment, suggesting that the number of hours per worker may vary positively with TFP. However, the difference between the elasticity of hours and that of employment is small. This means that firms adjust labour to firm-specific productivity developments mainly through the extensive margin, rather than the intensive margin. In order to take into account variations in labour compensation due to changes in hours worked, we also estimate equation (1a) for hourly labour compensation. The elasticity with respect to TFP is slightly larger but of the same order of magnitude than that of labour compensation.

These results are consistent with previous analyses for Belgium. The survey evidence in Druant et al. (2008) indicates that when reducing costs following an adverse shock, 60% of Belgian firms declared that they cut employment, 14% of the companies said they adjust pay (and only do so through the variable components), and only a very small proportion of enterprises reduce working time.[20] The results of the wage bill decomposition in Fuss (2009) reveal that employment is the driving component of wage bill adjustment.

Note that the close-to-zero elasticity of average labour compensation combined with a positive elasticity of labour to firm-level TFP supports the hypothesis of real wage rigidity in Belgium.[21] However, our estimates do not provide a test or a measure of real wage rigidity because there is no theoretical reference value for the average labour compensation elasticity and labour elasticity under the flexible wage case. In the model of Blanchard and Galí (2008) without labour market frictions, the response of labour is null under perfect wage and price flexibility. But this results from the fact that income and substitution effects cancel each other out in their model.

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19 The long-run impact is computed as $\beta_1/(1-\rho_1-\rho_2)$, where β_1 is the TFP coefficient, ρ_1 and ρ_2 are the coefficients on dep.var$_{it-1}$ and dep.var$_{it-2}$., respectively.

20 For comparison, Bertola et al. (2008) report that on average over 15 European countries, around 30% of firms declare that they reduce employment, 11% of the firms reduce pay, and up to 7% cut working time.

21 In general, models with wage rigidity typically find greater variability of employment in response to productivity shocks, as compared to the flexible wage scenario (see, for example, Hall (2005) and Blanchard and Galí (2007, 2008)) so that labour productivity can match the real wage.

In addition, our finding of a positive current impact of TFP on labour may be due to the fact that TFP measures may capture demand shocks or variation in factor prices together with technological changes because nominal variables are deflated using sector-level price indices rather than firm-level output prices (Foster et al. (2008), Katayama et al. (2003), Klette and Griliches (1996)). Demand shocks will tend to induce a positive correlation with labour and a smaller correlation with wages (except to the extent that demand shocks raise profits and wages through rent-sharing mechanisms).

Nevertheless, the estimated elasticity of labour compensation to firm-specific TFP is small. One possible explanation for this is the driving role of sector-level collective agreements for firms' pay policies. As noted above, most companies follow the sector-level collective wage agreement. This leaves little room for adjustment of labour compensation at the firm level, except for those that operate through changes in the level of bonuses and premiums and variations in hours worked.

In addition to institutional factors that may be responsible for wage rigidity, the low response of firms' wages to firm-specific shocks may be explained by labour market competition and efficiency wage considerations, as well as product market competition. On the one hand, in a tight labour market, it may not be desirable for a company to reduce wages following a negative productivity shock because this makes other companies more attractive for its workers. Further, this may generate adverse selection problems. On the other hand, firms with limited market power may not be able to afford wage increases which cannot be offset by price rises.

Our results may be summarised as follows. First, labour has a positive elasticity to firm-specific TFP; while that of average labour compensation is close to zero. Although the elasticity of labour under perfect wage and price flexibility has no natural reference value, this finding is consistent with real wage rigidity in Belgium that shifts the burden of adjustment towards employment. Labour adjustment itself occurs mainly through the extensive margin. Our results are also consistent with the importance of sector-level collective agreements in the wage formation process, as will be discussed below. The following two sub-sections examine in more detail whether the finding translates into sector-level TFP and the role of collective wage agreements in shaping the response of average labour compensation.

