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FLEXIBLE WAGE CONTRACTS, TEMPORARY JOBS AND WORKER PERFORMANCE: EVIDENCE FROM ITALIAN FIRMS

Michele Battisti *Giovanna Vallanti*

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Center for Labor and Economic Growth
Department of Economics and Business
LUISS Guido Carli
Viale Romania 32, 00197, Rome -- Italy
http://www.luiss.edu/celeg

FLEXIBLE WAGE CONTRACTS, TEMPORARY JOBS AND WORKER PERFORMANCE: EVIDENCE FROM ITALIAN FIRMS

MICHELE BATTISTI AND GIOVANNA VALLANTI

Abstract. This paper focuses on the effects of decentralized wage schemes and temporary forms of employment on worker/firm performance. The effect of monetary incentives on worker effort and firm performance is a central topic in economics. According to the principal-agent paradigm, firms (the principal) have to link employees' remuneration scheme to any verifiable indicator of performance in order to avoid opportunistic behaviours. The effectiveness of incentives on workers' behaviour may vary significantly accordingly to the institutional/economic context in which the firms operate but in general the empirical evidence shows that financial incentives have the potential to exert strong effects on indicators of firm performance, such as productivity and worker absenteeism. Both from a theoretical and empirical point of view, the prediction on the effects of temporary forms of employment on effort and productivity is less neat. In light of these considerations, the aim of this paper is to provide further empirical evidence on whether and to what extent the performance related pay and the contract flexibility affect workers effort and in turn firm productivity for different type of workers (white collar vs. blue collar), working in workplaces characterized by different degree of uncertainty and risk and in firms operating in different economic and institutional settings using a sample of Italian firms. According to our results, wage flexibility appears to have a significant effect on effort and then on firm's productivity and white collars are more responsive to monetary incentives than blue collars. Moreover, the presence of a large share of temporary contracts implies a lower dismissal probability for permanent workers and a deterioration in the working environment and then it reduces workers' motivation and effort.

JEL Classification: J22, J33, J38.
Productivity, Effort, Performance-related-pay, Temporary contracts.

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Michele Battisti, Dipartimento di Studi su Politica, Diritto e Societá, University of Palermo, Piazza Bologni 8, 90134 Palermo, Italy. Giovanna Vallanti, Dipartimento di Scienze Economiche e Aziendali University LUISS Guido Carli, Viale Romania 32, 00197 Roma, Italy. We wish to thank Massimo Egidi, Francesca Mazzolari and all the participants to IAB workshop *Labour Market Flexibility: Boon or Bane?* - Nurmberg 18-19 March.

1. Introduction

The last two decades have witnessed a significant increase in the labour market flexibility in all European countries. The most debated strand of macroeconomic literature considers the presence of rigidities in the labour market as responsible for the poor performance of the labour market both in terms of participation and employment (among the others Siebert, 1997, Blanchard and Wolfers, 2000, Burgess *et al*, 2000). In this paper we are interested in an empirical assessment of the effect of flexibility on workers effort and then on firm productivity. In particular, we will focus on two forms of flexibility identified in the literature: external (numerical) flexibility and wage (financial) flexibility.[1] The former is related to the capacity of the firm to adjust its workforce to changes of the economic conditions and it depends on the strictness of employment protection legislation and the availability of temporary forms of employment, while the latter concerns the responsiveness of wages to external shocks and changes in internal productivity and largely depends on the features of the wage setting institutions.

Temporary employment has grown in a number of OECD countries during the past two decades raising concerns that temporary jobs may be crowding out more stable forms of employment, becoming an additional source of insecurity for workers. From a theoretical and empirical point of view, the predictions on the effects of temporary forms of employment on effort and productivity are ambiguous and mainly depend on the reasons why employers use them. For instance Boeri and Garibaldi (2007) found a positive temporary effect on employment and a permanent negative effect on productivity while other authors (see for example Ichino and Riphahn, 2005) find a positive impact of effort and productivity when temporary jobs have a high probability to be transformed into permanent ones after the probation period. Generally speaking, the use of temporary workers as buffer stocks increases job instability and uncertainty inside the firm, reduces investment in training, lowers workplace cooperation and workers' motivations and harms long-run growth prospect (Blanchard and Landier, 2002). On the contrary, temporary contracts used as screening devices generate better growth prospects due to better learning about the quality of the match and lower incentive to shirking for temporary workers. It may translate into better job matches

[1]For a detailed classification of labour market flexibility see Beatson (1995).

and, therefore, more stable employer-employee relationships in the long run (Portugal and Varejao, 2009).

Considering the second dimension of flexibility, there is a large theoretical and empirical literature on the effects of wage incentive schemes on effort and productivity. The efficiency wage theory in the eliciting effort version (Solow 1979, Shapiro and Stiglitz, 1984) shows how firms pay higher salary in order to motivate workers to work harder. A similar reason, else if in a dynamic setting inside the careers' profiles is the basis to design right schemes of incentives under tournaments (Lazear and Rosen, 1981). It means that in the face of asymmetric information, firms should tie the remuneration of employees to any verifiable (individual or collective) signal of performance. Based on such a theoretical prediction, a number of studies in recent years have shown that, when implemented wisely, financial incentives have the potential to exert strong effects on indicators of firm performance, such as productivity (Lazear, 2000; Gielen et al., 2010) and worker absenteeism (Wilson and Peel, 1991; Brown et al., 1999). By exploiting another dimension of wage flexibility Guiso et al., 2005 find that sensitivity of workers' wages to permanent shocks is negatively correlated with the workers' risk aversion and the overall variability of firms' performance.

In Italy the period of labour market reforms aimed to reduce worker protection and decentralized wage determination started at the beginning of nineties with the tripartite agreements of 1993 (signed by national trade unions, Government and industrial associations), which marked the end of the automatic wage indexation system (the so-called "scala mobile") . Moreover, the 1993 Agreement introduced a two stage bargaining system consisting of national-level bargaining (by economic sector) and local-level agreements. The main objective of the national/sector level bargaining was to maintain the purchasing power of wages and to determine the basic wage guarantees (*minimi tabellari*) which represent a floor to wage adjustments. Local bargaining (either at the regional or firm level) had to allow eventual rent sharing through performance-related pay schemes rather than fixed (usually irreversible) premiums. Institutional reforms aimed at deregulate the Italian labour market through the introduction of various forms of temporary and atypical contracts have been gradually introduced since the middle nineties. The two principal reforms in this direction have been the Treu (1997) and Biagi (2003) reforms, which (de)regulated and extended the adoption of

fixed-term contracts, allowed the use of temporary agency workers, and introduced new 'atypical' contractual arrangements.

