JRC Technical Notes

IPTS WORKING PAPER on
CORPORATE R&D AND INNOVATION - No. 13/2009

The impact of innovation on labour productivity growth in European industries: Does it depend on firms' competitiveness strategies?

Francesco Bogliacino and Mario Pianta

September 2009

JRC
EUROPEAN COMMISSION

Institute for Prospective Technological Studies

The ***IPTS Working Papers on Corporate R&D and Innovation*** address economic and policy questions related to industrial research and innovation and their contribution to the European competitiveness. Mainly addressed to policy analysts and the academic community, these are scientific papers (policy relevant, highlighting possible policy implications) and proper scientific publications which will be typically issued at the moment they are submitted to peer-reviewed scientific journals. The working papers are useful to communicate to a broad audience the preliminary research findings of the work we develop, to generate discussion and to attract critical comments for further improvements. The working papers are considered works in progress and are subject to revision.

These *IPTS Working Papers on Corporate R&D and Innovation* can take the form of more *policy oriented notes*, mainly addressed to EU policy-makers. They present policy implications derived from our own research and the views of the most prominent authors in the field, making the appropriate references.

The main authors of this paper are Francesco Bogliacino (Universidad EAFIT and RISE Group, Medellin - Colombia) and Mario Pianta (University of Urbino - Italy). The paper summarizes the main findings of a study commissioned by the JRC-IPTS in the framework of its industrial research and innovation activities. The full report from which this paper has been based is available at the following address: http://iri.jrc.ec.europa.eu/innovation/docs/impact_final.pdf.

The *IPTS Working Papers on Corporate R&D and Innovation* are published under the editorial responsibility of Andries Brandsma, Pietro Moncada-Paternò-Castello and Michele Cincera at the Knowledge for Growth Unit – Industrial Research and Innovation Action of IPTS / Joint Research Centre of the European Commission.

Contact information:

P. Moncada Moncada-Paternò-Castello
European Commission, Joint Research Centre - Institute for Prospective Technological Studies
Edificio Expo
C/ Inca Garcilaso, 3
E-41092 Seville (Spain)
Fax: +34 95 448 83 00; E-mail: jrc-ipts-secretariat@ec.europa.eu
IPTS website: http://ipts.jrc.ec.europa.eu/; JRC website: http://www.jrc.ec.europa.eu

IPTS WORKING PAPER on CORPORATE R&D AND INNOVATION - No. 13/2009
Full electronic version of the paper can be downloadable at http://iri.jrc.es/

JRC 53698 Luxembourg: Office for Official Publications of the European Communities

Latest update of this working paper: 29 July 2009

Abstract

The diversity of technological activities that contribute to growth in labour productivity is examined in this paper for manufacturing and services industries in eight major EU countries. We test the relevance of the two major strategies of technological competitiveness (based on innovation in products and markets) or cost competitiveness (relying on innovation in processes and machinery) and their impact on economic performances. We propose models for the determinants of changes in labour productivity and we carry out empirical tests both for the whole economy and for the four Revised Pavitt classes that group manufacturing and services industries with distinct patterns of innovation. Tests are carried out by pooling industries, countries and three time periods, using Community Innovation Survey (CIS) data from CIS 2, 3 and 4, linked to economic variables.
The paper summarizes the main findings of a study commissioned by the JRC-IPTS in the framework of its industrial research and innovation activities.
The results confirm the strong diversity of the mechanisms leading to productivity growth in Europe, with different roles of sector-specific technological activities developed in the pursuit of the strategies of technological competitiveness and cost competitiveness. In all empirical tests, for all industries as well as for each revised Pavitt class, we find a presence of both strategies, with a relevance and impact that is specific to each subgroup of industries. Economic performances in European industries appear to fit different innovation models, with strong specificities for the four Revised Pavitt classes (i.e. "Science Based industries", "Scale and Information Intensive industries", "Specialised Suppliers industries" and "Suppliers Dominated industries").
A number of policy lessons emerge from our findings. Policies aiming at greater labor productivity growth may have to take into account the different mechanisms resulting from technological and cost competitiveness strategies, and the different relevance that they have in industry groups. Efforts to introduce new processes have emerged as a strong aspect of innovative activities in all industries, but their impact on productivity growth is likely to be inferior to that of a search for new products and markets, typical of "Science Based" and "Specialised Suppliers" industries alone. Policies may be more effective when they focus on the latter type of efforts. As the dynamics of demand plays a strong role in the potential for productivity growth, innovation policies should also develop a stronger integration with industrial and macroeconomic policies.

JEL Classification: O31, O33, O41

Keywords: Innovation, Labour Productivity, Industry Taxonomies, Technological and Cost Competitiveness

1 Introduction

The relationship between innovation and productivity growth is at the centre of continuing interest in both academic and policy-oriented research. This paper aims to improve on the existing literature in two main directions.

First, we explore the existence of two distinct "engines" of productivity growth, that we conceptualize as alternative competitiveness strategies. We argue that a distinction is needed between *technological competitiveness,* meaning the effort by firms to improve performance through new products and new markets, and *cost competitiveness,* the strategy based on process innovation and labour saving technological change (Pianta, 2001). The existence of these two mechanisms and their effects on performance, employment and distribution has been documented in a variety of empirical works (Bogliacino and Pianta, 2008a, 2008b; Crespi and Pianta, 2007, 2008a, 2008b; Pianta and Tancioni, 2008).

Second, we investigate the role of industry specificities - in both manufacturing and services - in shaping the innovation-performance relationship. A large literature has shown that the patterns and effects of technological change depend on the features of industries' technological regimes, where the knowledge base, the appropriability conditions and the degree of cumulativeness define specific trajectories (Dosi, 1988). Industry taxonomies - such as the one proposed by Keith Pavitt (1984) - have been helpful in operationalising such an approach, but have been generally confined to studies on manufacturing industry. We rely on a Revised Pavitt taxonomy (Bogliacino and Pianta 2008a and 2008b) in order to extend the analysis also to services. By testing our models separately on the four Revised Pavitt Classes, we will identify the diversities in the ways the two "engines" of productivity growth operate in specific technological regimes.

The paper proceeds as follows: Section 2 presents a review of the literature, Section 3 discusses data and methodology, in Section 4 we show the results, Section 5 concludes.

