MANAGEMENT, GOVERNANCE, AND ENTREPRENEURSHIP

New Perspectives and Challenges

Edited by

Darko Tipurić

Faculty of Economics and Business, University of Zagreb

Marina Dabić

Faculty of Economics and Business, University of Zagreb

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An economic analysis of the structural problem of the function of Research and Development in relation to firm size in Italy

Alessandro Ruggieri*
Enrico Maria Mosconi*
Cecilia Silvestri*
Alessio Maria Braccini*
Stefano Poponi*
Elsa Serpico*

INTRODUCTION

An firm's desire to innovate is always grounded on and driven by two concepts, one tactical, which can be summed up as follows "innovate not to succumb", the other of a more strategic and structural nature "innovate for competitive advantage" (Afuah, 1998, de Jong, and Vermuelen, 2007; Schilling, 2005). Thus, firms view innovation as a repetitive and continuous process, in which the changes in technology, organization and management are intertwined and mutually fuel each other, kick-starting a virtuous circle of improved business results (Davenport, 1994; Schilling, 2005; Tabacci, 2003).

Since Solow's groundbreaking study (1957), many others have demonstrated the key role of technological change in economic growth (Fortis, 2005, 2012; Gros-Pietro, 2004; Quadrio et al., 2002; Miglietta, 2004; Mariotti, 2005; Santarelli, Sterlacchini, 1990; Yang and Liu, 2006). In the wake of these studies, a vast literature has flourished on the relationship between technology and the growth of productivity and the economy. Over the last two decades, an abundant and varied literature has investigated the economic impact of innovative activities. The focus, *inter alia*, was estimating the rate of return, for firms, of investments in Research and Development. In particular, this issue has been thoroughly investigated in a number of industrialized countries, recent examples of which are the studies by Hall and Mairesse (1995) in France, Harhoff (1998) in Germany, and Wakelin (2001) in the UK.

In Italy, the analyses of how investments in R&D (Parisi et al., 2002; Del Monte and Papagni, 2003), Information Technology and Telecommunications (Azteni and Carboni 2001; Bugamelli and Pagano 2001) can influence the productivity of manufacturing companies has provided new empirical evidence in support of the hypothesis that innovative activities and firm performance are positively correlated. However, these studies have left open the issue of how to determine the rate of return of R&D efforts.

Over the years, empirical evidence has emerged, and produced a great deal of literature, to the effect that there is no direct relationship between the large number of new products launched on the mar-

* Department of Economics and Management, University of Tuscia

ket and the classical values of investment in research and development (Aiello and Pupo 2003, 2004). Italy has always been a particularly interesting case because, as is well known, its production structure is based on so-called "traditional" sectors, specializing in low-tech products produced by unskilled labour. Therefore, Italy is often represented as an economy of late development, mid-way between the developed and developing countries, in terms of its factor endowments and comparative advantage structure (Fortis, 2005, 2012; Gros-Pietro, 2004; Quadrio et al., 2002; Miglietta, 2004; Mariotti, 2005). Its international specialization appears to be concentrated in traditional sectors that tend to employ a higher proportion of unskilled labour, compared to those in which its main trading partners specialize.

In this respect too, in Italy's case, several scholars argue that the distributional effects of international trade, as predicted by the model developed by Stolper and Samuelson (1941), may have been beneficial to unskilled workers.

However, the advantages descending from the intermediate position of the Italian economy have been undermined by the progress in international economic integration.

For example, trade liberalization policies (the abolition of the Multifibre Agreement) have affected the traditional areas of specialization of the Italian economy, favouring the expansion of emerging countries (Faini et al., 1999).

In order to successfully trigger significant innovation processes, in firms and countries, existing knowledge must be put to effective use and new knowledge created, expertise in the fields of base and applied research must be consolidated or established and then readily transformed into useful applications for the production of material goods and services. In addition, the gradual broadening of the business "environment" and its increased dynamism impairs the effectiveness of the traditional internationalization strategies (Darra and Kurtzbergb, 2000).

The international dimension also requires that small and medium-sized companies adopt a global vision, which expands and involves all stages of production and marketing: choice of suppliers, make-or-buy decisions, productivity and efficiency comparisons with competitors, the search for sources of financing, technological decisions, business strategies.

For many years now, the Italian industrial system has been characterized by the implementation of different internationalization strategies by manufacturing firms, primarily as a function of their size.

We should also add that Italian firms operate today in a very uncertain economic environment, both nationally and internationally. The modest growth of our economy over the last ten years – weighed down by debt and the strength of the euro – and fierce international competition have resulted in the overall loss of competitiveness of Italian companies, with regard to both maintaining their share of European markets and seizing the growth opportunities offered by emerging markets.

BACKGROUND

The trade specialization patterns of the Italian economy

A contribution to the research for outlining "informal" innovation definitely comes from the market data of industrial systems. It can, in fact, be found in the new products or services launched on the market, which can be summarized – in aggregate form – in the country's trade specialization pattern.