In order to assess how and in what direction reforms have impacted on the Italian regulatory framework and how Italy ranks in comparison to other industrialized countries, we can look at a standard de jure labor market flexibility indicator, the Employment Protection Index (EPL) constructed by the OECD. According to the EPL indicators, in 2008 Italy ranks broadly mid-field in OECD comparison (25th out of 40 countries) with the EPL indicators being 1.89 against an OECD average of 1.94. In 1990 Italy ranked 4th out of 26 countries in the same decreasing order of protection. We should stress that, in Italy, as in many other European countries in the 1990s, the increase in flexibility was mainly obtained through the liberalization of the use of temporary forms of employment while leaving unchanged the protection of permanent incumbent workers. Concerning wage flexibility, Clar *et al.* (2007) rank Italy 12th out of 18 OECD countries in a meta-analysis, by confirming the previous results obtained by Heylen (1993). This seems to indicate that the so called numerical flexibility has changed much more than wage flexibility by the effect of reforms.

The aim of this paper is to empirically assess whether and to what extent decentralized wage schemes on one hand and temporary forms of employment on the other, affect workers' effort using a sample of Italian firms. We want also to disentangle the specific contribution of wage and employment flexibility to firm productivity. Finally, we use white and blue collars as different labour inputs in the production function in order to see if they are affected in different ways from flexibility practices. The remainder of the work is the following: in section 2 we explain our empirical strategy and briefly describe the methodologies we use. In section 3 we describe the datasets and the characteristics of the sample. Then in section 4 we present and discuss the results of the empirical analysis. Conclusive considerations follow.

2. Empirical strategy and measurement issues

In order to assess the impact of wage and numerical flexibility on productivity, our empirical model takes into account the simultaneous interactions between workers effort and firms performance on the one hand and workers' effort and effort determinants on the other hand. One

important issue is how to define and measure workers' effort. Despite there is a large consensus on the fact that the commitment and effectiveness with which workers apply themselves to their assigned tasks is relevant in explaining labour productivity, nevertheless neither the theoretical nor the empirical literature provide a unique, widely accepted definition of this concept. The empirical investigators have operationalised the idea of effort in a number of different ways that may be classified in two main categories. There is a large empirical literature which uses observable and "objective" indicators of effort (or negative effort) such as absenteeism (Barmby et al., 1991; Winckelmann, 1999; Engellandt and Riphahn, 2005; Bradley et al. 2007) or disciplinary dismissals (Cappelli and Chauvin, 1991). Other studies based on information collected from employees surveys consider self reported (subjective) measures of effort/motivation as indicators of individual commitment to work.

Our approach is twofold. Firstly we use an observable proxy of effort (negative absenteeism) and estimate a model in which workers effort and firm productivity are both observable and endogenous. Secondly, we acknowledge that absenteeism can be an imperfect measures for effort so that we carry out additional checks to assess the (direct) effects of our variables of interest (numerical and wage flexibility) on firm's performance. Following Black and Lynch (2001) two steps procedure, we estimate firm specific time invariant component of the residual (where also effort is present) and then we regress it on the effort determinants. An additional control is obtained using the Structural Equation Modeling (SEM) technique in order to capture the relationship between the unobserved (latent) variable effort and firms productivity.

2.1. **The basic model.** The basic framework is a standard Cobb-Douglas production function for a representative firm with only two inputs: effective labour (E) and capital (K)

$$Y_i = A_i K_i^{\alpha} E_i^{\beta} exp^{u_i} \tag{1}$$

$$E_i \equiv e_i \hat{L}_i \tag{2}$$

$$e_i = f(Z_i) \tag{3}$$

where E is a broad concept of the labour factor including effort (equation 2). In particular e_i is the average effort of the labour force in firm i and $\hat{L}_i$ is the number of workers employed expressed in term of full-time equivalent units and adjusted for quality (human capital), type of contracts (temporary vs. permanent) and qualification (blue collars vs. white collars). In turn, the average amount of effort in firm i is influenced by a number of variables in the vector $\mathbf{Z}_i$, which contains:

- Wage structure indicators which include the performance related pay (as a share of total remuneration)[2], other production premia/bonuses, superminimum differentials[3], and seniority differentials[4].
- Numerical (external) flexibility indicators which include the share of temporary contracts (fixed-term contracts, traineeship contracts and other "atypical" contracts[5]), conversion rates (from temporary to permanent jobs), turnover rate, hiring policies (temporary vs. permanent), displacement risk and an indicator for the degree of employment protection related to firm's dimension.
- Workers outside opportunities such as the local unemployment rate (that is a measure of the degree of the economic activity in the local labour market), and indicators for local production characteristics (whether the firms is located in an industrial districts or in a metropolitan area).
- Labour force and firm characteristics such as human capital endowment and gender composition, firm size, workers' contractual arrangements, workers qualification (white collars and blue collars).

Effort e_i is proxied by an indicator for (negative) absenteeism measured as the ratio between actual hours worked and workable hours at firm level.

We allow labour input heterogeneity by differentiating workers by multiple characteristics. We distinguish between temporary and permanent workers, skilled and unskilled workers (share of graduates) and white and blue collars.

[2]This component of the wage is based on previous year performance results. The performance results are decided without formal negotiations with the trade unions and not on permanent basis.
[3]Superminimum are company-level wage increments added to the contractual minimum on a permanent basis with either a firm-level or a worker-level component.
[4]Superminimum and seniority differentials are relative to firms operating in the same sector of activity.
[5]Atypical contracts include external collaborations and agency contracts.

