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"INNOVATION, DEMAND AND STRUCTURAL CHANGE IN EUROPE"

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Innovation, demand and structural change in Europe

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Abstract

The model and the empirical test developed in this paper address the determinants of structural change for six major European economies from 1995 to 2007. The performances of sectors are explained by the unfolding of uneven technological opportunities and different conditions of demand. Building on the literature on structural change and on previous studies on the link between sectoral patterns of innovation and economic performance of sectors, a set of tests is developed on a panel of 21 manufacturing sectors and 17 services, merging three different sources of data. The results show the importance of breaking up the innovative efforts of sectors and the role of demand in shaping their trajectories of development.

Keywords: structural change, demand, innovation, industry-level analysis

JEL classification: O10, O33, O41

1. Introduction[1]

In this paper structural change is represented by a model that combines a neo-Schumpeterian approach to technological change and a post-Keynesian view of growth. The model tries to disentangle the impact of supply and demand factors on the process of economic change, explaining the medium term performances of sectors.
On the technological side, moving from the Schumpeterian distinction between product and process innovation, firms are supposed to follow a technological or cost competitiveness strategy (Pianta, 2001). The first is associated with the search for high productivity, rooted in quality advantages and high internal innovative efforts; the latter focuses on processes of mechanization, restructuring and labour saving activities. While at the firm level these strategies coexist, at the sectoral level it is possible to identify the dominant strategy and characterize the different technological opportunities of sectors.
On the demand side, as described by post-Keynesian studies, the structure of demand, with price and income elasticities, is vital for industry-specific trends. Different components of demand (consumption and investment, domestic and foreign) and stages of maturity of goods imply uneven opportunities of growth.
In order to investigate industry specificities in technological and demand conditions, a large quantity of information is required. Building on the previous edition of the Sectoral Innovation Database (SID) of the University of Urbino (2007), the new edition of the SID (2011) makes it possible to explore the relationships between innovation, demand and structural change. The dataset merges three different sources of data: the OECD STAN database for measures on economic performances of sectors; Eurostat CIS data for indicators of their innovative activities; and OECD Input Output tables for data on sectoral demand. The new version of SID includes data on six major European economies, Germany, France, Italy, the Netherlands, Spain and the United Kingdom, corresponding to about 80% of EU15 value added, at the level of 21 manufacturing and 17 services, covering a time span from 1995 to 2007.
The rest of the paper is organized as follows. Section 2 presents a brief review of the literature on structural change; section 3 describes the dataset; section 4 presents the empirical evidence. Section 5 introduces the general model and the econometric strategy. Section 6 shows the results. Section 7 concludes.

2. Structural change in the economic theory[2]

Neoclassical growth theory largely disregards the analysis of structural change as it looks at the economic growth as a process which is generated at the aggregate level.
Nevertheless, some models introduce structural change by revising some standard assumptions of the basic models. Kongsamut, Rebelo and Xie (2001) introduce nonhomothetic preferences to engender structural change in a three sectors-economy (agriculture, manufacturing, services); Foellmi and Zweimueller (2002) propose a model of endogenous growth in which structural change is associated with changes in demand side through a non standard utility function and a mechanism of hierarchy of needs and saturation. Starting from Baumol (1967), Ngai and Pissarides (2007) and Acemoglu and Guerrieri (2008) offer a supply-side explanation of structural change. The latter propose a two sectors model, where capital deepening at the

[1] I am grateful to Mario Pianta for his collaboration and his advice and to Francesco Bogliacino for his comments. All errors are responsibility of the author.
[2] A survey on the theoretical approaches on structural change theory is provided by Kruger (2008); Silva and Teixeira (2006) offer an interesting bibliometric account on structural change literature. See also Acemoglu (2008), Buera and Kaboski (2009), Metcalfe (2009), Pasinetti (1993) and Syrquin (2007) for some considerations on the analysis of structural change in the economic literature.

aggregate level induces a reallocation of capital and labour between sectors, embedded with different capital intensity. Further studies introduce sectoral specificities in human capital or home distortion in production of services in order to qualify the strong raise of the share of tertiary sector during the last fifty years (Buera and Kaboski, 2009).
All in all, these models show that a change in the sectoral composition of the economy can be reconciled with a path of balanced growth at the aggregate level but do not ascribe any role to structural change in shaping the path of economic growth.
On the contrary, Schumpeterian and evolutionary approaches highlight the relationship economic growth and changes in the composition of economy.
In his growth theory, Schumpeter (1934, 1939) considers the technological competition among firms as the engine of the industrial evolution. The technological competition takes the form of a clustering of basic innovations that trigger intermittently the economic system: slowly, sectors with an old technological content are driven out from the market while sectors which exploit new and radical innovations grow faster. The action of this "creative destruction" favours the adaptation of economic system to the new technology and changes radically the shares of sectors in output and employment. In contrast to the neoclassical theory, price competition plays a little role as qualitative changes induced by technology upset the previous order. Thus, economic growth is always related to a renovation of the industrial structure.[3] For the neo-Schumpeterian theories (Freeman, Clark and Soete, 1982, Freeman and Louca, 2001, Perez, 1985), the definitive adaption of economic system to the new technology is however constrained to a "mismatch" between the techno-economic and the socio-institutional system: the process of innovation-diffusion is not a passive adaptation to new technologies but asks for a phase of coordination and co-evolution among these two systems.
Following Schumpeter, evolutionary theorists model knowledge advancements through the emergence of a "technological paradigm" (Dosi, 1982). It represents an "amount of knowledge" characterized by "specific patterns of solution to selected techno-economic problems" that slowly shapes the direction and the rate of development of technological change. Each paradigm is characterized by a variety of strategies of adaptation at the micro/firm level, whose selection continuously feeds the diffusion of paradigm. It is this succession of variety and selection that engenders the conditions for the economic development (Dosi and Nelson, 2010). Moving from this representation of the process of growth, Metcalfe (1998) and Montobbio (2002) describe the evolution of the industrial structure of an economy, incessantly stimulated by a mechanism of heterogeneity and selection, directly related to the characteristics of firms and sectors. In Montobbio (2002), two processes are pointed out: a "sorting" process, which is connected to changes of the aggregate output and to differences in elasticity of demand; and a process of "selection", where relative cost structure drives the decline of firms. In this model, the variety of firms engenders economic growth also in absence of technological change. In Metcalfe, Foster and Ramlogan's model (2006), dynamic sectoral differences at the technological level are explicitly considered. The sectoral variety, the interaction among sectors and their coordination through market cause structural change.[4]
While the evolutionary approach stresses the role of technological change as source of change,

[3] Endogenous growth models (Aghion and Howitt 1998) drawn on some themes of Schumpeterian theory, by assuming a continuous replacement of technologies and firms during the process of economic growth. The economy is characterized by a process of "creative destruction" that drives growth at the aggregate level through a spillover effect on the level of productivity of system. In fact, the sectoral composition of the economy remains constant as sectors are supposed to be symmetric (see Kruger, 2008).
[4] In Saviotti and Pyka (2004), the creation of new goods and sectors is the principal source of growth for the economic system.

it basically neglects the role of demand. On the contrary, there are several studies that reckon a great importance to demand as a driving force for the process of structural change.
Studying the successive dominance over time of a primary (agriculture), a secondary (manufacturing) and a tertiary (service) sector, Fisher (1939), Clark (1957) and Fourastié (1969) describe the relationship between real income growth and changes of preferences of consumers. The sectors are characterized by different values of the income elasticity of demand, as predicted by Engel's law. As per-capita real income rises, a hierarchy of needs implies the saturation of primary goods, the consumption of manufacturing goods and, finally, the use of products of tertiary sector. Thus, resources shift consistently with demand changes, while changes in relative prices are supposed not to have a decisive impact on demand shifts.
In the analysis of Kuznets (1971) the shifts of the sectoral composition of economies mark the intensity of a process of transformation which is associated with deep changes of social and institutional conditions. While technological change implies a shift in the structure of production, the process of structural change is also affected by the different patterns of demand of consumers and by the strategic exploitation of comparative advantages in foreign trade. The interaction of these forces shapes the path of structural change and, crucially, causes deep changes in the productive and social structure of countries. The attempt to put together different dimensions of the process of development of an economy is one of the principal contributions of Kuznets.
The matching between demand and industrial structure is also emphasized by the literature on development economics, emerged in '50 and '60 (Rostow, 1960, Rosenstain-Rodan, 1961, Nurske, 1953, Hirschman, 1958). In these studies, complementarity among factors is essential: an effective plain of investments has to match the structure of domestic demand in order to conciliate over time supply and demand of goods and services. Moreover, some forms of balancing between leading and follower sectors are necessary in order to avoid possible distortions and restrictions to production.
The interest for a better comprehension of the sectoral interdependences asks for the development of new tools of analysis: the contribution of Leontief (1928, 1941) is a powerful apparatus of investigation for the analysis of structural change. In fact, Input Output tables provide a snapshot of the industrial system of inter-relationships. Looking into the structural characteristics of an economy, they highlight the relative importance of sectors and the deepness of the economic relations among industries. Introducing a preliminary evaluation of shares of production of each sector to final consumption, they also provide an empirical assessment of link between demand and productive structure.
The role of demand for the process of economic growth is particularly emphasized by the Post-Keynesian approach. Kaldor (1966, 1981) highlights the role of increasing returns of scale, principally related to the development of the manufacturing sector. They are produced by the division of labour that, in turn, grows with the extension of markets. For Kaldor, increasing returns are connected to a process of disintegration and vertical differentiation of production into separate activities, which feeds an uneven process of development (Young, 1928). Productivity growth reduces costs and allows a further expansion of production (Verdoorn, 1949). In this process, demand is the crucial factor.[5]
Emphasizing the processes of cumulative modification of sectors, Kaldor (1966) stresses as

