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Labour market flexibility and productivity growth: new evidence from firm-level data

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Abstract: Various theories suggest the existence of a negative relationship between external labour flexibility and productivity growth, arguing that firms' utilisation of flexible arrangements may reduce the incentives to innovation and internal training, and decrease workplace cooperation. This paper aims at providing new evidence on the occurrence of these effects in Italy, where the changes in labour legislation in the last fifteen years (alongside with an 'institutional' wage moderation period) have been accompanied by a considerable job creation process, but also by a significant labour productivity slowdown.

The paper explores these aspects by using microdata from a unique firm-level database provided courtesy of ISFOL (the Italian Institute for Vocational Training). The ISFOL RIL (*Rilevazione su Imprese e Lavoro*) survey refers to the universe of firms operating in the non-agricultural private sector in 2005, and provides very detailed information about firms' utilisation of labour. In order to link the information concerning labour forces to indicators of firm performance, assets and labour costs, a sub-sample of the RIL dataset has been merged with balance sheet data coming from the Bureau Van Dijk AIDA archive, available for a nine-years period (1997-2005). As a consequence, a final sample of around 5,000 firms presenting longitudinal data on value added, labour productivity, labour costs and fixed capital, and cross-sectional data on firms' composition of the labour force by contractual arrangements, has been used.

In order to estimate the effect of fixed-term contracts on labour productivity growth, a two-step approach has been adopted. Namely, in the first stage we estimated an equation for labour productivity growth by applying both the within estimator and the Arellano and Bover (1995) system-GMM estimator (in order to control for the potential endogeneity of right-hand side variables). Subsequently, the individual effects estimated in the first stage have been regressed on cross-sectional information concerning the utilisation of fixed-term contracts, free-lance workers and temporary help workers.

The results of second-stage estimation pointed at a negative correlation between the utilisation of fixed-term contracts and labour productivity growth at firm level, providing some evidence for the hypothesis that labour market deregulation curbed, to a certain extent, the incentives of employers to innovate. These considerations raise some doubts concerning the sustainability of recent labour market reforms in the long run.

Keywords: labour flexibility, fixed-term contracts, labour productivity

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Introduction

This paper aims at providing new evidence on the link between firms' use of fixed-term contracts and labour productivity growth, by relying on a unique firm-level database provided courtesy of ISFOL, the RIL (Rilevazione su Imprese e Lavoro) survey.

In Lucidi (2007), we tried to assess the effects of external labour flexibility (along with wage moderation) on labour productivity growth for a sample of Italian manufacturing firms in the period 2001-2003. To do this, according to data availability[1], we estimated (in a cross-sectional framework) a modified version of Sylos Labini's labour productivity equation, augmented by including lagged labour flexibility indicators (the share of fixed-term contracts and total labour turnover) among right-hand side variables. Results pointed at a negative and significant correlation between flexibility indicators and the growth of value added per worker in the estimation period. Moreover, lagged labour costs in both levels and growth rates displayed a positive effect on labour productivity growth during the period, providing some evidence on the role of the 'wage push' hypothesis for labour-saving technical progress at firm level.

However, some aspects of this analysis seemed to deserve further investigation. First, the limitation to the manufacturing industry called for an extension to other sectors and in particular to services, where flexible contractual arrangements show a more intensive utilisation. Second, the simple cross-sectional framework adopted for the regression analysis[2] did not allow to take into consideration the existence of unobserved heterogeneity (firms' individual effects), with potentially harmful consequences for the consistence of estimated parameters.

The availability of the RIL dataset offers an attractive chance to provide an answer to these issues, allowing to carry out a robustness check for previous findings. On the one hand, the RIL dataset, being representative of the universe of firms operating in the non-agricultural private sector, and providing a high level of detail on the utilisation of flexible contractual arrangements at firm level, can help extending the field of the analysis to the whole economy and, in particular, to services. On the other hand, its merge with longitudinal data on labour productivity and labour costs extracted from the Bureau Van Dijk AIDA dataset (covering up to nine time periods for a sub-sample of firms, i.e. from 1997 to 2005) allows to deal simultaneously with the presence of firms' unobserved fixed effects in the equations for productivity growth, as well as with the endogeneity of explanatory

[1] The "Indagine sulle imprese manifatturiere" provided courtesy of Capitalia bank was used in that context.
[2] No attempt was made to merge with the previous wave of the survey (which covered the period 1998-2000) in order to avoid a strong reduction in the number of observations due to the incidence of missing values.

variables, by using the panel structure of the data in order to find 'internal' instrumental variables.

In such a context, a usual estimation strategy to identify the effect of cross-sectional variables on the dependent variable (in this case, labour productivity growth) is to adopt a two-step approach (Black and Lynch, 2001; Cristini *et al.*, 2003; Zwick, 2004). Accordingly, in the first stage we estimated a version of Sylos Labini's labour productivity equation, by applying both the within estimator and the Arellano and Bover (1995) GMM-SYS estimator (in order to control for the endogeneity of explanatory variables). Subsequently, the individual effects estimated in the first stage were regressed on a series of cross-sectional controls, including the composition of the labour force by different contractual arrangements.

The structure of the paper is as follows. Section 1 provides some theoretical background about the relationship among labour flexibility, innovative activity and productivity growth. The dataset and the variables used for the empirical estimation are described in Section 2, while the estimation methodology is presented in Section 3. Section 4 presents estimation results, and a concluding section summarizes and draws some policy implications.

1) Some theoretical considerations

The Italian labour market underwent radical transformations in recent years. In face of the high and increasing levels of unemployment recorded at the beginning of the 1990s, a thorough reform process occurred in the field of labour market flexibility, with the aim to create a more labour-friendly environment for both employers and employees. Labour market reforms occurred "at the margin": from 1997 on, various legislative changes eased the conditions for hiring workers on fixed-term contracts and introduced new 'atypical' contractual arrangements, while leaving substantially unchanged the employment protection granted to permanent workers (thus falling into the definition of "two-tier" reforms). Along with these changes, a long period of wage moderation took place, as a consequence of the 1992 and 1993 agreements, which drastically reformed the wage bargaining system after about half a century of automatic wage indexation (*scala mobile*) [3].

[3] Though the wage moderation episode seems to have mostly institutional roots (see Zenezini, 2004; Tronti, 2007; Brandolini et al., 2007), the deregulation of fixed-term contracts cannot be considered unrelated to it. In fact, even if in principle workers accepting temporary jobs should demand, *ceteris paribus*, a risk premium to off-set the chance of not being hired permanently on expiry of their temporary contracts (*compensating differentials theory*), empirical evidence from Italy (Picchio, 2006) and from other countries (Segal and Sullivan, 1995; Sànchez and Toharia, 2000; Booth et al., 2002; McGinnity and Mertens, 2004; Addison and Surfield, 2005) shows that fixed-term workers, on average, earn less than regular workers even after observed and unobserved personal characteristics

After almost a decade since the beginning of this process, the combined results of these events actually point at an increased job creation during the period (the employment rate increased from 51.8% in 1995 to 58.4% in 2007), although high employment growth came along with a huge increase of the fixed-term share over total employment (in particular, the share of fixed-term employees over total employees increased by five percentage points from 7.3% in 1995 to 13.2% in 2007), as well as with an emerging labour market segmentation. It seems interesting to observe that the bulk of employment growth occurred in a context of substantial economic stagnation, pointing at an increased elasticity of employment to output (with respect to the pre-reform period). A consequence of this situation came to light in terms of stagnating (and even decreasing in some years) labour productivity[4], entailing potentially harmful effects in terms of long-term competitiveness for Italian firms.

The impact of (external) labour market flexibility on innovation and, subsequently, productivity growth has been quite debated in the literature (Lucidi, 2007). While, on the one hand, it has been claimed that the availability of flexible contractual arrangements favours the shift of labour from declining sectors to developing ones, thus easing technological advance and structural change, an increasing stream of the literature suggests different causes why labour market deregulation may actually harm innovative activity, by favouring technological laggards, retarding the process of dynamic substitution between labour and capital, reducing the incentives to the provision of firm-sponsored training, and lowering workplace cooperation. In the latter context, the utilisation of flexibility may benefit firms that follow a "low road" to competitiveness, based on passive price competition and cost scrapping (especially in traditional industries), rather than on process and product innovation.