The empirical specification is the following:[6]

$$\ln Y_i = \alpha \ln K_i + \beta \ln(eL)_i + \phi_T \left(\frac{L_T}{L}\right)_i + \phi_H \left(\frac{L_H}{L}\right)_i + \phi_w \left(\frac{L_W}{L}\right)_i + u_i \tag{4}$$

$$\ln e_i = \gamma' Z_i + \epsilon_i \tag{5}$$

In equation (4), $\frac{\phi_T}{\beta}$ represents the productivity premium of a temporary worker relative to a permanent worker, $\frac{\phi_H}{\beta}$ represents the productivity premium of a high-schooled worker relative to a low-schooled worker, and $\frac{\phi_W}{\beta}$ represents the productivity premium of a white collar relative to a blue collar (Konings and Vanormelingen, 2010). Unfortunately we do not observe the number of high-schooled and low-schooled workers, nor the number of temporary and permanent workers for each employee type. This forces us to make some simplifying assumptions similar to other studies that divide the labor force among several dimensions (Van Biesebroeck, 2007; Konings and Vanormelingen 2010). First, we have to assume that the relative differences in marginal productivity between two workers that differ by one characteristic are the same irrespectively of what their other characteristics are. Second we restrict the proportion of one type of workers to be constant across other groups defined by the other characteristics.

We then relax the assumption that blue collars and white collars are perfect substitutes. Similar to the equation (1) we divide the workforce by their human capital characteristics and type of contract but we allow blue collars and white collars to be imperfectly substitutable in the production process. We then include effective labour for blue collars and white collars separately in the production function and obtain the following specification [7]:

$$Y_i = A_i K_i^{\alpha} E_{W,i}^{\beta_W} E_{B,i}^{\beta_B} exp^{u_i} \tag{6}$$

[6]See appendix 1 in Konings and Vanormelingen (2010) for a formal derivation of the empirical specification of equation (1) when workers can be differentiated by multiple characteristics.

[7]Although we could also observe the number of managers in a firm, including them as a separate category in the production function would imply to exclude too many observations because only a small percentage of firms report a positive number of managers. We count the number of managers as white collar workers instead.

$$E_{W,i} = e_{W,i}\hat{L_{W,i}} \tag{7}$$

$$E_{B,i} = e_{B,i}\hat{L_{B,i}} \tag{8}$$

$$e_{W,i} = f(Z_{W,i}) \tag{9}$$

$$e_{B,i} = f(Z_{B,i}) \tag{10}$$

where $e_{B,i}$ and $e_{W,i}$ are the average effort of blue collars and white collars respectively in firm i. As before, the average effort is influenced by a number of variables in the vectors $\mathbf{Z}_{Bi}$ and $\mathbf{Z}_{Wi}$, which may be specific to workers'qualification.

The corresponding empirical equation for the system of equations is the following:

$$\ln Y_i = \alpha \ln K_i + \beta_W \ln (e_W L_W)_i + \beta_B \ln (e_B L_B)_i + \phi_T \left(\frac{L_T}{L}\right)_i + \phi_H \left(\frac{L_H}{L}\right)_i + u \tag{11}$$

$$\ln e_{Wi} = \gamma'_W Z_{Wi} + \epsilon_{Wi} \tag{12}$$

$$\ln e_{Bi} = \gamma' Z_{Bi} + \epsilon_{Bi} \tag{13}$$

where the effort equations for white collar and blue collar workers are estimated separately.

These two systems of equations are estimated through a 3 stage least squares technique, given the simultaneity of the work variables in the production and in the effort functions.

2.2. **The two-step procedure.** There are two potential shorthcomings in this pooled 3SLS regression approach: we are not able to control for the firm specific time invariant component and

this may bias the results.[8] Moreover, as we already stressed, effort may be poorly observed, that is our proxy for effort may be affected by a measurament error. To address these two issues we substitute (2) into (1) and we estimate a reduce-form equation relying upon a two-step procedure introduced by Black and Lynch (2001) in a similar analysis.

In the first step we estimate a production function using data on value added, capital and production workers which are available for a longer period of time from 2000 to 2009. This allows us to obtain robust estimations of the parameters on labour and capital. We then use the firm specific-time invariant component of the residuals in the period 2001-2009 for the second step estimation in order to identify the direct effect of quasi time invariant firm-level regressors such as remuneration policy, human resources policies and other time-invariant characteristics on productivity.

We obtain the following equation which is basically a reduced form of equations (1) - (2):

$$lnY_{i,t} = \alpha lnK_{i,t} + \beta lnL_{i,t} + \gamma\theta_i + \upsilon_i + \epsilon_{i,t} \tag{14}$$

where θ_i is a vector of firm characteristics which includes the vector Z_i of the effort determinants as in equation (2), υ_i is an observed time invariant firm effect and $\epsilon_{i,t}$ is an error term. In particular θ_i includes firms' wage strategy (such as performance related payments), human capital composition (skilled vs. unskilled workers and white vs. blue collars) and flexible work practices (type of contracts). Once obtained a robust estimation of the parameters α and β, we compute the predicted values of equation (12) and get an estimate of the $gamma\theta_i + \upsilon_i + \epsilon_{i,t}$ term. Averaging this latest term over time we obtain an estimate of the firm specific-time invariant component of the residual. In the second step, we regress the average residual on the vector Z_i, human capital composition, industry and regional dummies. The two-steps procedure allows us to estimate the second step without the possible sources of biases arising from capital and labour correlations with time invariant effect υ_i. In order to run the first step coefficients, we use the GMM procedure as

[8]The firm level dataset contains unbalanced information for 2008 and 2009. With the most part of firms belonging to the 2009 survey, the number of observations for which data are available for both 2008 and 2009, is restricted to 178 firms. We provide first difference estimation of the effort equations on this limited sample of firms as a robustness check.

highlighted in Blundell and Bond (2000) that show how other panel estimators than the system give unreliable low values of production factors parameters.[9]

3. Data Description

The empirical analysis is based on a sample of about 2000 Italian firms. The data are derived from the annual survey carried out by the Italian Manufacturing and Service Industries Association. The survey represents a unique source of information on firms' wage strategy (wage structure for different type of workers) and numerical flexibility practises (both in terms of stocks and flows). Moreover it provides detailed information on the human capital characteristics of workforce employed in the firms and working time. Though the survey is conducted annually information on the wage structure and absenteeism is only available for the years 2008 and 2009. The sample is comprising of 25% of observations in 2008 and 75% in 2009. [10] The questionnaire consists of three main sections. The first section asks questions on the employment composition of the firm (by sex, type of contract, education and qualification), employment flows (hires by type of contract, number of fixed-term contracts converted to permanent, separation by reason). The second part of the questionnaire asks questions on working time (including overtime and hours of absence by reason). Finally the third part of the questionnaire reports detailed information on wage structure by qualification including the variable pay component disentangled in performance premium (generally based on firms performance) and other individual premium and bonus (generally related to individual and team performance). The data from the Confindustria Survey are matched with information on balance sheets data, provided by AIDA database, information on the conditions and characteristics of the local labour market[11] collected by the Italian National Institute of Statistics (ISTAT) and union membership by sector of activity and localization obtained from the Italian trade union confederations.