Table 1 - SGMM estimates of equations (1a) and (1b)

	w_{it}	l_{it}	h_{it}	$wb\text{-}h_{it}$
dep. var_{it-1}	0.90***	1.46***	1.23***	0.45*
	(0.33)	(0.15)	(0.16)	(0.23)
dep. var_{it-2}	-0.06	-0.50***	-0.30**	0.38
	(0.27)	(0.14)	(0.14)	(0.19)
tfp_{it}	0.02	0.06*	0.08**	0.03***
	(0.01)	(0.03)	(0.04)	(0.01)
k_{it}		0.03***	0.03***	
		(0.01)	(0.01)	
w_{it}		0.00	0.03	
		(0.05)	(0.05)	
$\%BLUE_{it}$	-0.12**			-0.11***
	(0.06)			(0.04)
$\%TEMP_{it}$	-0.06***			-0.07***
	(0.02)			(0.02)
$\%WOMEN_{it}$	-0.06			-0.05*
	(0.04)			(0.03)
$L>100_{it}$	0.00			0.00
	(0.00)			(0.00)
Sargan	14.35	58.03	71.44	10.74
p-value	0.28	0.03	0.00	0.55
AR(1)	-2.12	-5.24	-4.25	-1.25
p-value	0.03	0.00	0.00	0.21
AR(2)	0.71	0.82	0.39	-1.26
p-value	0.48	0.41	0.69	0.21

Note: Firms with at least 50 employees and 6 consecutive annual accounts. 1,518 firms and 7735 observations. Two-step System GMM estimates are reported with standard errors in parentheses following the correction proposed by Windmeijer (2004). All equations include a constant, interactive sector and year dummies but their coefficients are not reported. Instruments in the difference equation for w_{it} and wh_{it} include lags 4 and 5 of the endogenous variable. Instruments in the level equation for w_{it} and wh_{it} include lag 3 of the endogenous variable. Instruments in the difference equation for l_{it} and h_{it} include lags 4 and 5 of the endogenous variable, and wage; lags 3 and 4 of predetermined capital stock. Instruments in the level equation for l_{it} and h_{it} include lag 3 of the endogenous variable, and w_{it}; lag 2 of predetermined capital stock. The remaining regressors are treated as exogenous. AR displays the test for serial correlation in the first-differenced residuals. Lower-case variables are in log. The remaining variables are defined in the text. * indicates significance at the 10% level, ** at the 5% level, *** at the 1% level.

3.2. Differences in the elasticity to firm-specific TFP and sector-level TFP

Here, we compare the response of labour compensation and labour to firm-specific TFP and to sector-level TFP. A new secret recipe or a patented innovation can serve as examples of idiosyncratic productivity shocks. The innovating firm will then have a productivity advantage over its competitors. The introduction of new software by Microsoft would be a common productivity shock, for instance. In principle, all firms have access to this technological improvement. Clearly, an individual firm might have different incentives and varying ability to change its wages and prices when it is the only one facing the shock than if the shock is common to all firms.

While the previous section highlights a close-to-zero response of average labour compensation to firm-specific TFP, the same may not hold with respect to sector-level TFP. One of the reasons not to adjust wages downwards is the fear that the best workers might leave for better-paying companies. In the survey by Druant et al. (2008), over 80% of Belgian firms with more than 50 employees reported that this is a relevant motive for not cutting wages. However, the argument does not hold when all firms undertake wage contractions at the same time, as opposed to a single company doing so unilaterally. Also, if competition on the product market is strong, i.e. if markups are small or if firms are price takers, they cannot undertake isolated wage increases because they cannot raise their prices without incurring losses unless their competitors follow suit. It has been argued that centralisation of wage bargaining may ease wage contraction (see Bruno and Sachs (1985)), thanks to coordination of decisions and internalisation of the externalities of individual actions. We examine this last issue below.

Estimates of equations (2a) and (2b), including firm-level as well as sector-level TFP are reported in Table 2. The estimates allow for additive year and sector dummies, instead of sector-specific year effects. To account for other fluctuations at the sector level, we also include value added per sector in the labour compensation equations and the log change in value added per sector in the labour equations.