In detail, four main theoretical headings have been identified to explain the direct and indirect effects of external labour flexibility (along with wage moderation) on productivity growth. These four transmission channels involve:

a. effects on firms' innovative activity;
b. effects on workforce training;
c. effects on workplace cooperation;
d. the impact of aggregate demand on productivity growth.

Under the first heading, it has been argued that labour market deregulation may inhibit the innovative activity within firms, by providing employers with incentives to maintain labour-intensive production processes and slowing down, in a Schumpeterian perspective,

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have been controlled for. This evidence is confirmed by estimates of firm-level wage equations in Spain (Bentolila and Dolado, 1994) and the Netherlands (Kleinknecht et al., 2006).

[4] For a detailed analysis of the Italian productivity slowdown, see for instance ISTAT (2006, 2008).

the process of *creative destruction* (Kleinknecht, 1998; Naastepad and Kleinknecht, 2004; Kleinknecht et al., 2006). On this view, innovative firms are deemed to be better able to compete in a context of higher costs (both labour costs and adjustment costs due to stricter regulation). By contrast, looser regulation and (downward) wage flexibility can be considered as a grant to low-productive firms competing through 'low-road' practices, that is preferring cost scrapping to innovation. While the effects on job creation may be positive (at least in the short run[5]), an ultimate loss of entrepreneurship quality and lower innovation, with detrimental effects on economic growth, may occur in the long run.

In this perspective, it should be taken into account the 'classical' viewpoint of Sylos Labini (1984, 1993, 1999), according to whom wage increases[6] (and, by extension, labour market rigidity) represent a stimulus for the adoption of technological innovations intended to save labour both in absolute terms (by increasing workplace efficiency) and relative ones (by dynamically substituting labour with capital)[7]. This process is influenced by firms' market power, in particular by the capacity to transfer labour cost increases onto prices by means of mark-up pricing. In a competitive environment entrepreneurs will have a greater incentive to enhance labour productivity in order to preserve their profit share. Bhaduri (2006) has recently proposed a model of endogenous growth built on such a mechanism, along similar lines of reasoning.

The standard view on this matter generally suggests an alternative position: namely that greater labour market rigidity may have negative effects on productivity because it hampers the reallocation of labour "from old and declining sectors to new and dynamic ones" (for a review of the effects of labour market institutions on economic performance see Nickell and Layard, 1999). However, while this effect may be apparent at a higher level of aggregation, it does not seem relevant when the performance of individual firms within a given sector is considered. In a similar vein, some authors argue that, in rigid labour markets, the adjustment costs (due to expensive firing of redundant personnel) arising from the adoption of a new technology may inhibit the innovative process itself[8] (Bassanini and Ernst, 2002;

[5] Boeri and Garibaldi (2007) maintain that the introduction of two-tier labour market reforms is likely to produce positive effects on employment, though limited to the short run ('honeymoon effect'), entailing as well a temporary reduction of labour productivity due to the occurrence of diminishing returns to labour. That is, the decrease of labour productivity is explained by the participation into the labour market of workers with lower marginal productivity. Conversely, effects of labour market reforms on firms' innovative activity are not envisaged.

[6] In particular, with respect to the price of 'machinery'.

[7] In this perspective, dynamic substitution between capital and labour differs from the static substitution, with constant technology, implied by the neoclassical production function as a response to the relative variation in the prices of factors. The former, in fact, involves technological change incorporated in new capital goods (Sylos Labini, 1993).

[8] An analogous mechanism may be at work if decentralized unions appropriate the rents deriving from innovation and productivity gains through higher wage claims (this is the classical *hold-up* problem: for literature surveys see Metcalf, 2003 and Menezes-Filho and Van Reenen, 2003).

Scarpetta and Tressel, 2004). Nonetheless, the real occurrence of these effects seems to depend on the nature of industrial relations, on whether employees can be internally reassigned ('functional' flexibility), and whether internal activities can be contracted out. This position has also been challenged by part of the neoclassical literature: for example, a model that explicitly links the presence of firing costs with greater scope for process innovation has been presented by Saint-Paul (2002).

The existence of a trade-off between static (allocative) efficiency, which may be increased by deregulating the labour market, and long-term competitiveness (in terms of productivity gains) is well highlighted by Boyer (1993), through the concept of 'wage-labour' nexus. In particular, two main configurations of the wage-labour nexus may emerge: "the first adopts defensive adjustments, by developing atypical labour contracts and sometimes preserving obsolete technology by low wages. This might be quite efficient in creating jobs and containing unemployment, but rising inequalities and poor productivity performance are usually the cost to be paid for such a short-run flexibility. The second model develops a long-term strategy based on innovation, product quality and differentiation, which supposes quite different labour contracts based on long-run commitment to the firm and a permanent modernization of organization and equipment" (Boyer, 1993, p. 66).

Turning to the second heading, it appears obvious that labour flexibility impacts on training and human capital accumulation. If labour relationships are expected to be short-lived, there is little incentive for firms to invest in both the general and specific training of their workforces (firms need an adequate pay-back period in order to recoup their investment costs). Workers, for their part, will be reluctant to acquire firm-specific skills if they do not feel a long-term commitment to their employers (Bélot et al., 2002). Similar conclusions emerge from the hypothesis that higher labour flexibility (in particular, along the wage dimension) reduces the compression of the wage structure (both within and between firms), which is one of the main determinants for the provision of firm sponsored training (Acemoglu and Pischke, 1999; Agell, 1999). The result of higher labour flexibility could therefore be an under-investment in on-the-job training, with potentially negative effects on productivity growth. Empirical evidence of a negative correlation between fixed-term employment and the probability of receiving work-related training has been provided for the UK by Arulampalam and Booth (1998) and Booth et al. (2002).

Turning to the third heading (effects of labour flexibility on productivity via workplace cooperation), a strand in the literature supports the idea that productivity-enhancing effects ensue from 'high trust' or 'high road' human resources management practices, and from cooperative labour relations (Huselid, 1995; Buchele and Christiansen, 1999; Lorenz, 1999; Michie and Sheehan, 2001, 2003; Naastepad and Storm, 2005). According to these theories, higher on-the-job protection and subsequent cooperative relationships between management and employees may positively affect firm performance, encouraging innovative activity and promoting efficiency gains.

Finally, it should be noted that labour flexibility (as well as wage moderation) may have negative effects on aggregate demand, both directly and indirectly (for example, through increases in precautionary saving by employees with temporary jobs), and, through this channel, may negatively affect labour productivity growth. Various theories suggest indeed that there is a direct link among demand growth, innovation and labour productivity growth, both assuming the occurrence of dynamic increasing returns (via the so-called 'Verdoorn-Kaldor law')[9] and on a demand-pull hypothesis concerning innovative activity (Schmookler, 1966; Brouwer and Kleinknecht, 1999).

A number of empirical analyses have been conducted on the effects of labour flexibility on productivity growth (labour productivity and/or TFP) or on the innovative activity of firms. The majority of these studies focuses on the country or sectoral level (Buchele and Christiansen, 1999a, 1999b; Nickell and Layard, 1999; Bassanini and Ernst, 2002; Scarpetta and Tressel, 2004; Auer et al., 2005; Naastepad and Storm, 2005), and most of them report a positive effect of employment protection (measured by the OECD index or other indicators) on productivity growth or other innovation indicators. Auer et al. (2005) find a positive (though decreasing) relation between job stability, measured as average tenure, and labour productivity. The paper by Scarpetta and Tressel (2004), however, shows a negative effect of employment protection, mainly in countries with sectoral and uncoordinated wage bargaining. The distinction among different industrial relations models is also considered by Bassanini and Ernst (2002), who assert that EPL strictness is significantly correlated to technological specialization in countries with coordinated relations.