In order to compute residuals for the Black and Lynch (2001) procedure we have firm budget data for the production function, from 2000 to 2009, that are still available in the AIDA database.

[9] Results using the standard fixed effect estimator are qualitatively and quantitatively similar to those obtained using the GMM procedure and are available from the authors.

[10] We take into account this features of the sample in several ways in the estimations.

[11] Italy's Local Labour Systems (Sistemi Locali del Lavoro) are defined as self-contained labour markets with respect to daily commuting trips. The Italian territory is partitioned into 686 local labour systems using the Population Census of 2001.

4. Results

4.1. **3SLS pooled estimation results.** Table 1 and Table 2 show the three stage least squares results for the production function and for the effort equation for all firms pooled together[12]. In each table, Column (1) reports the unweighted estimates, while in column (2) observations belonging to the two different surveys (2008 and 2009) are weighted differently so that the results are not entirely driven by the results in 2009. Specifically, the weights are the inverse of the number of observations by year, so that both years have the same impact on the final results.

The Cobb-Douglas production function fits well the data: the coefficients have the expected signs and the CRS hypothesis is not rejected. The fact that the coefficient of labour is higher than the textbook expectation is usually explained in the growth accounting tradition by the fact that we should consider also human capital together with physical capital stock[13] and it is in line with previous empirical works at firm level (Konings and Vanormelingen, 2010). Moreover, our specification of labour as effort augmented is not rejected by the data so that labour input measured as number of workers in full-time equivalent units and the effort indicator have the same coefficient[14]. More qualified workers are more productive than blue collars with a productive premium of being white collars of about 20 percent. The presence of a higher share of graduates has a positive effect although not significant at conventional levels. Temporary forms of employment do not appear to have a significant direct effect on productivity .

TABLE 1 AROUND HERE

The coefficients of the effort equation as in specification (2) are presented in Table 2. Wage flexibility appears to have a negative impact on the average level of effort inside the firm although the coefficient is only marginally significant and becomes not significant in the sample-weighted regression. Also the other monetary forms of incentivation do not have a significant impact on effort.

[12]All regressions include year, macro-region and industry dummies. Firms are classified according to the sectoral classification identified by the national collective agreement (Contratto Collettivo Nazionale del Lavoro, CCNL) applied in the company. We define 10 productive sectors: food and beverages, textiles, footwears and leather products, rubber and plastic products, chemical and pharmaceutical products, metalworking, other manufacturing sectors, construction, trade, transport and telecommunication, other service.

[13]See for instance Caselli, 2005.

[14]The restriction is tested and then imposed in the model.

TABLE 2 AROUND HERE

Considering the effect of numerical flexibility of labour utilization inside the firms on permanent workers' effort, we can see that the level of absenteeism increases with the share of temporary workers employed by the firms both if we consider the flow (temporary hirings) and the change in the stock. Moreover such effect appears to be quantitevely and qualitatively the same whatever the type of temporary contract we consider either they are fixed-term employment contracts or atypical contracts (external collaborations and agency contracts). The negative effect of fixed term contracts is decreasing with the probability of a temporary worker of obtaining a permanent position at the current employer and becomes positive when the conversion rate into permanent positions is above 35%[15].

Since our measure of effort concerns permanent workers only, this result suggests that a high degree of job instability may be detrimental for effort and motivation of those who held a permanent position. Theoretically, this may be explained by arguing that when temporary employment is used as a buffer for permanent employment, workers with a permanet job position in the firm have a higher incentive to shirk because the workforce adjustments in case of negative shocks will be primarily carried out through changes in temporary workers flows[16]. Moreover, there is a large socioeconomic literature which relates workers effort to the working environment characteristics and to co-workers' behaviour. This strand of literature predicts that an increase in the degree of uncertainty and precariousness inside the firm may lead to a deterioration in the working environment, reduce workers cooperation and undermine workers' motivations and effort.

In order to control for the effect of legislative protection on workers' shirking behaviour, we use a dummy variable (art. 18 in Table 2 and following tables) which assumes value 1 for firms with a number of employees larger than 15. This dummy captures the effect of employment protection legislation, firing costs being significantly lower in firms below 15 employees in Italy. After controlling for firm size, the coefficient of the dummy variable for EPL strictness is not significant at

[15]The conversion rate is calculated as the share of fixed term contracts that became permanent during the current and previous year over the total numbers of such contracts that existed during the same period. In our sample, less than 30% of the firms which employ on temporary basis report a value above the 35% threshold.

[16]According to Goux et al. (2001), when temporary employment is used as a buffer for permanent employment, establishments foreseeing a decline in net employment in the long run opt to increase their temporary job or worker flows to accommodate their current demands while still keeping future dismissal costs low.

conventional levels. On the other hand, absenteeism increases with the firm size at a decreasing rate. The negative size-effect on effort can be due both to differences in the degree of workers protection also related to a higher degree of unionization of large firms (Origo, 2009) and to difficulties of monitoring performance in large organizations.

Finally, considering workforce characteristics, higher absenteeism is related to a large share of part-time workers, a large share of women (this result is in line with Ichino and Moretti, 2010) and a large share of blue collar workers.

In the second specification of the empirical model we remove the assumption of perfect substitutability between white and blue collar workers and we estimate separately the effort equation for the two types of workers.

TABLE 3 AROUND HERE

The results of the production function substantially confirm the conclusion reported in the previous set of estimates. Considering the effort equation of white collar workers, a larger share of variable wage premium (which is the share of remuneration linked to firm's performance) and other wage premium (linked to individual performance) have a positive and significant effect on workers' effort reducing the absenteeism. Moreover, as in the aggregate case, the share of fixed tem contracts is negatively signed, suggesting that instability is detrimental to workers' effort when the conversion rate to permanent employment is low. Finally the coefficient on the rate of unemployment in the local labour market is positive and significant, implying an increase in effort when the outside options are less favourable. The effects of numerical flexibility on the blue collars' effort (Table 4) are qualitatively similar, with some differences in the magnitude and significance of the estimated parameters. Differently from the white collars' effort equation, that blue collars' effort is not affected by monetary incentives, all the controls for wage flexibility being not significant. This different response to monetary incentive may be due to difference in the risk attitude of blue collar workers (Prendergast, 1999; Sloof and Praag, 2008) and differences in skill endowment (Bonner and Sprinklbut, 2002).