The most striking result is that the elasticity of average labour compensation to sector-level TFP is very high (0.42) compared to that with respect to firm-specific TFP (0.01), which is not significant. This holds for both average and hourly labour compensation. For the sake of comparison, the estimates of the elasticity of wages aggregated over all workers to labour productivity for the US over the period 1984-2006 obtained by Haefke et al. (2007) range from 0.17 to 0.37. By contrast, the elasticity of employment to sector-level TFP (0.07) is of the same order of magnitude as that with respect to firm-specific TFP (0.06), but significantly different from zero only at the 15% level. The long-run impact of sector-level TFP on labour compensation (3.77) is more than twice as large as the impact on employment (1.66).[22] On the contrary, the long-run impact of firm-specific TFP on employment (1.48) is ten times larger than that on wages (0.13).

The picture that emerges from these results is one of sluggish average labour compensation and positive employment adjustment in response to idiosyncratic TFP, but more flexible average labour compensation to aggregate fluctuations and similar sensitivity of labour in response to idiosyncratic and aggregate fluctuations.[23] One interpretation of these results is that firms in Belgium are bound by sector-level collective wage agreements and tend not to deviate too much from them. Another interpretation is that common wage actions make it possible to alleviate the efficiency wage and adverse selection issues involved when undertaking isolated wage actions. In turn, coordination of wage decisions may be eased by the existence of sector-level collective wage bargaining structures. This hypothesis is examined in the next section.

[22] See footnote 20.

[23] Robustness tests reported in the Appendix show that these qualitative conclusions remain robust to alternative specifications of the labour compensation and labour equations, TFP definitions and endogeneity assumptions.

Table 2 - SGMM estimates of equations (2a) and (2b)

	w_{it}	l_{it}	h_{it}	$Wb\text{-}h_{it}$
dep. var_{it-1}	1.12***	1.47***	1.15***	1.23***
	(0.20)	(0.16)	(0.17)	(0.20)
dep. var_{it-2}	-0.24	-0.51***	-0.21	-0.29*
	(0.16)	(0.15)	(0.16)	(0.17)
tfp_{it}	0.01	0.06*	0.07*	0.01
	(0.01)	(0.03)	(0.04)	(0.01)
tfp_{st}	0.42***	0.07	0.03	0.42***
	(0.03)	(0.05)	(0.05)	(0.04)
y_{st}	-0.12***			-0.13***
	(0.05)			(0.05)
Δy_{st}		0.02	0.04	
		(0.04)	(0.04)	
k_{it}		0.03***	0.03***	
		(0.01)	(0.01)	
w_{it}		0.00	0.05	
		(0.05)	(0.05)	
$\%BLUE_{it}$	-0.08			-0.04
	(0.05)			(0.04)
$\%TEMP_{it}$	-0.06***			-0.05
	(0.02)			(0.02)
$\%WOMEN_{it}$	-0.04			-0.01
	(0.04)			(0.03)
$L>100_{it}$	0.00			0.00
	(0.00)			(0.00)
Sargan	17.74	50.76	77.51	21.25
p-value	0.12	0.10	0.00	0.05
AR(1)	-4.16	-5.12	-3.49	-3.57
p-value	0.00	0.00	0.00	0.00
AR(2)	1.87	0.79	-0.08	1.77
p-value	0.06	0.43	0.94	0.08

Note: Firms with at least 50 employees and 6 consecutive annual accounts. 1,518 firms and 7735 observations. Two-step System GMM estimates are reported with standard errors in parentheses following the correction proposed by Windmeijer (2004). All equations include a constant, interactive sector and year dummies but their coefficients are not reported. Instruments in the difference equation for w_{it} and wh_{it} include lags 4 and 5 of the endogenous variable. Instruments in the level equation for w_{it} and wh_{it} include lag 3 of the endogenous variable. Instruments in the difference equation for l_{it} and h_{it} include lags 4 and 5 of the endogenous variable, and w_{it}, and lags 3 and 4 of predetermined capital stock. Instruments in the level equation for l_{it} and h_{it} include lag 3 of the endogenous variable, and wages; lag 2 of predetermined capital stock. The remaining regressors are treated as exogenous. AR displays the test for serial correlation in the first-differenced residuals. Lower-case variables are in log. The remaining variables are defined in the text. * indicates significance at the 10% level, ** at the 5% level, *** at the 1% level.