Only a few studies, conversely, report firm-level evidence. In particular, Michie and Sheehan (2001, 2003) studied the impact of various flexibility practices on innovation indicators for British firms, evidencing a negative effect of external flexibility and a positive effect of functional flexibility. Similar results have been obtained with reference to labour productivity growth by Dekker and Kleinknecht (2004) and Kleinknecht et al. (2006) for Dutch firms. Arvanitis (2005) found a positive relationship between functional flexibility and labour productivity for a sample of Swiss companies, but a not significant effect of external flexibility. Autor et al. (2007) analysed the effects of dismissal protection (envisaged as legal exceptions, adopted by some state courts in the U.S., to the 'employment-at-will' common law doctrine) on a sample of U.S. firms, finding a positive effect of employment protection on capital investment, skills and labour productivity, but a negative effect on total factor

[9] For a recent survey about the 'Verdoorn-Kaldor law', see McCombie et al. (2002).

productivity. As for Italy, Boeri and Garibaldi (2007) complemented their theoretical model with preliminary evidence on a sample of manufacturing firms in the period 1995-2000 and found a negative effect of the share of fixed-term contracts on labour productivity growth[10]. Finally, Pieroni and Pompei (2008) found a negative effect of labour turnover (as a proxy for external flexibility) on patenting activity in the regions of Northern Italy[11].

2) The data

The analysis reported in the following paragraphs has been feasible due to the availability, courtesy of ISFOL, of the first wave of the RIL (*Rilevazione Imprese e Lavoro*[12]) dataset, which refers to 2005. The RIL survey has been conducted with the aim to fill a gap in the availability of information about the diffusion of flexible staffing arrangements in Italy. In fact, the focus of the survey is on firms, which represent the unit of analysis. This constitutes an important difference with respect to other sources currently available, which usually look at individuals or households (Labour Force Survey, INPS archive, Bank of Italy SHIW dataset, etc.). An exception is the survey carried out by Confindustria (see Confindustria, 2007) whose universe, however, is limited to member companies; other firm-level surveys (for example the *Indagine sulle imprese manifatturiere* by Capitalia bank, used in Lucidi, 2007), though providing information on the characteristics of the labour force, are not explicitly designed to inspect labour relationships.

The RIL survey refers to the universe of firms operating in the non-agricultural private sector (thus including also services), sampling both partnerships (*società di persone*) and limited companies (*società di capitali*). The sample, stratified by firm size, industry, geographical area and legal form, counts 21,728 firms. According to the aims of ISFOL, the survey will be performed every two years (the second wave is likely to be released in 2008), and a group of firms will be tracked longitudinally, in order to obtain a panel and to assess the evolution of firms' behaviour over time.

The peculiarity of this survey stands in the availability of very detailed information about firms' utilisation of labour. In particular, the dataset provides complete information about the structure of the labour force, disaggregated by type of contract (full-time or part-time, open-ended or temporary, with a thorough specification of all the contractual arrangements currently available in Italy), gender (for each type of contract) and qualification (blue-collars,

[10] They used data from the Capitalia survey on manufacturing firms as in Lucidi (2007) whose results, however, refer to the period 2001-2003 and to a quite different specification for labour productivity equations.
[11] We include their analysis in this section even if at regional rather than firm level, for its relevance to support our view about the Italian case.
[12] Survey on Firms and Employment.

white-collars, managers). Unfortunately, no information about the educational levels of the workforce is included; conversely, useful insights on industrial relations are provided, with variables reporting firms' unionisation, existence and modes of firm-level bargaining, and hours of work lost due to strikes.

In order to link the information concerning labour forces to indicators of firm performance, assets and labour costs, a sub-sample of the RIL dataset has been merged with balance sheet data coming from the Bureau Van Dijk AIDA archive, available for a nine-years period (1997-2005). This dataset collects balance sheets for limited companies with turnover higher than 100,000 euros (from 2004 on; 500,000 euros, previously); moreover, it provides the number of employees, which represents an important information in view of our analyses, due to its panel dimension (which allows us to consider the evolution over time of labour costs per worker and labour productivity).

After the merge, we end up with a reduced dataset composed by a panel section including balance sheet data, and a cross section (referred to 2005) containing information on the composition of firms' labour force and on industrial relations. According to the characteristics of the RIL and AIDA datasets, the representativeness of this merged sub-sample is restricted to limited companies. However, its coverage over the sample of limited companies in RIL (10,817 firms) is good, with a percentage of merged firms over 50% from 2000 on, and approaching 90% in 2004[13].

Beside the restriction to limited companies, there also emerges a problem of over-representation of larger firms, mostly due to the turnover criterion, which increases the probability of inclusion in AIDA for larger firms (at least until 2004, when the turnover threshold has been reduced to 100,000 euros). Table 1 shows the composition of the RIL dataset by firm size.

It appears evident that, with respect to the full sample (composed both by limited companies and partnerships), the sample containing only limited companies, as expected, shows a lower share of small (micro) firms: firms with less than 10 employees decrease from 46.1% to 27.9% of the total, while the fraction of firms with at least 50 employees almost doubles. When using the RIL-AIDA merge, different statistics could be provided according to the year considered (for example, if we refer to 2004 balance sheets, available for about 90% of limited companies in RIL, the comparability of the samples is very high). It appears more meaningful to refer to the final sample used for estimations, which counts almost 5,000 observations (the next section will provide information about the inclusion criteria).

[13] The growth of the coverage over years is due both to the increase of firms included in the AIDA archive in recent years (as a result of methodological changes), and to the fact that more "recent" firms do not provide, obviously, balance sheets for the years preceding their opening. However, the most recent firms in the RIL dataset have been established in 2002, therefore this problem is limited to the years 1997-2001.

Table 1. Composition of the sample by firm size.

	RIL, full sample		RIL, only ltd. companies		RIL-AIDA final sample (with balance sheets)	
	Number	**% of total**	**Number**	**% of total**	**Number**	**% of total**
1-9 employees	10,024	46.1	3,020	27.9	436	8.8
10-49 employees	8,967	41.3	5,156	47.7	2,514	50.6
50-249 employees	2,054	9.5	1,960	18.1	1,497	30.1
250 and more employees	683	3.1	681	6.3	525	10.6
Total	21,728	100.0	10,817	100.0	4,972	100.0

With respect to the sample of limited companies, we observe a shift in the distribution by size from firms with less than 10 employees (decreasing from 27.9% to 8.8% of the total) to firms with more than 50 employees, while the fraction of firms with 10 to 49 employees does not change considerably. Unsurprisingly, the turnover criterion hits primarily smallest firms, causing their under-representation in the final sample.

3) The methodology

Due to the peculiar structure of the sample, where each firm presents cross-sectional information on the composition of the labour force (referred to 2005), and longitudinal information on the other variables, a 'two-step' estimation procedure has been adopted. Namely, in the first step a labour productivity equation has been estimated using panel techniques, thus taking into account the existence of firms' fixed effects (potentially correlated with the regressors); subsequently, in the second step the estimated individual fixed effects were regressed on a series of cross-sectional controls, including the composition of the labour force by different contractual arrangements. This is a common strategy to estimate the effect of time-invariant variables in fixed-effect models (where, due to the estimation procedure, time-invariant variables are dropped), or of variables which, though being time-variant in principle, are available only in cross-section. Some recent examples of the latter case, applied to a context similar to ours (analysis of the effects of functional flexibility and new work practices on productivity) can be found in Black and Lynch (2001), Cristini et al. (2003) and Zwick (2004)[14].

[14] Black and Lynch (2001) assessed the effect of workplace practices on productivity by estimating in the first step a Cobb-Douglas production function for a panel of establishments in the period 1987-1993 (via the within and GMM estimators), and, in the second step, by regressing the average residuals on cross-sectional data (referred to 1994) including information on workplace practices, industrial relations, recruitment strategies and training investments. An analogous exercise has been carried out for Italy by Cristini et al. (2003), who merged a survey on workplace practices conducted in Lombardy in 1999 with longitudinal data (taken from balance sheets) covering the period 1990-1999. It should be noted that, due to the high number of work practices which were

It seems important to remind that the panel section of the RIL-AIDA dataset is unbalanced, that is, the number of observations per firm varies from a minimum of 1 to a maximum of 9 (or 8, when taking into consideration growth rates, as we do in this paper). Since our primary interest is to estimate firms' individual effects, whose estimation is consistent for "large" *t*, we dropped firms exhibiting less than four observations in the relevant variables. That is, we end up with an unbalanced panel including 4 to 8 observations per firm, in order to mediate between the need of estimating individual effects consistently, and the loss of information (as well as potential selection bias) occurring in case of a further restriction of the sample[15]. This choice, though arbitrary, does not appear to affect significantly the estimation results. However, for sake of completeness, Appendix B provides evidence also for the balanced panel including only firms for which information is available through the whole period 1998-2005[16].

