PRODUCTIVITY, WAGES AND PROFITS AMONG BELGIAN FIRMS: DO FIXED-TERM CONTRACTS MATTER?

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Abstract

This paper is one of the very first to estimate the impact of fixed-term contracts (FTCs) on labour productivity, wages (i.e. labour cost) and productivity wage gaps (i.e. profits). The analysis relies on detailed Belgian linked employer-employee panel data covering the period 1999-2010. Controlling for a large set of covariates, state dependence, firm time-invariant heterogeneity and endogeneity using both the dynamic system GMM and Levinsohn & Petrin (2003) estimators, findings show that the share of FTCs within firms has no significant impact on productivity, wages and profits. Yet, interaction effects between FTCs and gender suggest that the share of female FTCs fosters profits (i.e. it increases proportionally more productivity than labour cost), while the fraction of male FTCs is found to decrease productivity to a small extent. The effect of male FTCs on wages and profits also turns out to be negative but it is not statistically significant. As regards the interaction between FTCs and part-time employment, results show that the lower productivity of permanent part-timers (w.r.t. part-timers on a FTC) is compensated by lower wages, so that profits remain unchanged. As regards full-timers, being on a FTC or on a permanent contract is not found to affect productivity, wages or profits.

Keywords: Fixed-term contracts; productivity; wages; profits, linked panel data.
JEL codes: D24, J24, J31, M12

1. Introduction

In order to facilitate employment adjustment by firms and to reduce the unemployment rate (Bentolila and Bertola, 1990; Mahy, 2005), legislation regarding temporary employment has been relaxed in Belgium (as in most European countries) over the last 20 years. Accordingly, the share of temporary jobs as a percentage of total employment in Belgium has increased from 5.3 to 8.9 percent between 1990 and 2011 (Eurostat, 2012). The growth of temporary employment can also be understood from an industrial organisation perspective (Dhyne and Mahy, 2012). While mass production tends to favour the planning of production and therefore the smoothing of changes in the labour force (Holt *et al.*, 1960), the spread of elements of the Japanese 'lean production' model (e.g. just-in-time production) in advanced economies since the 1990s increased the need for flexible labour management. Enterprises nowadays have more flexibility to adjust the size of their labour force to changes in the business-cycle. Temporary contracts may notably be used as a buffer to product demand fluctuations (Jahn *et al.*, 2012). In turn, this may lead to a division of the labour force into a core component, which is relatively well protected from demand fluctuations, and a peripheral component, which is at risk to demand fluctuations (Boeri, 2011; Piore, 1978).

In light of this evolution, an accurate understanding of the different repercussions of temporary employment contracts has emerged as an increasingly salient problem in labour and industrial economics. In this context, our research aims to investigate how the use of fixed-term contracts (FTCs)[1] affects labour productivity, wages (i.e. labour cost) and productivity-wage gaps (i.e. profits) at the firm level in the Belgian private sector.

A growing literature examines the impact of labour contracts on wages. Empirical results typically document a significant gap between employees under fixed-term (FTC) and indefinite-term (ITC) contracts. By and large, this gap has been attributed to substantial heterogeneity between jobs and/or between individuals (Bosio, 2009; Brown and Sessions, 2003; Comi and Grasseni, 2012; De la Rica, 2004). Yet, for some countries a significant fraction of this gap remains unexplained after controlling for observable heterogeneity. This may point to discrimination against FTC workers or other forms of labour market inequality. Unfortunately, only very few studies have been able to link this debate to the issue of productivity differences between temporary and permanent workers. In fact, the relationship between FTCs and productivity has not been clearly established: both extant theory and empirical results are inconclusive (Cappelari *et al.*, 2012; Damiani and Pompei, 2010; Dolado and Stucchi, 2008; Nielen and Schiersch, 2012; Roux and Leclair, 2007). Moreover, no studies we

[1] The share of FTCs in temporary employment has increased from 44 to 49% between 1999 and 2011. In 2011, FTCs accounted for 4.4% of total employment.

are aware of use accurate information on both wages and productivity in order to investigate whether FTCs generate profits (see appendix 1). Finally, little is known on whether the FTC-productivity-wages-profits nexus varies across workers' characteristics and working environments. However, from a profit maximizing point of view, the optimal use of FTCs is likely to depend on the nature of the production unit.

This paper contributes to the literature on labour contracts by estimating the effect of FTCs on productivity, wages and productivity-wage gaps in the Belgian private sector. More precisely, we are among the first to examine how changes in the proportions of FTC workers affect the productivity of firms and test for the presence of productivity-wage gaps. To do so, we use detailed longitudinal matched employer-employee data over the period 1999-2010. Our data offer several advantages. First, the panel provides accurate information on average productivity and wages within firms (i.e. on the average added value per hour and the mean hourly wage) and allows to control for a range of worker and firm characteristics (such as education, age, occupation, sex, working time, firm size, industry and level of collective wage bargaining). Second, we are able to address important methodological issues such as state dependency of firm productivity and wages, firm-level invariant heterogeneity and endogeneity of labour contracts by using both the generalized method of moments (GMM) and the Levinsohn and Petrin (2003) estimators. Hence, our dataset allows to tackle various potential biases that are not always accounted for in the empirical literature on labour contracts. To our knowledge, our study is the first that empirically analyses the impact of FTCs on the productivity wage gap across workers' characteristics and working environments by addressing the three above-mentioned methodological issues.

The remainder of this paper is organized 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 FTCs on productivity, wages and productivity-wage gaps is analysed in Section 5. The last section concludes.

2. Theoretical and empirical background

Human capital and working conditions

A first set of explanations emphasizing a relationship between FTCs, wages and productivity refers to compensating wage differentials theories, i.e. to human capital and to the hedonic theory of wages.

Human capital theory (Becker, 1964) posits that employers might be more reluctant to invest in training for FTC workers due to the shorter period of time to benefit from on-the-job training

(Bassanini *et al.*, 2007). Various studies confirm this prediction and suggest the existence of a trade-off between FTCs and investments in human capital (Arulampalam and Booth, 1998; Booth *et al.*, 2002; Fouarge *et al.*, 2012). Other papers show that FTC workers are generally less qualified and over-represented among young people, which explains their lower labour market experience and tenure (see Eurostat, 2012). All these factors should, according to human capital theory, lead to lower wages and lower productivity among FTC workers. However, differences in human capital between FTC and ITC workers should not affect firms' profitability. Indeed, in line with the perfect competition model, human capital theory assumes that all workers are paid at their marginal productivity. Empirical results, notably for Spain (De la Rica, 2004), show that diversity in observed skills explains more than 50% of wages differentials between FTC and ITC workers. As regards the impact of FTC jobs on productivity, results are rare and inconclusive. Using a panel of Italian private sector firms, Cappellari *et al.* (2012) find that the deregulation of FTCs in the early 2000's led to productivity losses. In contrast, Nielen and Schiersch (2012) show, on the basis of a large dataset of German manufacturing firms, that FTCs have no significant effect on labour productivity. Results obtained by Roux and Leclair (2007) with French firm-level panel data suggest that the relationship between temporary employment and productivity varies across industries. Indeed, while temporary employment is found to enhance productivity in services, the impact turns out to be insignificant in the manufacturing industry. On the opposite, using sector-level data covering 16 European countries, Damiani and Pompei (2010) show that FTCs in labour-intensive sectors, such as services, discourage human capital investments and deteriorate multifactor productivity. Interestingly, the authors also highlight the importance of the collective relations' climate to sustain long-run relationships and to mitigate potential drawbacks in terms of low productivity gains.