2 The relevant literature

This paper is related to three strands of research. A first stream of literature - starting with Griliches (1979, 1995, 2000) - has explored the role of R&D in productivity growth, with studies at the national, sectoral and firm levels, finding evidence of a positive and significant impact, with some variability in terms of magnitude.[1] Firm level studies include Griliches and Mairesse (1982) on US and French data, and Cuneo and Mairesse (1983) on French firms; they distinguish between firms belonging to science-related sectors and other firms, and find a substantial impact of R&D on productivity in the former (elasticity equal to 0.20), twice as large as in the rest of firms. Wakelin (2001) examined the impact of R&D, capital and labour on productivity in 170 UK quoted firms in the years 1988-1992, finding a positive and significant role of R&D; however the firms defined as “net users of innovation” showed returns to R&D higher than other firms. Tsai and Wang (2004) investigated 156 large Taiwanese quoted firms over 1994-2000, reporting a positive and significant R&D effect on productivity (elasticity equal to 0.18); in high-tech firms the impact was much higher than in low-tech ones (0.3 against 0.07). Ortega-Argilés, Potters and Vivarelli (2008) studied the top 532 European R&D investors, finding that the R&D coefficient shows higher values and significance for medium-

[1] In this approach, productivity has been calculated either as value added per worker (or per hour) or as TFP (among recent studies, see Klette and Kortum, 2004; Janz, Lööf and Peters, 2004; Rogers, 2006; Lööf and Heshmati, 2006). The estimated average elasticity of productivity with respect to R&D ranges from 0.05 to 0.25 (see Mairesse and Sassenou, 1991 for a survey; Griliches 1995, 2000; Mairesse and Mohnen, 2001, 2005).

tech and high-tech than for low-tech industries. Industry level studies have shown weaker evidence on the R&D-productivity link. Verspagen (1995) used a R&D-augmented production function and found that in OECD countries the effect of R&D on output was positive and significant in high-tech sectors only, with no impact in medium and low-tech sectors.

The second line of research concerns the relevance of industries in shaping innovation processes and their impact on performances (Levin et al., 1987; Winter, 1984; Dosi, 1988). "Technological regimes" and "sectoral systems of innovation" constrain the patterns of innovation in industries through different opportunities, appropriability conditions, selection processes, etc. (Breschi et al., 2000; Malerba 2004). The Pavitt taxonomy - developed on the SPRU database on innovation in UK manufacturing firms (Pavitt, 1984) - represents a major effort to conceptualize these differences and has been widely adopted in studies on firms and industries.[2] A Revised Pavitt taxonomy, extended to services and addressing the role of ICT industries, has been developed by Bogliacino and Pianta (2008a), where a detailed discussion and statistical tests are provided. In this article we adopt such a Revised taxonomy in order to highlight the diversity in the relationships between innovation and productivity. An application of the Revised Pavitt taxonomy to employment is in Bogliacino and Pianta (2008b).

The third stream of relevant literature concerns the use of Innovation Surveys as a tool to provide a detailed description of innovative activities. The availability of such data has made it possible to move beyond the reliance on R&D and patent data as the main indicators of technological activities, and has opened up new possibilities to investigate the diversity of innovative efforts.[3] In recent years, there has been a growing effort by scholars to develop models and empirical tests relying on this source. Crépon, Duguet and Mairesse (1998) have developed a model where R&D affects innovation which in turn affects productivity (see also Mohnen and Roller, 2005). The importance of the distinction between product and process innovation - allowed by innovation surveys - has been documented by the results of several studies at the industry level (Pianta 2001, Crespi and Pianta, 2007, 2008a, 2008b); at the firm level, Parisi et al. (2006), in a study of Italian firms, found robust evidence that R&D increases the likelihood of introducing product innovation. The comprehensive nature of innovation survey data can highlight the diversity of innovative efforts carried out in firms and industries, and the alternative competitiveness strategies that can be pursued using different "engines" of productivity growth.

3 Data and methodology

We use a database recently developed at the University of Urbino - the Sectoral Innovation Database (SID). This database includes most variables of the three comparable waves of the Community Innovation Survey (CIS 2, 3 and 4), and integrates innovation data with a large amount of statistical information on economic performance and employment at the same

---

2 For a review and discussion, see Archibugi (2001). Pavitt originally applied the taxonomy to UK firms; Dosi et al. (2007) analysed the firm size distribution; Marsili and Verspagen (222) applied the analysis to Dutch firms; Evangelista (2000) and Evangelista and Savon (2003) investigated Italian microdata; Castellacci (2007 applied it to 24 European countries.

3 See Smith (2005) for a discussion on the measurement of innovation. R&D data underestimate research in service industries and do not account for innovative activities linked to design, engineering and new processes. Patents are a rough proxy of innovation as not all inventions are patented; inventions may have widely differing economic relevance; patenting is biased towards large firms; different sectors show very different propensities to patent their inventions; patenting is negligible or not available for the innovations of most service industries (see Patel and Pavitt, 1995; Archibugi and Pianta, 1992). The literature on the "Knowledge Production Function" has tried to investigate the relationship between R&D and patents considered as inputs and outputs of innovative activities.

sectoral level, drawn from different sources (but mainly OECD STAN[4]). The country coverage of the database includes 8 major European countries – Germany, France, Italy, Norway, Netherlands, Portugal, Spain, and United Kingdom - that represent more than eighty percent of the European Economy. Data are available for the two-digit NACE classification of both manufacturing and service industries. The full description of the sources and methodology followed for the construction of the database is provided in the SID Methodological Notes (University of Urbino, 2007). Table A1 in the Appendix A.1 shows the industries included into the SID, grouped in the four Revised Pavitt classes.

The matching between STAN data and CIS data takes into account the need to let technology display its effect with a lag, but also the time span for which data are available. In particular, one may think that an optimal choice could be to use four years windows, since CIS data refers to 1994-1996 (second wave), 1998-2000 (third one), and 2002-2004 (fourth one) and a natural matching would be to use the subsequent four years for economic data. Unfortunately, STAN data are not updated up to 2008, so we have to readjust the periods. We ended up using 1996-1999 with CIS two, 2000-2003 with CIS three and 2003-2006 with CIS 4.
We will start from a general model common to all industries, and move towards more specific versions, including variables that better account for the particular technological activities typical of each Revised Pavitt class, so that we can better capture the complex relationships between innovation and economic performance across European industries.

As a microfoundation, we can propose the following model:

$$y_{ijt} = tc_{ijt}\beta_1 + cc_{ijt}\beta_2 + d_{ijt}\beta_3 + u_{ij} + v_{ijt}$$

where all variables are assumed to be measured in log scale; *y* is the productivity level, by *tc* we want to identify a technology based on competences and capabilities for the development of new products, i.e. belonging to the *technological competitiveness* trajectory; similarly, by *cc* we identify a technology based on competences and capabilities over production processes, where cost concerns are important and that belongs to a *cost competitiveness* trajectory. We add also a demand variable *d*, allowing the system to have a Kaldorian mechanism of dynamic increasing returns. The error components term has standard properties. By taking the difference, we get the following equation:

$$\Delta y_{ijt} = \Delta tc_{ijt}\beta_1 + \Delta cc_{ijt}\beta_2 + \Delta d_{ijt}\beta_3 + \Delta v_{ijt}$$

where the variations in the technologies adopted are reflected by the different types of innovative activities carried out over time. While *tc* and *cc* define the technology that exists at one point in time in firms, which affects labour productivity (in level), its variation can be proxied by the set of variables - in terms of innovative activities, expenditures and performances - that are referred to a given period. Such activities lead to an evolution of the stock of technology and describe how firms are changing products and processes; even when they are described as intensities (or percentages of total firms, rather than in terms of rate of change), they are proxies for the flow of new technological activities that adds on the existing stock of technological capabilities, both product and process-oriented.
The equation above should be seen as the structural model and the estimated equation, where we use technological variables taken from CIS, as a reduced form. Since the innovation variables lead the performance one, we are robust to endogeneity considerations.
We adjust for heteroskedasticity and we adjust also for intra-group correlation at industry level (for the presence of intra-industry heterogeneity). We maintain a constant, for the presence of an eventual trend in productivity.