In summary, after excluding firms exhibiting missing values in relevant variables, and operating a trimming procedure to eliminate extreme and unrealistic values from variables (excluding observations falling out the first and last 0.5 percentile), we end up with a sample counting almost 5,000 firms, which has been used for estimation purposes.

The details of the two-step estimation procedure are hereby explained. In the first stage, we estimated a modified version of Sylos Labini's labour productivity equation (Sylos Labini, 1984, 1993, 1999)[17], amended for the application to firm level data (see also Lucidi, 2007). The utilisation of Sylos Labini's model appeared suitable, in this framework, since it explicitly allows for the occurrence of dynamic increasing returns (via the so-called Verdoorn law), and for the effects of wage dynamics on productivity growth, allowing to investigate the validity of a 'wage-push' hypothesis for innovative activity, which appears worth testing in our context (since the growth of flexible labour and wage moderation appeared closely related in recent years). As in the intention of Sylos Labini's original model, the growth rate

considered in the survey, principal component analysis has been carried out by the authors in order to reduce the number of regressors in second step estimates. Finally, Zwick (2004) estimated the impact of employee participation on productivity by first estimating a Cobb-Douglas production function (for a 1997-2000 panel) and then regressing individual effects estimates on employee participation variables referred to 1996 and 1997. In order to correct for the endogeneity of participation in the second step, this variable has been instrumented by using external instruments (two variables on expected personnel problems concerning skill gaps and two training forms).

[15] Note that both Cristini et al. (2003), and Zwick (2004) use unbalanced panels for their estimations.

[16] It seems important to remark that also estimations using the full unbalanced panel (all observations with $t>1$) substantially confirm the results presented throughout the chapter (results are available upon request).

[17] Differently from models based on the production function, Sylos Labini's model explains productivity growth by means of three components. Specifically, productivity increases (at aggregate level) depend on: the variation of wages relative to the price of investment goods ('Ricardo effect'); the growth of aggregate demand, in order to allow for the existence of dynamic increasing returns (Verdoorn law); investment expenditures, in order to consider the impact of new technology embodied in new fixed capital and not captured by the other factors. See Corsi and Guarini (2007) for a review on Sylos Labini's function.

of labour productivity (measured as value added per employee) has been explained by means of three "effects", namely:

a) the "Smith" effect (corresponding to the Verdoorn coefficient, measuring the existence of dynamic increasing returns), which has been assessed by including the growth of firms' value added among regressors;
b) the "Ricardo" effect, catching the effect of dynamic substitution between labour and capital, which has been measured by including among regressors the growth rate of labour costs per worker, as a ratio to the deflator of gross fixed investment at 2-digit sectoral level (a proxy of the "price of machinery");
c) the growth rate of the fixed capital stock per employee[18] (replacing the variable "investments", originally included in Sylos Labini's model, but not directly computable from firms' balance sheets), which catches the effect of technical innovation embodied in new fixed capital and not captured by the other factors.

The estimated equation in the first stage is therefore:

$$\widehat{\left(\frac{y_{it}}{l_{it}}\right)} = \alpha + \beta_1 \hat{y}_{it} + \beta_2 \widehat{\left(\frac{w_{it}}{pma_{it}}\right)} + \beta_3 \widehat{\left(\frac{k_{it}}{l_{it}}\right)} + v_i + u_t + \varepsilon_{it} ,$$

where the circumflex indicates growth rates. In summary, $\widehat{(y_{it}/l_{it})}$ is the growth rate of labour productivity, $\hat{y}_{it}$ is the growth rate of firms' value added, $\widehat{(w_{it}/pma_{it})}$ is the growth rate of labour costs relative to the price of machinery, $\widehat{(k_{it}/l_{it})}$ is the growth rate of fixed capital per employee, v_i is the firm's individual effect, u_t indicates the inclusion of time dummies (to control for common time shocks) and ε_{it} is the idiosyncratic error term[19]. Some of the estimated specifications of the model also include the lagged dependent variable and one lag for the regressors, as in Sylos Labini's model possible delays are considered in order to verify the impacts of right-hand side variables on productivity growth.

It seems interesting to notice that, apart from the "Ricardo" effect, this specification of Sylos Labini's equation essentially corresponds to an "augmented" Verdoorn law (see for instance Michl, 1985; Mc Combie et al., 2002; McCombie and Roberts, 2007), where capital deepening is added in the standard specification of the Verdoorn law. According to this

[18] Due to data availability, fixed capital stock has been included at book value (net of amortization). Lacking information on investments, it has not been possible to use the perpetual inventory method to calculate the value of the fixed capital stock.

[19] It seems important to specify that firm-level value added and fixed capital have been deflated, respectively, by the value added deflator and the fixed investments deflator at 2-digit sectoral level (taken from national accounts).

consideration, the baseline model has been estimated without including the growth rate of the ratio between labour costs per worker and the price of fixed investments, in order to verify how the inclusion of this variable impacts on the other coefficients.

An immediate concern about the above specification comes from the endogeneity of right-hand side variables. This issue, which is usually acknowledged for the estimation of the Verdoorn law (due to the simultaneous inclusion of output on both sides of the equation) and is variously addressed in the related literature, in our case appears relevant also for the other regressors. It is worth noting that a consistent estimation of the coefficients in the first stage is crucial to estimate consistently also the fixed effects, which is our main concern in view of second-stage estimation.

The treatment of endogeneity, in a context of panel data exhibiting "large *n*" and "small *t*", has been undertaken by resorting to the system GMM (GMM-SYS) estimator proposed by Arellano and Bover (1995). The GMM-SYS estimator has been proven to increase the efficiency of the standard Arellano and Bond (1991) difference GMM estimator, which takes first differences to eliminate unobserved firm-specific effects and uses lagged levels of the variables as instruments to correct for endogeneity in the equation in first differences. As Blundell and Bond (1998) demonstrate, the difference GMM estimator often performs poorly because past levels contain little information about future changes (this is likely if variables are close to random walks), so that they may represent "weak instruments" for first-differenced variables. The GMM-SYS estimator, instead, uses lagged first differences as instruments for variables in the equation in levels, in addition to lagged levels as instruments for variables in the equation in first differences[20]. Using the additional conditions, a gain in efficiency is obtained, ensuring more precise estimates for coefficients.

The approach used in the estimation of our labour productivity growth equation appears similar to that adopted by Seguino (2007), who used FE and GMM estimators to assess the occurrence of the Verdoorn law in a panel of industries in semi-industrialized countries. In a similar fashion, we will present results from both procedures, in order to visualise how the correction for endogeneity affects the coefficients estimates. As suggested by Roodman (2006), dealing with an unbalanced panel, we used the "forward orthogonal deviations" transformation proposed by Arellano and Bover (1995) instead of the standard first differences transformation when estimating GMM regressions. In fact, the first difference transformation increases gaps in unbalanced panels (if some y_{it} is missing, both Δy_{it} and Δy_{it+1} are missing in the transformed equation). Forward orthogonal deviations, instead, subtracting from each observation the average of all *available* future observations, expunge

[20] The additional orthogonality conditions in the GMM-SYS estimator are valid if changes in any instrumenting variable *w* are uncorrelated with the fixed effects, i.e. $E[\Delta w_{it} v_i] = 0$ for any *i* and *t* (see Roodman, 2006 for details).

fixed effects (as the first differences transformation does) but minimizing data loss. Moreover, as lagged observations do not enter this transformation, they are still valid as instruments[21].

As for the choice of instruments, the usual rule in the GMM approach is to start from the first lag for pre-determined variables, and from the second for endogenous ones (Roodman, 2006). However, the standard approach to validate the instruments choice is to look at the Hansen test for over-identifying restrictions, and at the difference-in-Hansen test, which allows to test the validity of instruments subsets. Nonetheless, these tests are weakened by the inclusion of an excessive number of instruments (this problem, however, is likely to emerge when the number of individuals is "small" with regards to the number of instruments, which is not the case in our situation). According to these observations, by looking at the results of the Hansen test, we chose to include instruments starting from (t-3) for variables included simultaneously in the labour productivity equation, and from (t-2) for variables originally included with a lag[22]. Moreover, in order to limit the instruments count, we chose to stop at (t-4) in both cases[23]. Time dummies, which allow to control for productivity shocks common to all firms (and whose inclusion is crucial for testing correctly the auto-correlation of the residuals) are always included as "external" instruments.