The heterogeneity in working conditions is also likely to influence the relationship between labour contracts, wages and productivity. Indeed, the hedonic theory of wages (Rosen, 1974) highlights that perfect competition mechanisms provide reimbursement for workers occupying strenuous jobs (e.g. dangerous jobs, jobs with a heavy workload, an unpleasant environment or a low social status). The intuition is that employers have to compensate a greater harshness by a higher wage so that workers utility remains unchanged and that the hardest jobs get filled. Workers with identical productivity could thus earn different wages due to heterogeneous working conditions.[2] Given that FTCs are generally associated with inferior working conditions and greater insecurity (Damiani and Pompei, 2010), the hedonic theory of wages suggests that FTC workers, at given productivity, should be paid more than their permanent counterparts. Put differently, if diversity in

[2] From a firm's point of view, this could also be explained by the fact that harder jobs are associated to lower non-wage costs, e.g. smaller investments to reduce accident risks.

working conditions is not (or imperfectly) controlled for, empirical results should indicate that FTC workers are paid above their marginal productivity and that firm profit increase with the share of permanent workers.

Social norms

The literature on social norms and remuneration has also some relatively straightforward implications for the over- or under-payment of FTC workers with respect to productivity. Skott (2005) treats wage norms as endogenous, with past events shaping what is considered to be 'fair' wages. This creates a hysteresis of the wage structure, slow adjustment to productivity shocks and therefore potential deviations from productivity-based pay. Similarly, Doeringer and Piore (1985) view the related concepts of 'customs' and 'habits' as important factors in the determination of employment rules in their model of internal labour markets. They argue that beside efficiency considerations (employers' interests) and demands for stability and job security (employees' interests), strong customs render changes in pay rules difficult. Given that technological change over the past decades appears to be skill/task-biased and that FTC workers are generally less skilled and doing more routine tasks (Autor *et al*., 1998; Acemoglu 2002; Goos *et al.*, 2009), the hysteresis of social norms could lead to the overpayment of FTC jobs whose productivity might have been negatively affected by technological change, and to the underpayment of ITC jobs whose productivity might have increased.

Asymmetric information

Information asymmetry regarding the quality of labour provides another potential explanation. According to Dhyne and Mahy (2012), workers hired on an FTC could be more productive than their permanent counterparts if they wish to send a good signal to their employer and increase their likelihood to obtain a permanent contract. Engellandt and Riphahn (2005) support this prediction using Swiss data. They find that being on an FTC increases the probability of doing unpaid overtime by about 60%. Moreover, Dolado and Stucchi (2008) show that Spanish temporary workers provide more effort in firms in which the transition rate from a temporary to a permanent contract is higher. These results suggest that the gap between productivity and wages (i.e. profit) should be higher in firms employing more FTC workers. A complementary 'screening' argument is that firms offering ITCs only to the most productive FTCs will increase their productivity in the long run (Nielen and Schiersch, 2012).

For employers willing to manage asymmetric information through incentive practices, tournament theory (Lazear and Rosen, 1981) suggests the implementation of a performance-related pay system, where the prize (a promotion or a bonus) is attributed to the most productive worker. This system aims to trigger competition and to encourage workers to provide sustained effort. It generates a convex relationship between a worker's pay and his position in the firm's hierarchy, to the extent that workers at the top of the hierarchy might receive wages beyond their marginal products. According to tournament theory, "the president of a corporation is viewed as the winner of a contest in which he receives the higher prize. His wage is settled on not necessarily because it reflects his current productivity as president, but rather because it induces that individual and all other individuals to perform appropriately when they are in more junior positions" (Lazear and Rosen, 1981: 847). Given that temporary workers are generally found at the bottom of corporate hierarchies, tournament theory suggests that firm-level profit should increase with the share of FTC workers.

Another strand of the literature uses more sophisticated assumptions about the individual utility function of the worker. Hamermesh (1975), for instance, developed a theory in which utility depends not only on one's own, but also on other people's wages. As a consequence, high wage inequality could lead to lower utility and lower effort. Workers may perceive wage inequality as 'unfair' and decrease their effort accordingly (Akerlof and Yellen, 1988). Hence, there is an efficiency argument in paying high-productivity jobs in a firm below and low-productivity jobs above their marginal products so as to compress the overall wage structure (Mahy *et al.*, 2011). If one assumes that ITC workers are more (less) productive than their temporary counterparts, this theory thus suggests that firm-level profit should decrease (increase) with the share of FTC jobs.

Collective bargaining

A productivity-wage gap may also come from collective bargaining. In most advanced economies, temporary workers are less likely to be affiliated to a trade union than their permanent counterparts (Salvatori, 2009). Trade unions may thus be more willing to defend the advantages of the latter, notably with respect to wages. Moreover, temporary workers may also suffer from a wage penalty if firms accept wage increases for permanent workers by imposing wage restraint for other categories of employees (Heery, 2004). Empirical results in Brown and Sessions (2003) suggest the existence of wage discrimination against FTC workers in the UK. They also highlight that union coverage only improves wages of permanent workers. Using Spanish data, Jimeno and Toharia (1993) also find that FTC employees perceive lower wages than their permanent counterparts, after controlling for observable individual and job characteristics. Their estimates suggest in addition that wages grow

faster in industries in which the proportion of FTC workers is bigger. The authors' explanation, in line with dual and insider-outsider labour market theories (Piore, 1978; Lindbeck and Snower, 1986), is that ITC workers' employment protection and bargaining power increase with the share of FTC workers as that the latter are the first to be laid off during economic downturns. Put differently, assuming that trade unions defend more the interests of permanent workers, wage claims/increases (profit) will be bigger (smaller) in sectors employing more FTC workers.

Collective bargaining may also contribute to protect workers against the monopsonistic power of firms (Manning, 2003). As FTC workers are over-represented among more 'fragile' groups of employees (i.e. young and less qualified workers, women, immigrants) their bargaining power is often more limited. Put differently, as their labour supply curve is on average more inelastic (notably due to smaller geographical and occupational mobility), they are more likely to accept harder jobs and to be paid below their marginal productivity. Bertrand-Cloodt *et al.* (2012) analysed the situation of temporary workers on the Dutch labour market. Their results show that recent graduates with a temporary contract face large wage penalties, benefit less from training and have a worse job match that their permanent counterparts, even after controlling for ability differences.

Demand fluctuations and adjustment costs

One of the main advantages of FTCs is that they allow the adjustment of workforce size to business-cycle fluctuations while avoiding termination costs (Nielen and Schiersch, 2012). Nunziata and Staffoli (2007) for instance present a model in which the probability of using FTCs depends positively on the volatility in product demand and on the level of firing costs. This prediction, supported by empirical evidence (e.g. Houseman, 2001), suggests that FTCs offer more flexibility which in turn should lead to higher productivity. However, as noted by Nielen and Schiersch (2012), the gains may be limited because dismissing FTC workers without paying redundancy costs is only possible at the end of the contract.

Labour adjustment costs (i.e. hiring and separation costs) can also influence productivity-wage gaps. In the dynamic labour demand model, adjustment costs are considered as 'quasi-fixed' and amortized over a worker's average length of service within a firm (Oi, 1962). Workers are no longer paid at their marginal productivity. Indeed, the total present value of wages is now equal to the difference between the total present value of marginal productivities and adjustment costs. Given that adjustment costs (notably firing costs) are generally lower for FTC workers (Dhyne and Mahy, 2012), this model predicts that the gap between productivity and wages will be bigger for ITC workers.