The pattern of trade specialization of the Italian economy has changed significantly in recent years, featuring the substantial weakening of its traditional comparative advantages, eroded by growing competition from the emerging countries. Italy, in fact, ranks eighth, worldwide, in terms of the sale of products and goods (Table 31.1)

Table 31.1. – League table of the top exporters of goods

Rankings			Countries	Value		% Δ	% Share		
2001	2010	2011		2010	2011	2010-2011	2001	2010	2011
6	1	1	China	1578	1899	20.3	4.3	10.3	10.4
1	2	2	U.S.	1278	1481	15.8	11.8	8.4	8.1
2	3	3	Germany	1259	1474	17.1	9.2	8.3	8.1
3	4	4	Japan	770	823	6.9	6.5	5.0	4.5
9	5	5	Netherlands	574	660	15	3.7	3.8	3.6
4	6	6	France	523	597	14.1	5.2	3.4	3.3
13	7	7	South Korea	466	555	19.0	2.4	3.1	3.0
8	8	8	Italy	447	523	16.9	3.9	2.9	2.9
17	12	9	Russia	400	522	30.4	1.6	2.6	2.9
11	9	10	Belgium	409	476	16.5	3.1	2.7	2.6

Source ICE

Table 31.2 – League table of the top exporters of services

Graduatorie			Countries	Value		% Δ	% Share		
2001	2010	2011		2010	2011	2010-2011	2001	2010	2011
1	1	1	U.S.	523	578	10.6	17.9	13.9	13.9
2	2	2	UK	246	274	11.3	8.0	6.6	6.6
3	3	3	Germany	233	253	8.5	5.7	6.2	6.1
12	4	4	China	170	182	6.9	2.2	4.5	4.4
4	5	5	France	144	161	11.4	5.5	3.9	3.9
24	7	6	India	123	148	20.4	1.1	3.3	3.6
5	6	7	Japan	139	143	2.9	4.4	3.7	3.4
7	8	8	Spain	123	141	14.3	3.7	3.3	3.4
8	9	9	Holland	116	128	11.1	3.4	3.1	3.1

Graduatorie			Countries	Value		% Δ	% Share		
2001	2010	2011		2010	2011	2010-2011	2001	2010	2011
14	10	10	Singapore	112	125	11.6	1.9	3.0	3.0
10	11	11	Hong Kong	106	121	13.8	2.8	2.8	2.9
18	13	12	Ireland	97	107	10.3	1.6	2.6	2.6
6	12	13	Italy	98	107	9.2	3.9	2.6	2.6

Source ICE

The export surplus from manufacturing stands at about 56.4 billion, making good much of the ground lost in the previous two years, when the surplus was 37.9 billion.

In particular, if we exclude the chemical (which depends on organic hydrocarbons) and pharmaceutical sectors, all the other macro-sectors have contributed to this improvement, mechanical engineering first and foremost with a surplus of 44.4 billion euro (equal to about twice the surplus for consumer goods for personal/home care).

The official figures for 2011 show that manufacturing exports have grown in value (in euros) by 11.5 percent, slightly above the world trade average: after three years of gradual decline (from 4.35 percent in 2007 to 3.70 percent in 2010), Italy's manufacturing market share has risen slightly to 3.72 percent.

This trend has been supported by a positive "product effect" (due to the weak dynamics, as a result of falling prices, of the international trade value of electronic goods, a sector in which Italy is not specialized); in any case, the increasing market shares in a number of sectors has also contributed, such as the iron and steel industry (from 4.9 to 5.1 percent), pharmaceuticals (from 3.6 to 4 percent), leather goods (from 13.2 to 13.4 percent), footwear (from 10 to 10.2 percent), and most importantly, given its size, the mechanical tools sector, whose share rose from 6.3 to 6.5 percent, slightly up compared to a bad 2010.

Italy's share of the worldwide garment market remained unchanged at 5.6 percent, after falling for two years; while the downward trend was ongoing in the other sectors in which the Italian economy is traditionally specialized (textiles, ceramic tiles, marble, appliances, furniture, jewelry), albeit at a slower rate.

Having regard to the manufacturing industry as a whole, last year, Italian exports grew more than in France or Germany, and the comparison with France almost invariably sees Italy on top, since 2005 (except in 2008 and 2009).

In the 2009-2011 period, the comparison with all the EU competitors shows mixed results in the single sectors, with an upward trend in the traditional sectors, such as textiles, leather and footwear, intermediate sectors, such as chemistry and metalworking, and high innovation-intensive sectors (computers-electronics-optical products).

In 2011, Italy still ranked second, with regard to worldwide exports of clothing, leather and footwear, third with respect to textiles, furniture, household appliances, non-metallic mineral products (tiles, glass, building materials), fourth for metal products (mechanical tools, cutlery, etc.), and fifth for steel, rubber and plastics, electrical and mechanical engineering.

Figure 31.1 gives an overview of "Economic Complexity: Mapping Paths to Prosperity", for mapping products based on certain inherent requirements, in terms of knowledge, in order to identify the processes for accumulating production knowledge and defining each country's place within an international geography of complexity, also with a view to anticipating future changes in its competitive structure, to highlight the strategic options associated with its economic development. In particular, Italy finds itself in an intermediate position, which signifies 'moderately complex' worldwide trade activities.