[4] STAN STructural ANalysis Database.

Given the grouped nature of our data, we use weighted regression, using as a weight the employment level of each industry, which statistically proves to be more stable than value added[5].

In a first step we apply a general model to all industries. Among the large number of innovation variables in our database, we selected the regressors following two main criteria: their closeness to theory[6] and their economic and statistical significance. Closeness to theory leads to consider variables capable to account for different innovative activities (such as R&D or the acquisition of machinery) and strategies (such as the search for new markets or for labour cost reduction), capable to capture the economic relevance of new products (share of innovative turnover), or capable to document specific innovative behaviours (e.g., we used the *share of firms identifying clients as a source of innovation* because neo-Schumpeterian theory stresses the importance of this relation for several industries.
Economic and statistical significance leads us to consider variables that provide general measures (such as expenditure on machinery or in house R&D) and a very large coverage of countries and industries (we used only variables where the number of missing cases was restricted[7]). After this general model we will run separate regression for Pavitt classes in order to detect peculiar channels of productivity growth related to alternative technological regimes.

4 Results

In Table 1 we can find the results for the baseline regression. In this general model, across all manufacturing and service industries, labour productivity growth appears to be supported by both strategies of *technological and cost competitiveness* - proxied by R&D and machinery expenditure - and by demand growth, proxied the change in industries' value added. All variables are positive and significant. We can now introduce a measure of human capital. Our database includes data over the share of workers with secondary education in 2000 and 2003, which can be put in relation to innovation data of CIS 3 and CIS4. The results are shown in Column 2. There is an improvement in the fitness, and the quality of labour variable has also a significantly positive effect on productivity, but the introduction of the further regressor affects the significance of the machinery variable. For these reasons, we substitute it with a source variable: the share of firms that identify the suppliers of machinery and equipment as the main origin of their innovation. The results are in column 3 of Table 1.

This regression identifies the key sources of labour productivity growth, the parallel innovation-based strategies of technological and cost competitiveness, the quality and skills of labour, and the Kaldorian role of demand growth accounting for increasing returns. Additional versions of this simple model have been tested. In the Appendix A.2 we provide the tables with additional results and a discussion of technical issues. We start by looking at separate regressions on manufacturing and services: the results are confirmed, apart for the biased in manufacturing towards technological competitiveness.

5 We do not have problems of endogeneity for the innovation variables, since - as explained above - they always refer to periods that precede those used for calculating economic performances.
6 We refer to the conceptualization proposed in Pianta (2001).
7 Missing observations are not a problem if they are random. For this reason we avoid variables that show some persistent pattern of holes (e.g. that are not observed for services, for one country and so on).

Table 1. The determinants of labour productivity growth.

	1 **WLS rob s.e.**	2 **WLS rob s.e.**	3 **WLS rob s.e.**
Innovation for Technological Competitiveness			
In-house R&D expenditure per employee	0.147 (0.044)***	0.163 (0.046)***	0.170 (0.035)***
Innovation for Cost Competitiveness			
Machinery expenditure	0.168 (0.073)**	0.132 (0.097)	
Share of firms with suppliers of equipment as sources of innovation			0.050 (0.013)***
Human Capital			
Secondary Education (share)		0.063 (0.011)***	0.049 (0.011)***
Demand			
Rate of growth of Value Added	0.702 (0.052)***	0.678 (0.068)***	0.666 (0.063)***
constant	-0.205 (0.268)	-3.402 (0.611)***	-3.575 (0.618)***
N obs	618	284	307
R2	0.48	0.51	0.54

Dependent variable: Compound annual rate of change of labour productivity.
*significant at the 90% level; **significant at 95%; ***significant at 99%.
Standard errors in parentheses.

We move forward to consider three separate issues: the potential existence of catching up in productivity levels, the robustness of the results to the potential objection of endogeneity for the Kaldoor-Verdoorn effect[8]; finally the role of wages. First, the relevance of catching up in productivity was tested. The issue is important at the micro level, where imitation may lead to convergence in productivity among competing firms, and has been widely addressed also in the context of the growth performances of countries. At the industry level, there is little ground for assuming a process of convergence among sectors within the same country; in fact the idea of inter-sectoral convergence seems at odds with the theory and evidence on structural change. We considered the possibility of an inter-country convergence in the same industries, e.g. the hypothesis that labour productivity in Portuguese industries may tend to converge to the productivity level of the same industries in Germany.

[8] The Kaldoor-Verdoorn effect is the positive effect of increases in production on productivity growth: it can be interpreted as a learning-by-doing process or as the result of dynamic increasing return to scale. For a discussion see McCombie et al. (2002).

Such national patterns could be captured in a rough way by country dummies, but the results do not add much to the results we obtained above[9]. In a more specific test, we included in the model a measure of the relative distance of industries' productivity levels from the top European performer; the results were never significant, in any of the specifications we tested (see the Appendix A.2). In fact, we may argue that our model explicitly considers the different sources of technological change - based on either new products or new processes, on the introduction of major novelties as well as on imitation and diffusion of small innovations - and directly accounts for the mechanisms that have sometimes been indirectly captured by proxies of catching up effects in labour productivity in studies that could not include innovation variables in their models.

This result is important under a policy perspective: the absence of a catching up process means that convergence is no longer a driver of growth inside Europe. The overall area needs to act in a coordinate way in order to push a technological frontier. Second, the strength of change in value added as a proxy of demand and its independence from productivity growth has been considered, testing for endogeneity. The debate on the Kaldoor Verdoorn effect is huge (see McCombie et al., 2002 for some references): endogeneity may exists whenever the increase of productivity expand the growth of that sector. We instrumented the value added variable using the growth of operating surplus, that is certainly correlated with the rate of change of value added, but is determined by the distributive conflict. We show with a TSLS (Two Stages Least Squares) regression that our regression is robust (see the Appendix). Third, the possibility of a wage-productivity relation, through an efficiency wage effect, has been considered. If we include wage growth in our model we find significant results, but it seems very difficult to distinguish the chain of causation, and the standard relationship from productivity growth to wage increases (rather than vice-versa) remains the most convincing one (see the Appendix A.2).