Once consistent estimates of the parameters have been computed, we calculated for each firm the average of the residuals over the period 1998-2005, in order to obtain an estimate of the firm-specific, time invariant component of the residual. In the second step, we regressed these estimated individual effects on variables concerning the utilisation of labour flexibility, plus the usual controls including firm size, geographical area and industry dummies.

To be precise, in the second step we included, as explanatory variables, four dummies indicating firm's utilisation of fixed-term employees covered by collective bargaining (in the following, simply "fixed-term employees"), contract workers[24], temporary help workers and on-the-job training workers[25]; in alternative, we included the share of each category of

[21] The implementation of the orthogonal deviations transform is an option available in the Stata command *xtabond2*. It seems interesting to observe that the utilisation of this transformation requires a change in the one-step GMM weighting matrix, which, in this case, becomes simply the identity matrix (for details, see Roodman, 2006).

[22] The need of an "extra" lag to achieve the validity of instrument with regards to the standard rule probably depends on the fact that our variables in levels are already growth rates, thus conveying in t also information concerning $t-1$.

[23] Anyway, estimations results would not change substantially in absence of this parsimonious limit.

[24] We collect under the definition of "contract workers" (*prestatori d'opera*) three contractual arrangements identifying contingent workers employed on their own and free-lance workers. These contractual arrangements, namely project workers (*collaboratori a progetto*), "employer-coordinated free-lance workers" (*collaboratori coordinati e continuativi*), and occasional workers (*collaboratori occasionali*) are formally classified among self-employed, but are actually employed by firms, in many cases, as substitutes for regular workers.

[25] We collect under the definition of "on-the-job training contracts" (*contratti a causa mista*) apprenticeship contracts and training and work contracts (*contratti di formazione e lavoro*).

workers over total employment[26]. In a further specification, in order to catch possible non-linearities, we transformed each share in a set of dummies indicating respectively no utilisation, low utilisation (less than 5% of total employment), medium utilisation (from 5% to 20% of total employment) or high utilisation (more than 20%) of the specified contracts. This categorization, though arbitrary, appears quite informative as it will be apparent from the estimation results.

It should be noted that the explanatory variables included in the second step should be considered quasi-fixed during the estimation period (Zwick, 2004). This is a demanding assumption: though it can be assumed that firms' preferences about the exploitation of labour flexibility practices are slowly changing, the period under analysis is quite long (eight years), and various laws during the period provided for a deregulation of fixed-term arrangements. It should also be noted that our two-step approach does not take into account the possible occurrence of endogeneity in the second stage: in particular, one might think that a firm's decision to hire on fixed-term contracts could be related to poor business performances, culminating in slow labour productivity growth. The occurrence of such a reverse causality could produce biased coefficients.

By the way, the existence of a 'vicious circle' between the utilisation of labour flexibility and slow productivity growth has been explicitly taken into account from a theoretical point of view. In particular, we argued that technological laggards may be induced by a slack labour regulation to follow "low road" practices (utilisation of flexible labour), which in turn may affect negatively long-term competitiveness prospects.

In this context, we suggest to consider the results of the second step estimations as simple correlations between the unexplained component of labour productivity growth and the utilisation of atypical contractual arrangements, without the ambition to infer about causal effects. However, room is open for further research on this point. Two directions appear worthwhile for future research, namely looking for "external" instruments for the utilisation of fixed-term contracts, or using the second wave of the RIL survey (when it will be available) to track longitudinally the utilisation of flexible contractual arrangements at firm level (as in Black and Lynch, 2004).

The next section will provide econometric evidence about both first and second step estimations.

[26] Our classification into different categories closely resembles those used by Houseman (2001) and Gramm and Schnell (2001).

4) Econometric results

Table 2 presents first-step estimations of labour productivity growth equations in the period 1998-2005. As anticipated in the previous section, we estimated as baseline model (columns 1 and 2) an ″augmented Verdoorn law″ (considering as explanatory variables the growth rates of value added and fixed capital stock per employee), while including in columns 3 and 4 the "Ricardo effect", i.e. the growth rate of labour costs per employee as a ratio to the deflator of fixed investments at 2-digit sectoral level. Both the "augmented Verdoorn law" and the basic Sylos Labini's equation have been estimated by both the within groups (FE) estimator and the Arellano and Bover (1995) GMM-SYS estimator, thus taking into account the existence of individual fixed effects, as explained in the previous section.

In columns (5-7) we estimated Sylos Labini's equation dinamically, by including lagged productivity growth (to verify the occurrence of a catch-up process among firms) and, in succession, the "Ricardo" effect with a lag (without including it simultaneously), the lagged growth of the capital stock per employee, and, in column 7, both variables in addition to the simultaneous "Ricardo" effect. Due to the inclusion of the lagged dependent variable, the latter equations have been estimated only by GMM (being aware of the well-known inconsistency of the FE estimator in this case).

It could be observed that, in columns (1-4), all the estimated coefficients present the expected sign and show statistical significance. As for the "augmented Verdoorn law", the correction of endogeneity made by the GMM estimator (whose instruments' validity is assessed by the value of the Hansen statistic and by the absence of second order correlation in the residuals) leads to an increase of the coefficients on both the growth rates of value added and fixed capital per employee. This is somehow contrary to our priors for what concerns the Verdoorn coefficient, which is expected to be upward-biased in the FE specification, but turns from 0.591 to 0.795 after the correction for endogeneity[27].

However, a higher than expected Verdoorn coefficient could probably stem from the omission of relevant variables. This hypothesis is confirmed when the "Ricardo" effect is included into the baseline equation (columns 3-4). In this specification, in fact, it can be observed that the Verdoorn coefficient stands at around 0.5, slightly decreasing in the GMM specification with regards to the FE one.

[27] It should be noted that usual estimations of the Verdoorn coefficient stand between 0.30 and 0.70 (see McCombie et al., 2002).

Table 2. Determinants of labour productivity growth using within and GMM estimators (first-step estimation)

	(1) FE	(2) GMM	(3) FE	(4) GMM	(5) GMM	(6) GMM	(7) GMM
Smith effect	0.591***	0.795***	0.537***	0.511***	.726***	0.736***	0.648***
	(0.009)	(0.232)	(0.005)	(0.158)	-0.187	(0.192)	(0.153)
Ricardo effect			0.907***	0.853***			0.846***
			(0.003)	(0.076)			(0.069)
Ricardo effect (t-1)					0.105	-0.033	-0.018
					(0.124)	(0.173)	(0.080)
Growth of capital stock per employee	0.370***	0.527***	0.055***	0.160**	0.768***	0.778***	0.151**
	(0.003)	(0.113)	(0.002)	(0.080)	(0.083)	(0.086)	(0.067)
Growth of capital stock per employee (t-1)						0.127	0.024
						-0.113	(0.054)
Growth of labour productivity (t-1)					-0.095	-0.100	-0.017
					(0.119)	(0.123)	(0.069)
Constant term	-0.036***	-0.077**	0.012***	0.007	-0.060***	-0.063***	-0.023***
	(0.010)	(0.031)	(0.005)	(0.022)	(0.015)	(0.016)	(0.007)
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of firms	4972	4972	4972	4972	4756	4756	4756
Number of observations	31003	31003	30956	30956	24751	24712	24688
Number of instruments	-	36	-	50	63	63	63
Hansen (p-value)	-	18.29 (0.865)	-	37.17 (0.553)	62.62 (0.149)	61.28 (0.153)	47.63 (0.569)
AR(1) (p-value)	-	-14.42 (0.000)	-	-6.78 (0.000)	-7.60 (0.000)	-2.57 (0.010)	-4.43 (0.000)
AR(2) (p-value)	-	-0.36 (0.712)	-	-0.14 (0.892)	-1.33 (0.182)	-1.33 (0.183)	-0.83 (0.409)

One-step GMM-SYS estimation with robust standard errors in columns (2) and (4-7)
Dependant variable: labour productivity growth. 'Smith effect': growth rate of value added. 'Ricardo effect': growth rate of labour costs per employee as a ratio to the deflator of fixed investments at 2-digit sectoral level.
Standard errors in parentheses. Estimation period: 1998-2005. * Significant at 10%; ** significant at 5%; *** significant at 1%.