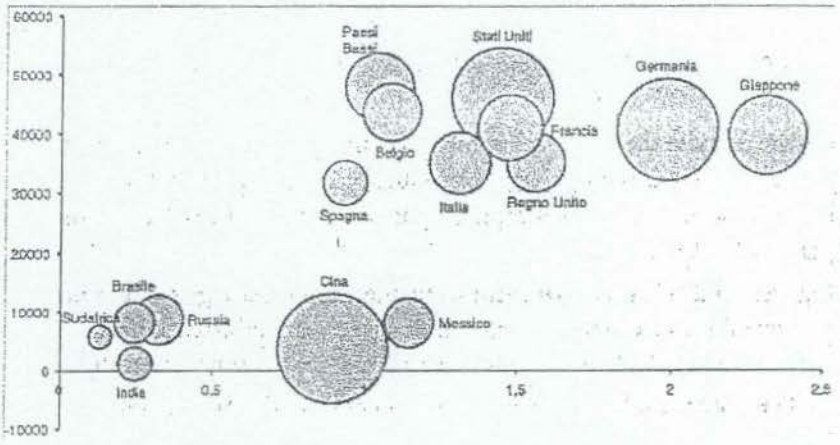

Figure 31.1 Degree of complexity of international trade
Source: Rapporto ICE 2012

Italian industry has concentrated its specialization in the fields of mechanical engineering and other specialist productions, such as electric cars.

In these sectors, the 'industrial district' model, consisting of a web of small and medium firms – which is the key trait of Italy's economic system – has maintained a significant competitive advantage, helping to reduce the impact of competition from emerging countries.

Table 31.3 Trade specialization indices of the Italian manufacturing sector

	1980-81	1990-91	2000-01	2007-08
Furniture and other products in manufacturing industries	0.62	0.63	0.59	0.44
Machinery and mechanical devices	0.34	0.43	0.41	0.44
Products of manufacturing of non metal-bearing minerals	0.47	0.48	0.51	0.43
Metal products, machinery and equipment excluded	0.43	0.44	0.42	0.43
Ships and boats	0.3	0.04	0.44	0.37
Coke, refined petro products and nuclear propellers	-0.12	-0.21	-0.01	0.29
Leather, articles for travel, bags, saddler and shoes	0.69	0.62	0.38	0.29
Air and space crafts	-0.17	0.03	-0.05	0.28
Rubber articles and plastic materials	0.25	0.25	0.25	0.26
Textile products	0.23	0.37	0.35	0.23
Clothing articles, fur coats	0.51	0.51	0.3	0.19
Locomotives, including manoeuvring locomotive, and rail-tram rolling stock	0.5	0.26	0.16	0.17
Electric tools and machinery	0.06	0.11	0.07	0.15
Medical devices, precision devices, optical instruments, and watches	-0.33	-0.22	-0.16	-0.06
Paper paste, paper and paper product, editorial and printing products	-0.26	-0.14	-0.15	-0.06
Steel industry products	0.04	-0.04	-0.12	-0.08
Deli products, beverages, tobacco	-0.41	-0.31	-0.16	-0.1
Pharmaceutical base products and pharmaceutical preparations	-0.01	-0.25	0	-0.11
Motor vehicles, towing and semi-towing cars	-0.19	-0.13	-0.19	-0.16
Chemical products	-0.32	-0.34	-0.29	-0.24
TV and telecommunication devices	-0.37	-0.38	-0.25	-0.35
Non iron base metals	-0.73	-0.63	-0.58	-0.42
Wood, or wood and cork products (excluding furniture)	-0.58	-0.49	-0.4	-0.44
Office machines, computers and informatics systems	-0.15	-0.13	-0.47	-0.65

Source: STAN-OECD-ICE 2012 data

Table 31.3, which shows the NTS indices (this is an indicator based on the formula proposed by Balassa and Bauwens – 1988, commonly used in the economic literature for measuring the intensity of intra-industry trade). The NTS indices may be more directly interpreted as a measure of the intensity of inter-industry specialization, because they do not incorporate other variables, such as the size of the sector or its degree of openness - (Iapadre, 2001, 2002) for 24 manufacturing sectors.

Until the early Nineties, the most specialization-intensive areas of the Italian economy were still the traditional consumer goods sectors, such as clothing, footwear and furniture.

Over the past two decades, the comparative advantage of most of these sectors has been considerably impaired, as a result of which they have dropped significantly in the rankings. On the other hand, the mechanical engineering industry has established itself as the most important field of specialization, further consolidating an already strong position, held also thanks to the production of instrumental goods for manufacturing traditional consumer products. The specialization indices have relatively improved in such sectors as precision instruments and aeronautics.

The conclusion is that the specialization pattern of Italian industry has been transformed, both actively and passively, as a result of the progress made by emerging countries, but also due to the fact that many Italian firms operating in traditional sectors have reflected the international process of production fragmentation, stimulating exports of intermediate goods and investments in the global production networks.

This transformation however raises the question of the capacity of medium-tech industries, in which Italy is specialized, to absorb the workforce made redundant by the traditional high labour-intensive sectors, and fuels the widespread fear that the process of outsourcing, observed in the data on employment, may be the result of industrial decline, rather than a beneficial structural evolution of the economy.

Outline of the Italian production system and firm size for the capacity to innovate

The Italian production structure is characterized by a predominance of small and medium-sized firms, with a high percentage of so-called "microfirms" (fewer than 10 employees). In 2007, SMEs accounted for 81.1% of the Italian workforce, the highest percentage among Spain, France, Germany and the United Kingdom. Likewise, small and medium-sized firms account for 71.3% of the added value generated in Italy, while in Spain this indicator amounts to 68%, in France 56%, Germany 536% and the UK 51%. In 2006, Italian SMEs invested, on average, 1.7% of their turnover in innovation, second only to Germany (1.8%) among the major European countries. Compared to Spain, France, Germany and the United Kingdom, Italy also features the smallest gap in terms of the impact of investments in innovation on turnover, between SMEs and large firms.