TABLE 4 & TABLE 5 AROUND HERE

Finally Table 6 reports the regressions of the effort equations (aggregate, white collars and blue collars) in first differences rather than in levels for a restricted sample of firms in order to control for firm-specific time invariant fixed effects. We still find a positive and statistically significant effect of the variable wage premium on white collars' effort and a negative effect of temporary employment on both white collars and blue collars' effort. This seems to confirm the prevoius conclusions that wage flexibility can have a postive impact on effort and then on firms productivity, while numerical flexiblity is detrimental for productivity through the negative impact on effort.

TABLE 6 AROUND HERE

4.2. **Panel data two-step estimation results.** Now we address the issues of potential bias in the estimate of the production function coefficients caused by the correlation among unobserved time invariant effects and productive factors. Our first step is the estimation of a simple Cobb-Douglas production function using information on capital and labor (number of workers), from 2000 through 2009 (1988 firm-year observations). GMM system estimations in the first step are reported in the first panel of Table 7. By a cursory look, regression is highly significant, standard specification tests hold[17] and constant return to scale is not accepted. As expected, the estimated coefficient on capital stock is now larger than the one reported in Table 1, while that on labour input is smaller[18]. Using these first-step estimates, we then calculate the average residual for each firm in the sample. The second panel of Table 7 shows the second-step results obtained from regressing the average residuals on the controls which were previously included in the effort equations. In this way we want to check whether monetary incentives and numerical flexibility has a direct and significant effect on firms productivity once we control for unobserved time-invariant characteristics in the estimation of the coefficeints of the production function. All the effects appear to be qualitatively similar to those estimated using the three stage least squares technique. In particular, the presence of a performance-related premium for white collars has a positive and significant effect on productivity while the same premium paid to blue collar workers has no impact on aggregate productivity. As

[17]The common factor test shows that the nonlinear restrictions implied by the dynamic representation of production function with an autoregressive error component is not rejected and the difference version of the Sargan test accepts the validity of the instruments. Both of these tests are in line with the results of Blundell and Bond (2000).

[18]The coefficients on capital and labour input cannot be exactly compared with those in Table 1 also because in this second set of regressions the sample is different (slightly smaller) and we are not controlling for the quality of labour input (human capital, effort and the share of white collars) when we estimate the production function.

in the previous set of regressions, numerical flexibility is positively related to productivity only when convertion rates from temporary to permanent employment are high enough[19]. This finding is consistent with the theoretical predictions that when fixed term contracts are used as a screening device, they can be beneficial in terms of productivity because they improve the quality of the match between firms and workers and reduce turnover.

4.3. **SEM Robustness check: an alternative effort proxy.** In this section we present an alternative way to estimate the effects of wage and numerical flexibility on productivity through workers' effort. We treat effort as an unobservable (latent) variable, and we use some observable variables that are potentially correlated with effort to model it and its impact on productivity. To this aim, we use the Simultaneous Equation Modelling (SEM) technique[20]. In line with the analysis developed in the previous section, we classify the exogenous (latent) determinants of effort as: wage flexibility ξ_1, numerical flexibility ξ_2 and workforce characteristics ξ_3. In turn, we assume that these latent exogenous variables influence some exogenous observables x_j such as the share of variable wage premium or the share of temporary workers. The relationships among latent and observed variables represent the so called *measurement* model, which is the following set of equations (in compact and logarithmic form) as follows[21]:

$$x_j = \varphi_j' \xi + \omega_j \tag{15}$$

$$y = \lambda e + \sum_{k=1}^{K} \beta_k \; x_k + \epsilon \tag{16}$$

In equation (15) x_j are the observable exogenous variables which are determined by the exogenous (latent) factors $\xi_{1,2,3}$ through φ[22]. In (16) y is value added, x_k are manifest exogenous, that are human and physical capital inputs which affect directly y and e is the endogenous latent effort with

[19]The threshold for conversation rate above which the effect of the share of temporary workers becomes positive and significant is around 20%

[20]For a description see Bollen, 1989, Corbetta, 2002, Kline, 2010.

[21]Suffix $_i$ which identify firms is omitted in order to simplify the notation

[22]The exogenous variables included in the vector x_j are the same regressors included in the vector Z as determinants of effort in equation (3). See page 6 for a full description of the variables.

λ being its impact coefficient on productivity. Finally ω_j and ϵ are error terms in equation (15) and (16) respectively.

The *structural* model links the exogenous latent determinants $\xi_{1,2,3}$ to the endogenous latent effort as follows:

$$e = \gamma_1\xi_1 + \gamma_2\xi_2 + \gamma_3\xi_3 + \nu \tag{17}$$

Where $\gamma_{1,2,3}$ are the impact coefficients of the structural model and ν is the error term. Figure n.1 in the appendix shows the links among latent and observed variables.

We then estimate the correlation matrices[23] among variables and put a constraint for each equation containing a latent variable in order to identify the system[24]. The model is estimated through maximum likelihood, while we use the confirmatory factor analysis to extract latent factors from the observed exogenous variables. We estimate the coefficients for the two years of the survey separately because we cannot include categorical variables to identify common time specific shocks that are relevant given the nature of our sample. Table 6 describes our results. In this case we don't have separate tables for each equation but aggregate results for the whole system [25].

TABLE 6 AROUND HERE

We notice that the fit of the regression is good and the production function has coefficients very close to the 3SLS estimation. However the estimates are different in the two years. Using the 2008 data, the results show that the effort is significant and positively correlated with productivity. Moreover the coefficients of the latent exogenous variables are consistent with the empirical findings of the previous section. In particular, the results show that wage flexibility has a positive effect on effort and through effort on productivity, while numerical flexibility has an opposite impact. The results obtained for the 2009 survey are qualitatively the same, however the coefficients are smaller and/or less precisely estimated.

[23]All the exogenous variables have the same scale because are expressed in deviation from the means. This way we have a correlation matrix instead of a covariance matrix.

[24]The model described by equations (15)-(17) has a structure that is similar to the 3SLS model we estimated in the previous section, except for the fact that we have endogenous latent variables on the right hand side with coefficients φ,λ. If we have identity equations among y and $\mathbf{e}$ and $\mathbf{x}$ and ξ then all the x variables influence directly y as in a standard reduced form estimation.