[5] "This theory [*Kaldor's theory*] brings a general expansion of effective demand into the forefront, since this is the precondition for the vertical disintegration of industries: mass production is predicated on the formation of mass markets. For tasks to become specialized and eventually lead to the creation of distinct industries there must be sufficient demand to sustain the independent entities. Demand, in other words, acts like the temperature regulating the speed of a chemical decomposition, with one important variation. The decomposition itself begins to generate its own heat, thereby pushing the reaction further." (Argyrous, 1996).

different sources of demand characterize specific phases of the process of development of economies. In particular, he draws attention to the role of exports as driver of growth for advanced economies (Dixon and Thirlwall, 1975, Thirlwall, 2003).
The analysis of Pasinetti (1993) is probably the most accomplished attempt to tie up technological and demand factors in an analysis of structural change. His model is based on a process of continuous changes of the industrial structure, principally driven by demand.
Pasinetti considers a dynamic (time-consuming) representation of the production system, where the sectors are vertically integrated and each one produces a single good, using only labour as input.[6] Technological change is represented by general learning and research activities that, through the action of process innovations, reduce sectoral labour coefficients. A rise in sectoral productivity contributes to a higher level of productivity for the economy as a whole and sustains per capita real income growth. Along the path described by Engel's law, driven by a specific activity of learning and adapting of consumption patterns, sectors experience different rates of growth of consumption that drive the allocation of resources and the path of structural change.
However, while productivity increases, a permanent status of stagnant demand for the existent goods can occur. In this case, the economy experiences a reduction of incomes and the conditions for the stability of the level of employment are threatened. For Pasinetti, this is a problem of coordination among individuals and collective decisions: employment dynamics is the product of the interaction between productivity evolution and demand growth. In order to sustain employment and income, labour enhancing product innovation is the most effective strategy.
As explained in section 1, this paper tries to describe the process of economic change through the co-evolution of demand and technological factors, merging neo-Schumpeterian and Post-Keynesian topics.[7] A large body of literature in neo-Schumpeterian and evolutionary approaches shows that the sectors are characterized by different modes through which innovation occurs and several technological trajectories at the industry level can be identified in order to conceptualize the differences in innovative activity (Pavitt, 1984, Malerba and Orsenigo, 1997, Malerba, 2002). Starting from this literature, we follow Pianta (2001) and characterize each sector with a particular innovative strategy, related to nature of competition sectors are playing. The technological competitiveness is associated with a general tendency to internal innovative activity, a prevalence of product innovations and a propensity to search for new market shares; conversely, the cost competitiveness is related to an inclination towards cost efficiency and process innovation. This distinction is a powerful tool of selection when the process of structural change is investigated: in fact, it is able to characterize the technological opportunity of sectors and their ability of exploiting the technological content of their products. As discussed in the following sections, CIS data will allow us to represent the different "competitiveness" of sectors and obtain in this way a description of their technological trajectories.
However, each sector is also characterized by a specific demand dynamics. While it is obvious that the higher demand growth, the higher value added will be, each sector is related to a specific demand structure: the share of consumption and investment, domestic and foreign that is addressed to each sector affects its competition regime and its strategies. The demand trajectory is thus identified by considering the intensity of demand growth and the type of market addressed. Input Output data will allow us to deal with these issues.

[6] Pasinetti's model can be extended to sectors using capital goods (Pasinetti, 1981).
[7] Some authors have presented different models where the joint effect of supply and demand factors drives economic growth and structural change, linking Kaldorian and Schumpeterian theories (Ciarli, Lorentz, Savona, Valente, 2010).

3. Data description

The empirical work of this paper is based on the extension of the Sectoral Innovation Database (SID) (University of Urbino, 2007). The SID 2011 provides a comprehensive description of the sectoral dynamics of the principal European economies, merging different sources of data: Eurostat Community Innovation Survey (CIS) for a measure of the innovation activity of sectors; the OECD STructural Analysis (STAN) database for industrial performances; the OECD Input Output tables for demand variables. Data cover 21 manufacturing sectors and 17 services (Nace Rev.1 subsections). The detail of sectors is shown in the Appendix A. The SID 2011 considers the six largest countries that were part of the EU before the new accessions (Germany, France, Italy, the Netherlands, Spain and the United Kingdom), covering the period from 1995 to 2007. The selection of countries for the SID 2011 has been carried out in terms of the largest coverage of sectors and reliability of data.

This section offers a basic description of the three sources of data and the relative elaborations. Further information about the construction of data, data management and the detail of variables will be soon available (University of Urbino, 2011).[8]

Data on economic performances of sectors have been drawn from the OECD STAN (STructural ANalysis) database, released in October 2010. It includes data on value added, employment, investments and wages. These measures are representative of the universe of firms in each sector (OECD, 2003).

Demand variables are drawn from OECD 2010 Input/Output Tables (OECD, 2006, Eurostat, 2008a). The OECD Input-Output Tables collect the matrices of inter-industrial transaction flows of goods and services at current prices (domestically produced and imported) and provide measures of the final demand for 40 countries (OECD and non-OECD member), covering the years 1995, 2000 e 2005. The tables make it possible to study the composition of final demand, breaking down the information under indicators statistically representative of the universe of firms: information on household consumption, gross fixed capital investments, government expenditure, exports and final imports can be obtained. The 2010 Input-Output edition covers 48 industrial sectors and admits a perfect comparability with the STAN database. However, when the level of aggregation of sectors is higher, we consider the same rate of growth of demand for each sector.

CIS data provide important information on a wide range of measures of the innovative activities of sectors. The dataset includes three waves of Eurostat innovation surveys: 1994-1996 (CIS2), 1998-2000 (CIS3), 2002-2004 (CIS4). Innovation variables have been collected by the University of Urbino through cooperation agreements with national data providers - either national statistical institutes or research groups with access to CIS data and authorization to exchange them - in the case of CIS 2 and CIS3; CIS 4 data are available from Eurostat, except for the United Kingdom, whose data have been obtained from the national data provider. The assembling of the database has been carried out using common data protocols and statistical procedures on data integration and standardization. The selection of countries and sectors has been made in order to make sure that no confidentiality problems in the access to data emerge (due to the policies on data release by national statistical institutes or to the low number of firms in a given sector of a given country); therefore all available data are certified free from confidentiality problems by the national data provider. For each variable, firm level data coming from the survey have been weighted by the weighting factors provided by National Statistical Institutes in order to report survey data to the universe of firms. In this way, the database provides information for the total population of firms. This is a necessary condition to link innovation to other industry economic data coming from other international