3. Methodology

Empirical results presented in section 5 are based on the separate estimation of a value added function and a wage (i.e. labour cost) equation at the firm level. It provides parameter estimates for the impact of temporary contracts on average productivity and wages, respectively. Given that both equations are estimated on the same samples with identical control variables, the parameters for marginal products and wages can be compared and conclusions can be drawn on how the benefits or losses due to temporary contracts are shared between workers and firms. This technique was pioneered by Hellerstein and Neumark (1995) and refined by Hellerstein *et al.* (1999), Hellerstein and Neumark (2004), Aubert and Crépon (2009) and van Ours and Stoeldraijer (2011). It is now standard in the literature on the productivity and wage effects of labour heterogeneity (see e.g. Cataldi *et al*. 2012; Göbel and Zwick 2012; Vandenberghe 2012).

The estimated firm-level productivity and wage (i.e. labour cost) equations are the following:

$$\log(HourlyAdd\,Val)_{i,t} = \alpha + \beta \log(Hourly\,Add\,Val)_{i,t-1} + \gamma\ FTC_{i,t} + \delta OTC_{i,t} + \lambda X_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$\log(HourlyWage)_{i,t} = \alpha^* + \beta^* \log(HourlyWage)_{i,t-1} + \gamma^*\ FTC_{i,t} + \delta^* OTC_{i,t} + \lambda^* X_{i,t} + \varepsilon^*_{i,t} \quad (2)$$

The dependent variable in equation (1) is firm *i*'s hourly added value, obtained by dividing the total added value (at factor costs) of the firm *i* in period *t* by the total number of work hours (taking into account paid overtime hours) that have been declared for the same period. The dependent variable in equation (2) is firm *i*'s average hourly wage (labour cost), obtained by dividing the difference between total added value (at factor costs) and gross operating surplus of the firm *i* in period *t* by the total number of work hours. Hence, the dependent variables in the estimated equations are firm averages of added value and wage on an hourly basis.

The main variable of interest ($FTC_{i,t}$) is the proportion of hours paid to workers on a FTC over the total amount of hours paid within the firm. $OTC_{i,t}$ is the share of hours paid to workers with other types of temporary employment contracts (e.g. agency workers). Control variables, contained in the vector $X_{i,t}$, include observable characteristics of the firm (the number of workers, capital stock[3], and industry affiliation) and its labour force (the mean of workers' age and years of education, and the share of total hours worked respectively by: employees having at least 10 years of tenure, women, part-timers and blue-collar workers). The vector $X_{i,t}$ also contains year dummies.

[3] It is estimated through the "perpetual inventory method" (or PIM, see OECD (2009) for more details). The PIM rests on the simple idea that the capital stock results from investment flows (available in our data) after correction for retirement and efficiency loss. Following standard practice, we assume a 5 percent annual rate of depreciation of capital.

Estimating equations (1) and (2) allows gauging the effect of the share of hours worked by FTCs on firm productivity and wages, but it does not allow testing directly whether the difference between the value added and the wage coefficients associated to our main variable of interest is statistically significant. A simple method to obtain a test for the significance of productivity-wage gaps has been proposed by van Ours and Stoeldraijer (2011). We apply a similar approach and estimate a model in which the profit, the gap between firm *i*'s hourly value added and hourly wage (i.e. the hourly gross operating surplus) is regressed on the same set of explanatory variables as in equations (1) and (2). This produces a coefficient for the share of FTCs and directly measures the size and significance of the productivity-wage gap. We estimate thus equation (3):

$$\log(Hourlygap)_{i,t} = \alpha ** + \beta ** \log(Hourlygap)_{i,t-1} + \gamma ** FTC_{i,t} + \delta ** OTC_{i,t} + \lambda ** X_{i,t} + \varepsilon **_{i,t} \quad (3)$$

Equations (1) and (2), as well as the productivity-wage gap (3), can be estimated with different methods: pooled ordinary least squares (OLS), a fixed-effect (FE) model, the generalized method of moments (GMM) estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998), or a more structural approach suggested by Levinsohn and Petrin (2003, hereafter LP). This being said, pooled OLS estimators of productivity models have been criticized for their potential "heterogeneity bias" (Aubert and Crépon 2003: 116). This bias is due to the fact that firm productivity depends to a large extent on firm-specific, time-invariant characteristics that are not measured in micro-level surveys. As a consequence, OLS regression coefficients associated to FTCs will be biased since unobserved firm characteristics may affect simultaneously the firm's added value (or wage) and the composition of its workforce. This is referred to as a problem of spurious correlation and could be caused by factors such as an advantageous location, firm-specific assets like the ownership of a patent, or other firm idiosyncrasies.

One way to remove unobserved firm characteristics that remain unchanged during the observation period is by estimating a FE model. However, neither pooled OLS nor the FE estimator address the potential endogeneity of our main explanatory variable. Yet, the share of fixed-term contracts is likely to be endogenous. Indeed, any shock in wages or in productivity levels might generate correlated changes in the firm's workforce that are not due to changes in the firm's workforce composition *per se*. For instance, one might expect that a firm undergoing a negative productivity shock will be more likely to reduce personnel among workers with a FTC as adjustments costs are typically lower for the latter. In order to control for this endogeneity issue and

for the presence of firm fixed effects, we estimate our model using the system GMM (GMM-SYS) and LP estimators, respectively.

The GMM-SYS approach boils down to simultaneously estimating a system of two equations (one in level and one in first differences) and to relying on 'internal instruments' to control for endogeneity. More precisely, the FTC variable[4] in the differenced equation is instrumented by its lagged levels and the FTC variable in the level equation is instrumented by its lagged differences. The implicit assumption is that changes (the level) in (of) the dependent variable – productivity or wages – in one period, although possibly correlated with contemporaneous variations (levels) in (of) the FTC variable, are uncorrelated with lagged levels (differences) of the latter. Moreover, changes (levels) in (of) the FTC variable are assumed to be reasonably correlated to their past levels (changes). One advantage of GMM-SYS is that time-invariant explanatory variables can be included among the regressors, while the latter typically disappear in difference GMM. Asymptotically, the inclusion of these variables does not affect the estimates of the other regressors because instruments in the level equation (i.e. lagged differences of the FTC variable) are expected to be orthogonal to all time-invariant variables (Roodman, 2009). In order to find the correctly specified model, we start with the moment conditions that require less assumptions and increase the number of instruments progressively (Göbel and Zwick, 2012). To examine the validity of additional instruments, we apply the Hansen (1982) test of over-identifying restrictions. In addition, Arellano-Bond (1991) test for serial correlation (i.e. for second-order autocorrelation in the first differenced errors) is used to assess whether estimates are reliable.