3.3. The role of sector-level collective wage bargaining

Collective bargaining plays a dominant role in the wage-setting process in Belgium. First, an indicative norm for maximum nominal hourly labour cost increases is set at the national level. Next, given expected indexation, sector-level agreements fix real increases of the base wages or minimum pay scale. In order to illustrate the role of sector-level collective bargaining in shaping the response of average labour compensation to TFP, Table 3 below reports three sets of estimates for average labour compensation. Column (1) is directly taken from Table 2. Column (2) includes the impact of sector-level collective wage agreements on firms' average labour compensation but omits sector-level TFP (we do not include the two together for colinearity reasons explained below).

The impact of sector-level collectively agreed wage increases at the firm level is positive and significant. The point estimates imply that a one percent increase in the collectively agreed wage induces firms to raise average labour compensation on average by 0.67 percent for both blue-collar and white-collar workers.

We then perform simple OLS regressions of changes in the log of the indices of sector-level collectively agreed wage increases (deflated by value-added prices) on changes in sector-level TFP per sector, including separate time and sector effects. These confirm that there is a highly significant and positive relationship between TFP and collective wage increases at the sector level. The coefficient of TFP is equal to 0.41 for white-collar workers and 0.43 for blue-collar workers. This confirms the conjecture that productivity developments are taken into account in sector-level collective wage agreements in Belgium. Importantly, this also suggests that the impact of TFP on average labour compensation is not zero but labour compensation in Belgium is mainly adjusted through collectively agreed wage increases, which take into account sector-level common productivity evolutions rather than idiosyncratic or firm-specific TFP changes.

All in all, our results suggest that firms have little room for adjusting their average labour compensation to firm-specific developments but respond to sector-level TFP via sector-level collective bargaining. First, firms may not deviate too far from sector-level collective agreements for workers already employed by the firm, i.e. job stayers. Bonuses and premiums generally do not account for a substantial proportion of earnings in Belgium.[24] Second, one might argue that firms could adjust their average wage bill by applying a different pay scheme to new entrants and workers under fixed-term contracts. However, the percentage of workers under fixed-term contracts in Belgium is below the average for Europe (see Section 2.1). In addition, minimum pay scales set at the activity, occupation and tenure level, within sector-level collective agreements, provide a lower bound for new entrants' wages. The survey results in Druant et al. (2008) reveal that firms set newly recruited employees' wages mostly according to collective wage agreements or their own internal pay scale. In addition, in a competitive environment (in the product and labour markets), idiosyncratic wage changes may not be optimal. For instance, when firms compete for workers on the labour market, firm-specific wage cuts may be harmful due to efficiency wage, adverse selection and shirking considerations. On the contrary, coordinated wage decisions may alleviate the problem incurred with isolated wage actions. This highlights the role of centralisation and coordination of wage bargaining in facilitating wage adjustment.

24 Data from the Belgian Structure of Earnings Survey (SES) indicates that bonuses form on average 8.4 percent of earnings. The proportion varies from 2.4 percent in hotels and restaurants to 13.3 percent in financial services.

Table 3 - SGMM estimates of equations (2a) and (3) for average labour compensation

	(1)	(2)
dep.var$_{it-1}$	1.12***	0.66***
	(0.20)	(0.22)
dep.var$_{it-2}$	-0.24	0.13
	(0.16)	(0.17)
tfp$_{it}$	0.01	0.02**
	(0.01)	(0.01)
tfp$_{st}$	0.42***	
	(0.03)	
%WHITE$_{it}$.i^{W}_{st}		0.67***
		(0.11)
%BLUE$_{it}$.i^{B}_{st}		0.67***
		(0.05)
y_{st}	-0.12***	0.10*
	(0.05)	(0.05)
%BLUE$_{it}$	-0.08	-0.16***
	(0.05)	(0.05)
%TEMP$_{it}$	-0.06***	-0.07***
	(0.02)	(0.02)
%WOMEN$_{it}$	-0.04	-0.08**
	(0.04)	(0.04)
L>100$_{it}$	0.00	0.00
	(0.00)	(0.00)
Sargan	17.74	17.93
p-value	0.12	0.12
AR(1)	-4.16	-2.15
p-value	0.00	0.03
AR(2)	1.87	-0.30
p-value	0.06	0.77