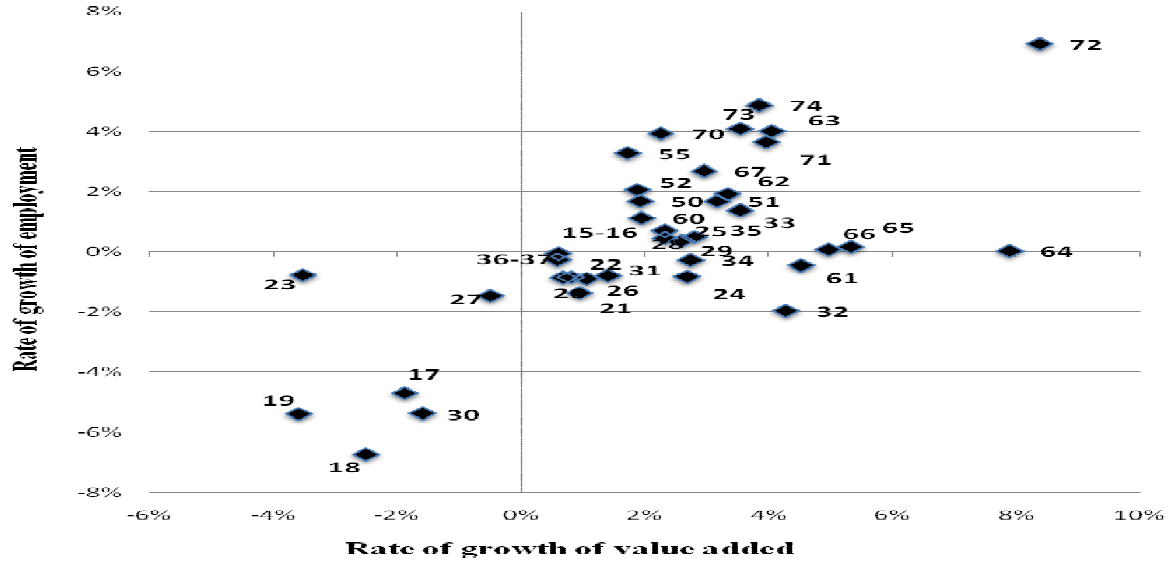
[8] The SID 2011 also includes data from Eurostat Labour Force Survey and Eurostat Structural Earning Survey.

sources, such as the OECD STAN database and OECD Input Output Tables. CIS data provide extensive evidence on several dimensions of the innovative activity, including the sources, the inputs and expenditure - for internal and external R&D, design, external technology acquisitions, innovation related machinery and equipment -, the types of innovations introduced - new products and new processes-, other relevant outputs of the innovative activities - patents, sales associated to new products -, the overall strategies adopted by firms in their pursuit of innovation - new markets, greater quality, lower costs, greater flexibility, etc.
An analysis of the stability of the innovation variables across three waves of CIS is provided in Bogliacino and Pianta (2009).
Monetary variables in the SID are expressed as values at constant prices (2000) using sectoral deflators (from STAN) and GDP deflator (from OECD). Sectors 30 (Office, accounting & computing machinery) and 66 (Insurance and Pension Funding, except compulsory social security) have been deflated considering the price index of the aggregate of the electrical and optical sector (30-33 sectors) and financial intermediation (65-67) respectively. All monetary variables are expressed in Euro. For United Kingdom, the original figures provided in GBP millions are transformed using the exchange rate expressed in PPP (Eurostat, EU25=1).

4. The empirical analysis

In this paper the variety of industrial trajectories is represented through a combination of sector specific technological strategies and demand conditions. Different trajectories affect the performance of sectors in terms of value added and employment growth, contributing to modify the composition of economies.
A general view of the principal modifications occurred in the structure of the principal European economies from 1995 to 2007 is provided in Graph 4.1, by comparing the average growth rates of sectors (across countries) in terms of value added and employment.

Graph 4.1 Compound Annual Rate of Growth of Value Added and Employment from 1995 to 2007



Source: SID

The whole period has been characterized by the maturity of the technological paradigm based on Information and Communication Technologies (ICTs) and by an increase of the fragmentation of production at the domestic and international level: Business Services sectors (71, Renting of Machinery and Equipment, 72, Computer & Related activities, 73, Research

and Development and 74, Other business activities) are mainly distributed in the top right half of graph as well as sector 64 (Post and Telecommunications), which shows a null dynamics of employment; on the contrary, sectors which are particularly exposed to the international markets (Textiles, Clothing and Leather and Footwear sectors, 17, 18 and 19) show a joint decline in value added and employment performance. They are distributed on the bottom-left part of the Graph 4.1. Value added growth and employment creation in sector 30 are singular but the change of deflator has produced a downsizing of its performance.

The different dynamism of the manufacturing and services sector is rather evident in terms of employment growth. The average rate of growth of employment has been 2.45% for services, -1.34% for manufacturing. Although country specificities are important, these patterns look stable across countries.

Pavitt (1984) has conceptualized the existence of different classes of innovation for the manufacturing sector in terms of the process of appropriation of technology, the sources of innovation and the structure of market, implying a different level of technological opportunity for each sector: the latter corresponds to the capacity of take advantage of the innovative efforts that sectors sustain. Following Bogliacino and Pianta (2008), we conceptualize the technological specificities of sectors in four Revised Pavitt classes, by extending to services the original Pavitt taxonomy.[9] According to Bogliacino and Pianta (2008), Science Based and Specialized Suppliers sectors are naturally oriented towards a technological competitiveness while Scale and Information Intensive and Suppliers Dominated prevalently pursue a strategy based on cost competiveness. As shown in Appendix B, a one-way relationship between the two competitiveness strategies and the Revised Pavitt classes emerges from the analysis of CIS data.

The clustering of sectors in terms of their technological opportunity must be associated with a differentiated pattern of growth of industries. Table 4.1 show the differences in manufacturing, considering the average values across countries of the compound annual rates of change of sectors, grouped in terms of the Revised Pavitt taxonomy.

Table 4.1 The link between technological opportunities and sectoral growth in manufacturing industries

Manufacturing	Value Added Growth	Employment Growth
Science Based	2.23%	-1.66%
Specialized Suppliers	2.27%	0.04%
Scale and Information Intensive	0.53%	-0.75%
Suppliers Dominated	-0.52%	-2.31%
All sectors	0.75%	-1.34%

Source: SID

Science Based and Specialized Suppliers sectors have shown high levels of growth of value added. While these differences emerge for all the countries at different intensities, the impact of the innovation activity seems to be less clear for employment creation. Science Based industries are associated with a strong productivity growth while Specialized Suppliers sectors point out a strong creation of employment. Employment creation in Scale and Information Intensive industries has slowed down. The employment has grown in the Suppliers Dominated

[9] See Appendix A for grouping.

sectors, although with lower intensity.
Table 4.2 shows the dynamics of services. Again, innovation seems to be correlated with the performances of sectors. Data at the country level are available in Appendix C, putting together manufacturing and service sectors.

Table 4.2 The link between technological opportunities and sectoral performance in service industries

Services	Value Added Growth	Employment Growth
Science Based	6.60%	3.67%
Specialized Suppliers	3.35%	4.14%
Scale and Information Intensive	4.41%	0.97%
Suppliers Dominated	2.82%	1.91%
All sectors	3.86%	2.45%

Source: SID

Although in a preliminary way, Tables 4.1 and 4.2 provide important considerations about the nature and the potential of growth of economies. A slightly dynamics of employment in the manufacturing has been associated with the activity of Specialized Suppliers sectors, which however represent only a small part of total employment. Moreover, while Science Based and Specialized Suppliers sectors are characterized by a strong increase in labour productivity, the stability of productivity performances in other sectors can bring about a rise of wage inequality, especially in manufacturing.
As explained above, changing patterns of consumption can also affect the dynamics of sectors. As observed in section 2, the evolution of patterns of demand brings about an uneven reallocation of resources among industries. At the same time, demand growth is able to feed the occurrence of increasing returns so that it is possible to accelerate productivity growth.
In order to investigate the sectoral evolution of demand, information is drawn from the OECD Input-Output Tables (2010). By interpreting the Input-Output Tables horizontally, it is possible to study the evolution of demand of goods or services that is addressed to each sector (see Appendix D for the detail of sectors).
From 1995 to 2005, the growth of demand in manufacturing is principally due to exports, while there is a substantial lack of internal demand. At the sectoral level, there is a core of sectors whose dynamics prevalently depends on exports: Office, accounting and computing machinery (30), Building and Repairing of ships and boats (35), Motor vehicles, trailers and semi-trailers (34), Radio, television and communication equipment (32), revealing a link between technologically advanced industries and international competitiveness. Conversely, in a group of sectors with lower technological intensity, Food products, beverages and tobacco (15-16) and Textiles, textile products, leather and footwear (17, 18, 19), demand growth is prevalently related to dynamics of household consumption.
For the services sector, intermediate demand grows faster than in manufacturing. Although exports have strongly risen, the local nature of markets and the scarce tradability of services reduce their possibility of expansion. The weight of intermediate consumption is tied to the process of fragmentation of production, in particular for business services. In general, while household consumption growth is relevant for a number of traditional sectors (Trade and Leisure sectors, 50, 51, 52), the evolution of internal demand seems to experience a poor dynamics.