Our second approach to tackle endogeneity and firm fixed effects in the productivity equation is the semi-parametric estimation method proposed by LP. This broadly used method, particularly well-suited for panels with small *t* and big *N*, boils down to estimating a value added function with material inputs (i.e. inputs – such as energy, raw materials, semi-finished goods, and services – that are typically subtracted from gross output to obtain value added) as instruments.[5] The underlying assumption is that firms respond to time-varying productivity shocks observed by managers (and not by econometricians) through the adjustment of their intermediate inputs.[6]

[4] By 'FTC variable', we mean the FTC variable *stricto sensu* and other endogenous input factors.
[5] The LP estimation procedure, when using diversity indicators as main explanatory variables, differs somewhat from the standard setup. More details can be found in Ilmakunnas and Ilmakunnas (2011: 252-253).
[6] The LP approach is an extension of the Olley and Pakes (1996) estimation strategy. The latter uses investments (rather than intermediate inputs) as instruments which presents some drawbacks. In particular, LP have argued that investments respond less smoothly to productivity shocks (than intermediate inputs) due to considerable adjustments costs. Moreover, the OP approach implies that any observation with zero investment has to be dropped from the data. This typically leads to a large drop in sample size (that is not encountered with LP).

4. Data and descriptive statistics

Our empirical analysis is based on a combination of two large data sets covering the years 1999-2010. The first, carried out by Statistics Belgium, is the 'Structure of Earnings Survey' (SES). It covers all firms operating in Belgium which employ at least 10 workers and with economic activities within sections C to K of the NACE Rev.1 nomenclature.[7] The survey contains a wealth of information, provided by the management of firms, both on the characteristics of the latter (e.g. sector of activity, number of workers) and on the individuals working there (e.g. age, education, sex, tenure, gross earnings, paid hours, occupation).[8] The SES provides no financial information. Therefore, it has 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 firm-level material inputs, investments, value added and gross operating surplus. 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.

A first point to consider for the econometric specification is that information in the SES refers to the month of October in each year, while data in the SBS are measured over entire calendar years, that is, over all months from January to December of each year. Hence, to avoid running a regression where information on the dependent variable precedes (to a large extent) the date on which the

[7] 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).

[8] 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 firm. The sample size in each stratum depends on the size of the firm. Sampling percentages of firms 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 a firm, 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. Firms employing 300 workers or more have to report information for an absolute number of employees. This number ranges between 30 (for firms with between 300 and 349 workers) and 200 (for firms with 12,000 workers or more). To guarantee that firms 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).

explanatory variables have been recorded, all explanatory variables in Equations (1) to (3) have been lagged by one year. In this way, information relative to the month of October in year *t* is used to explain firm-level productivity and wages in year *t*+1. This methodological choice restricts our sample to firms that are observed in at least two consecutive years. It thus leads to the over-representation of medium-sized and large firms given that sampling percentages of firms in our data set increase with the size of the latter.[9] Next, we exclude workers and firms for which data are missing or inaccurate.[10] Finally, we drop firms with less than 10 observations, the reason for this being our use of the first and second moments of workers' characteristics at the firm level.[11]

Our final sample consists of an unbalanced panel of 6,714 firm-year-observations from 1,844 firms. It is representative of all medium-sized and large firms 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).

Table 1 sets out the means and standard deviations of selected variables. It indicates that firms employ on average 306 workers. We observe that firms have a mean value added per hour worked of 66 EUR. The mean wage (labour cost) per hour amounts to 33 EUR, and the firms have a mean profit per hour of also 33 EUR.

The average share of workers with a FTC equals 3% within firms.[12] We also observe that around 26% of the workers are women, 53% are blue-collars, 40% have at least ten years of tenure, 11% occupy part-time jobs and 30% have a low level of education (i.e. lower secondary school at most). Employees in our sample have on average 12 years of education, are 39 years old, and are essentially concentrated in the manufacturing industry (58%), wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods (12%), construction (10%) and real estate, renting and business activities (10%). Moreover, firms have a mean capital stock reaching on average 236,000 EUR.

[9] See footnote 10
[10] For instance, we eliminate a (very small) number of firms for which the recorded value added was negative.
[11] This restriction is unlikely to affect our results as it leads to a very small drop in sample size. The average number of observations per firm in each year is equal to 35 in our final sample.
[12] The share of workers with a FTC is measured in terms of the proportion of hours worked by the latter over the total amount of hours worked within firms.

Table 1
Descriptive statistics of selected variables

Variables	Mean	Std. Dev.
Value-added per hour (€)	66.19	526.00
Hourly wage (labour cost) per hour (€)	33.34	19.62
Profit per hour (€)	32.85	524.56
Education:		
Primary and lower secondary education: edu12	0.30	0.30
Higher secondary (general, technical and professional): edu 34	0.43	0.27
Higher education (university and non university, short and long type, post-university and PhD): edu567	0.28	0.25
Average education (years)	11.62	1.70
Workers with 10 years of tenure or more (%)	0.40	0.23
Share of workers < 30 years	0.21	0.13
Share of workers > 49 years	0.17	0.12
Average age (years)	39.02	3.94
Women (%)	0.26	0.23
Part-time (less than 30 hours per week, %)	0.11	0.13
Blue-collar workers (%)	0.53	0.33
Fixed-term employment contracts (%)	0.03	0.08
Apprentices (%)	0.00	0.01
Temporary agency workers (%)	0.00	0.04
Sector (%)		
Mining and quarrying (C)	0.01	0.09
Manufacturing (D)	0.58	0.49
Electricity, gas and water supply (E)	0.00	0.06
Construction (F)	0.10	0.30
Wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods (G)	0.12	0.33
Hotels and restaurant (H)	0.01	0.12
Transport, storage and communication (I)	0.06	0.23
Financial intermediation (J)	0.02	0.13
Real estate, renting and business activities (K)	0.10	0.30
Firm-level collective agreement (%)	0.32	0.46
Size of the firm (# full-time equivalent workers)	306.36	493.31
Brussels	0.15	0.34
Flanders	0.57	0.48
Wallonia	0.28	0.43
Capital stock (€)	236,013	2,095,986
Number of observations	6,714	
Number of firms	1,844	
T-bar (i.e. nber obs / nber firms)	3.64	
Number of observations per firm	36.99 (min=10, max=2,076)	

5. Results

5.1. Overall specification

We first estimate equations (1) to (3) by pooled OLS. We control for state dependence in our dynamic model, together with heteroscedasticity and autocorrelation of residuals. Table 2 presents our results. Estimates from columns (1) to (3) point towards the existence of a positive and significant relationship between fixed-term contracts and labour costs, while no significant effect appears between FTCs and the other two explained variables, i.e. labour productivity and profits.

Table 2
Fixed-term contracts, productivity, labour cost and profits: pooled OLS results

Dependent variables:	Value added per hour worked (ln) OLS	Labour cost per hour worked (ln) OLS	Profit per hour worked (ln) OLS
Intercept	0.367***	0.669***	-0.241***
	(0.098)	(0.285)	(0.114)
Fixed-term employment contracts (%)	0.046	0.054*	0.091
	(0.036)	(0.032)	(0.087)
Worker characteristics [a]	Yes	Yes	Yes
Firm characteristics [b]	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Adjusted R-squared	0.841	0.819	0.684
F-stat	498.63	606.67	239.14
p-value	(0.00)	(0.00)	(0.00)
Sig.Model (p-value)	0.000	0.000	0.000
Number of observations	6,714	6,714	6,714
Number of firms	1,844	1,844	1,844

Notes: *** /**/* significant at 1%, 5%, and 10% level, respectively. Robust standard errors are shown in brackets.
[a] Share of the workforce that: (i) has at most a degree of lower secondary education, (ii) has at least 10 years of tenure, and (iii) is younger than 25 and older than 49 years, respectively. The share of women and the share of blue-collar workers are also included.
[b] Sectoral affiliation and number of workers.