Today, the Italian production system in the manufacturing sector comprises about 460,000 manufacturing firms, mostly small firms scarcely equipped to withstand the type of competition engendered by globalization, and differs from the predominant production systems in Anglo-Saxon countries (characterized by a form of capitalism that has developed, over time, a strong specialization in the field of finance, with the London Stock Exchange acting as a powerful driver), Germany (where manufactur-

ing is based on a Fordist-type model integrating firms, banks and trade unions), France (dominated by strong industrial complexes partnered with a nationwide network of science parks and strong connections with the military-industrial complex), and in the Hanseatic Nordic countries, from Flanders to Sweden and Finland (based on the modern economic mix of technological knowledge and expertise).

In fact, the competitiveness of Italian firms has declined in relative terms, compared to its main international competitors, also due to:

- a limited propensity to investing in R&D, accompanied by deep-rooted difficulties encountered by the research system in building links between research results and their implementation in the production process;
- the typical size of Italian firms.

On top of this, the Italian production system is represented by a locally-based form of capitalism, which, according to Beccattini (2006), tends to view the firm as an individual 'life project', reflected in the predominance of family-run businesses.

Firms mostly start off as small businesses, they grow and become medium-sized and, eventually, transform into small (pocket-sized) multinationals; the whole country has been transformed into one large industrial district, while the local districts become production platforms. This is a form of seamless industrialization, which incorporates the family, the firm and the local community, straddling agriculture, manufacturing, tourism and services. In practice, we have examined a succession of three historical cycles that have produced patterns and hegemony.

The first cycle was the era of industrialization, dominated by the establishment of large private companies; the second cycle witnessed the development of large public companies (IRI, ENI, EFIM) and of molecular capitalism, spread by small firms gathered into 'business districts'.

The third, and current, cycle is characterized by a "fourth capitalism", according to a definition coined by the firm history scholars of the Bocconi University.

As mentioned above, Italy is characterized by a large number of small and very small businesses; suffice it to mention that over 90% of all registered companies have fewer than 20 employees, compared to an average of 80 to 85% in many OECD countries. Firm demographics in Italy are relatively low, despite the limited size of companies (see Table 31.4), generally associated with a more dynamic business stance (small companies tend to have a higher birth/death rate compared to the larger companies).

Table 31.4 The size of Italian firms compared to several other European countries

	Employees	France	Germany	Italy	Spain	UK
Micro	0-9	188,500	119,418	373,932	155,699	96,912
Small	10-49	23,000	55,131	74,647	30,468	23,275
Average	50-249	5,600	16,720	9,753	4,937	6,699
Middle Big	+249	1,400	4,170	1,396	868	1,531
Totale		218,500	195,439	459,728	191,972	128,417

Source: Eurostat data processed by Mediobanca (2012)

MAIN FOCUS OF THE CHAPTER

Products and the technological content of production in international trade

Product innovation is understood differently today than in the past. It is no longer just a matter of achieving product leadership.

This was undoubtedly a defining characteristic for many Italian manufacturing companies, which, for many years, ensured the success of our products on the international markets. Unfortunately, today, product leadership – which means focusing on high-quality, high-end and exclusive brand products – is no longer sufficient (Fortis, 2005, 2012, Gros-Pietro, 2004; Quadrio et al., 2002; Miglietta, 2004; Mariotti, 2005). The combination of product and price leadership is viewed as the main strength of leading companies in the forthcoming years, and the approach Italian companies intend to adopt to achieve this end is based on improving the effectiveness of the product lifecycle management process (Boitani and Cicciotti, 1992; Amendola et al. 2005; Balloni and Iacobucci, 2004). According to the results of our survey, in fact, single manufacturing companies expect to obtain a series of benefits from improved product lifecycle management, including a dramatic increase in product quality, reduced prototyping and "industrialization" costs, savings generated by the reuse of existing components, and reduced costs resulting from compliance with regulations. In short, firms believe that better product lifecycle management will lead to a combination of price and product leadership.

A survey recently conducted in Italy, on the benefits descending from effective product lifecycle management, has revealed that the major motivation for businesses to innovate was the financial benefits that could be obtained, namely, the reduction of product "industrialization" costs, the savings generated by the reuse of existing components, the reduction of prototyping costs, along with the number of prototypes, and the increase in product quality, regardless of whether their organization was formally equipped to do so (Drucker, 2002; Fortis, 2005; Becheikh et al. 2006).

Following is an overview of the advantages of an effective product lifecycle management:

1. Reducing waste and reprocessing
2. Providing partners / clients with safe and functional access to information
3. Speeding up the design and introduction of new products
4. Improving collaboration between the various departments and with suppliers
5. Integrating workflows
6. Reducing regulation compliance costs
7. Financial benefits
8. Reducing product "industrialisation" costs
9. Saving money by reutilizing existing components
10. Reducing prototyping costs and the number of prototypes
11. Increasing product quality
12. Providing more efficient responses to clients

Source: IDC Manufacturing Insights – Oct 2011

Based on an investigation into the technological content of production, we can summarize the key tenets of innovation as follows:

1. Technological innovation is the basis of the economic growth of a country.
2. High-tech industries feature a greater growth of added value.

With regard to investment in research and production, Italian-owned companies are segmented into industrial sectors, with pharmaceutics, transportation and electronics topping the list. Moreover, these sectors are also those featuring the highest level of internationalization (Figure 31.2).