[25]We use the R package called sem, by Fox, 2006.

5. Conclusions

Some final considerations may be drawn from our work: first wage flexibility appears to have a positive and significant effect on effort and then (still positive) on firm's productivity. The results hold using both absenteeism as a standard proxy of effort and a latent variable to describe it. This is confirmed with an additional check given by a GMM based panel estimation where wage flexibility has a direct positive effect on productivity. Second, white collars are more responsive to monetary incentives than blue collars. Finally we found that a higher share of temporary contracts has a negative impact on permanent workers' effort when the conversation rate of jobs from temporary to permanent is low. This may happen either because a larger share of fixed term workers implies a lower dismissal probability for permanent workers, or because an increase in the degree of precariousness inside the firms can lead a deterioration in the working environment and reduce workers' motivation and effort. Through the framework of production function we used, this has a indirect negative effect on firm productivity.

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TABLE 1. Production function: 3SLS results

Dependent variable: Value Added

	Absolute variables	Weighted variables
Labour input (E=eL)	0.607*** (0.029)	0.679*** (0.025)
Physical Capital Stock	0.187*** (0.019)	0.204*** (0.017)
Share temporary workers	-0.206 (0.270)	-0.136 (0.239)
Share white collars	0.723*** (0.128)	0.715*** (0.116)
Share graduate workers	0.082 (0.181)	0.040 (0.228)
Time dummies	yes	yes
Sectorial dummies	yes	yes
Macro-regional dummies	yes	yes
Observations	2098	2098
R^2	0.58	0.70
P-value l=e	0.66	0.25

***,** ,* indicate sign. at 1, 5 and 10%.
Standard errors between brackets
Labour input and capital stock had been instrumented with the lagged values

TABLE 2. Effort equation

Dependent variable: workers' effort

	Pooled estimation	Pooled weighted
Wage Flexibility		
Share variable wage premium	-0.056* (0.031)	-0.046 (0.031)
Share other wage premium	0.007 (0.023)	0.022 (0.024)
Superminimum differentials	0.000 (0.000)	0.001 (0.001)
Seniority differentials	-0.001 (0.000)	-0.001 (0.000)
Numerical Flexibility		
Risk of dismissals	-0.028* (0.015)	-0.035** (0.016)
Hiring rate	-0.000 (0.003)	0.002 (0.003)
Share of temporary hiring	-0.005** (0.002)	-0.008*** (0.003)
Share of temp. workers	-0.038*** (0.014)	-0.068*** (0.016)
Share of temp. workers*trans. to permanent	0.109*** (0.042)	0.208*** (0.047)
Share of apprenticeship workers	-0.007 (0.015)	-0.013 (0.017)
Share of collaborators	-0.009 (0.009)	-0.002 (0.018)
Share of interinal workers	-0.0001** (0.000)	-0.0001** (0.000)
Labour and firm characteristics		
Share of part time workers	0.002 (0.012)	-0.023* (0.012)
Presence of supervisors	-0.003 (0.002)	-0.002 (0.002)
Share women	-0.031*** (0.005)	-0.027*** (0.005)
Share of white collars	0.031*** (0.005)	0.034*** (0.005)
Firm size	-0.016*** (0.004)	-0.014*** (0.004)
Firm size squared	0.001*** (0.000)	0.001** (0.000)
Institutional and labour market characteristics		
Dummy art. 18	0.001 (0.003)	-0.003 (0.003)
Unemployment rate by province 2006	0.000 (0.001)	0.000 (0.001)
Metropolitan area	-0.003 (0.002)	-0.004* (0.002)
Presence of an industrial district	0.001 (0.002)	0.001 (0.002)
Year dummies	yes	yes
Sectorial dummies	yes	yes
Macro-regional dummies	yes	yes
Observations	2098	2098
R^2	0.15	0.14

***,** ,* indicate sign. at 1, 5 and 10%.

Standard errors between brackets

TABLE 3. Production function with two labour inputs: 3SLS results

Dependent variable: Value Added

	Pooled	Pooled weighted
Labour Input$_{WHITE}(E = eL)$	0.410*** (0.028)	0.452*** (0.025)
Labour Input$_{BLUE}(E = eL)$	0.186*** (0.028)	0.211*** (0.024)
Physical Capital Stock	0.191*** (0.019)	0.212*** (0.019)
Share temporary workers	-0.354 (0.273)	-0.273 (0.245)
Share graduate workers	0.548** (0.276)	0.456** (0.225)
Time dummies	yes	yes
Sectorial dummies	yes	yes
Macro-regional dummies	yes	yes
Observations		2103
R^2	0.57	0.70
P-value l=e	0.70	0.22

***,** ,* indicate sign. at 1, 5 and 10%.
Standard errors between brackets
Labour input and capital stock had been instrumented with the lagged values

TABLE 4. Effort equation with two type of workers: White collars

Wage flexibility		
	Pooled	Pooled weighted
Share variable wage premium	0.078** (0.039)	0.091** (0.038)
Share other wage premium	0.042 (0.028)	0.086** (0.029)
Super minimum differential	0.000 (0.001)	0.001 (0.001)
Seniority differential	-0.001 (0.001)	-0.001 (0.001)
Numerical flexibility		
	Pooled	Pooled weighted
Risk of dismisalls	-0.034** (0.014)	-0.056*** (0.016)
Hiring rate	-0.005 (0.003)	0.004 (0.004)
Share of temporary hiring	-0.001 (0.003)	-0.002 (0.003)
Share of temp.workers	-0.058*** (0.018)	-0.074*** (0.020)
Share of temp. workers*trans.	0.130** (0.054)	0.236*** (0.057)
Share of apprenticeship	-0.004 (0.020)	-0.014 (0.022)
Share of collaborators	0.007 (0.011)	-0.003 (0.012)
Share of interinal workers	-0.000 (0.000)	-0.000 (0.000)
Labour and firm characteristics		
	Pooled	Pooled weighted
Share of part-time workers	-0.006 (0.015)	-0.022 (0.015)
Presence of a supervisor	0.000 (0.003)	0.001 (0.003)
Share of women	-0.018*** (0.006)	-0.014** (0.006)
Share of white collars workers	-0.007 (0.006)	-0.009 (0.007)
Share of graduate workers	-0.033*** (0.012)	-0.029** (0.012)
Firm size	-0.015*** (0.005)	-0.016*** (0.005)
Firm size^2	0.001** (0.000)	0.001** (0.000)
Institutional and labour market characteristics		
	Pooled	Pooled weighted
Art. 18	0.004 (0.004)	0.006 (0.004)
Unemployment rate	0.001 (0.001)	0.002** (0.001)
Metropolitan area	-0.001 (0.003)	-0.002 (0.003)
Presence of an industrial district	0.001 (0.002)	0.002 (0.003)
Year dummies	yes	yes
Sectorial dummies	yes	yes
Macro-regional dummies		yes
Observations	2098	2098
R^2	0.07	0.08