5. The basic model and the econometric strategy

In this section, the results of the empirical tests are presented. As baseline model, the following equation is estimated:

$$y_{it} = x'_{it}\beta + \eta_i + \varepsilon_{it}$$

where y is the real value added, x the vector of regressors, η is the individual effect and ε is the error term, for industry i and time t. All the variables are supposed to be in log scale. By taking the difference, the individual effect is eliminated. As the differences in log approximate the rates of variation, the dependent and the regressors are expressed in average compound rates of growth.

The vector of regressors includes technological and demand variables.

The growth rates of value added are a proxy for the variation of the share of each sector in the whole economy, which would be a more specific measure of structural change. However, growth rates allow a better representation of the heterogeneity of sectors.

Demand variables are drawn from Input/Output tables, by calculating the changes in demand levels from one table to the next (with a five year lag).[10]

The innovation variables reflect the technological activities carried out by sectors and are inserted in the model at levels: they are interpreted as the flow of efforts that, over time, feeds the stock of technology of each industry. In order to assure comparability among sectors, expenditure data are scaled by the number of employees. The other variables are expressed as the share of firms identifying as relevant a particular source of innovation or a specific market aim.

The final equation is the following:

$$\Delta y_{it} = \beta_0 + \beta_1 tc_{it} + \beta_2 cc_{it} + \beta_3 \Delta d_{it} + \Delta\varepsilon_{it}$$

As discussed in previous sections, value added growth is the result of the combination of technological activities and the dynamics of industries' demand. Technological efforts are not homogeneous; a variety of activities can be identified, with contrasting economic effects. As explained in Pianta (2001), firms that innovate mainly in products develop a strategy of technological competitiveness; they are characterized by high levels of internal innovative activities and R&D, search for high productivity and a general improvement in the quality and range of products. Conversely, firms oriented to process innovation concentrate their efforts on investments in new machineries, the restructuring of production and labour saving innovation: they are characterised by a strategy based on cost competitiveness. As explained in neo-Schumpeterian studies, the differing innovative behaviour of firms is affected by the industry-specific technological regimes that shape the opportunities and trajectories of innovation. It is therefore possible to identify a prevailing orientation of sectors towards technological or cost competitiveness; this distinction has been shown to affect industries' performance in terms of productivity and employment, as shown by Crespi and Pianta (2008) and Bogliacino and

[10] In effect, the evolution of the inter-sectoral interdependencies documented by intermediate demand is certainly related to some form of technological change. Further research needs to deepen the theoretical and empirical link between demand and technology.

Pianta, (2010a), (2010b). However, as the overall growth of value added is investigated, the effects of innovation on productivity and employment have to be "combined".
In sectors characterized by technological competitiveness, the growth of value added is expected to be stronger, supported by the introduction of new products; while productivity may increase rapidly, there may be room for job creation.
Conversely, industries characterized by cost competitiveness focus on process innovation and efficiency increases, replacing labour and reducing costs. The result is positive on productivity, but negative on employment, and the overall effect on value added depends on whether there is an expansion of capacity supported by innovative investments or new processes that accelerate restructuring and consolidation, leading to an industry's decline.
Summing up, technological strategies may have the following expected impact on value added:

- Strategies of technological competitiveness are expected to support value added growth as they lead to new products that may encounter demand growth

- Strategies of cost competitiveness mainly increase efficiency and their outcome in terms of value added depends on the nature of innovative efforts:

  - when the search for cost competitiveness leads to new processes and investments that expand production capacity and efficiency, the overall effect is an increase in value added, even when jobs are lost as a result of a stronger increase in productivity

  - innovative efforts focus on labour savings and restructuring, and result in cuts in production capacity and falling value added (and even worse job losses), while productivity may increase even in the context of declining production.

In all cases, a positive relationship is expected between demand dynamics - both final and intermediate components - and value added.
However, demand and technology result naturally intertwined. Different demand conditions can have a role in the technological dynamics. A strong demand growth in sectors with high technological opportunities may stimulate "Schumpeterian innovators" and the introduction of radical novelties in markets. Conversely, when technological opportunities are modest, a strong demand may reduce competitive pressures and the very incentives for innovative efforts. While our model simplifies the complexity of this relation, the challenge for the future research is to deepen (also empirically) this interaction.
The temporal dimension of the database makes it possible to study the process of structural change through the use of a panel structure. However, three waves of Input/Output (1995, 2000 and 2005) allow us to calculate the growth rates of demand for two periods, 1995-2000 and 2000-2005.
Hence, looking at the overall dynamics of value added and employment during the period 1995-2007, we decide to select two distinct phases of growth of value added: the period 1996-2000, characterized by a growth of value added and scarce growth of employment and the period 2003-2007, with productivity recovery and decreasing job losses. In this way, we neglect the period of downswing of the economic activity in 2000-2003 and focus on the trend of sectors during a phase of upswing of the economic activity.
Lucchese and Pianta (2011) offer an analysis of the stability of the relationship between innovation and sectoral growth during the downswing phase in 2000-2003.
Table 6.2 reports the temporal matching of model.
As the technology is supposed to affect the economic performances of sectors, value added growth is associated with the last year of reference of the respective CIS (CIS2, 1994-1996 and CIS4 2002-2004). Moreover, we consider a (not strict) overlapping between demand variables

and value added growth.

Temporal matching

C.A. Rate of Growth of Real Value Added	1996-2000	2003-2007
Technological activities	1996	2004
C.A. Rate of Growth of Real Industries' demand	1995-2000	2000-2005
Average Firm Size (CIS)	1996	2004

The baseline model can be estimated consistently with OLS. It is adjusted for heteroschedasticity and intra-group correlation at the industry level, checking for intra-sectoral heterogeneity (due to a certain level of dependence inside each sector). In order to distort at minimum the real importance of sectors, weighted regressions are used. With the aim to assure stability over time, employment levels for the year 1996 and 2003 are chosen (as starting year of each growth rate). In order to reduce endogeneity problems, a structure of lags for innovation variables is introduced. The use of long differences as a means to deal with endogeneity problems is known in the literature (e.g. Caroli and Van Reenen, 2001, Piva *et al.,* 2005) and is supposed to reduce the problems of endogeneity on demand variables. Moreover, the differencing has eliminated the individual effect. The possibility of multicollinearity is checked through the VIF analysis (Variance Inflation Factors). In every regression, the VIF values of regressions do not exceed 5. A preliminary analysis on the distribution of variables has allowed dropping possible extreme values. Moreover, only the significant variations of variables are considered (in particular, for final imports, compound annual changes superior to 20% have been dropped). In general, the presence of outliers does not affect the values of coefficients in every model. A list of the variables used is shown in the following table:

Technological activities	Share of Turnover due to new or improved products
	Total Innovative Expenditure per employee (per 1000 euro)
	Innovative Machinery and equipment expenditure per employee (per 1000 euro)
	Share of firms innovation sources from within the enterprise
	Share of firms aiming to reduce labour costs
	Share of firms innovation sources from Suppliers of equipment
	Share of firms aiming to open up new markets
	Share of firms aiming to improve product quality
Industries' demand growth	Household Consumption (Growth)
	Exports (Growth)
	Intermediate Consumption (Growth)
	Final Imports (Growth)

The joint influence of technological and demand factors on sectoral value added growth is tested carrying out a regression analysis across 21 manufacturing and 17 services sector for six European countries, Germany, France, Italy, the Netherlands, Spain and the United Kingdom. In the following section, the results are shown. First, the baseline model for manufacturing and services sector is presented; finally, a general model across the whole economy is studied.