4.1. The results on Pavitt classes.

An aggregate evidence of the relationship between productivity and innovation in the Pavitt groupings can be found in Figure 1. It suggests that our conceptualization is grounded into empirical evidence. Science Based (SB) industries concentrate on R&D (and use new machinery as well), and have the highest rates of productivity growth, more than three times higher than the Suppliers Dominated (SD) and Specialised Suppliers (SS) groups. The intermediate productivity performance of the Scale and Information Intensive (SII) industries heavily relies on process innovation. For the Suppliers Dominated group the low economic performance appears rooted in the low levels of innovative activities, while Specialised Suppliers rely more on research as well as on the continuing high employment of (relatively skilled) labour - as we will see in the next chapter - and this may explain the low productivity increases found here.

The results of the econometric test of the basic model for the four Revised Pavitt classes are shown in Table 2.

[9] In fact, since the underlying model is based on a difference transformation to obtain the rate of change, country dummies are eliminated.

Figure 1. Competitiveness strategies and productivity growth

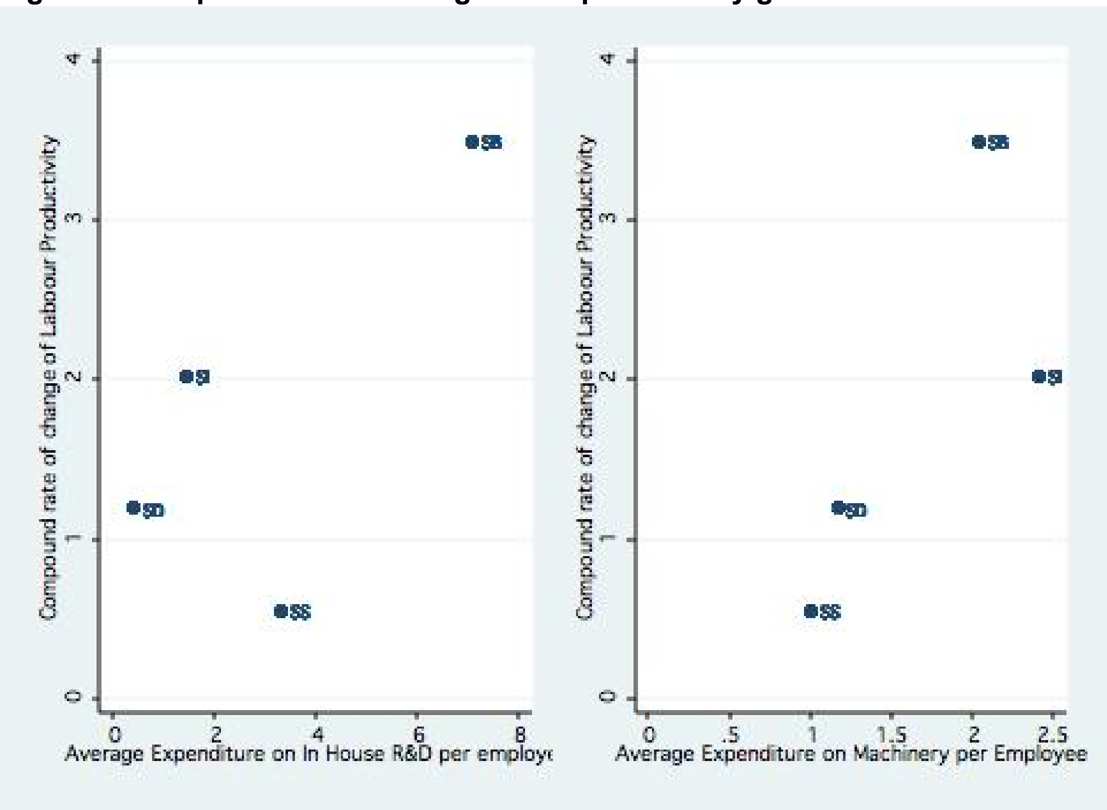

Table 2. The determinants of labour productivity growth in the Revised Pavitt classes

	1 **SB** **WLS rob s.e.**	2 **SII** **WLS rob s.e.**	3 **SS** **WLS rob s.e.**	4 **SD** **WLS rob s.e.**
Innovation for Technological Competitiveness				
In-house R&D expenditure per employee	0.103 (0.064)*	-0.081 (0.091)	0.291 (0.113)**	0.394 (0.161)*
Innovation for Cost Competitiveness				
Machinery expenditure	0.092 (0.121)	0.087 (0.105)	0.280 (0.198)	0.143 (0.163)
Demand				
Rate of growth of Value Added	0.762 (0.140)***	0.836 (0.067)***	0.775 (0.088)***	0.466 (0.091)***
constant	0.632 (0.838)	0.863 (0.419)**	-1.589 (0.651)**	-0.051 (0.370)
N obs	111	184	92	231
R2	0.54	0.74	0.57	0.19

Dependent variable: Compound annual rate of change of labour productivity.
*significant at the 90% level; **significant at 95%; ***significant at 99%.
Standard errors in parentheses.

The basic model appears less appropriate to account for the specificities of the four Revised Pavitt classes. Technological competitiveness (weakly) emerges for Science Based and Specialised Suppliers, while the search for cost competitiveness through new machinery does not emerge in any class. Demand growth is always significant. However, the importance of scale economies for Scale and Information intensive industries is not captured by the machinery expenditure, the role of customers in driving the innovative process for in Specialised Suppliers industries is not emerging, and other missing factors can be identified. These results suggest that there is large room for improving the explanatory ability of this model by searching for more specific versions that can account for the peculiarity of the innovation-productivity relationship in each of the four sectors. We therefore develop specific versions of the productivity equation for each Revised Pavitt class, introducing specific relevant variables[10]. The table below reports the estimates for Science Based industries.

As widely documented, R&D is the main determinant of the innovative activity in this group. In house research and external acquisition are both significant. Although machinery is not significant, there is a relevant role of the suppliers of equipment that contribute to productivity growth through improved processes. The share of workers with secondary education is not significant, but this is a rather poor proxy of the human capital employed, as Science Based sectors have high shares of workers with university education). Demand is positive and significant, as expected. As a further robustness check, in column (4) we substitute R&D for a good proxy for product innovation, the share of firms applying for a patent, that is positive and significant, as expected. The sources of productivity growth in this group appear to be well identified by this model. We now move to the Scale and Information Intensive industries.

In this group, we do not find a robust evidence on product innovation: R&D is not significantly affecting productivity growth, while an important influence is played by the share of firms indicating the suppliers of equipment as the source of their (process) innovation. The share of workers with secondary education has a significantly positive role, while the search for new markets plays no (or negative) effect. As expected, demand growth is important.

The Specialized Suppliers group is made up by industries where there is a non-negligible R&D, highly skilled labour, flexible small scale production arrangements and a strong relation with customers, all elements that drive the innovative process. The results, in Table 5, confirm our expectations; in-house R&D expenditure is significant and positive, clients are important sources of innovation and both the strategies of labour saving and increasing flexibility are positively related with productivity growth. The share of employees with secondary education is not significant, although positive, as the skills that are relevant for the industries are not easily reflected by the educational level. Demand has a strong effect, as usual.