The regression coefficient associated to the effect of FTCs on labour cost is equal to 0.054. This estimate suggests that a one unit (i.e. one percentage point) growth in the FTC ratio within firms increases hourly labour cost by 0.054%. This positive effect of the relative share of FTCs on average labour cost is consistent with the hedonic theory wage (Rosen, 1974). Indeed, as the FTCs generally have poorer working conditions and an increased risk of losing their jobs (and that these variables are imperfectly controlled for in our OLS regressions), this theory predicts that they should receive higher compensating wages. This positive impact of FTCs on wages also supports the dual (Piore, 1978) and insider-outsider labour market theories (Lindbeck and Snower, 1986). According to these

theories, the employment protection of ITCs increases with the proportion of FTCs, because the latter are the first to lose their jobs in case of economic downturn. Therefore, considering that the interests of permanent workers are privileged by unions, wage claims are more important when temporary workers are more present within firms. So wages are increasing faster in these firms.

Next, results associated to our FE estimations that allow to control for constant unobserved heterogeneity among firms' characteristics are presented in Table 3. They do not differ that much from those obtained by using pooled OLS. The estimate of the impact of FTCs on hourly gross wage is still positive and significant, while no significant effect is estimated between FTC, hourly added value and profits. Though, the regression coefficient associated to fixed-term contracts decreases to 0.036. So controlling for firms unobserved characteristics effects seems to reduce the estimate. The result suggests that a one unit (i.e. one percentage point) growth in the FTC ratio within firms increases labour costs by 0.036%.

Table 3
Fixed-term contracts, productivity, labour cost and profit: Fixed-effects results

Dependent variables:	Value added per hour worked (ln) FE	Labour cost per hour worked (ln) FE	Profit per hour worked (ln) FE
Intercept	2.899***	3.086***	1.814***
	(0.183)	(0.166)	(0.205)
Fixed-term employment contracts (%)	0.061	0.036*	0.059
	(0.038)	(0.022)	(0.148)
Worker characteristics [a]	Yes	Yes	Yes
Firm characteristics [b]	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Adjusted R-squared	0.087	0.080	0.046
F-stat	6.08	11.00	4.62
p-value	(0.00)	(0.00)	(0.00)
Sig.Model (p-value)	0.000	0.000	0.000
Number of observations	6,714	6,714	6,714
Number of firms	1,844	1,844	1,844

Notes: *** /**/* significant at 1%, 5%, and 10% level, respectively. Robust standard errors are shown in brackets.
[a] Share of the workforce that: (i) has at most a degree of lower secondary education, (ii) has at least 10 years of tenure, and (iii) is younger than 25 and older than 49 years, respectively. The share of women and the share of blue-collar workers are also included.
[b] Sectoral affiliation and number of workers.

However, neither pooled OLS nor FE estimators address the potential endogeneity of our explanatory variables. In order to control for it and for the presence of firm unobserved heterogeneity, we estimate our dynamic equations (1) to (3) by using GMM-SYS and LP[13] estimators, respectively. For all specifications, the Hansen and Arellano-Bond tests respectively do not reject the null

[13] The LP is only appropriate to estimate labour productivity (equation (1))

hypothesis of valid instruments and of no second-order autocorrelation in the first differenced errors (see Table 4).

Using GMM-SYS, estimates associated to our FTC variable of interest are presented in columns (1) to (3). They all become non-significant, meaning that significance vanishes after controlling for endogeneity (in addition to a large set of covariates, state dependence and firm fixed effects). In other words, FTCs' impact appears to be non-significant on labour productivity, labour cost and profits. LP estimates, reported in columns (4) and (5), confirm that FTCs have no significant effect on productivity.

Table 4
Fixed-term contracts productivity, labour cost and profit: SYS-GMM and LP results

Dependent variables:	Value added per hour worked (ln) SYS-GMM	Labour cost per hour worked (ln) SYS-GMM	Profit per hour worked (ln) SYS-GMM	Value added per hour worked (ln) LP (30 it.)	Value added per hour worked (ln) LP (50 it.)
Lagged dependent variable (ln)	0.655***	0.447***	0.539***	0.791***	0.791***
	(0.057)	(0.135)	(0.047)	(0.044)	(0.050)
Fixed-term employment contracts (%)	0.061	-0.027	0.156	0.029	0.029
	(0.052)	(0.038)	(0.189)	(0.040)	(0.032)
Worker characteristics [a]	Yes	Yes	Yes	Yes	Yes
Firm characteristics [b]	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Sig.Model (p-value)	0.000	0.000	0.000		
Hansen statistic	620.0	639.2	586.91		
p-value	0.27	0.12	0.63		
Arellano-Bond statistic (AR2)[c]	1.52	0.94	1.30		
Number of instruments [d]	634	634	634		
Number of observations	6,714	6,714	6,714	6,691	6,691
Number of firms	1,844	1,844	1,844	1,844	1,844

Notes: *** /**/* significant at 1%, 5%, and 10% level, respectively. Robust standard errors are shown in brackets.
[a] Share of the workforce that: (i) has at most a degree of lower secondary education, (ii) has at least 10 years of tenure, and (iii) is younger than 25 and older than 49 years, respectively. The share of women and the share of blue-collar workers are also included.
[b] Sectoral affiliation , number of workers and dummy.
[c] AR2 displays the test for second-order autocorrelation in the first-differenced errors.
[d] First and second lags of explanatory variables, including time dummies, are used as instruments.

5.2. Specifications by considering worker characteristics and working environments

So far, results based on GMM-SYS and LP estimators have shown that FTCs have no significant consequences for productivity, wages and profits within firms at an overall level. To gain a better understanding of the underlying processes, we now examine whether the effects of FTCs may vary across workers' characteristics and working environments. More precisely, we test whether FTCs have a different effect on productivity, wages and profits when the latter are occupied by men versus women, full- versus part-time workers and younger versus older workers. We also investigate whether the impact of FTCs vary across sectors, depend on the degree of technological/knowledge intensity and on the level of collective wage bargaining.

We estimated equations (1) to (3), respectively with GMM-SYS and LP estimators, considering in turn these six types of environments. In what follows, we focus on interaction effects with gender and working time estimated by SYS-GMM, as they lead to the most interesting results.[14] In both cases, as shown in Tables 5 and 6, estimates pass the Hansen and Arellano-Bond tests which implies that they respectively do not reject the null hypothesis of valid instruments and of no second-order autocorrelation in the first differenced errors.

Interacting with gender

Interaction effects with gender are reported in Table 5. They first indicate that male FTCs are significantly (slightly) less productive than male ITCs (the control group), while their impact is no significant on neither labour cost nor profit. The estimated relation between male FTCs and productivity amounts to -0.025. Unobserved characteristics such as longer seniority could explain male ITCs higher level of human capital and productivity.

Next, chi-square tests of differences between coefficients associated to the impacts on female FTCs and ITCs, respectively on productivity, cost and profits, are all significant at a 5% level. As regards productivity, the coefficient associated to female FTCs is 0.071, against -0.054 for female ITCs (male ITCs is the control group). In terms of labour cost, female FTCs coefficient amounts to 0.02 (though not significant), against -0.094 for female ITCs. As far as profits are concerned, the coefficient associated to female FTCs corresponds to 0,127 (though non-significant), against -0.274 for female ITCs. So these significant differences indicate that female FTCs would be more productive, receive higher wages (though to a lesser extent than their higher productivity), and generate higher profits than corresponding ITCs.

[14] Results for other interaction effects and LP estimator are available on request.