Turning to the "Ricardo" effect, it should be noted that the coefficient attached to the growth of labour costs relative to the price of fixed capital shows an upward bias in the FE specification, turning from 0.907 to 0.853 after the correction for endogeneity. This coefficient measures the elasticity of labour productivity with respect to labour costs (deflated by the price of fixed capital at sectoral level). In principle, a coefficient taking on a value of approximately one should insure the constancy of the labour share on firms' value added[28], while a coefficient of less than one is coherent with an increase of the labour share if an exogenous increase of labour costs per worker occurs (after controlling for the other variables)[29]. Conversely, in a context of decreasing labour costs (in real terms), a coefficient of less than one is consistent with a decrease of the labour share: this is exactly the situation which occurred in Italy during the last decade, when, in spite of its stagnation, real wages grew less than labour productivity, causing an increase of the profit share on national income (Zenezini, 2004; Tronti, 2007).

According to Sylos Labini's model, the size of this coefficient is influenced by firms' market power, i.e. by the capacity to transfer labour costs onto prices by mark-up pricing. In particular, in a competitive environment, firms are more stimulated to raise labour productivity rather than shifting labour costs on prices; this should translate into a higher coefficient on the "Ricardo" effect. In this regard, it seems interesting to analyze how this coefficient changes among different sectors. Appendix A shows estimates of Sylos Labini's equation estimated at sectoral level (industry, construction and services). It should be noted, in particular, that industry (manufacturing plus energy production and supply) shows an elasticity coefficient of approximately one, coherent with the constancy of the wage share, while construction and services exhibit a lower coefficient (that could be explained by a less competitive market structure in those sectors, or, alternatively, by lower chances of dynamic labour/capital substitution)[30].

In columns 5 to 7 we estimated the model dynamically, including the lagged dependent variable (in order to allow for the occurrence of a catch-up effect) and specifying different lag structures for the regressors, according to Sylos Labini's original estimation of the model (where lags were allowed for both the "Ricardo" effect and the investments variable). Interestingly, it can be observed that all lagged variables do not show statistical significance at conventional levels; in particular, the lagged "Ricardo" variable does not display a significant effect on productivity growth, even if included alone[31].

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[28] This condition, at aggregate level, is better known as "Bowley's law" (see Tronti, 2007b).

[29] The hypothesis that this coefficient is statistically different from 1 is accepted by a Wald test at 5% significance level.

[30] Interestingly, it could also be noted that the magnitude of the "Smith" effect is higher in manufacturing than in services, coherently with the hypothesis of stronger increasing returns in manufacturing.

[31] In Sylos Labini's model, the effect of real wage increases on labour productivity growth in the short run may stem from an "organization effect", i.e. by a higher scope for internal restructuring, while the effect in the longer run is explained in terms of "dynamic substitution" between labour and capital. The evidence from our data seems to support the occurrence of the first hypothesis rather than the second one.

According to this evidence, we will rely on the equation in column 4 as our favourite specification of the model, and we will use it (together with the equation in column 2) as our starting point for the second-step estimation[32].

Table 3 shows estimates of second-step regressions, where the dependent variable is the vector of firm fixed-effects, which has been estimated by averaging firm-specific residuals over time[33]. As it can be observed, the specification includes alternatively four dummies for the utilization of different typologies of flexible contractual arrangements (fixed-term employees, contract workers, temporary help workers and on-the-job training contracts) or their shares over the total workforce. As additional controls, dummies for firm size, geographical area and industry (not shown in the table) have been included. Robust standard errors have been computed.

Looking at the first two columns, the utilisation of both fixed-term employees and on-the-job training contracts comes out to be negatively correlated with labour productivity growth (the latter with a higher statistical significance when Sylos Labini's equation is estimated at the first stage). In particular, the use of fixed-term contracts seems associated with an yearly decrease of labour productivity by 1% if using Sylos Labini's model, and by 1.8% if using the "augmented Verdoorn law" model.

When looking at proportions, this evidence appears to a certain extent confirmed. The share of fixed-term employees still shows a negative and significant sign when Sylos Labini's equation is estimated at the first stage, though statistical significance disappears when the "Ricardo effect" is omitted. As for the coefficients' magnitude, a share of fixed term contracts standing at 10% appears correlated with an annual decrease of labour productivity by 0.63 percentage points[34]. It should be noted that, in this specification, the share of contract workers is positively correlated with productivity growth. This may be explained by the fact that, in many cases, contract workers are knowledge workers or consultants (different statistics point at a higher diffusion of these contractual typologies among workers with upper secondary and tertiary education). However, we are not able to take into account this issue, due to the absence of information on skills or educational levels in our dataset. Otherwise, this could be a spurious effect due to the fact that contract workers are considered self-employed, so that they should not enter the count of employees in the AIDA dataset (the denominator of labour productivity)[35].

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[32] It seems worth noting to observe that the validity of the instruments choice for both equations is confirmed not only by the overall Hansen test, but also by the difference-in-Hansen test performed on each subset of instruments and on the instruments in levels (results available upon request).

[33] Note that Table 3 refers to columns 2 and 4 in Table 2.

[34] It seems interesting to observe that the magnitude of this coefficient appears comparable with Lucidi (2007), where a 10% fixed-term share was correlated with a labour productivity decrease in 2001-2003 ranging from 1.38% to 2.71% (according to different specifications), i.e. between 0.69% and 1.35% per year.

[35] However, this issue should be more relevant in explaining differences in productivity *levels*, rather than *growth rates*. Nonetheless, we verified that the average growth of employment (observed in the AIDA data) in the period 1998-2005 is not statistically different between firms using or not using contract workers. Moreover, it should be remarked that the incidence of contract workers is far higher in small firms, where the risk of reporting unreliable information in balance sheets appears higher. Excluding from second-stage regressions firms with less than 10 employees (about 400 hundred firms) the coefficient of contract workers turns insignificant, while all the other results are confirmed.

Table 3. Effects of labour flexibility on average productivity growth 1998-2005 (second step estimation)

First-step eq. (column from Table 2)	(2)	(4)	(2)	(4)
Use of fixed-term employees	-0.018**	-0.010**		
	(0.008)	(0.004)		
Use of contract workers	0.009	0.007		
	(0.009)	(0.005)		
Use of on-the-job training contracts	-0.014*	-0.012***		
	(0.008)	(0.004)		
Use of temporary help workers	-0.008	-0.004		
	(0.009)	(0.005)		
Share of fixed-term employees			-0.065	-0.063**
			(0.046)	(0.028)
Share of contract workers			0.079**	0.043**
			(0.035)	(0.018)
Share of on-the-job training contracts			-0.023	-0.066*
			(0.066)	(0.035)
Share of temporary help workers			-0.156	-0.086
			(0.128)	(0.059)
10-19 employees	0.022	0.026**	0.026	0.026**
	(0.017)	(0.011)	(0.018)	(0.011)
20-49 employees	0.032*	0.026**	0.035*	0.024**
	(0.017)	(0.010)	(0.018)	(0.011)
50-249 employees	0.011	0.022**	0.015	0.021*
	(0.017)	(0.011)	(0.018)	(0.011)
250-499 employees	0.021	0.029***	0.024	0.027**
	(0.019)	(0.011)	(0.020)	(0.012)
More than 500 employees	0.050**	0.028**	0.051**	0.024*
	(0.021)	(0.013)	(0.022)	(0.013)
North-East	-0.003	-0.002	-0.004	-0.001
	(0.008)	(0.004)	(0.008)	(0.004)
Centre	-0.026**	-0.015**	-0.024**	-0.014**
	(0.011)	(0.007)	(0.012)	(0.007)
South	-0.034***	-0.027***	-0.029**	-0.022***
	(0.013)	(0.007)	(0.013)	(0.007)
Constant term	0.010	-0.022	-0.005	-0.027
	(0.028)	(0.024)	(0.029)	(0.025)
Number of observations	4972	4972	4914	4914
F-test (p-value)	2.19 (0.00)	3.15 (0.00)	2.19 (0.00)	3.39 (0.00)

Dependant variable: average residual from first-step estimation. Estimation method: OLS.
Robust standard errors in parentheses. * Significant at 10%; ** significant at 5%; *** significant at 1%.
Industry dummies are included

Looking at control variables, it appears evident that increasing firm size corresponds to higher labour productivity growth (in particular, with respect to firms with less than 10 employees). Moreover, if geographical area is taken into account, firms in Central and Southern regions show a worse performance, in terms of productivity growth, with respect to firms located in the North of Italy.