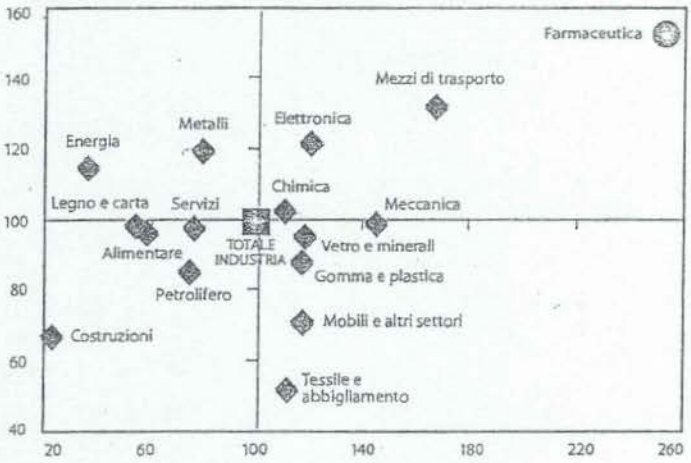

Figure 31.2 The characteristics of Italian-owned companies (total industry index=100) Internationalization index (ratio of mean exports and sales abroad to turnover)

There are many reasons behind Italy's low-profile performance, with respect to innovation: weakness factors are concentrated in the area of both innovation inputs, i.e. low technical/scientific specialization, lack of continuous training, low number of university graduates in scientific subjects, lack of collaborative innovation projects between firms and with universities, collapse of investments by venture capital operators and of expenditure in the ICT sector, and outputs, such as, in particular, the low propensity to international patenting.

Table 31.5 Technological intensity of production

	Germany	Italy	Spain
Low	31.1	39.9	39.6
Medium-Low	26.3	30.2	33.4
Medium High	33.9	26	19.3
High	8.7	3.9	7.7

Source: OECD and Mediobanca data

Consequently, the predominant interpretations explain the existing difficulties in terms of the limited capacity of firms to invest in Research & Development; as well as in the Italian entrepreneurial model, based on small-sized businesses specializing in mature sectors, unable to keep up with international competition, which has gradually moved towards high added-value productions and an increasing content of knowledge and innovation.

Table 31.6 Several characteristic structural parameters of industrial sectors in Italy

	Medium/High technology sector
Value added for personnel unit	126
Expenses for employers	118
Export per employer	183
Investments per employer	146
- in production	106
- in R&D	257
- in environment protection	174

Manufacturing = 100

Source: Farmindustria data

Table 31.7 The top 10 Italian companies investing in R&D

Firm	Sector	R&S Mil €
Finmeccanica	Aerospace-Defence	1,926
Fiat	Automotive	1,692
Telecom Italia	Telecommunications	842
Intesa Sanpaolo	Banking	211
Eni	Hydrocarbon	207
Unicredit	Banking	142
Pirelli	Automotive and components	137
Chiesi Farmaceutici	Pharmaceutics	132
Italtel	Telecommunications	94
Enel	Electricity	88

Source: Edison Foundation on Monitoring industrial research: the 2010 EU industrial R&D investment scoreboard

For an accurate confirmation of the aggregate indicators, we can take as an example the data relating to the top 10 Italian companies. Observing Table 31.7, we can see that the sum of the R&D investments by the top Italian companies (totaling € 5,471 billion) is equal to the sum invested, in the same year, by the German Volkswagen firm alone (€ 5,790 billion).

This technological gap in Italy, compared to other European countries, also emerges from the analysis of the data on employment, particularly in high-tech sectors, where the level of employment is

below the European average. On the contrary, in the medium-high technology sectors, this gap is substantially smaller; Italy, in fact, appears to be in line with the European average (7.5% in Italy compared with an average of 6.69%), due to its well-established skills in mechanics, transportation and space technology.

The country's export capacity in the science-based sectors, however, is still small, compared to the EU average (5.11 compared to 14.51% of total exports) (Figures. 30.3-30.4).

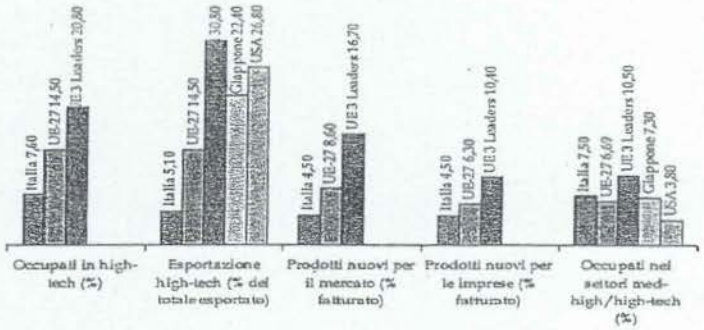

Figure 31.3 Indicators of the types of industrial productions in Italy, compared with other countries.
Source: PNR 2011-2013 and European Innovation Scoreboard

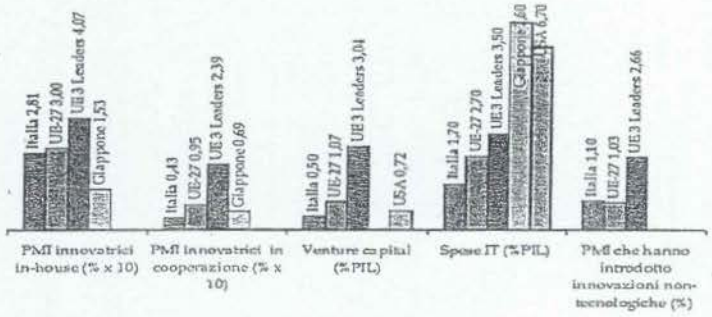

Figure 31.4 Innovation capacity indicators in Italy, compared with other countries
Source: PNR 2011-2013 and European Innovation Scoreboard

R&D expenditure trends and the structure of R&D in the Italian production system, compared with other European countries

The structure of investments in research and development can either slow down or speed up the ability to pursue the creation of knowledge.