***,**,* indicate sign. at 1, 5 and 10%.
Standard errors between brackets

TABLE 5. Effort equation with two type of workers: Blue collars

Wage flexibility		
	Pooled	Pooled weighted
Share variable wage premium	-0.021 (0.037)	0.001 (0.037)
Share other wage premium	0.001 (0.028)	-0.003 (0.029)
Super minimum differential	0.000 (0.001)	0.001 (0.001)
Seniority differential	-0.001 (0.001)	-0.001 (0.001)
Numerical flexibility		
	Pooled	Pooled weighted
Risk of dismissals	-0.001 (0.013)	-0.016 (0.015)
Hiring rate	0.003 (0.003)	0.006* (0.003)
Share of temporary hiring	-0.009** (0.003)	-0.007** (0.003)
Share of temp.workers	-0.046*** (0.018)	-0.080*** (0.020)
Share of temp. workers*trans.	0.127** (0.052)	0.204** (0.056)
Share of apprenticeship	-0.017 (0.019)	-0.022 (0.021)
Share of collaborators	-0.020* (0.011)	-0.021* (0.012)
Share of interinal workers	-0.000*** (0.000)	-0.000** (0.000)
Labour and firm characteristics		
	Pooled	Pooled weighted
Share of part-time workers	-0.007 (0.014)	-0.030** (0.015)
Presence of a supervisor	-0.006** (0.003)	-0.006** (0.003)
Share of women	-0.024*** (0.006)	-0.021*** (0.006)
Share of white collars workers	-0.038*** (0.006)	0.042*** (0.006)
Share of graduate workers	-0.032*** (0.012)	-0.009 (0.012)
Firm size	-0.018*** (0.005)	-0.014*** (0.005)
Firm size^2	0.001** (0.000)	0.001** (0.000)
Institutional and labour market characteristics		
	Pooled	Pooled weighted
Art. 18	0.000 (0.004)	-0.004 (0.004)
Unemployment rate	0.001 (0.001)	0.001 (0.001)
Metropolitan area	-0.006** (0.003)	-0.006** (0.003)
Presence of an industrial district	0.000 (0.002)	0.001 (0.003)
Year dummies	yes	yes
Sectorial dummies	yes	yes
Macro-regional dummies		yes
Observations	2098	2098
R^2	0.15	0.15

***,**,* indicate sign. at 1, 5 and 10%.
Standard errors between brackets

TABLE 6. Effort equations: First differences estimation

Wage flexibility			
	Effort	Effort white collars	Effort blue collars
Share variable wage premium	0.057 (0.063)	0.190*** (0.065)	-0.012 (0.099)
Share other wage premium	-0.017 (0.043)	0.070 (0.052)	-0.004 (0.050)
Super minimum differential	0.001 (0.003)	0.005** (0.002)	-0.001 (0.004)
Seniority differential	-0.001 (0.003)	-0.008 (0.007)	-0.006 (0.005)
Numerical flexibility			
	Effort	Effort white collars	Effort blue collars
Risk of dismissals	0.030* (0.016)	0.037** (0.017)	0.042* (0.022)
Hiring rate	0.003 (0.006)	0.000 (0.007)	0.005 (0.009)
Share of temporary hiring	0.001 (0.006)	0.006 (0.006)	0.001 (0.008)
Share of temp.workers	-0.155**(0.070)	-0.229** (0.096)	-0.115 (0.084)
Share of temp. workers*trans.	0.356*** (0.130)	0.439** (0.170)	0.338** (0.147)
Share of apprenticeship	-0.033 (0.043)	-0.103 (0.066)	-0.018 (0.049)
Share of collaborators	-0.002 (0.018)	0.005 (0.016)	0.010 (0.029)
Share of interinal workers	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Labour and firm characteristics			
	Effort	Effort white collars	Effort blue collars
Share of part-time workers	0.002 (0.037)	0.010 (0.033)	-0.015 (0.076)
Presence of a supervisor	-0.007 (0.007)	-0.004 (0.008)	-0.008 (0.009)
Share of women	-0.043** (0.017)	-0.017 (0.014)	-0.045* (0.023)
Share of white collars workers	0.035*** (0.013)	-0.019 (0.015)	0.024 (0.016)
Share of graduate workers	0.001 (0.016)	0.001(0.018)	-0.004 (0.023)
Firm size	-0.023*** (0.008)	-0.015 (0.010)	-0.027*** (0.009)
Firm size^2	0.002** (0.001)	0.001 (0.001)	0.002** (0.001)
Observations	356	356	356
R^2	0.24	0.15	0.23

***,** ,* indicate sign. at 1, 5 and 10%.
Standard errors between brackets

TABLE 7. Robustness checks: Two step GMM results

First Step: Value Added 2000-2009	
Labour input	0.491*** (0.090)
Physical Capital Stock	0.359*** (0.058)
Year dummies	yes
Observations	11425
Wald χ^2	8032 (0.000)
Comfact (prob.)	0.21
Diff. Sargan (prob.)	0.29
Second Step: WLS on Avg residuals	
Share variable wage premium white collar	0.473** (0.216)
Share variable wage premium blue collar	0.046 (0.213)
Share other wage premium white collar	0.160 (0.228)
Share other wage premium blue collar	-0.222 (0.224)
Super minimum differentials	0.011 (0.007)
Seniority differential	-0.009*** (0.003)
Share of women	-0.111 (0.264)
Share of graduate workers	0.221*** (0.074)
Share of temp.workers	0.037 (0.102)
Share of temp. workers*trans.	0.859*** (0.299)
Share of apprenticeship	0.019 (0.109)
Share of collaborators	0.172 (0.109)
Risk of dismissions	0.001 (0.009)
Presence of supervisors	0.037*** (0.014)
Share of part-time workers	-0.080 (0.077)
Unemployment rate	-0.010** (0.004)
Size	-0.024 (0.018)
Size^2	0.004** (0.002)
Sectorial dummies	yes
Regional dummies	yes
Observations	1988
R^2	0.090
F prob.	(0.000)