Focusing on female FTCs specific situation, their non-significant impact on wages (in comparison to male ITCs, the control group) compared to their significant higher productivity also suggests that FTCs are not paid below their marginal productivity. This result could be explained by their relative disadvantage of being hired on a temporary contract. It also appears in line with Heery's theory (2004), who explains that temporary workers may suffer from a wage penalty if firms accept wage increases for permanent workers by imposing wage restraint for other categories of employees. Furthermore, Jimeno and Toharia (1993) also find that FTCs perceive lower wages than their permanent counterparts, after controlling for observable individual and job characteristics.

Table 5
Fixed-term contracts, productivity, labour cost and profit by gender: GMM–SYS results

Dependent variables:	Value added per hour worked (ln) GMM-SYS	Labour cost per hour worked (ln) GMM-SYS	Profit per hour worked (ln) GMM-SYS
Lagged dependent variable (ln)	0.656***	0.464***	0.457***
	(0.058)	(0.134)	(0.033)
FTC male	-0.025*	-0.001	-0.040
	(0.015)	(0.008)	(0.046)
FTC female	0.071**	0.02	0.127
	(0.032)	(0.023)	(0.094)
ITC female	-0.054	-0.094**	-0.274**
	(0.046)	(0.041)	(0.133)
FTC female - ITC female (chi-sq stat)	4.71**	4.32**	5.06**
p-value	0.030	0.038	0.025
Worker characteristics [a]	Yes	Yes	Yes
Firm characteristics [b]	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Sig. model (p-value)	0.00	0.00	0.00
Hansen statistic	657.34	826.17	613.46
p-value	0.187	0.385	0.632
Arellano-Bond statistic (AR2)[c]	1.54	1.01	1.38
p-value	0.124	0.311	0.169
Number of instruments [d]	662	851	662
Number of observations	6,699	6,699	6,699
Number of firms	1,842	1,842	1,842

Notes: *** /**/* significant at 1%, 5%, and 10% level, respectively. Robust standard errors are shown in brackets.
[a] Share of the workforce that: (i) has at most a degree of lower secondary education, (ii) has at least 10 years of tenure, and (iii) is younger than 25 and older than 49 years, respectively. The share of women and the share of blue-collar workers are also included.
[b] Sectoral affiliation , number of workers and dummy.
[c] AR2 displays the test for second-order autocorrelation in the first-differenced errors.
[d] First and second lags of explanatory variables, including time dummies, are used as instruments.

Turning to female ITCs situation, their estimated negative impact on profits could be related to the fact that their labour costs could decrease to a bigger extent compared to their labour productivity (still in comparison to male ITCs, the control group). Indeed, while ITC wages are

estimated to vary by -9,4% compared to a -5,4% variation in productivity, these variations correspond to an average level of hourly productivity (66,19 €) which is nearly twice as much as the level of labour cost (33,34 €) in our sample.

Interacting with working time

Interaction effects between FTCs and working time are reported in Table 6. Results first show that, among full-time workers, being on a FTC or on an ICT does not significantly affect productivity, wages nor profits.

However, the impact of working time is more contrasted when part-time is considered. First, the positive difference between the coefficients associated to the impacts on productivity of respectively FTC part-timers and full-timers is significant. The coefficient associated to part-time FTCs amounts to 0.109, against -0.173 for part-time ITCs (full-time ITCs is the control group). This result could be explained by the fact that FTC part-timers want to send an appropriate signal to their employer by working harder, in order to further occupy a full-time job. This finding can be compared with studies outlined to explain the transition from a temporary to a permanent contract. For instance, the study conducted by Dolado and Stucchi (2008) shows that temporary workers provide more effort in firms in which the transition rate from a temporary to a permanent contract is higher. Furthermore, Engellandt and Riphahn (2005) and Booth *et al.* (2002b) show that temporary workers provide more effort than permanent workers to show the best signal to their employer.

Table 6:
Fixed-term contracts, productivity, labour cost and profit by working time: GMM–SYS results

Dependent variables:	Value added per hour worked (ln) GMM-SYS	Labour cost per hour worked (ln) GMM-SYS	Profit per hour worked (ln) GMM-SYS
Lagged dependent variable (ln)	0.656***	0.492***	0.567***
	(0.057)	(0.157)	(0.031)
FTC full-time	-0.012	0.0004	0.131
	(0.011)	(0.022)	(0.092)
FTC part-time	0.109*	0.025	-0.184
	(0.059)	(0.071)	(0.269)
ITC part-time	-0.173***	-0.126**	-0.195
	(0.054)	(0.053)	(0.182)
FTC part-time - ITC part-time (chi-sq stat)	8.42***	2.09	0.00
p-value	0.004	0.148	0.978
Worker characteristics [a]	Yes	Yes	Yes
Firm characteristics [b]	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Sig. model (p-value)	0.00	0.00	0.00
Hansen statistic	649.98	587.16	553.28
p-value	0.246	0.301	0.685
Arellano-Bond statistic (AR2)[c]	1.51	1.03	1.74
p-value	0.132	0.305	0.082
Number of instruments [d]	662	606	606
Number of observations	6,699	6,699	6,699
Number of firms	1,842	1,842	1,842

Notes: *** /**/* significant at 1%, 5%, and 10% level, respectively. Robust standard errors are shown in brackets.
[a] Share of the workforce that: (i) has at most a degree of lower secondary education, (ii) has at least 10 years of tenure, and (iii) is younger than 25 and older than 49 years, respectively. The share of women and the share of blue-collar workers are also included.
[b] Sectoral affiliation, number of workers and dummy.
[c] AR2 displays the test for second-order autocorrelation in the first-differenced errors.
[d] First and second lags of explanatory variables, including time dummies, are used as instruments.

Next, ITC part-timers receive significant lower wages (compared to full-time ITCs, the control group), while no significant impact appears when considering part-time FTCs. Such a finding could be explained by lower returns coming from experience and seniority among part-timers (Kalleberg, 2000). Yet, the negative difference in regression coefficients between FTC and ITC part-timers is only merely significant (p-value = 0.148). On the opposite, results suggest that full-timers' wages are not affected by their employment contract.

Overall, in line with results presented in columns (1) and (2), findings in column (3) suggest that profits are unaffected by the share of (full or part-time) workers with a FTC. Put differently, it appears that the lower productivity of part-time ITCs (w.r.t. part-time FTCs) is compensated by their lower wages, so that profits remain unchanged.

6. Conclusion

Legislation regarding temporary employment has been relaxed in Belgium (as in most European countries) over the last 20 years. In light of this evolution, an accurate understanding of the different repercussions of temporary employment contracts has emerged as an increasingly salient problem in labour and industrial economics.

This paper estimates the impact of FTCs on productivity, wages (i. e. labour cost) and productivity-wage gaps (i.e. profits). It contributes significantly to the existing literature as it is one of the first: i) to rely on large representative data (i.e. Belgian linked employer-employee panel data covering most private sector firms over the period 1999-2010), ii) to address important methodological issues such as firm-level invariant heterogeneity and endogeneity, iii) to examine how the benefits or losses of FTCs are shared between workers and firms (i.e. to extend the analysis to wages and productivity-wage gaps), and iv) to investigate whether the FTC-productivity-wage nexus depends on workers' characteristics and working environments, notably gender and working time.