In particular, in the field of publicly-funded research, Italy invests 0.56% of its GDP, compared to the EU average of 0.65% (the figure relates to 50% of funding to universities and 100% of funding to public research institutions and centres).

Private investments in R&D are considerably below the European average: only 0.55 compared to 1.17% of the GDP, while, in the case of R&D investments by large and medium-sized companies, the Mediobanca figures indicate a situation in line with their principal international competitors.

In terms of the annual increase in the percentage of GDP invested in R&D, Italy ranks bottom in the EU-27 list, with an increase of 14.8% over the past year (Table 31.8). Further food for thought is given by crossing the value of the SII (Summary Innovation Index) with the level of *per capita* income and the EU27 average. Italy is the only European economy with an income level in line with the EU average and at the same time a performance in innovation lower than the same benchmark. Furthermore, Spain, Portugal, Czech Republic, Slovenia, Cyprus, Estonia are all currently ahead of Italy, confirming that Italy is not accelerating in the drive for innovation, while the enlargement countries are catching up and quickly bridging the structural gaps, aiming with determination towards an innovation-based economy. Moreover, in the SII 2009 league table Italy ranks only 19th, below the European average, confirming a serious delay in grasping the competitive advantages of innovation.

Table 31.8 R&D investment trends in Italy between 1980 and 2011

Year	Cost R&D/GDP	Cost R&D Mil €	Cost R&D Ind Manufacture
1980	0.74	1,496	726
1985	1.47	6,308	2,408
1990	1.25	11,171	4,522
1991	1.19	11,517	4,887
1992	1.15	11,255	5,044
1993	1.09	9,566	4,730
1994	1.02	9,080	4,696
1995	0.97	8,386	4,809
1996	0.98	9,779	5,167
1997	1.02	10,828	5,266
1998	1.04	11,401	5,007
1999	1.02	11,524	6,294
2000	1.04	12,460	6,879
2001	1.08	13,572	7,237
2002	1.12	14,600	7,288
2003	1.11	14,895	7,208
2004	1.1	15,375	7,345
2005	1.09	15,657	7,859
2006	1.14	16,835	8,173

Year	Cost R&D/GDP	Cost R&D Mil €	Cost R&D Ind Manufacture
2007	1.17	18,231	9,285
2008	1.21	18,993	10,222
2009	1.26	19,209	10,069
2010	1.26	19,539	10,764
2011	1.22	19,305	10,861

Source: ISTAT data processed by Farmindustria

The international comparison of the Innovation index scoreboard shows how our country is classed among the moderate innovators. Our greatest strength is represented by intellectual assets, innovative firms and the results they produce. The major weaknesses, instead, consist in the (scarce) investments in innovation and cross-border collaboration between companies.

In Italy, large companies alone cover 72.7% of industrial research. On the contrary, investments by small businesses are very low and correspond to 5.1% of total investments, a situation also shared by other countries: the figure, however, is a source of concern if one considers that, in Italy, SMEs account for 99% of firms, and are concentrated in "traditional" medium-to-low technology sectors.

Table 31.9 Investments in R&D by sector, in relation to market size

	Mil €	%	% Manufacturing	% business presence on the market
Aeronautics and other transportation means	3.424	23,8	31,5	4,4
Pharmaceutical and biotech for health	1.788	12,4	16,5	3,3
- of which Pharmaceutics	1.250	8,7	11,5	6,2
Mechanics	1.291	9	11,9	2,1
Informatics and office machines	667	4,6	6,1	3,4
Precision and electro-medical devices	500	3,5	4,6	5,8
Electric devices	436	3	4	1,4
Chemical and petrol	403	2,8	3,7	0,4
TV, radio, and telecommunications devices	302	2,1	2,8	2,7
Medium-high technology sectors	8.272	57,6	76,2	2,5
Manufacturing industry	10.861	75,6	100	1,2
Total	14.365	100		1

Source: ISTAT data processed by Farmindustria

In 2010, spending in innovation – which includes the cost of research and development, investments in new products and their introduction on the markets – reached the figure of 121 billion euros and was expected to rise, in 2011, to 130 billion, beating the previous 2008 record of 126 billion euros. A survey sponsored by the European Commission enables a comparison between Italy and the other major European countries, in terms of spending on research and industrial development.

Table 31.10 shows how Germany is by far the European country with the greatest industrial potential for investing huge sums in research: Germany, among the major European countries, is the only one with an industrial group, Volkswagen, which spends more than 5 billion a year in R&D, plus as many as 4 groups that invest between 2.5 and 5 billion. In comparison, France and England feature no group with an R&D budget in excess of 5 billion and only two groups that invest between 2.5 and 5 billion euros each; in Italy there are no companies at all that spend above 2.5 billion per year.