6. Structural change in Europe

Table 6.1 shows the results of model covering the manufacturing sector, putting together the technological activities of sectors and industries' demand growth.
On the technological side, the share of turnover due to new or improved products is a proxy for technological competitiveness. It is significant and positive as well as the expenditure in machinery and equipment related to innovation, proxy for an internal push to improve the efficiency of productive processes and productivity growth.
On the demand side, the rate of growth of exports drives sectoral growth, highlighting a strong dependency of the European manufacturing system on foreign demand. While at the firm level, demand growth can depend on the competitive advantage of a particular good, at the sectoral level it correspond to a real constraint to expansion of sectors. The integration of the European manufacturing in international markets can open up major opportunities of growth as well as the rising penetration of imports in domestic markets should reduce the rate of expansion of sectors and crowd out domestic production. Although final imports results weakly significant, their negative sign in column 1 and 3 shows the inverse relationship between the increase of imports and sectoral performance. When introduced, household consumption is not significant: while per-capita income growth determines a shift of the available resources towards services, the low growth of the European domestic market and the low dynamics of wages can have reduced the internal demand push. The demand for gross fixed investments is not inserted in Table 6.1, but it is not significant: only few sectors produce capital goods and their impact is inevitably reduced; however, this result reveals a reduced "multiplier effect" of investments on manufacturing growth and can represent a sign of the internal weakness of the European manufacturing system. Intermediate consumption is instead positive and significant, stressing the rising process of internal fragmentation of production.
It is worth mentioning that, in a Kaldorian perspective, investments in capital follows demand growth. However, when gross fixed capital growth is introduced in the model, it results not significant (moreover, a part of its impact should be captured by the innovative variables expenditure).
A variable that describes the average firm size of each sector is also added to the baseline model. Its negative sign shows the high dynamism of sectors with a low average dimension. A model of "Schumpeter Mark I" seems to prevail: in the periods of upswings, the most dynamics sectors are characterized by a low average dimension of firms. A higher facility of entry and the role of more competitive markets can explain this result. Time dummy shows the stability of performance of manufacturing over time.
In order to investigate in a deeper way the differences in technological and demand intensity, an additional test for groups of sectors is proposed, using the Revised Pavitt taxonomy briefly described in section 4 and in Appendix B. The results are exposed in Table 6.2.
On the one hand, Science Based and Specialized Suppliers sectors show higher levels of internal R&D activities and a search for product and quality innovation; on the other hand, Scale Intensive and Suppliers Dominated sectors are more cost competitiveness oriented. Thus, the application of the (Revised) Pavitt taxonomy is a useful tool to discriminate the different technological opportunity of sectors. In Table 6.2 the basic model (1) is compared with two alternative specifications (2 and 3). Column 2 combines Science Based and Specialized Suppliers industries, while column 3 sums the impact of Scale Intensive and Suppliers Dominated sectors. On the demand side, only export and intermediate consumption variables are introduced as the most significant components of demand.
The general model for the whole manufacturing system confirms the sign and the significance of all the coefficients. When the model is applied separately to the two subsets of industries, some differences are present. In column 3, there is no impact of product innovation

(technological competitiveness) on sectoral growth. At the same time, machinery expenditure is significant, showing the efficacy of a less active strategy of innovation, more process oriented (cost competitiveness). Conversely, Science Based and Specialized Suppliers sectors show high values for the innovative variables, due to a high average technological intensity of sectors. However, the different impact of the innovative turnover on sectoral growth highlights the difference in the quality of innovation carried out by firms in different sectors. Also demand patterns are interesting. Export coefficient is higher in Science Based and Specialized Suppliers sectors. In fact, these industries experience high shares of exports in total production and are in general more successful in terms of competitiveness. The dynamics of exports is counterbalanced by the different role of intermediate consumption that shows higher values for Scale Intensive and Suppliers Dominated sectors.

Due to the use of CIS data, the availability of manifold indicators of innovation provides the opportunity to deepen the analysis of technological strategies.

Table 6.3 shows the impact of different innovative variables on the growth of value added, using different proxies of demand. Column 1 adds to the basic model the share of firms which try to reduce labour costs. Its impact on sectoral value added growth is negative: the share of industries with a major propensity to labour reduction is associated with lower rates of growth of value added. In this case, the destruction of value added can be associated with the process of restructuring and strong reduction of employment: it can be related to a real consolidation of industrial activities, trained by a weak demand growth.

Also the negative impact on value added of the share of firms with suppliers of machinery as source of innovation in column 2 and 3 can be explained in this way. It should grasp the falling market share of firms which are followers in the innovative dynamics and extremely dependent on external suppliers of innovation. Conversely, the innovative activity sourced from the internal to enterprise (column 2 and 3) is associated with a growth of value added.

Summing up, the positive sign of innovative sales is largely explained by the action of technological competitiveness that pushes value added growth, especially when it is supported by the external conditions of growing demand.

The expenditure in innovative machineries increases the productive capacity of sectors and improves the productivity, although it can substitute labour. Alternatively, when the activity of restructuring is robust, a declining dynamics of value added can emerge.

The dependence of the manufacturing sector from the international demand emerges as a key-point in this representation as well as the declining role for internal household consumption.

It is worth mentioning that the introduction of the country dummies does not alter the basic relationships.

The basic model for services is exposed in Table 6.4. The results confirm the importance of a model that combines technological and demand factors.[11]

The proxies for product innovation show a positive and significant sign. In particular, the share of firms which try to improve the quality of products results strongly significant: this share is particularly high for business services sectors and finance sectors. Conversely, the share of firms which try to reduce labour costs and the share of firms which express as source of innovation the external availability of equipment are not significant. In contrast with the manufacturing sector, services experience increasing market shares over time and are characterized by a positive dynamics of employment. At the sectoral level, these aspects can reduce the weight of a strategy based on cost competitiveness.

As expected, on the demand side, intermediate consumption is highly significant as well as the internal demand. The average firm size variable is positive but not significant, stressing the absence of a clear pattern of growth related to the intra-sectoral dynamics of sectors.

[11] There is a reduced availability of innovation variables for services in CIS2 data. This makes the comparability with the manufacturing sector less direct.

In sum, the extension of the basic model to services seems to confirm the general patterns of development, although some differences emerge. In general, the higher variability of performance of sectors is illustrated by the lower fitting of model (comparing the values for R^2 in manufacturing and services).
Table 6.5 presents the results of the general model for the whole economy.
First, Column 1 shows the impact of the total innovation expenditure of sectors on sectoral value added, joined to the contemporary presence of three different sources of demand: household consumption, exports and intermediate demand growth (final imports are not considered for the limited number of services with a sufficient level of imports). In column 2, the composition of the innovative activities is pointed out in order to identify the weight of different sectoral strategies. In general, there is an increase of fit of model when different strategies are proposed. In column 1 and 2, manufacturing sector is overrepresented. When the representativeness of services increases (Column 3), the share of firms with suppliers as source of innovation is not significant while the proxy for product and quality innovation has a positive impact on growth. On the demand side, due to rising level of interaction among sectors, the intermediate consumption sustains value added growth as well as export growth, although with less intensity. As expected, household consumption becomes significant when services are more represented. The services dummy is strongly significant, highlighting the need to differentiate the models of development (column 1 and 2). A final regression in Table 6.6 completes our analysis. It increases the efficiency of the estimates, considering the whole sample and differentiating the coefficients. It reproduces the previous results, confirming the role of the principal variables of model; what is more, it shows a strong relevance of product innovation in services sector.

7. Conclusions

The analysis of the previous sections has shown that the complex evolution of industrial system can be understood as a process that jointly combines supply and demand factors.
Starting from the literature on structural change analysis and on the studies on sectoral pattern of innovation and industry performances, we have deepened the role of demand and analyzed the dynamic of value added of sectors, comparing the effects on employment and productivity of unequal technological opportunities and different demand conditions.
On the technological side, the analysis confirms the importance of breaking up the innovative efforts of sectors. On the one hand, technological competitiveness fuels sectoral growth through the introduction of new products and a parallel improvement of productivity and employment. On the other hand, cost competitiveness is based on process innovation, expansion of productive capacity and labour saving recoveries of productivity that can also be associated with a declining dynamics of value added, when strong processes of restructuring are carried out and job losses are present. For services, product innovation and technological competitiveness result dominant.
On the demand side, different components of demand contribute to shape the trajectories of development of sectors. In manufacturing, exports growth represents the principal source of expansion, while the potentialities of growth are reduced by final imports that reduce the demand pull. In services, household consumption is an important source of growth as well as the intermediate consumption whose weight reflects the rising de-verticalization of the productive processes.
In conclusion, three aspects have to be emphasized in the light of what we have seen above.
First, structural change plays a role in pulling economic growth. For advanced economies, the presence of faster growing sectors oriented towards a technological competitiveness represents a source of strength for the economic system. Economies which are specialized in sectors with low technological opportunities can experience a gradual impoverishment of the human capital

and lower employment conditions.
Second, demand is a driving force in the process of structural change, as described by the Post-Keynesian approach. The lack of demand depresses economic growth and creates a mismatch between the potentiality of innovation and the consumption opportunity.
Third, different mechanisms of growth operate in different industries and this variety is an important characteristic of the process of economic growth and structural change. At the level of policy interventions, strategies of sectoral and specific industrial policy can be more effective than horizontal actions that involve the whole industrial system.