Using both the dynamic system GMM and Levinsohn & Petrin (2003) estimators, findings show that the share of FTCs within firms has no significant impact on productivity, wages and profits when considering the whole sample of firms. Yet, interaction effects between FTCs and gender suggest that the share of female FTCs fosters profits (i.e. it increases proportionally more productivity than labour costs), while the fraction of male FTCs is found to decrease productivity. The effect of male FTCs on wages and profits also turns out to be negative but it is not statistically significant. As regards the interaction between FTCs and part-time employment, results show that the lower productivity of permanent part-timers (w.r.t. part-timers on a FTC) is compensated by lower wages, so that profits remain unchanged. As regards full-timers, being on a FTC or on a permanent contract is not found to affect productivity, wages or profits.

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Appendix 1. Studies on (proxies of) productivity, wages and/or profits

Study	Country	Data/Coverage	Explained variable	Estimation method	Control for Heterogeneity / Simultaneity / Dependence	Results
Bertrand-Cloodt *et al.* (2012)	Netherlands	Panel data, "Labour Force Survey of Statistics Netherlands.",1987 - 2008.	- Type of contract (probability of accepting a fixed-term or temporary agency job)	- Multnominals and ordered logit regressions - OLS regression	No/No/No	Fixed-effect contracts in academic level, such as trainee positions in hospitals or doctoral universities can provide a stepping stone to a more attractive career.
Cappellari *et al*. (2012)	Italy	Balanced panel dataconcerning concerning 13,000 companies in the private sector, 2004 -2007.	- Labour productivity per worker	- OLS regression - Fixed effects regression	Yes/Yes/No	The reform of fixed-term contracts has not produced expected results: it led to a substitution of temporary employees by subcontracting, generating productivity losses.
Comi and Grasseni (2012)	9 countries of the European Union	Multidimensional micro data, " European Union Statistics on Income and Living Conditions (EU-SILC)"	- Wage gap (hourly wage)	- Semi-parametric approach - OLS regression - Fixed effects regression	Yes/No/No	Workers receive higher wages if they worked in permanent contracts, in almost all the countries. -The wage gap of temporary workers decreases as the highest quantiles are considered. Having a fixed-term contract is disadvantageous because it usually corresponds to workers who are at the bottom of the earnings distribution.
Fouarge *et al*.. (2012)	Netherlands	Panel data on 65,000 households (between 15 and 64 years old),"Labour Force Survey", 2004-2008.	- Training (training rate) - Labour mobility	- Logit regressions - Multinomial Logit regression	No/No/No	Temporary workers participate less in training than permanent workers. FTCs are more likely to participate in a general rather than specific training.

Appendix 1 (*Continued*)

Nielen and Schiersch (2012)	Germany	German Panel data, "IAB Establishment Panel data" annual survey of approximately 16,000 establishments, 2004-2009.	- Labour productivity (real sales per capita)	- OLS regression - Fixed effects regression - GMM regression	Yes/Yes/Yes	No significant effect from temporary employment to labour productivity.
Cataldi *et al.* (2011)	Belgium	Panel data from two databases: the Structure of Earnings Survey (SES) - the Structure of Business Survey (SBS) 1999-2006.	- Productivity (Value added/ Hours worked) - Wage (hourly wage) - Productivity-wage gap	- OLS regression - GMM regression - Fixed effects regression	Yes/Yes/Yes	Workers over 49 are significantly less productive than their younger colleagues. Workers aged under 30, have a significantly lower productivity than older workers. The impact of the share of young people (aged) on the productivity-wage gap is significantly positive (negative).
Dohmen *et al.* (2011)	Germany	Panel data, "German investigation of the resident population", 11,803 households. The study was run between June 9th and July 4th, 2005, and a total of 450 participants took part.	- Individual Risk Attitudes	- OLS regression - Ordered probit regressions	Yes/No/No	Graduates more easily accept temporary contracts.
Mahy *et al.* (2011)	Belgium	Panel data based on a combination of two large data sets covering the years 'the Structure of Earnings Survey' (SES) and the 'Structure of Business Survey' (SBS), 1999-2006.	- Hourly wage - Value added per hour worked	- OLS regression - Fixed-effects regression - GMM regression	Yes/Yes/Yes	A significant hump-shaped relationship between wage dispersion and firm productivity for all working environments under investigation. Moreover, the intensity of the relationship between wage dispersion and firm productivity is stronger among firms with a larger proportion of highly skilled workers.

Appendix1 (*Continued*)

Damiani and Pompéi (2010)	16 countries of the European Union	Panel data on international and sectoral differences in multifactor productivity growth, 1995-2005.	- Labour productivity (firm value added)	- GMM regression	Yes/Yes/Yes	FTCs work in bad conditions. A reduction in employment protection causes a decline in productivity growth.
Bosio (2009)	Italy	Cross sectional micro data on income and wealth of Italian households, 2006.	- Returns - Wage gap (hourly wage; wage distribution)	- OLS regression - Quantile regression - The decomposition of Machado-Mata	Yes/No/No	Workers who are at the bottom of the earnings distribution, are penalized, especially FTCs whose gap between productivity and wages is stronger compared to permanent workers.
Dhyne and Mahy (2009)	Belgium	Panel data from the Belgian accounting data, 1998-2005.	- Labour costs	- S-GMM (Blundell and Bond) - Random effects probit regression	Yes/Yes/Yes	Unexpected demand shocks increase the probability to use FTC. Companies tend to react to these shocks by introducing flexible forms of employment contract. The average wage of FTC could be lesser than the average wage of permanent workers. Levels of adjustment costs are much lower when it comes to hiring FTC but they must be amortized over a shorter period.
Salvatori (2009)	21 countries of the European Union	Cross sectional data from 21,000 workplaces, "Establishment Survey on Working Time and Work-Life Balance (ESWT)", 2004.	- Wage (Pay for Performance)	- Multivariate model - OLS	No/No/No	The presence of unions in companies would increasing the number of temporary, in order jobs to increase the wages of permanent contracts.

Appendix1 (*Continued*)

Dolado and Stucchi (2008)	Spain	Panel data of 3,759 Spanish manufacturing firms and 22,922 observations, 1991-2005.	- Labour productivity (total factor productivity)	- Non parametric and multivariate regressions	Yes/No/No	Temporary workers provide higher effort when they perceive a sufficiently large probability of getting their fixed-term contracts converted into a permanent ones, for given effort. Temporary workers use some average of the previous conversion rates in their current firms as a signal of the probability of getting upgraded. Therefore, the model implies that, other things equal, workers exert higher effort in firms with larger conversion rates. Moreover, using both bivariate nonparametric tests of stochastic dominance and multivariate regression techniques, they also find that, even after controlling for expected conversion rates, firms with a high share of temporary workers are less productive than those with lower shares.
Appendix1 (*Continued*)	Germany and Spain	Panel data, German Socio-Economic Panel (GSOEP) for Germany and European Community Household Panel (ECHP) for Spain, 1995-2000.	- Hourly wage	- OLS regression - A model of quantile regression	Yes/No/No	Individuals with fixed-term contracts earn less that permanent contracts in the two countries. In Germany, FTCs with more experience are less penalized than FTCs at the bottom.