Table 31.10 Spending in research and development by major European industrial companies in 2009. Number of companies in each country by class of R&D spending

	Italy	Germany	France	UK
oltre 5		1	0	0
2,5-4,9		4	2	2
1-2,5	2	6	2	1
0,5-0,99	1	3	10	5
0,25-0,49		8	6	5
0,1-0,24	5	26	15	18
Number of Industrial Societies with more than 100 Mil €	8	48	35	31

Source: Edison Foundation in Monitoring industrial research: the 2010 EU industrial R&D investment scoreboard

Considering the companies that, in 2009, invested over 100 million Euros in research, no less than 48 are located in Germany, with a total expenditure of more than € 39 billion, 35 in France, which invested 22.5 billion overall, 31 in England, with a level of expenditure of 15.8 billion, while only 8 are located in Italy, with an aggregate investment of about 5.3 billion (Table 31.10).

Italy and Germany share the feature of being countries with a strong manufacturing industry. But while Germany features many large industrial groups, which boost its leading role in the fields of research and internationalization, Italy is the reign of small and medium firms, which is yet another reason why it is so difficult here to invest large sums in research and development.

FINDINGS

Innovation and the trade in technology in Italy

Table 31.11 % composition of innovation producers and transferors by type

	2010	2011
Firms	56.9	57.3
Single entrepreneurs	18.6	16.7
Inventors	10.8	14.8
Professionals/Consultants	3.9	5.6
Industrial property agents	7.8	5.6
Universities	2	

Source: Rapporto Unioncamere 2012

A survey by the Chambers of Commerce, on its innovation services, has highlighted the structure of technology producers and transferors.

Table 31.12 Applications received by Patent & Trademark Offices in 2010-11

	2010	2011
Ornamental models	208	944
Designs and models	1,181	1,115
Utility models	2,500	2,393
PATLIB-PIP services	3,639	3,317
Transcriptions	4,175	4,037
Notations	4,231	4,282
International trademarks	4,941	4,667
Miscellaneous petitions	8,860	6,353
Inventions	9,470	9,519
Translation of EU patents	26,069	26,955
Trademarks	55,122	54,033

Source: Rapporto Unioncamere 2012

In terms of innovation dynamics, Table 31.11 shows how applications to Chambers of Commerce increased, in 2011, with respect to patents, utility models, inventions, designs and requests for translations of European patents. There was a slight decline only in the number of applications for the registration of trademarks (-2% yoy), a trend which demonstrates that the industrial fabric, in Italy, is substantially "resisting" against the ongoing economic crisis, which weighs heavily on the ability to spend.

Lastly, the reluctance to invest in R&D is confirmed by the Italian performance in the transformation of knowledge into economic value, as can be inferred from the analysis of patents and licenses.

The number of Italian patents per million inhabitants filed with the European Patent Office, and the U.S. Patent and Trademark Office, is approximately equal to half the EU average (87.3 and 31.2, respectively, compared to 136.7 and 50.9). The low number of patents produced by the public sector (universities and public research facilities) confirms the need to intervene with respect to the national public institutions, both in terms of governance and incentive policies (Figure 31.5).

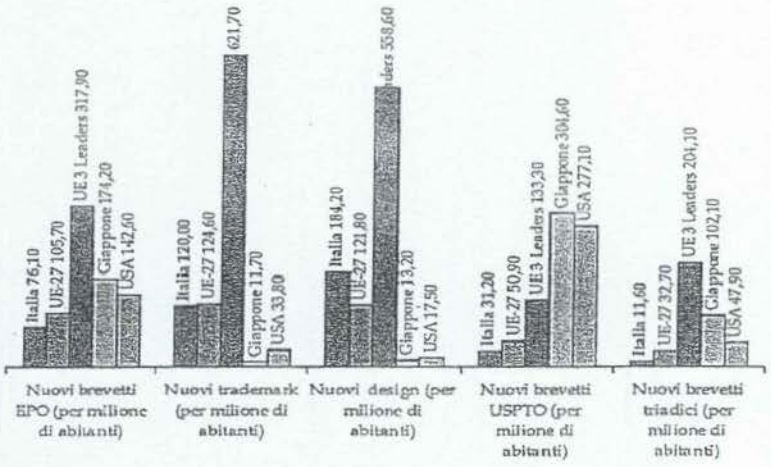

Figure 31.5 Transformation of knowledge into patents in Italy and elsewhere

Source: PNR 2011-2013 e European Innovation Scoreboard

The above trend is confirmed by the technology balance of payments (TBP), whose flows are an indicator of the input (payments) and output (proceeds) of technology.

Table 31.12 shows that, internationally, Italy has a strong competitive position in terms of the exchange/exploitation of patents, know-how and inventions. Despite the situation of economic downturn, recent trends have shown a development in the intensity of product-process innovation. It is also showing a recovery by smaller companies, while confirming the structural trend, according to which the larger the firm, the greater the propensity to innovate.