Note: Firms with at least 50 employees and 6 consecutive annual accounts. 1,518 firms and 7735 observations. Two-step System GMM estimates are reported with standard errors in parentheses following the correction proposed by Windmeijer (2004). Instruments in the difference equation for w_{it} include lags 4 and 5 lags of the endogenous variable. Instruments in the level equation for w_{it} include lag 2 of the endogenous variable. The remaining regressors are treated as exogenous. All equations include a constant, additive sector and year dummies but their coefficients are not reported. AR displays the test for serial correlation in the first-differenced residuals. Lower-case variables are in log. The remaining variables are defined in the text. * indicates significance at the 10% level, ** at the 5% level, *** at the 1% level.

5. Conclusion

In this paper, we have estimated the sensitivity of average labour compensation, employment, hours, and hourly labour compensation to Total Factor Productivity. The sign and size of these elasticities may be affected by the presence of wage rigidity as well as employment adjustment costs. On the one hand, real wage rigidity reduces the sensitivity of wages to shocks and shifts the burden of adjustment towards labour (Boldrin and Horvath (1995), Hall (2005)). On the other hand, hiring and firing costs may restrict adjustment through employment.

One contribution of our paper is that we have distinguished between firm-specific and sector-level TFP. We compared the response of average labour compensation and labour to firm-level TFP with the response to sector-level TFP. When firms compete for workers on the labour market, they may refrain from isolated wage adjustments and implicitly coordinate their pay policies. And low market power on the product market makes wage increases less affordable if they cannot be absorbed by price variations. On the other hand, common wage actions make it possible to alleviate these constraints. Given the prominent role of sector-level wage bargaining, collective wage agreements offer an opportunity to coordinate decisions and ease wage adjustment. These arguments tend to translate into a higher elasticity of average labour compensation with respect to sector-level TFP than with respect to firm-specific TFP.

We rely on a dataset obtained from firms' annual accounts and social balance sheets in Belgium over the period 1997-2005. Belgium is usually singled out as a country with substantial real wage rigidity, due in part to its system of full automatic indexation of base wages. In addition, wage developments are largely driven by sector-level collective wage agreements. This makes Belgium a relevant case to study the role of real wage rigidity on alternative adjustment margins, and the role of centralised collective agreements in wage dynamics.

Our models are dynamic regression equations for each of the components of the wage bill, and include TFP as an explanatory variable.

Our results can be summarised as follows. First, focusing on the response to firm-level TFP, our estimates of the elasticity of average labour compensation to TFP is close to zero, and the elasticity of labour is positive. Both are of a small order of magnitude. However, the long-run elasticity of labour is substantially larger than that of labour compensation. Although our analysis does not provide a test or evaluation of the extent of real wage rigidity, our finding of a low sensitivity of average labour compensation and positive elasticity of labour in response to firm-specific TFP is consistent with the hypothesis of real wage rigidity in response to idiosyncratic productivity developments.

Second, in contrast to the response to idiosyncratic TFP, the elasticity of average labour compensation to aggregate sector-level TFP is high. This is consistent with the labour market competition and product market competition issues discussed above.

Third, our results support the view that the high importance of centralised wage bargaining at the sector level in Belgium may ease coordination of wage adjustment to aggregate changes. Indeed, the response of average labour compensation to sector-level TFP is large. Additional estimates suggest that real wage increases agreed within sector-level collective agreements do respond to sector-level TFP developments and have a significant impact on firm labour compensation.