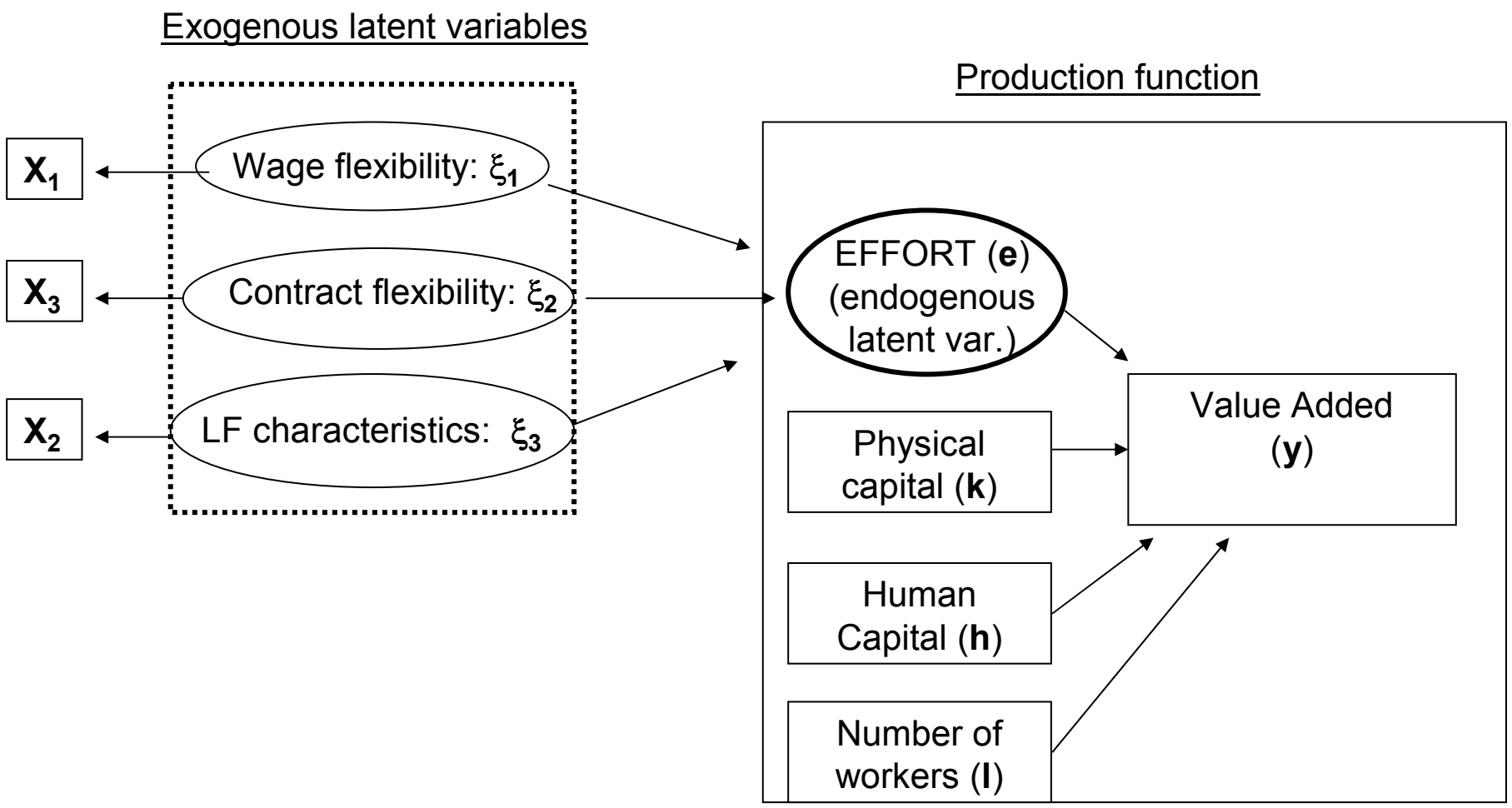
***,** ,* indicate sign. at 1, 5 and 10%.
Standard errors between brackets

TABLE 8. Production function: SEM results

Dependent variable: Value Added		
	Year 2008	Year 2009
Stock of Labour	0.697*** (0.021)	0.437*** (0.029)
Physical Capital Stock	0.264*** (0.021)	0.239*** (0.029)
Share graduate workers	0.070*** (0.015)	0.069*** (0.019)
Effort	0.093*** (0.027)	0.324(0.606)
Effort determinants		
Wage flexibility	0.814** (0.372)	0.219 (0.426)
Numerical flexibility	-0.467* (0.285)	-0.049 (0.132)
Labour force and firm characteristics	1.000 (constraint)	1.000 (constraint)
Wage flexibility exogenous observed variables		
Seniority differentials	0.218** (0.069)	0.006 (0.057)
Superminimum differentials	0.171** (0.068)	0.005 (0.058)
Share of variable wage premium	0.205** (0.068)	0.197*** (0.047)
Share of other variable premium	1.000 (constraint)	1.000 (constraint)
Numerical flexibility exogenous observed variables		
Share of fixed term workers	0.288*** (0.060)	0.124*** (0.047)
Share of part-time workers	0.141** (0.071)	-0.017 (0.041)
Share of apprenticeship	1.000 (constraint)	1.000 (constraint)
Share of collaborators	0.044 (0.072)	0.205*** (0.041)
Share of atypical workers	-0.076 (0.071)	-0.053 (0.041)
Share fired or dismissed workers	-0.118* (0.070)	-0.016 (0.040)
Labour characteristics exogenous observed variables		
Share of white collars	1.000 (constraint)	1.000 (constraint)
Share of women	0.495*** (0.057)	-0.010 (0.061)
Observations	758	1631
Goodness of fit index	0.75	0.78
P-value model χ^2	0.000	0.000

***,** ,* indicate sign. at 1, 5 and 10%.
Standard errors between brackets

SEM STRUCTURE



X_1=(Risk of dismissals, Seniority differentials, Superminimum differentials, Share of variable wage premium, Share of other variable premium)
X_2=(Share of fixed term workers, Share of part-time workers, Share of apprenticeship, Share of coll., Share of atypical workers, Share dismissed workers)
X_3= (Share of white collars, Share of women)