We now move to the last group, Suppliers Dominated industries, where R&D is irrelevant and new processes dominate the innovative strategy. The results are in Table 6 below.

[10] As we point out in Section 3 on data, the rationale for choosing specific explanatory variables is twofold: theoretical relevance and number of observations. When we break down our investigation into an analysis of Revised Pavitt classes, sample size - as well as the availability of data for service industries - becomes a major concern, in order to avoid biased results.

Table 3. The determinants of labour productivity growth in Science Based Industries.

	1 WLS rob s.e.	2 WLS rob s.e.	3 WLS rob s.e.	4 WLS rob s.e.
Innovation for Technological Competitiveness				
In-house R&D expenditure per employee	0.103 (0.064)*	0.104 (0.042)**	0.135 (0.050)**	
Total R&D expenditure per employee				
Patent Application (share of firms)				0.044 (0.027)*
Innovation for Cost Competitiveness				
Machinery expenditure	0.092 (0.121)			0.112 (0.100)
Share of firms with suppliers of equipment as sources of innovation		0.044 (0.019)**	0.055 (0.026)**	
Human Capital				
Share of workers with Secondary Education			0.024 (0.031)	
Demand				
Rate of growth of Value Added	0.762 (0.140)***	0.811 (0.134)***	0.802 (0.163)***	0.755 (0.138)***
constant	0.632 (0.838)	-0.602 (0.840)	-2.106 1.570	0.420 (0.832)
N obs	111	110	60	109
R2	0.54	0.60	0.56	0.58

Dependent variable: Compound annual rate of change of labour productivity.
*significant at the 90% level; **significant at 95%; ***significant at 99%.
Standard errors in parentheses.

Table 4. The determinants of labour productivity growth in Scale and Information Intensive industries.

	1 WLS rob s.e.	2 WLS rob s.e.	3 WLS rob s.e.
Innovation for Technological Competitiveness			
In-house R&D expenditure per employee	-0.081		
	(0.091)		
Share of firms aiming to open up new markets		-0.023	-0.044
		(0.018)	(0.019)**
Innovation for Cost Competitiveness			
Machinery expenditure	0.087		
	(0.105)		
Share of firms buying machinery		0.043	
		(0.019)**	
Share of firms with suppliers of equipment as sources of innovation			0.054
			(0.019)***
Human capital			
Share of workers with Secondary Education			0.053
			(0.016)***
Demand			
Rate of growth of Value Added	0.836	0.881	0.829
	(0.067)***	(0.054)***	(0.067)***
constant	0.863	-0.261	-1.928
	(0.419)**	(0.685)	(0.913)**
N obs	184	196	79
R2	0.74	0.79	0.86

Dependent variable: Compound annual rate of change of labour productivity.
*significant at the 90% level; **significant at 95%; ***significant at 99%.
Standard errors in parentheses.

Table 5. The determinants of labour productivity growth in Specialized Suppliers Industries.

	1 **WLS rob s.e.**	2 **WLS rob s.e.**	3 **WLS rob s.e.**	4 **WLS rob s.e.**
Innovation for Technological Competitiveness				
In-house R&D expenditure	0.277 (0.099)***	0.238 (0.080)***	0.219 (0.104)**	0.267 (0.090)***
Innovation for Cost Competitiveness				
Share aiming to reduce labour cost	0.040 (0.017)**			
Share of firms aiming to flexibilize production process				0.056 (0.021)***
Share of firms with clients as sources of innovation		0.048 (0.016)***	0.058 (0.031)*	
Human Capital				
Share of workers with Secondary Education			0.038 (0.046)	
Demand				
Rate of growth of Value Added	0.766 (0.070)***	0.744 (0.072)***	0.780 (0.103)***	0.742 (0.074)***
constant	-2.091 (0.685)***	-2.586 (0.704)***	-4.699 (1.511)***	-2.458 (0.745)***
N obs	89	90	50	89
R2	0.62	0.66	0.67	0.63

Dependent variable: Compound annual rate of change of labour productivity.
*significant at the 90% level; **significant at 95%; ***significant at 99%.
Standard errors in parentheses.

Table 6. The determinants of labour productivity growth in Suppliers Dominated Industries.

	1 **WLS rob s.e.**	2 **WLS rob s.e.**	3 **WLS rob s.e.**
Innovation for Cost Competitiveness			
Share of firms aiming to flexibilize production process	0.041 (0.014)***		0.052 (0.021)**
Machinery expenditure per employee	0.009 (0.147)	0.006 (0.149)	0.001 (0.194)
Share of firms with clients as sources of innovation		0.043 (0.012)***	
Human Capital			
Share of workers with Secondary Education			0.054 (0.012)***
Demand			
Rate of growth of Value Added	0.451 (0.087)***	0.432 (0.086)***	0.341 (0.110)***
constant	-0.510 (0.445)	-0.596 (0.422)	-3.379 (0.751)***
N obs	225	226	112
R2	0.22	0.23	0.32

Dependent variable: Compound annual rate of change of labour productivity.
*significant at the 90% level; **significant at 95%; ***significant at 99%.
Standard errors in parentheses.

All coefficients come out as expected, apart from machinery expenditure, which is positive but not significant and the relation with clients has a role comparable to that of Specialised Suppliers industries. The human capital variable is positive and significant. Demand appears to be the main driving force of productivity growth.

The above tables suggest an important result: they support the view that innovation is a main driver of productivity growth, but they show that the use of a single general model fails to capture the diversity in the engines of productivity growth and the relevance of the technological regimes and industry structure.

5 Conclusions

In this paper we have shown that the mechanisms at the root of technological change and the engines of labour productivity growth are related to the different strategies pursuing either technological competitiveness (such as innovation in products and markets) or cost competitiveness (such as innovation in processes and machinery, see Pianta, 2001).

Although these strategies may coexist in firms and industries, our evidence at the sectoral level has shown that each industry is characterised by the dominance of either technological or cost competitiveness; these two strategies affect economic performance in fundamentally different ways.

An understanding of economic performance in Europe in the last two decades requires an appropriate use of the previous results in order to explain the different patterns of productivity growth across countries and industries. Both technological and cost competitiveness strategies have contributed to better economic performance, operating through radically different mechanisms. However, only Science Based industries that have heavily invested in both, can show rapid productivity increases. Moreover, a parallel expansion of demand and an adequate qualification of workers represent additional key factors for explaining labour productivity performances across all industries in Europe.
In fact, the operation of the two engines of productivity growth differs significantly across manufacturing and service industries; we have shown that Revised Pavitt groups are able to effectively summarise this diversity.

Science Based industries show that better economic performances are obtained through the search for greater technological competitiveness - that is effectively described by variables such as R&D efforts and patent application - while a significant role is played also by the share of firms indicating the suppliers of equipment as the source of (process) innovation; here we can expect that user-producer interactions are relevant. Demand growth is always highly important, showing the relevance of increasing returns in this sector.