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Appendix

Table A1 - Descriptive statistics

Variable	obs.	mean	st dev.	P5	median	P95
W_{it}	10771	27904	8424	17542	26008	44539
L_{it}	10771	265.7	811.2	55.5	109.3	709.2
H/L_{it}	10771	1554	150	1301	1562	1777
WB/H_{it}	10771	17.91	4.86	11.86	16.84	27.4
Δtfp_{it}	10771	0.000	0.090	-0.14	0.00	0.12
$I_{it}/K_{it}^{(b)}$	10749	0.820	3.410	0.05	0.49	2.09
$\%BLUE_{it}$	10771	0.570	0.310	0.00	0.69	0.91
$\%TEMP_{it}$	10771	0.040	0.090	0.00	0.01	0.14
$\%WOMEN_{it}$	10771	0.260	0.220	0.02	0.19	0.70
$\%L>100_{it}$	10771	0.560	0.500	0.00	1.00	1.00
Δw_{it}	10771	0.020	0.080	-0.10	0.01	0.14
Δl_{it}	10771	0.010	0.110	-0.13	0.01	0.18
$\Delta(h-l)_{it}$	10771	-0.010	0.060	-0.09	0.00	0.07
$\Delta(wb-h)_{it}$	10771	0.020	0.080	-0.09	0.02	0.15
Δva_{st}	104	0.015	0.052	-0.07	0.02	0.09

Notes: Descriptive statistics for firms with more than 50 employees and 6 consecutive annual accounts over the years 1999-2005. P5 and P95 refer to the 5th and 95th percentile. Lower-case variables are in log. Δ stands for the difference operator.

W_{it}: Real wage bill per average number of employees in euro
L_{it} : Average number of employees over the year
H/L_{it} : Total hours worker over the average number of employees
WB/H_{it} : Real wage bill over the total number of hours worked
Δtfp_{it} : Difference log of firm-level TFP

I_{it}/K_{it} : Investment-capital ratio.

$\%BLUE_{it}$: Percentage of blue collar workers

$\%TEMP_{it}$: Percentage of employees under fixed-term contract

$\%WOMEN_{it}$: Percentage of women

$\%L>100_{it}$: Dummy equals to one when the firm employs 100 workers or more

Δva_{st}: Difference log of real value added at sector-level

Table A2 - Estimated production function coefficients and income shares

Sectors in the dataset	NACE	Prod. function coefficients capital	Prod. function coefficients labour	Income shares capital	Income shares labour
food	DA	0.24	0.56	0.20	0.59
textiles	DB	0.12	0.50	0.25	0.69
wood	DD	0.15	0.91	0.24	0.62
paper	DE	0.11	0.52	0.17	0.63
rubber	DH	0.17	0.85	0.20	0.65
metals	DJ	0.28	0.44	0.17	0.74
machinery & equipment	DK	0.19	0.46	0.14	0.70
electrical equipment	DL	0.14	0.48	0.17	0.74
other manufacturing	DN	0.36	0.34	0.23	0.67
construction	FF	0.17	0.81	0.10	0.58
trade	GG	0.13	0.87	0.13	0.56
hotels and restaurants	HH	0.09	0.25	0.19	0.56
financial services	JJ	0.11	0.30	0.16	0.60
real estate	KK	0.26	0.66	0.22	0.29
mean		0.18	0.57	0.18	0.61

Robustness tests

In this Appendix, we evaluate the robustness of our results with respect to alternative specifications, definitions of TFP and exogeneity assumptions. For the sake of brevity, we only report the estimates of the coefficient on firm-specific and sector-level TFP of equations (2a) and (2b). In Table 4, we first report the results from Table 2.

Firstly, we investigate whether changes in the specification of the labour compensation equation and labour equations alter the estimates of the TFP coefficients. In the labour equation, we replace the size dummy $L>100_{it}$, by a continuous size variable, measured as the number of employees. The variable is instrumented by its own lags. In the labour equations, we introduce additional lags of average labour compensation. More specifically, following Nickell and Wadhwani (1991), we introduce the log change in average labour compensation and one lag of labour compensation.[25] So, the second set of results reported in Table 4 refers to the estimates of the following equations for labour compensation and labour, respectively:

$$\text{dep.var}_{it} = \rho_1\,\text{dep.var}_{it-1} + \rho_2\,\text{dep.var}_{it-2} + \beta_1\,\text{tfp}_{it} + \beta_2\,\text{tfp}_{st} + \beta_3\,\text{va}_{st} + \beta_4\,\%\text{BLUE}_{it} + \beta_5\,\%\text{TEMP}_{it} + \beta_6\,\%\text{WOMEN}_{it} + \beta_7\,\text{size}_{it} + \delta_i + \delta_s + \delta_t + \varepsilon_{it} \quad (a.1)$$

$$\text{dep.var}_{it} = \rho_1\,\text{dep.var}_{it-1} + \rho_2\,\text{dep.var}_{it-2} + \beta_1\,\text{tfp}_{it} + \beta_2\,\text{tfp}_{st} + \beta_3\,\text{k}_{it} + \beta_4\,\Delta\text{w}_{it} + \beta_5\,\text{w}_{it-1} \;\; \beta_6\,\Delta\text{w}_{it} + \beta_7\,\text{w}_{it-1} + \beta_8\,\Delta\text{va}_{st} + \delta_i + \delta_s + \delta_t + \varepsilon_{it} \quad (a.2)$$

25 This specification aims to capture efficiency wage effects.

Estimates of TFP coefficients remain essentially unchanged.[26]

Secondly, we consider TFP shocks instead of the level of TFP. The motivation for this is that the estimated coefficient on the level of TFP may be a mix of the dynamic response to current and lagged TFP shocks. We construct the shocks as the residuals from an AR(2) model on TFP with sector-specific intercept and slopes. Replacing TFP level by AR(2) shocks strongly modifies the elasticity of labour with respect to idiosyncratic TFP, which increases sharply following a positive firm-specific TFP shock within the year. By contrast, the response to sector-level TFP shocks remains small and is insignificant.

Thirdly, we evaluate the robustness of our results when considering firm-specific TFP as endogenous. This does not change the main conclusions of our paper, but tends to reduce the significance level of firm-specific TFP, due to the difficulty of finding appropriate instruments.

All in all, our main qualitative conclusions remain robust to these alternative specifications and assumptions. The elasticity of labour compensation to firm-specific TFP is close to zero, while that of labour is positive, consistent with real wage rigidity. By contrast, the elasticity or labour compensation to sector-level TFP is very high, while that of labour is low and not significantly different from zero.

Table 4 - SGMM estimates - robustness tests

	w_{it}	l_{it}	h_{it}	$wb\text{-}h_{it}$
(1) Results of equations (2a) and (2b) as in Table 2				
tfp_{it}	0.01	0.06*	0.07*	0.01
	(0.01)	(0.03)	(0.04)	(0.01)
tfp_{st}	0.42***	0.07	0.03	0.42***
	(0.03)	(0.05)	(0.05)	(0.04)
(2) alternative specifications (a.1) and (a.2)				
tfp_{it}	0.01	0.04	0.05	-0.02
	(0.02)	(0.03)	(0.03)	(0.02)
tfp_{st}	0.43***	0.07	-0.09	0.42***
	(0.03)	(0.06)	(0.08)	(0.03)
(3) AR(2) shock on TFP				
tfp_{it}	0.01	0.25***	0.24***	0.02
	(0.02)	(0.04)	(0.03)	0.02)
tfp_{st}	0.41***	0.05	0.00	0.41**
	(0.03)	(0.04)	(0.04)	(0.03)
(4) TFP_{it} assumed endogenous				
tfp_{it}	0.05	0.03	0.03	0.03
	(0.03)	(0.05)	(0.05)	(0.03)
tfp_{st}	0.43***	0.05	0.00	0.42***
	(0.03)	(0.04)	(0.05)	(0.03)

Notes: The table presents only results for current and lagged TFP. In addition, each equation includes in addition the same control variables as Table 2. For details on GMM estimation, see note under Table 2. Standard errors in parentheses. * indicates significance at the 10% level, ** at the 5% level, *** at the 1% level.

[26] Note that, in labour compensation equations, neither the size dummy in Table 2, nor the size variable are significant at 10% level. In the labour equation, neither average labour compensation, nor the log change in average labour compensation are significant.