Appendix1 (*Continued*)

Nunziata and Staffoli (2007)	15 countries of the European Union	Empirical analysis on aggregate data from an unbalanced sample of the 15 major European countries, 1983-1998.	- The employment– population ratio	- OLS regression - MLE regression - FGLS regression	No/No/No	Temporary employment is positively correlated with permanent employment protection and negatively correlated with temporary work agency regulations. In addition, important complementarity effects between regulations. The stricter the regulations on permanent employment, the larger the impact of short-term contract regulations, especially the ones on temporary work agencies. Stricter employment protection, stricter fixed-term contracts and looser temporary work agency regulations are negatively correlated with permanent employment.
Roux and Leclair (2007)	France	Balanced annual panel.data , "DADS (Déclarations Annuelles de Données Sociales)" 1994 -2000. Private sector, excluding operational and financial services and real estate activities.	- Labour productivity (firm value added)	- OLS method - GMM method	Yes/Yes/Yes	No significant differences in hourly costs, except in services. The softening difference in productivity suggests insider / outsider phenomenon: temporary employees seem to be paid less.
Engellandt and Riphahn (2005)	Switzerland	Panel data of more than 16,000 households, "Swiss telephone survey on labour force (ESPA)", 1996-2001.	- Unpaid overtime hours - Absenteeism rate , by Type of Contract and Sex -	- Random effects probit regression - Random effects regression - Fixed effects regression -	Yes/No/No	Temporary workers provide more effort than permanent workers.

Appendix1 (*Continued*)

Almeida–Santos and Mumford (2004)	England	Panel data, "British Workplace Employee Relations Survey", 1998. 1,460 workplaces and 19,853 employees surveyed.	- Profit (Marginal return of labour) - Wage compression (in absolute and relative terms) - Training cost	- Probit regression	No/No/No	Temporary workers receive less training. Wage compression in the upper half of the distribution is significantly associated with more training. Women costs of training are not significantly different than men. However, their training time is shorter. Workers with lower education level are significantly less likely to be trained.
Casquel and Cunat (2004)	Spain	Sample panel data, "European Community Household panel» (ECHP)", 8,000 Spanish households, 1994-1998.	- Characteristics of temporary and permanent workers	- They develop a matching model built based on Blanchard and Landier (2002) and Wasmer (1999) in a labour market with heterogeneous workers and symmetric information	Yes/No/No	They conclude that temporary workers move into permanent jobs according to their characteristics. Thus, temporary workers who are qualified are more likely to have a permanent contract than low-skilled workers. However, unskilled workers remain in precarious jobs as temporary jobs.
Draca and Green (2004)	Australia	Sample of 22,704 people, "Survey of Employment and Training Experience (SETE)" conducted by the Australian Bureau of Statistics.	- Investment in Training - Proportion of temporary workers	- Binomial regression	No/No/No	Flexible workers receive 50-80% less training than the average workforce.
De la Rica (2004)	Several European Union countries	Stratified two-stage data (by region and firm size for the first and second level, each worker selected at random), "Earnings Structure Survey" of more than 130,000 full-time workers over 14,340 institutions, 1995.	- Wage gap (hourly wage and wage ratio)	- Least Squares regression, in two steps (Probit and OLS) - Fixed effects regression (at firm level and at the level of the hierarchical position in the company)in two steps (probit and fixed effects)	Yes/No/No	Mills ratio positively impacts wages, except for workers on permanent contractswhere its effect is not significant in most cases.

				- Mills ratio (Heckman method)		

Appendix 1 (*Continued*)

Arulampalam *et al.* (2003)	Several European Union countries	Panel data, "European Community Household Panel", 1994-1999.	- Training rate and wage distribution, by country and gender	- Probit regression with fixed random effects	Yes/Yes/No	Negative correlation between education and fixed-term contracts.
Brown and Sessions (2003)	England	Cross-sectional sample data , “British Social Attitudes Survey”, 1997. individuals aged 18 and over.	- Hourly wage	- OLS regression - Heckman regression - Probit regression	No/No/No	Wage discrimination against temporary workers (these are not unionized). The wage of permanent workers increases significantly in the presence of unions.
Guadalupe (2003)	England	Sectorial panel data for 32 industrial sectors, from 1988 to 1998.	- Labour productivity (growth rate of sectoral growth valued added)	- Logit regression	No/No/No	Temporary workers suffer higher job insecurity both in terms of lower wages and higher risk of accidents. Temporary contracts involve less human capital accumulation and potentially lower productivity.
Forrier and Sels (2003)	Belgium	Questionnaires sent in 2000 to three samples of employee , permanent workers " Banque Carrefour de la sécurité sociale", temporary workers "l'Office flamand de l'emploi et la formation professionnelle" agency workers . This sample was stratified by the age and sex of the population (1000 temporary agency workers, 1000 employees with fixed-term contracts and 800 permanent employees).	- Participation in training (Training rate)	- Logistic regression	- No/No/No	Employers finance more training for permanent employees than for temporary employees. .

Appendix 1 (*Continued*)

Booth *et al.* (2002b)	England	Longitudinal datap, "Panel survey of UK households", 1991-1997	- Hourly wage, by gender	- Ordered probit regression - Probit model in common - Kaplan-Meier rates - IV / GLS - OLS regression - FE regression	Yes/No/No	Fixed-term contracts are a stepping stone to permanent employment. Temporary workers put more effort. Transition to stable employment appears after between 18 months and three and a half years, according to the type of contract (fixed term or seasonal) and gender. Temporary workers have a lower level of job satisfaction, receive less training and are less paid.
Boockmann and Hagen (2001)	Germany	Panel data of more than 4,000 interviews, 1993-1999.	- Labour costs	- Meyer difference method - Multinomial probit model (Butler and Moffit)	Yes/No/No	Positive changes in expected or actual sales are associated with a higher probability to use atypical work, suggesting that these forms of employment are used as a mean of adjustment.
Goux *et al.* (2001)	France	Panel data of 915 French companies in the manufacturing sector. Data come from the INSEE between 1988 and 1992.	- Average wage firms	- GMM regression	Yes/Yes/Yes	Adjustment costs for FTCs are less expensive than for permanent contracts. Considering hiring FTC improves the ability to model the dynamics of the demand for workforce.
Booth *et al.* (2000)	England	Panel data from a survey of households, 1991-1997.	- Wage (average hourly wage)	- Semi-parametric and non-parametric regresssions - Probit regression with random effects - Tobit regression with random effects - OLS and fixed effects regressions - Instrumental variables - GLS	Yes/No /No	Fixed-term contracts workers are paid less because they are less educated and therefore have lower productivity.

Appendix 1 (*Continued*)

Arulampalam and Booth (1998)	England	Panel data using the first five waves of the British Household Panel Survey (BHPS). Their estimating sample includes 2982 men and 3117 women, with respectively 9659 and 9904 person-year observations for each1991-1995.	- Participation in training (Training rate)	- Pooled probit regression - Random effects probit regression	Yes/No/No	FTC Workers, who are working part-time, or who are not covered by a union collective agreement, are significantly less likely to be involved in any work-related training to improve or increase their skills.
Autor *et al*. (1998)	United States	Panel data from the National Income and Products Accounts (NIPA) and the Bureau of Labor Statistics (BLS) Industry Employment and Output Series in the aggregate U.S. labor market in each decade since 1940 and over the 1990 to 1995 period.	- Hourly Wage - Annual change in college wage-bill share - Annual change in employment share - Annual change in the college graduate wage-bill share - Annual change in the nonproduction wage-bill share	- OLS regression - OLS First-Difference regression	No/No/No	The spread of computer technology may "explain as much as 30 to 50 percent of the increase in the rate of growth of the wage-bill share of more-skilled workers since 1970. The growth of computer investments also appears to account for over 30 percent of the large increase in the rate of within-industry skill upgrading found in detailed U.S. manufacturing industries during the 1980s.