Scale and Information Intensive industries mainly rely on a cost competitiveness strategy with a major role played by the share of firms indicating the suppliers of equipment as the source of their (process) innovation. The mid-level skills of workers with secondary education are significant sources of better performances, while the search for new markets plays no (or negative) effect. Demand growth is important, suggesting the relevance of new expanding service markets.

Specialised Suppliers industries appear to rely on a more complex set of sources for productivity growth. Technological competitivess plays a clear role - proxied by R&D expenditures - but costs competitiveness factors are also present - share of firms aiming at lower labour costs or more flexible processes - and we can identify the highly specific role of interaction with clients among the sources of success in this group. While secondary education is not significant, demand growth is highly important.

Suppliers Dominated industries are characterised by the model of cost competitiveness, with the search for more flexible production and a role of clients as sources of innovation. The mid-level skills of workers with secondary education are significant, and also demand growth plays a role, although with coefficients much lower than in the previous models.

This empirical and econometric analysis of the relationship between innovation and economic performances appears robust in different versions of the model (see the additional tests carried out in the Appendix) and confirms the strength of the Revised Pavitt taxonomy as a

way to identify the diversity of innovation across industries and the specificity of the sources of productivity growth. The models and tests developed in this paper (and the additional tests carried in the Appendix) provide a solid evidence of systematic differences in the models explaining productivity growth across the Revised Pavitt classes.
An extension of our work will address the employment impact of innovation (see Bogliacino and Pianta, 2008a). We will assess patterns of job creation and loss in European industries using the same framework adopted here, considering the role of alternative competitiveness strategies and the evidence in Revised Pavitt classes.

A number of policy lessons emerge from our findings:

- Policies aiming at greater labor productivity growth may have to take into account the different mechanisms resulting from technological and cost competitiveness strategies, and the different relevance that they have in industry groups.
- Efforts to introduce new processes have emerged as a strong aspect of innovative activities is all industries, but their impact on productivity growth is likely to be inferior to that of a search for new products and markets, typical of Science Based and Specialised Suppliers industries alone.
- Policies may be more effective when they focus on the latter type of efforts. As the dynamics of demand plays a strong role in the potential for productivity growth, innovation policies could also develop a stronger integration with industrial and macroeconomic policies.

References

Archibugi, D. (2001), Pavitt's Taxonomy sixteen years on: A Review Article, Economics of Innovation and New Technology, 10, 415-425

Archibugi, D., Pianta, M. (1992), The Technological Specialization of Advanced Countries. A Report to the EC on International Science and Technology Activities, Preface by Jacques Delors, Kluwer, Dordrecht and Boston, pp.164.

Bogliacino, F. and Pianta, M., (2008a). The impact of R&D and innovation on economic performance and employment: a quantitative analysis based on innovation survey data. European Commission-Joint Research Centre, Institute for Prospective Technological Studies (JRC-IPTS-Seville) Report (J03/32/2007), 2008.

Bogliacino, F. and Pianta M. (2008b), Breaking the innovation-employment spell. An investigation on Revised Pavitt classes, University of Urbino working paper

Breschi, S., Malerba F. and Orsenigo L., (2000). Technological Regimes and Schumpeterian Patterns of Innovation. The Economic Journal, 110, 388-410.

Castellacci, F. (2007), Technological paradigms, regimes and trajectories: Manufacturing and service industries in a new taxonomy of sectoral patterns of innovation, Paper for the First ICONS Project Meeting.

Catozzella, A. and M. Vivarelli (2007) Beyond the Knowledge Production Function: The Role of R&D in a Multi-Faceted Innovative Process. Jena Economic Research Papers 087, 1-40

Crépon B., Duguet E., Mairesse J. (1998), Research, Innovation, and Productivity: An Econometric Analysis at the Firm Level, Economics of innovation and new technology, vol. 7.

Crespi, F. and Pianta, M. (2007) Innovation and demand in European industries, Economia Politica-Journal of Institutional and Analytical Economics, 24 (1), 79-112.

Crespi, F. and Pianta, M. (2008a) Demand and innovation in productivity growth. International Review of Applied Economics, 22, 5, 655-672.

Crespi, F., Pianta, M. (2008b) 'Diversity in Innovation and Productivity in Europe', Journal of Evolutionary Economics, 18, 3-4, 529-545.

Cuneo, P. and J. Mairesse. 1983. Productivity and R&D at the firm level in French manufacturing, NBER Working Paper 1068.

Dosi, G. (1988). Sources, Procedures and Microeconomic Effects of Innovation. Journal of Economic Literature XXVI, 1120-1171.

Dosi, G., A. Gambardella, M. Grazzi and L. Orsenigo (2007), Technological revolutions and the evolution of industrial structures. LEM working paper 12

Dosi, G., K. Pavitt and L. Soete (1990) The Economics of Technical Change and International Trade. London: Harvester Wheatsheaf

Evangelista, R. (2000), 'Sectoral patterns of technological change in services,' Economics of Innovation and New Technology, 9, 183-221.

Evangelista, R. and M. Savona (2003), Innovation, employment and skills in services. Firm and sectoral evidence. Structural Change and Economic Dynamics, 14, 449-474.

Griliches, Z. (1979) Issues in assessing the contribution of Research and Development to productivity growth. Bell Journal of Economics, 10, 92-116.

Griliches, Z. (1995) R&D and productivity: econometric results and measurement issues, in P. Stoneman (Ed.), Handbook of the Economics of Innovation and Technological Change, Oxford: Blackwell Publishers, 52-89.

Griliches, Z. (2000) R&D, Education, and Productivity. Cambridge, MA: Harvard University Press.

Griliches, Z. and J. Mairesse (1982) Comparing productivity growth: an exploration of French and US industrial and firm data, NBER Working Paper 961.

Janz, N., H. Lööf, and B. Peters (2004) Firm Level Innovation and Productivity – Is there a Common Story across Countries?, Problems and Perspectives in Management, 2:1-22.

Klette, J. and S. Kortum (2004) Innovating Firms and Aggregate Innovation, Journal of Political Economy, 112:986-1018.

Levin, R.C., Klevorick, A., Nelson, R.R., and Winter, S.G. (1987), 'Appropriating the Returns from Industrial Research and Development', Brookings Papers on Economic Activity, Vol. 1987: 3.

Lööf, H. and A. Heshmati. (2006) On the relation between innovation and performance: a sensitivity analysis. Economics of Innovation and New Technology, 15, 317-344.

Mairesse, J. and P. Mohnen. (2001) To Be or not To Be Innovative: An Exercise in Measurement, NBER Working Paper 8644, National Bureau of Economic Research, Cambridge, MA.

Mairesse, J. and P. Mohnen. (2005) The Importance of R&D for Innovation: A Reassessment Using French Survey Data, Journal of Technology Transfer, 30, 183-197.

Mairesse, J. and M. Sassenou (1991) R&D and Productivity: A Survey of Econometric Studies at the Firm Level, NBER Working Paper 3666, March 1991, National Bureau for Economic Research, Cambridge, MA.