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Table 6.1 Structural change in manufacturing

Dependent variable: Compound Annual Rate of Growth of Value Added Pool of industries in DE, FR, IT, NL, SP, UK - WLS rob s.e.						
	1		2		3	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Share of Turnover due to new or improved products	0.058	***	0.058	***	0.066	***
	(0.020)		(0.022)		(0.016)	
Innovative Machinery and equipment expenditure per employee	0.787	***	0.632	***	0.690	***
	(0.303)		(0.282)		(0.254)	
Exports	0.423	***	0.400	***	0.328	***
	(0.101)		(0.095)		(0.070)	
Final Imports	-0.051	*			-0.050	*
	(0.029)				(0.027)	
Household Consumption			0.027			
			(0.028)			
Intermediate Consumption					0.284	***
					(0.048)	
Average Firm Size	-5.185	***	-4.439	**	-4.992	***
	(1.981)		(1.912)		(1.499)	
Time Dummy	0.333		0.753		0.181	
	(0.481)		(0.584)		(0.511)	
Constant	-0.842		-1.168		-0.784	
	(0.865)		(1.018)		(0.655)	
N obs	197		200		196	
R^2	0.47	***	0.41	***	0.56	***

Standard Errors in brackets: * significant at 10%, ** significant at 5%, *** significant at 1% level

Table 6.2 Structural change in manufacturing

Dependent variable: Compound Annual Rate of Growth of Value Added
Pool of industries in DE, FR, IT, NL, SP, UK - WLS rob s.e.

	All industries		Science Based and Specialized Suppliers		Scale Intensive and Suppliers Dominated	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Share of Turnover due to new or improved products	0.042	**	0.097	**	-0.001	
	(0.020)		(0.036)		(0.012)	
Innovative Machinery and equipment expenditure per employee	0.467	**	0.876	**	0.321	**
	(0.255)		(0.375)		(0.151)	
Exports	0.283	***	0.500	***	0.200	***
	(0.066)		(0.121)		(0.037)	
Intermediate Consumption	0.299	***	0.206	***	0.310	***
	(0.052)		(0.053)		(0.051)	
Time Dummy	0.574		3.510		-0.622	
	(0.597)		(0.865)		(0.258)	
Constant	-1.010		-5.179		0.373	
	(0.919)		(2.130)		(0.467)	
N obs	205		65		140	
R^2	0.51	***	0.70	***	0.41	***

Standard Errors in brackets: * significant at 10%, ** significant at 5%, *** significant at 1% level

Table 6.3 Structural change in manufacturing

Dependent variable: Compound Annual Rate of Growth of Value Added Pool of industries in DE, FR, IT, NL, SP, UK - WLS rob s.e.						
	1		2		3	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Share of Turnover due to new or improved products	0.071	***				
	(0.021)					
Innovative Machinery and equipment expenditure per employee	0.658	**				
	(0.297)					
Share of firms innovation sources from within the enterprise			0.067	***	0.062	**
			(0.020)		(0.025)	
Share of firms aiming to reduce labour costs	-0.019	*				
	(0.010)					
Share of firms innovation sources from Suppliers of equipment			-0.029	*	-0.044	*
			(0.017)		(0.026)	
Exports	0.383	***	0.272	***	0.292	***
	(0.112)		(0.077)		(0.094)	
Intermediate Consumption			0.298	**	0.276	**
			(0.120)		(0.124)	
Household Consumption					0.022	
					(0.031)	
Average Firm Size	-4.175	**	-2.262	*		
	(1.954)		(1.825)			
Time Dummy	0.136		0.798		0.896	
	(0.571)		(0.592)		(0.672)	
Constant	-0.523		-1.431		-0.455	
	(1.094)		(1.024)		(0.672)	
N obs	187		208		199	
R^2	0.43	***	0.43	***	0.43	***

Standard Errors in brackets: * significant at 10%, ** significant at 5%, *** significant at 1% level

Table 6.4 Structural change in services

Dependent variable: Compound Annual Rate of Growth of Value Added Pool of industries in DE, FR, IT, NL, SP, UK - WLS rob s.e.								
	1		2		3		4	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Share of firms innovation sources from within the enterprise	0.045	**	0.063	**				
	(0.019)		(0.022)					
Share of firms aiming to improve product quality					0.055	***		
					(0.025)			
Share of firms aiming to open up new markets							0.034	**
							(0.015)	
Share of firms aiming to reduce labour costs			-0.040		-0.030		-0.013	
			(0.035)		(0.044)		(0.039)	
Share of firms innovation sources from Suppliers of equipment	-0.023							
	(0.018)							
Exports	0.001							
	(0.030)							
Intermediate Consumption	0.348	***	0.320	***	0.231	**	0.271	**
	(0.093)		(0.095)		(0.083)		(0.095)	
Household Consumption	0.207	**	0.206	**	0.191	**	0.210	**
	(0.075)		(0.080)		(0.075)		(0.076)	
Average Firm Size					1.174			
					(1.047)			
Time Dummy	2.061	*	1.520	*	1.851	*	1.713	*
	(0.763)		(0.927)		(0.927)		(0.9186)	
Constant	-0.291		0.096		-0.154		0.584	
	(0.797)		(1.000)		(0.964)		(0.971)	
N obs	139		144		149		149	
R^2	0.31	***	0.32	***	0.30	***	0.28	***

Standard Errors in brackets: * significant at 10%, ** significant at 5%, *** significant at 1% level

Table 6.5 The general model for manufacturing and services

Dependent variable: Compound Annual Rate of Growth of Value Added
Pool of industries in DE, FR, IT, NL, SP, UK - WLS rob s.e.

	1		2		3	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Total Innovative Expenditure per employee	0.124	*				
	(0.066)					
Share of Turnover due to new or improved products			0.046	**		
			(0.022)			
Share of firms innovation sources from within the enterprise					0.077	**
					(0.022)	
Share of firms innovation sources from Suppliers of equipment					-0.052	
					(0.030)	
Innovative Machinery and equipment expenditure per employee			0.352	**		
			(0.177)			
Exports	0.087	**	0.108	**	0.074	**
	(0.047)		(0.049)		(0.038)	
Intermediate Consumption	0.261	***	0.367	***	0.294	***
	(0.085)		(0.091)		(0.083)	
Household Consumption	-0.005		-0.005		0.084	*
	(0.027)		(0.032)		(0.049)	
Time Dummy	-0.622		0.430		-1.574	***
	(0.492)		(0.566)		(0.536)	
Country Dummies	Yes		Yes		Yes	
Services Dummy	2.458	***	1.919	**	1.238	**
	(0.682)		(0.729)		(0.561)	
Firm Average Size	0.107					
	(1.749)					
Constant	1.693	***	-0.162		-0.633	
	(0.573)		(0.842)		(1.456)	
N obs	294		254		338	
R^2	0.33	***	0.41	****	0.36	***

Standard Errors in brackets: * significant at 10%, ** significant at 5%, *** significant at 1% level

Table 6.6 The general model for manufacturing and services

Dependent variable: Compound Annual Rate of Growth of Value Added Pool of industries in DE, FR, IT, NL, SP, UK - WLS rob s.e.		
	Coeff.	Sig.
Share of turnover due to new or improved products (Manufacturing)	0.040	**
	(0.018)	
Share of turnover due to new or improved products (Services)	0.062	**
	(0.028)	
Innovative Machinery and equipment expenditure per employee (Manufacturing)	0.418	*
	(0.240)	
Innovative Machinery and equipment expenditure per employee (Services)	0.218	**
	(0.106)	
Exports (Manufacturing)	0.295	***
	(0.071)	
Exports (Services)	0.045	
	(0.044)	
Intermediate Consumption (Manufacturing)	0.295	***
	(0.049)	
Intermediate Consumption (Services)	0.334	***
	(0.087)	
Firm Average Size (Manufacturing)	-4.41	**
	(1.776)	
Firm Average Size (Services)	4.46	
	(3.171)	
Time Dummy and Constant	Yes	
N obs	260	
R2	0.45	***

Standard Errors in brackets: * significant at 10%, ** significant at 5%, *** significant at 1% level

Appendix A

The list of sectors and the Revised Pavitt classes (RPC, Bogliacino and Pianta, 2008)