In order to provide a deeper insight into these results, we re-estimated these equations by looking at the existence of non-linearities in the relationship between labour flexibility and productivity growth. To do this, we transformed shares into categorical variables, including three dummies in the specification, respectively for: low utilisation of the indicated contractual arrangement (less than 5% of the workforce); medium utilisation (between 5% and 20% of the workforce); high utilisation (more than 20% of the workforce). The reference case, obviously, is represented by no utilisation of the specified contract.

Table 4. Effects of labour flexibility on average productivity growth 1998-2005 (second step estimation)

First-step eq. (column from Table 2)	**(2)**	**(4)**
Share of fixed-term employees: low	-0.003	-0.002
	(0.009)	(0.005)
Share of fixed-term employees: medium	-0.020**	-0.009
	(0.010)	(0.006)
Share of fixed-term employees: high	-0.042**	-0.039***
	(0.019)	(0.014)
Share of contract workers: low	-0.007	0.000
	(0.011)	(0.006)
Share of contract workers: medium	0.008	0.004
	(0.010)	(0.005)
Share of contract workers: high	0.025*	0.016**
	(0.013)	(0.007)
Share of temporary help workers: low	0.000	0.000
	(0.013)	(0.006)
Share of temporary help workers: medium	-0.006	-0.008
	(0.011)	(0.005)
Share of temporary help workers: high	-0.191*	-0.054
	(0.112)	(0.043)
Share of on-the-job training contracts: low	-0.020**	-0.012***
	(0.009)	(0.005)
Share of on-the-job training contracts: medium	-0.008	-0.011**
	(0.011)	(0.005)
Share of on-the-job training contracts: high	-0.002	-0.012
	(0.020)	(0.011)
10-19 employees	0.026	0.026**
	(0.018)	(0.011)
20-49 employees	0.038**	0.026**
	(0.018)	(0.011)
50-249 employees	0.023	0.025**
	(0.019)	(0.012)
250-499 employees	0.034	0.031**
	(0.021)	(0.012)
More than 500 employees	0.064***	0.029**
	(0.023)	(0.014)
North-East	-0.001	0.000
	(0.008)	(0.004)
Centre	-0.023**	-0.013*
	(0.012)	(0.007)
South	-0.029**	-0.022***
	(0.013)	(0.007)
Constant term	-0.001	-0.026
	(0.030)	(0.025)
Observations	4914	4914
F-test (p-value)	2.08 (0.00)	3.11 (0.00)

Dependant variable: average residual from first-step estimation. Estimation method: OLS.
Robust standard errors in parentheses. * Significant at 10%; ** significant at 5%; *** significant at 1%.
Industry dummies are included

Looking at Table 4, it can be observed that the negative correlation between fixed-term employees and labour productivity growth is more evident for firms making a massive use of this employment typology. This appears clear especially in column 4 (corresponding to the estimation of Sylos Labini's model in the first stage), which shows that only firms exhibiting a share of fixed-term employees higher than 20% experienced a significant decrease of labour productivity in the period 1998-2005 (by a yearly 3.9%). This seems to provide some evidence to the idea that low shares of fixed-term employees (hired, for instance, to perform specific skilled occupations, or to deal with production peaks) are not harmful to firm performance, while their abuse may lead to detrimental consequences on productivity growth.

As for the other results, it should be noted that the utilisation of on-the-job training contracts appears correlated with a decrease of labour productivity at all intensities of utilisation (column 4) and by a similar magnitude (around 1.2% per year), though only the dummies corresponding to a "low" and "medium" share reach the conventional levels of significance.

The negative effect of on-the-job training contracts on productivity could be explained by the lower proficiency at work of employees entailed with this kind of contracts, whose aim is to provide young workers with a training and probationary period. Finally, it seems worth noting that the estimated effect of a "high" share of temporary help workers shows a large negative coefficient, which, however, fails to achieve the standard levels of significance.

Appendix B shows the estimation results obtained by using the balanced sample, which contains firms where full information from the AIDA dataset was available in the period 1998-2005. First-step results appear in line with those achieved by using the unbalanced sample, although some coefficients differ in magnitude, while the growth rate of fixed capital per employee turns insignificant in the GMM specifications when the "Ricardo" effect is included[36]. Interestingly, according to second-step estimations, the utilisation of fixed-term employees maintains a significantly negative correlation with labour productivity growth, while the dummies for the utilisation of other contractual typologies never achieve statistical significance. However, when shares are included in place of dummy variables, the proportion of fixed-term employees appears negatively related to productivity growth, but the significance level falls to 10% (if Sylos Labini's equation is estimated at first stage). Moreover, differently from the results presented for the unbalanced sample, the negative coefficient on the share of temporary help workers here achieves statistical significance.

It seems useful to remember that these differences could actually depend on the different composition of the samples, the balanced one showing a far higher percentage of large and manufacturing firms (see Appendix C).

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[36] This result closely resembles the evidence showed in Table 6 for firms with more than 250 employees, due to the higher incidence of large firms in the balanced panel. This evidence implies that in larger firms, which are supposed to be more capital intensive, a stronger role of wage costs in explaining capital deepening is observed.

Concluding remarks

The empirical results presented in this paper provide some evidence in support of the existence of a trade-off between firms' utilisation of flexible contractual arrangements and labour productivity growth. This evidence appears stronger, among the different employment typologies, for the utilisation of fixed-term employees (namely, the same contractual category taken into account in Lucidi, 2007). Interestingly, on-the-job training contracts as well appear negatively related to labour productivity growth.

Among the side results of the paper, it should be noted that the adopted two-step estimation methodology allowed to perform an additional test for the estimation of Sylos Labini's productivity equation at firm level. The application of the Arellano and Bover (1995) GMM-SYS estimator on a panel of firms, observed over a reasonably long period (1998-2005), allowed to control simultaneously for firms' unobserved heterogeneity and for the endogeneity of the explanatory variables, thus resulting in reliable coefficients estimates. Among the results, it seems interesting to remark that a significant (and plausibly sized) Verdoorn coefficient has been verified, pointing at the existence of dynamic increasing returns at firm level. Furthermore, a positive, though lower than one, elasticity of labour productivity to labour costs (measured as a ratio to the sectoral price of investment goods) has been estimated, coherent with the observed reduction of the wage share in the last years, in a wage moderation context.

The limits of the adopted two-step estimation approach stand mainly in the potential endogeneity affecting second-stage estimation, which has not been assessed so far. Two potential lines of research, in order to overcome this problem, may imply looking at "external" instruments for the utilisation of fixed-term contracts (as in Zwick, 2004, in the case of employee participation)[37], or relying on longitudinal data for the utilisation of flexible labour (namely, the second wave of the RIL dataset).

In spite of these drawbacks, the results on a whole seem to provide a robustness check for the evidence presented in Lucidi (2007). From a policy viewpoint, these results highlight a problem of sustainability of recent labour market reforms in terms of long-term competitiveness, pointing at the need of a reassessing the legislation on atypical employment as well as of proposals to reform the wage bargaining system.

In particular, reforms aiming at closing the wage differential between temporary and permanent workers appear crucial, in order to reduce the cost-saving incentive often associated to the utilisation of flexible staffing arrangements, in addition to the absence of firing costs due to their temporary nature (in particular, a suitable strategy seems to apply the same social contribution rate to all contractual typologies); these reforms should be included in a more general

[37] This, however, does not appear an easy task: finding an instrument being correlated with the utilisation of temporary contracts but uncorrelated to productivity growth is not straightforward.

revision of collective bargaining rules, which in the current system do not seem to provide employers with adequate incentives to innovation and technological change. On the flexibility side, temporal limits to the provision of fixed-term contracts appear welcome, in order to avoid the adoption of 'churning' strategies (Blanchard and Landier, 2002) with detrimental effects on labour productivity, as well as the occurrence of dual labour markets, which appear a direct consequence of the 'two-tier' nature of recent reforms. In these terms, labour market legislation should provide incentives to a proper utilisation of fixed-term contracts (i.e. facilitating their use as instruments to cope with demand fluctuations and production peaks, or to screen labour entrants, acting as 'stepping stones' to permanent employment) and rebalance the overall level of employment protection in favour of temporary employees.