Malerba, F. (ed.) (2004) Sectoral systems of innovation. Cambridge, Cambridge University Press.

Marsili, O. and B. Verspagen (2002), Technology and the dynamics of industrial structures: an empirical mapping of Dutch manufacturing, Industrial and Corporate Change, 11(4), 791-815

McCombie, J.S.L., M. Pugno and B. Soro (2002) Productivity Growth and Economic Performance. Palgrave MacMillan.

Mohnen P., Röller L. H. (2005) Complementarities in Innovation Policy. European Economic Review, 49, 1431-50.

Ortega-Argiles, R., Potters L., and M. Vivarelli. 2008. R&D and productivity: Testing sectoral peculiarities using micro data, IPTS Working Paper on Corporate R&D and Innovation, No. 03/2009, European Commission, JRC 50290 – Joint Research Center – Institute for Perspective Technological Studies, Luxembourg: Office for Official Publications of the European Communities.

Parisi, M. L., Schiantarelli, F., and Sembenelli, A. (2006) Productivity, Innovation and R&D: Micro Evidence for Italy, European Economic Review, vol. 50, pp. 2037-2061.

Patel, P.; Pavitt, K. (1995): The Localised Creation of Global Technological Advantage, en J. Molero [ed.]: Technological Innovation, Multinational Corporations and New International Competitiveness: The Case of Intermediate Countries, pp. 59- 74. Singapore: Harwood Academic Publishers.

Pavitt K., (1984). Patterns of technical change: towards a taxonomy and a theory. Research Policy, 13, 343-74.

Pianta M. (2001), Innovation, Demand and Employment, in: Petit P., Soete L. (Eds.) (2001), Technology and the future of European Employment, Cheltenham, Elgar. , pp. 142-165.

Pianta M., Tancioni M. (2008) Innovations, profits and wages, Journal of Post Keynesian Economics 31, 1, 101-123.

Rogers, M. (2006) R&D and Productivity in the UK: evidence from firm-level data in the 1990s", Economics Series Working Papers 255, University of Oxford.

Smith K. (2005). Measuring innovation. In Fagerberg J., Mowery D., Nelson R. (Eds.), The Oxford Handbook of Innovation, Oxford, Oxford University Press, 148-179.

Tsai, K.H. and J.C. Wang (2004) R&D productivity and the spillover effects of High-tech industry on the traditional manufacturing sector: The case of Taiwan, World Economy, 27, 1555-1570.

University of Urbino, Faculty of Economics (2007) Sectoral Innovation Database Methodological Notes, Urbino, mimeo.

Verspagen, B. (1995) R&D and productivity: A broad cross-section cross-country look, Journal of Productivity Analysis, 6, 117-135.

Wakelin, K. (2001) Productivity growth and R&D expenditure in UK manufacturing Firms, Research Policy, 30, 1079-1090.

Winter, S. G. (1984) Schumpeterian Competition in Alternative Technological Regimes. Journal of Economic Behavior and Organization, Vol. 5, pp. 287-320.

Annex

A1 The Revised Pavitt Taxonomy

Table A 1. Industries included in the SID (with NACE code) and the Revised Pavitt taxonomy.

REVISED PAVITT TAXONOMY	NACE
SCIENCE BASED	
Chemicals	24
Office machinery	30
Manufacture of radio, television and communication equipment and apparatus	32
Manufacture of medical, precision and optical instruments, watches and clocks	33
Communications	64
Computer and related activities	72
Research and development	73
SCALE AND INFORMATION INTENSIVE	
Pulp, paper & paper products	29
Printing & publishing	31
Mineral oil refining, coke & nuclear fuel	35
Rubber & plastics	70
Non-metallic mineral products	71
Basic metals	74
Motor vehicles	
Financial intermediation, except insurance and pension funding	
Insurance and pension funding, except compulsory social security	21
Activities auxiliary to financial intermediation	22
SPECIALISED SUPPLIERS	25
Mechanical engineering	26
Manufacture of electrical machinery and apparatus n.e.c.	27
Manufacture of other transport equipment	34
Real estate activities	65
Renting of machinery and equipment	66
Other business activities	67
SUPPLIERS DOMINATED	
Food, drink & tobacco	15-16
Textiles	17
Clothing	18
Leather and footwear	19
Wood & products of wood and cork	20
Fabricated metal products	28
Furniture, miscellaneous manufacturing; recycling	36-37
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel	50
Wholesale trade and commission trade, except of motor vehicles and motorcycles	51
Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	52
Hotels & catering	55
Inland transport	60
Water transport	61
Air transport	62
Supporting and auxiliary transport activities; activities of travel agencies	63

A.2 The basic productivity equation: a discussion.

A first point to address is the stability of the pooling between manufacturing and services, coherently with the conclusion of the schumpeterian literature quoted in Section 2. In Table A3 we run separately the baseline regression on restricted samples of manufacturing and services industries only.

Table A2. The determinants of Labour Productivity growth. Subgroups.

	1 **Manufacturing** **WLS rob s.e.**	2 **Services** **WLS rob s.e.**
Innovation for Technological Competitiveness		
In-house R&D expenditure per employee	0.130	0.149
	(0.045)***	(0.074)**
Innovation for Cost Competitiveness		
Machinery expenditure	-0.031	0.222
	(0.053)	(0.116)*
Demand		
Rate of growth of Value Added	0.570	1.001
	(0.054)***	(0.050)***
constant	1.140	-1.791
	(0.274)***	(0.354)***
N obs	441	177
R2	0.43	0.68

Dependent variable: Compound annual rate of change of labour productivity.
*significant at the 90% level; **significant at 95%; ***significant at 99%.
Standard errors in parentheses.

There are only minor differences: a lack of significance in machinery for manufacturing, and a much higher demand coefficient for services, reflecting the greater expansion of new service markets.

Moving to more theoretical concerns, we start by discussing the possibility of a catching up effect in productivity. The point is not straightforward: while at the firm level we can think of imitation effects, and at the country level some convergence process may take place, at the sectoral level the issue of catching up is less clear. There are in fact structural differences that cannot be eliminated and certainly there is a hierarchy among Pavitt classes, in terms of productivity growth, which means that we cannot think of a convergence across industries. Conversely, we can think of a catching up effect across countries at the industry level. The simplest way to control for it is through country dummies. As we can see from column (1) of

Table A4, when the add them in our basic productivity model, there are no significant changes in the estimated coefficients.
In order to find a more clean measure of catching up, we calculated the normalized distance of the labour productivity (in levels, at the starting year) of each industry from the country that has the highest value. The *catching up* variable for sector *i* in country *j* is defined as:

$$OPP_{ijt} = 100 \frac{\left| LP_{ijt} - LP_{i,j\max,t} \right|}{LP_{ijt}}$$
$$i \in NACE, \quad j \in \{DE, ES, FR, IT, NL, PT, UK, NO\}$$
$$j\max = j \; s.t. \; LP_{i,j\max,t} \geq LP_{i,k,t} \quad \forall k$$

Where *jmax* is the country in which sector *I* has the highest labour productivity. When we include this variable in our model, in columns (2) and (4), the coefficients are not significant.