Nace Rev.1 / Isic Rev.3	*Sector name*	*RPC**
15-16	FOOD PRODUCTS, BEVERAGES AND TOBACCO	SD
17	TEXTILES	SD
18	WEARING APPAREL, DRESSING AND DYEING OF FUR	SD
19	LEATHER AND LEATHER PRODUCTS AND FOOTWEAR	SD
20	WOOD AND PRODUCTS OF WOOD AND CORK	SD
21	PULP, PAPER AND PAPER PRODUCTS	SII
22	PRINTING AND PUBLISHING	SII
23	COKE, REFINED PETROLEUM PRODUCTS AND NUCLEAR FUEL	SII
24	CHEMICALS AND CHEMICAL PRODUCTS	SB
25	RUBBER AND PLASTICS PRODUCTS	SII
26	OTHER NON-METALLIC MINERAL PRODUCTS	SII
27	BASIC METALS	SII
28	FABRICATED METAL PRODUCTS, except machinery and equipment	SD
29	MACHINERY AND EQUIPMENT, N.E.C.	SS
30	OFFICE, ACCOUNTING AND COMPUTING MACHINERY	SB
31	ELECTRICAL MACHINERY AND APPARATUS, NEC	SS
32	RADIO, TELEVISION AND COMMUNICATION EQUIPMENT	SB
33	MEDICAL, PRECISION AND OPTICAL INSTRUMENTS	SB
34	MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	SII
35	OTHER TRANSPORT EQUIPMENT	SS
36-37	MANUFACTURING NC AND RECYCLING	SD
50	SALE, MAINTENANCE AND REPAIR OF MOTOR VEHICLES; RETAIL SALE OF FUEL	SD
51	WHOLESALE, TRADE & COMMISSION EXCL. MOTOR VEHICLES	SD
52	RETAIL TRADE EXCL. MOTOR VEHICLES; REPAIR OF HOUSEHOLD GOODS	SD
55	HOTELS AND RESTAURANTS	SD
60	LAND TRANSPORT	SD
61	SEA TRANSPORT	SD
62	AIR TRANSPORT	SD
63	SUPPORTING AND AUXILIARY TRANSPORT ACTIVITIES	SD
64	POST AND TELECOMMUNICATIONS	SB
65	FINANCIAL INTERMEDIATION except insurance and pension funding	SII
66	INSURANCE AND PENSION FUNDING, except compulsory social security	SII
67	ACTIVITIES RELATED TO FINANCIAL INTERMEDIATION	SII
70	REAL ESTATE ACTIVITIES	SS
71	RENTING OF MACHINERY AND EQUIPMENT	SS
72	COMPUTER AND RELATED ACTIVITIES	SB
73	RESEARCH AND DEVELOPMENT	SB
74	OTHER BUSINESS ACTIVITIES	SS

*SB Science Based, SS Specialized Suppliers, SI Scale and Information Intensive, SD Suppliers Dominated

Appendix B

The Revised Pavitt Taxonomy

An important conceptualization of the innovative activity of sectors is due to Bogliacino and Pianta (2008) that extend the structure of the well-known Pavitt taxonomy to services using CIS data (re-examining a previous work of Tidd et al, 2005). In analogy with the work of Pavitt, they identify four different "Revised" Pavitt classes, where manufacturing and services are indistinctly grouped in terms of the process of appropriation of technology, the sources of innovation and the structure of market. In general, these classes reflect the different level of technological opportunities of sectors. The following four classes are identified (see Appendix A for details):

a) Suppliers Dominated industries (SD). They are characterized by a low level of technological opportunities. The sources of innovation are especially external to sectors while the innovative activity is particularly direct to the mechanization of productive processes. The markets are characterized by small firms and a low level of barriers to entry.

b) Scale and Information Intensive industries (SII). They are characterized by a medium level of technological opportunities. The innovation is prevalently internal to sectors and prevalently tied to process and organizational innovation. SIIs are marked by large firms which share high levels of investment and barriers to entry.

c) Specialized Suppliers industries (SS). They are tied to a medium-high level of technological opportunity. Their main objective is the introduction of specific products for users-industries. Innovations are tied to new products and to a "tacitness" of knowledge, with a strong internal activity of research. The markets are characterized by high barriers to entry and small-scale markets.

d) Science Based industries (SB). They are prevalently tied to product innovations and the creation of new technologies. The main source of innovation is Research and Development expenditure. The high barriers to entry are associated with high level of technological opportunities and a mixed dimension of industries.

For the manufacturing sector, the Revised Pavitt classification coincides with the original Pavitt taxonomy.
Table B.1 highlights the ability of CIS data to discriminate the technological opportunity of sectors.
Also Graph B.1 shows the differences among classes, using two proxies for technological and cost competitiveness. It plots the In-House R&D expenditure per employee against the machinery and equipment expenditure per employee, through a merger of three CIS waves. The different disposition of sectors makes it possible to emphasize the technological orientation of each class. Science Based and Specialized Suppliers sectors are principally distributed in the low part of the Graph while Suppliers Dominated sectors are banished along the y axis. Scale Information Intensive sectors show an inclination towards process innovation.
There is a different variability in the distribution of sectors: Science Based show a high dispersion while the variability decreases as the technological opportunities of sectors become lower. Moving from the overview for EU economies as a whole to an analysis of separated six countries, general patterns are confirmed (Table B.2). Country differences exist, but they are

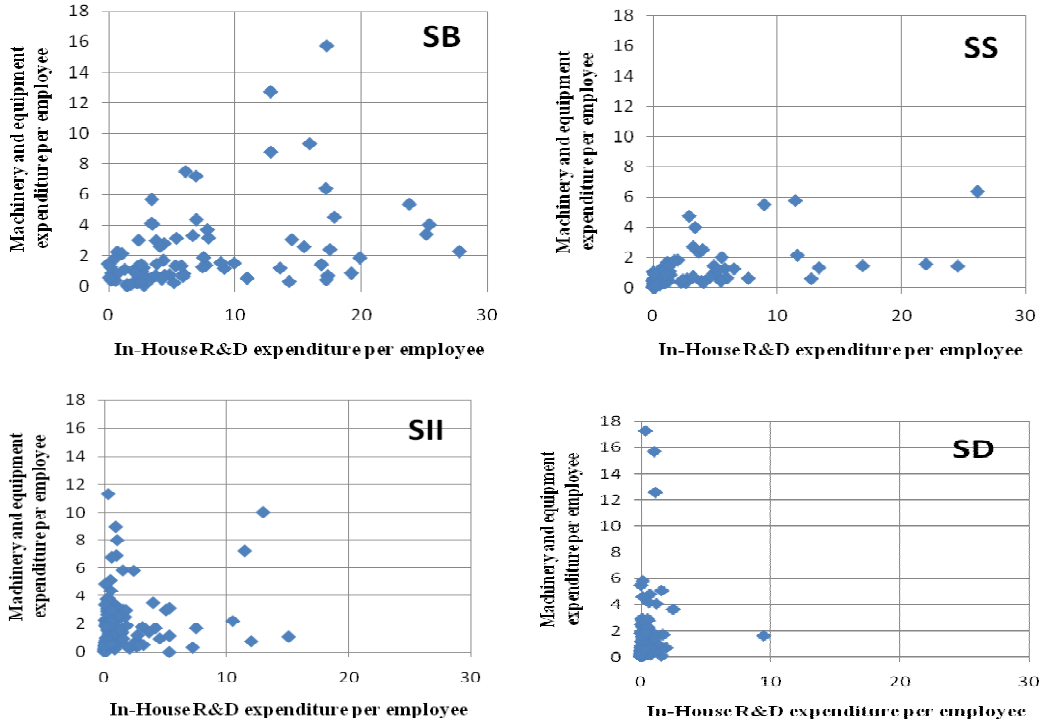
less relevant than the differences among Revised Pavitt classes discussed so far.