Appendix A – Estimation results by firm size and sector

Table 5. Determinants of labour productivity growth using GMM estimator (by sector)

	Industry	Construction	Services
Smith effect	0.748***	1.220***	0.407**
	(0.137)	(0.219)	(0.186)
Ricardo effect	1.009***	0.823***	0.876***
	(0.090)	(0.075)	(0.065)
Growth of capital stock per employee	0.026	0.051**	0.101
	(0.066)	(0.023)	(0.065)
Constant term	-0.005	-0.031	0.027
	(0.018)	(0.031)	(0.034)
Time dummies	Yes	Yes	Yes
Number of firms	2466	480	2026
Number of observations	15654	2888	12412
Number of instruments	50	50	50
Hansen (p-value)	34.92 (0.656)	36.24 (0.597)	43.75 (0.277)
AR(1) (p-value)	-8.75 (0.000)	-3.66 (0.000)	-7.13 (0.000)
AR(2) (p-value)	0.35 (0.724)	0.01 (0.988)	-0.18 (0.858)

One-step GMM-SYS estimation with robust standard errors.
Dependant variable: labour productivity growth. 'Smith effect': growth rate of value added.
'Ricardo effect': growth rate of labour costs per employee as a ratio to the deflator of fixed investments at 2-digit sectoral level.
Standard errors in parentheses. Estimation period: 1998-2005. * Significant at 10%;
** significant at 5%; *** significant at 1%.

Table 6. Determinants of labour productivity growth using GMM estimator (by firm size)

	1-9 employees	10-49 employees	50-249 employees	250 and more employees
Smith effect	0.844***	0.924***	0.479***	0.345**
	(0.074)	(0.192)	(0.134)	(0.172)
Ricardo effect	0.495***	0.899***	0.799***	1.115***
	(0.191)	(0.049)	(0.101)	(0.089)
Growth of capital stock per employee	0.410***	0.021	0.183**	-0.008
	(0.129)	(0.045)	(0.079)	(0.024)
Constant term	-0.055	-0.028	0.007	0.040
	(0.043)	(0.026)	(0.021)	(0.028)
Time dummies	Yes	Yes	Yes	Yes
Number of firms	436	2514	1497	525
Number of observations	2421	14997	10004	3532
Number of instruments	50	50	50	50
Hansen (p-value)	29.90 (0.852)	39.52 (0.447)	48.07 (0.151)	40.01 (0.425)
AR(1) (p-value)	-3.03 (0.002)	-7.78 (0.000)	-6.42 (0.000)	-4.14 (0.000)
AR(2) (p-value)	-1.37 (0.170)	-2.45 (0.014)	0.48 (0.630)	0.94 (0.345)

One-step GMM-SYS estimation with robust standard errors.
Dependant variable: labour productivity growth. 'Smith effect': growth rate of value added.
'Ricardo effect': growth rate of labour costs per employee as a ratio to the deflator of fixed investments at 2-digit sectoral level.
Standard errors in parentheses. Estimation period: 1998-2005. * Significant at 10%;
** significant at 5%; *** significant at 1%.

Appendix B – Estimation results for the balanced sample

Table 7. Determinants of labour productivity growth using within and GMM estimators on the balanced sample (first-step estimation)

	(1) FE	(2) GMM	(3) FE	(4) GMM	(5) GMM
Smith effect	0.602***	0.740***	0.570***	0.544***	0.492***
	'(0.011)	(0.179)	'(0.006)	(0.141)	(0.150)
Ricardo effect			0.911***	0.958***	0.928***
			'(0.006)	'(0.072)	(0.066)
Ricardo effect (t-1)					0.099
					(0.104)
Growth of capital stock per employee	0.237***	0.458***	0.026***	0.049	0.077
	'(0.004)	(0.075)	'(0.003)	(0.064)	(0.051)
Growth of capital stock per employee (t-1)					-0.033
					(0.047)
Growth of labour productivity (t-1)					-0.067
					(0.088)
Constant term	-0.027***	-0.062**	0.020***	0.022	-0.016**
	'(0.010)	(0.025)	'(0.006)	(0.020)	(0.008)
Time dummies	Yes	Yes	Yes	Yes	Yes
Number of firms	1606	1606	1606	1606	1606
Number of observations	12848	12848	12848	12848	11242
Number of instruments	-	36	-	50	63
Hansen (p-value)	-	20.02 (0.791)	-	40.51 (0.443)	57.25 (0.224)
AR(1) (p-value)	-	-9.34 (0.000)	-	-7.42 (0.000)	-5.50 (0.000)
AR(2) (p-value)	-	-0.21 (0.833)	-	0.85 (0.393)	'0.26 (0.793)

One-step GMM-SYS estimation with robust standard errors in columns (2) and (4-5). Dependant variable: labour productivity growth. 'Smith effect': growth rate of value added. 'Ricardo effect': growth rate of labour costs per employee as a ratio to the deflator of fixed investments at 2-digit sectoral level. Standard errors in parentheses. Estimation period: 1998-2005. * Significant at 10%; ** significant at 5%; *** significant at 1%.

Table 8. Effects of labour flexibility on average productivity growth 1998-2005 for the balanced sample (second step estimation)

First-step eq.	(2)	(4)	(2)	(4)
Use of fixed-term employees	-0.015*	-0.013***		
	(0.009)	(0.004)		
Use of contract workers	-0.009	-0.005		
	(0.009)	(0.004)		
Use of on-the-job training contracts	-0.007	-0.006		
	(0.008)	(0.004)		
Use of temporary help workers	-0.007	-0.007		
	(0.008)	(0.005)		
Share of fixed-term employees			-0.031	-0.041*
			(0.048)	(0.024)
Share of contract workers			0.022	-0.017
			(0.046)	(0.025)
Share of on-the-job training contracts			-0.023	-0.053
			(0.081)	(0.347)
Share of temporary help workers			-0.220*	-0.147**
			(0.126)	(0.065)
Number of observations	1606	1606	1587	1587
F-test (p-value)	1.79 (0.01)	3.79 (0.00)	1.80 (0.00)	3.91 (0.00)

Dependant variable: average residual from first-step estimation. Estimation method: OLS.
Robust standard errors in parentheses. * Significant at 10%; ** significant at 5%; *** significant at 1%.
Firms size, geographical area and industry dummies are included

Appendix C – Sample descriptive statistics

Table 9. Samples composition by firm size, geographical area and industry.

	Unbalanced panel (n=4972)	**Balanced panel (n=1606)**
1-9 employees	8.8	3.9
10-49 employees	50.6	37.4
50-249 employees	30.1	43.2
250 and more employees	10.6	15.5
Total	**100.0**	**100.0**
North-West	38.7	44.2
North-East	29.4	32.9
Centre	18.3	14.3
South	13.7	8.7
Total	**100.0**	**100.0**
Mining and quarrying; electricity, gas and water supply	4.3	3.1
Manufacturing	45.3	51.9
Construction	9.7	8.0
Trade, hotels and restaurants	15.0	16.4
Transport and communication	8.0	6.8
Financial intermediation	1.2	0.6
Other business services	6.8	5.1
Education, health and other public services	9.7	8.0
Total	**100.0**	**100.0**

Table 10. Descriptive statistics (unbalanced sample, first and second step)

Variable	**Obs.**	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**
Growth rate of value added per worker	30954	0.087	-0.014	0.716	-0.926	11.026
Growth rate of value added	30954	0.095	0.046	0.390	-1.000	7.150
"Ricardo" effect	30954	0.062	-0.020	0.643	-0.934	10.022
Growth rate of fixed capital per employee	30954	0.163	-0.046	1.106	-0.966	19.234
Use of fixed-term employees	4972	0.473	0.000	0.499	0.000	1.000
Use of contract workers	4972	0.697	1.000	0.460	0.000	1.000
Use of on-the-job training contracts	4972	0.428	0.000	0.495	0.000	1.000
Use of temporary help workers	4972	0.165	1.000	0.372	0.000	1.000
Share of fixed-term employees	4914	0.042	0.000	0.085	0.000	0.700
Share of contract workers	4914	0.106	0.050	0.141	0.000	0.861
Share of on-the-job training contracts	4914	0.028	0.000	0.056	0.000	0.500
Share of temporary help workers	4914	0.009	0.000	0.028	0.000	0.241

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