A second question concerns the possibility of an efficiency wage story, where the elasticity of the productivity at the wage is positive. When we include this variable in columns (3) and (4) of the Table below, the sign comes as expected, without affecting the rest of the equation. However, as most of the literature would object, it is difficult to distinguish the direction of causation.

A third question regards the Kaldoor-Verdoorn effect in the productivity equation. Some of the literature would in fact argue in favour of the reverse story: from productivity to value added growth. If this is the case, there is a problem of endogeneity. One suggestion could be to use a lag in the rate of growth of value added. Unfortunately, we can have a poor instruments problem: the correlation of the rate of growth of value added with its lag is just 10%.
We follow another direction: the rate of growth of operating surplus is related with the rate of growth of value added (the size of the *cake* to be divided), and it is determined through the distributive conflict, more than through the rate of growth of labour productivity. For this reason, we run a two stage least squares regression, where the rate of growth of value added is instrumented with its first lag, the rate of growth of operating surplus and the first lag of it. The methodology is a standard one, we first run a regression of the rate of value added over all the instruments, building a linear projection of the regressors, which is added as an explanatory variable in the second stage. We continue to weight data with employment.
We run three version of the equation: with country dummies, with catching up, and without the wage term. The results are shown in the Table below.
A part from attenuating the impact of the cost competitiveness strategy (but also the sample is now significantly reduced) there is no significant change in the results.

Table A3. The determinants of labour productivity growth.

	1 **WLS rob s.e.**	2 **WLS rob s.e.**	3 **WLS rob s.e.**	4 **WLS rob s.e.**
Innovation for Technological Competitiveness				
In-house R&D expenditure	0.112	0.184	0.111	0.185
	(0.037)***	(0.041)***	(0.040)***	(0.043)***
Innovation for Cost Competitiveness				
Share of firms with suppliers of equipment as sources of innovation	0.041	0.050	0.043	0.040
	(0.017)**	(0.012)***	(0.017)**	(0.013)***
Human Capital				
Secondary Education (share)	0.011	0.049	0.017	0.038
	(0.026)	(0.012)***	(0.026)	(0.013)***
Demand				
Rate of growth of Value Added	0.654	0.665	0.653	0.657
	(0.071)***	(0.065)***	(0.081)***	(0.076)***
Efficiency Wages Effect				
Rate of growth of Labour Compensation per Employee			0.282	0.276
			(0.147)*	(0.130)**
Catching up				
Labour Productivity Distance		0.001		-0.003
		(0.010)		(0.009)
Constant		-3.592 (0.655)***		-2.880 (0.686)***
Country dummies	**Yes**		**Yes**	
N obs	307	295	306	294
R2	0.62	0.54	0.64	0.57

Dependent variable: Compound annual rate of change of labour productivity.
*significant at the 90% level; **significant at 95%; ***significant at 99%.
Standard errors in parentheses.

Table A4. The determinants of labour productivity growth.

	1 **Weighted Two Stage Least Squares, rob s.e.**	2 **Weighted Two Stage Least Squares, rob s.e.**	2 **Weighted Two Stage Least Squares, rob s.e.**
Innovation for Technological Competitiveness			
In-house R&D expenditure	0.147 (0.046)***	0.217 (0.048)***	0.215 (0.046)***
Innovation for Cost Competitiveness			
Share of firms with suppliers of equipment as sources of innovation	0.027 (0.017)	0.031 (0.012)**	0.049 (0.013)***
Human Capital			
Secondary Education (share)	0.022 (0.022)	0.031 (0.012)**	0.047 (0.012)***
Demand			
Rate of growth of Value Added (instrumented)	0.337 (0.114)***	0.379 (0.105)***	0.352 (0.111)***
Efficiency Wages Effect			
Rate of growth of Labour Compensation per Employee	0.497 (0.122)***	0.433 (0.107)***	
Catching up			
Labour Productivity Distance		0.002 (0.011)	0.010 (0.011)
Constant		-2.206 (0.600)***	
Country dummies	**Yes**		
N obs	294	281	282
R2	0.54	0.52	0.45

Dependent variable: Compound annual rate of change of labour productivity.
*significant at the 90% level; **significant at 95%; ***significant at 99%.
Standard errors in parentheses.
Rate of growth of value added instrumented with its first lag, the rate of growth of operating surplus and the first lag of it.

The mission of the JRC-IPTS is to provide customer-driven support to the EU policy-making process by developing science-based responses to policy challenges that have both a socio-economic as well as a scientific/technological dimension.

European Commission

JRC 53698 – Joint Research Centre – Institute for Prospective Technological Studies

IPTS WORKING PAPER on CORPORATE R&D AND INNOVATION - No. 13/2009

Title: The impact of innovation on labour productivity growth in European industries: Does it depend on firms' competitiveness strategies?

Author(s): Francesco Bogliacino (Universidad EAFIT and RISE Group, Medellin - Colombia) and Mario Pianta (University of Urbino - Italy).

Luxembourg: Office for Official Publications of the European Communities
2009

Technical Note

Abstract

The diversity of technological activities that contribute to growth in labour productivity is examined in this paper for manufacturing and services industries in eight major EU countries. We test the relevance of the two major strategies of technological competitiveness (based on innovation in products and markets) or cost competitiveness (relying on innovation in processes and machinery) and their impact on economic performances. We propose models for the determinants of changes in labour productivity and we carry out empirical tests both for both the whole economy and for the four Revised Pavitt classes that group manufacturing and services industries with distinct patterns of innovation. Tests are carried out by pooling industries, countries and three time periods, using innovation survey data from CIS 2, 3 and 4, linked to economic variables.
The results confirm the strong diversity of the mechanisms leading to productivity growth in Europe, with different roles of sector-specific technological activities developed in the pursuit of the strategies of technological competitiveness and cost competitiveness. In all empirical tests, for all industries as well as for each revised Pavitt class, we find a presence of both strategies, with a relevance and impact that is specific for each subgroup of industries. Economic performances in European industries appear as the results of different innovation models, with strong specificities of the four Revised Pavitt classes (i.e. "Science Based industries", "Scale and Information Intensive industries", "Specialised Suppliers industries" and "Suppliers Dominated industries").
A number of policy lessons emerge from our findings. Policies aiming at greater labor productivity growth may have to take into account the different mechanisms resulting from technological and cost competitiveness strategies, and the different relevance that they have in industry groups. Efforts to introduce new processes have emerged as a strong aspect of innovative activities in all industries, but their impact on productivity growth is likely to be inferior to that of a search for new products and markets, typical of "Science Based" and "Specialised Suppliers" industries alone. Policies may be more effective when they focus on the latter type of efforts. As the dynamics of demand plays a strong role in the potential for productivity growth, innovation policies should also develop a stronger integration with industrial and macroeconomic policies.

Publications Office
Publications.eu.int