Table B.1 Average values of the innovative intensity for the Revised Pavitt classes. Averages among countries

	In house R&D expenditure per employee (per 1000 euro)	Share of turnover due to new or improved products	Share of firms aiming to open up new market	Innovative Machinery and Equipment Expenditure per employee (per 1000 euro)
1994-1996				
Science Based	8.31	40.82	62.08	2.46
Specialized Suppliers	4.46	36.52	48.26	1.28
Scale Informative Intensive	1.67	22.86	51.68	1.95
Suppliers Dominated	0.47	18.72	38.63	0.94
1998-2000				
Science Based	7.8	30.04	44.98	2.89
Specialized Suppliers	3.94	15.43	28.86	1.18
Scale Informative Intensive	1.42	13.34	30.16	3.37
Suppliers Dominated	0.32	9.04	20.85	1.23
2002-2004				
Science Based	7.66	28.90	33.21	1.85
Specialized Suppliers	3.74	18.82	20.18	1.02
Scale Informative Intensive	1.81	12.54	21.64	1.74
Suppliers Dominated	0.53	9.79	16.56	1.38

Source: SID

Graph B.1 In House R&D expenditure per employee (per 100 euro) versus Innovative Machinery and equipment expenditure per employee (per 1000 euro). Averages among countries and among CIS waves
SB (Science Based) SS (Specialized Suppliers) SII (Scale and Information Intensive) SD (Suppliers Dominated)



Source: SID

Table B.2 Average values of the innovative intensity of sectors. Averages among CIS waves

	Germany	France	Italy	Netherlands	Spain	UK
In House R&D expenditure per employee (per 100 euro)						
Science Based	11.29	12.83	5.14	9.52	2.72	6.28
Specialized Suppliers	7.34	7.19	1.51	4.41	1.69	3.41
Scale Informative Intensive	2.35	3.35	0.88	1.83	0.67	0.74
Suppliers Dominated	0.57	0.89	0.21	0.63	0.15	0.36
Innovative Machinery and equipment expenditure per employee (per 1000 euro)						
Science Based	4.51	0.92	2.9	2.36	0.69	2.68
Specialized Suppliers	4.58	0.66	1.19	0.74	0.47	1.41
Scale Informative Intensive	2.51	0.76	2.24	2.17	1.19	2.85
Suppliers Dominated	1.95	0.59	1	0.71	0.4	2.53
Share of Turnover due to new or improved products						
Science Based	42.10	31.36	33.30	28.07	32.97	29.78
Specialized Suppliers	36.72	18.80	22.77	25.84	23.60	17.75
Scale Informative Intensive	21.68	13.28	17.64	13.83	17.30	13.89
Suppliers Dominated	20.14	8.68	11.41	12.03	10.46	11.65

Source: SID

Appendix C

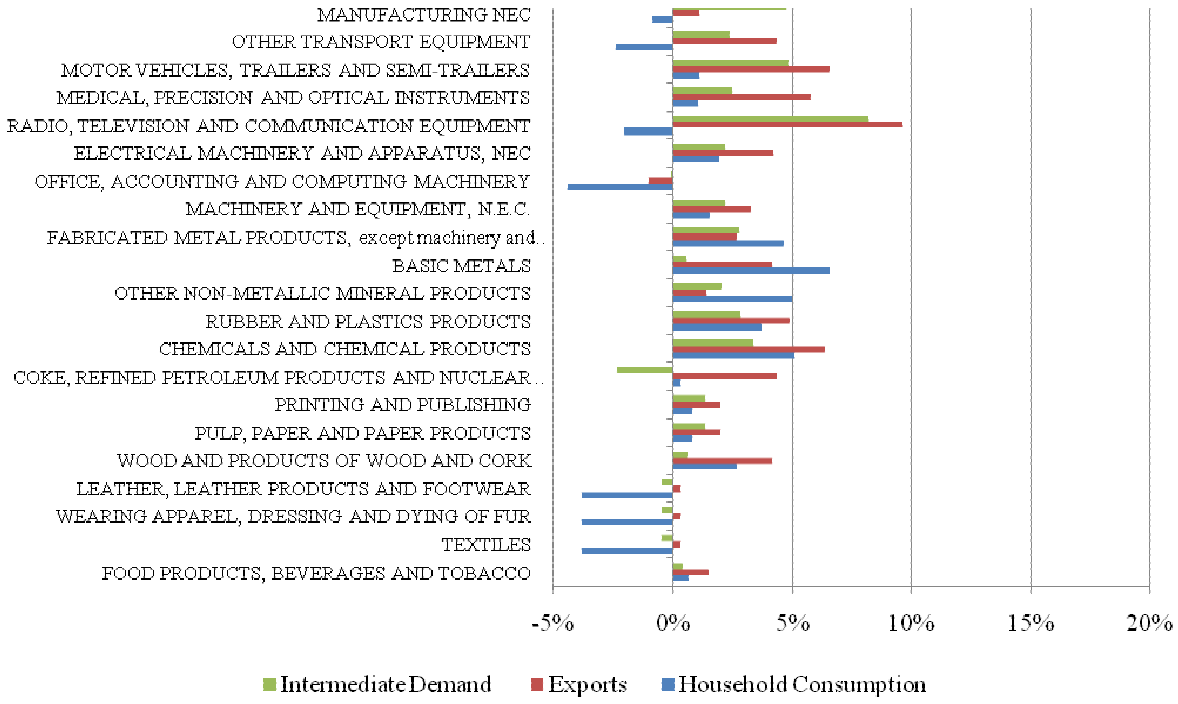
The link between technological opportunities and sectoral performance. Compound Annual Rate of change for Pavitt Classes, 1995-2007. Manufacturing and service sectors

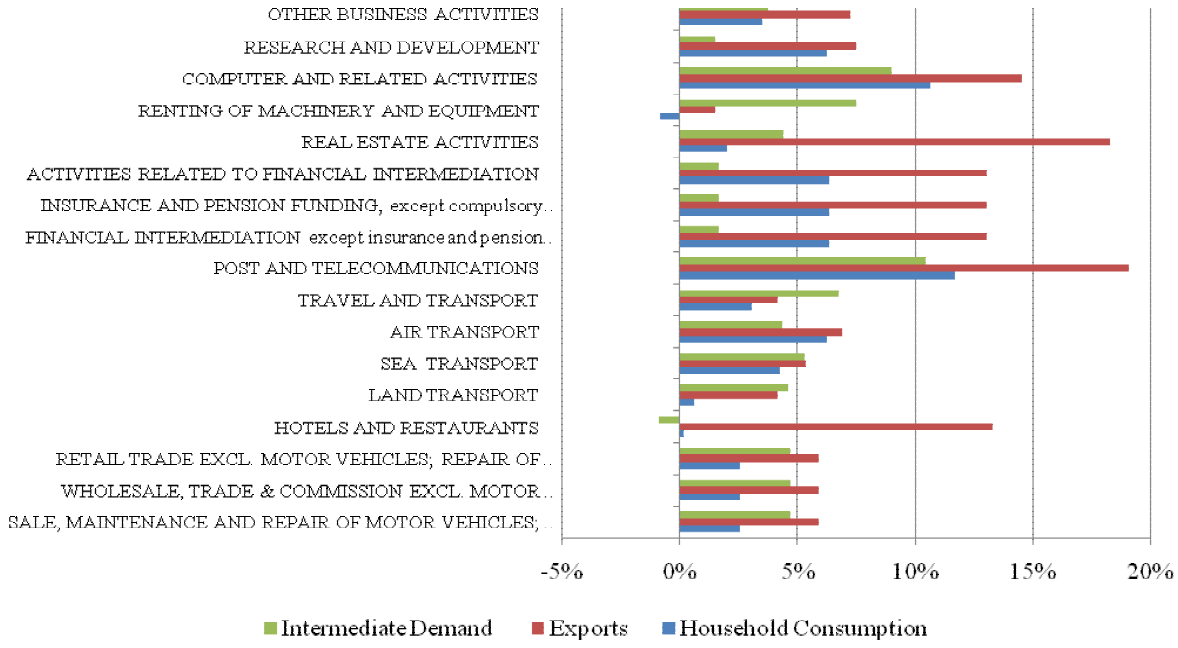
	Value Added	Employment	Productivity
Science Based sectors			
Germany	5.43	0.00	5.44
France	5.37	0.85	4.49
Italy	3.94	1.64	2.26
Netherlands	6.74		
Spain	5.05	3.06	1.92
United Kingdom	6.75	1.19	5.50
Average	5.55	1.35	3.92
St. D	2.90	1.13	1.72
Specialized Suppliers			
Germany	2.39	2.77	-0.37
France	2.77	2.77	-0.01
Italy	1.68	3.93	-2.17
Netherlands	2.76		
Spain	3.76	6.05	-2.16
United Kingdom	3.95	2.51	1.41
Average	2.88	3.61	-0.66
St. D	0.85	1.47	1.53
Scale Informative Intensive			
Germany	1.22	-0.70	1.94
France	2.46	-0.45	2.92
Italy	1.92	-0.02	1.94
Netherlands	4.01		
Spain	4.67	2.12	2.49
United Kingdom	3.10	-1.17	4.32
Average	2.90	-0.04	2.72
St. D	1.29	1.28	0.99
Suppliers Dominated			
Germany	1.47	0.35	1.12
France	1.86	0.91	0.95
Italy	0.96	1.57	-0.60
Netherlands	3.46		
Spain	2.76	4.03	-1.23
United Kingdom	2.29	0.60	1.68
Average	2.13	1.49	0.38
St. D	0.90	1.49	1.23

Source: SID

Appendix D

The evolution of demand for manufacturing and service sectors. Compound Annual Rate of growth, 1995-2007





Source: SID