Table 31.13 The technology balance of payments

In K Euros and % composition

	TAKINGS		PAYMENTS		BALANCES
	K euro	%	K euro	%	K euro
Commerce of technology	532.850	16,5	590.761	19,4	-57.911
Transfer/Acquisition of patents	53.172	1,6	32.257	1,1	20.915
Exploitation rights on patents	441.336	13,6	510.604	16,8	-69.268
Know how	37.756	1,2	47.612	1,6	-9.856
Transfer/Acquisition of inventions	586	0,0	288	0,0	298
Transactions in trading marks, drawings, etc.	185.820	5,7	633.423	20,8	-447.603
Exploitation rights on trademarks and drawings	172.132	5,3	550.944	18,1	-378.812
Transfer/Acquisition of trademarks and drawings	13.688	0,4	82.479	2,7	-68.791
Transfer/Acquisition of trademarks, models and drawings					
Services including technology	1.340.607	41,5	675.149	22,2	665.458
Technical assistance related to transfer of exploitation rights	32.461	1,0	60.800	2,0	-28.339
Deployment of expert technicians	145.441	4,5	91.188	3,0	54.253
Personnel training	18.065	0,6	30.737	1,0	-12.672
Technical and engineering studies	1.144.640	35,4	492.424	16,2	652.216
R&D activities financed abroad or by foreign countries	1.144.454	35,4	563.949	18,5	580.505
R&D services	1.144.454	35,4	563.949	18,5	580.505
Other regulations for technology	30.048	0,9	584.312	19,2	-554.264
TOTALE	3.233.779	100,0	3.047.594	100,0	186.185

Source: Ufficio Italiano Cambi

The latest official figures show that in 2009, the overall TBP was negative for about 186 million Euros, although improving greatly year on year.

The intangible infrastructure for informal research by small companies

R&D activities are of vital importance and the innovation process is depending more and more on a series of interrelated factors. Due to increasingly complex innovation processes and rising costs, especially for businesses located near or on the technological border, collaboration between firms has become a crucial success factor.

Interestingly, collaboration is not just a way to save money, in respect of the costs entailed by the innovation process, but also, if not predominantly, a means for broadening the scope of innovative projects and exploiting complementarities with other companies.

The OECD Report on Innovation Strategy (2010) shows how innovative Italian companies are only marginally involved in partnerships with other companies: about 10% of companies are engaged in innovation projects with other Italian companies, and only 3% are involved in international partnerships. Although reflecting the specific trait of Italian companies, with a predominance of small and medium-sized firms engaging in informal, rather than formal, innovation activities, this situation also underscores the need to promote relations between companies, in order to achieve the critical mass that is often a prerequisite for successful innovation.

"Informal" innovation, which is largely ignored and hardly ever enters the official statistics, due to surveying difficulties, is on the rise, as a result of the integration of supply chains and the ability of Italian companies to establish networks and synergies between the manufacturing and services sectors. Quadrio Curzio (2004) argues that innovation does not necessarily follow from research, a fact that seems to be confirmed by the typically Italian local district-based entrepreneurial model, characterized by informal research-based innovation led by inventor-entrepreneurs, rather than conventional scientific and technological research. This Italian capacity to produce innovation without conducting formal research is also reflected in the European Innovation Scoreboard historical data, which shows how Italy always excels in the indicator relating to the percentage of new – or significantly improved – products launched on the market by companies with a clearly higher positioning (Fortis, 2005; Gros-Pietro, GM, 2004, Miglietta, 2004).

Most of the costs that a firm incurs for research and innovation, in fact, are usually spread over a number of different budget items (purchase of raw materials, personnel, investments, consulting, etc.) and only a small portion of these appear – at times – in the notes to the financial statements.

As a rule, the interpretations of this phenomenon are based solely on the size of the firm. What is certain, however, is that they are absolutely inadequate to explain the phenomenon of innovation in Italy.

Suffice it to mention, in this regard, the widespread informal education consisting of a set of unorganized training activities that are generally not supported by the official educational establishments, but can spring from self-organized initiatives featuring spontaneous participation, or from spontaneous and random situations related to the ordinary professional activities of individuals. Likewise, "informal" innovation can be detected only in new products or services put on the market. A survey by Censis has measured the informal research and experimental activities carried out by small businesses, which often feature no specific entry in the firm's financial statements, but which fully engage the firm's human resources, enabling significant product and process innovation. The results of this study show that the informal research activities involve significant amounts of investments and human resources: the companies examined had incurred considerable costs dedicated to:

- investments aimed at product and process innovation;
- work dedicated to research, experimental activities and the development of models and prototypes;

- outsourcing and external consulting services aimed at product innovation;
- raw materials used to achieve product innovation.

The annual investments incurred amount to 19% of the firm's total spending.

The difficulties in measuring these innovation activities – as a result of which they hardly ever enter the official statistics – is confirmed by the survey carried out by the Italian research centre CENSIS, according to which 84% of the costs for achieving innovation are included in and distributed among various items of the financial statements (purchase of raw materials, personnel, investments, consulting, etc.) and only 16% of the costs appear in a specific section of the financial statements dedicated to research.

In a production system based on small firms, in which development is concentrated in districts, supply chains and networks, relations between firms play a crucial role in explaining the creation of innovative products.

In particular, the traditional paradigm of the subcontracting process, in which the strategic and operating decisions taken by the contractor – usually a medium-to-large firm – are the only drivers of integration within the supply chain, is prevailed over, on the ground, by a model in which the emphasis is on a multi-directional exchange, within the context of the different stages of innovation, between the contractor and the subcontractor, and in which the small suppliers even become the main catalyst of innovation in certain important phases, such as the provision and implementation of models and prototypes and the supply of materials and innovative equipment.

This leads to the development of a pattern according to which innovation is the result of a balanced creative interaction between the contractor, the supplier, and the provider of outsourced services; in many cases, this interaction is driven by the imagination and inventiveness of the team made up of the contractor and the technical employees of the small supplier, supported by external consultants.

It is against the backdrop of this model of inter-firm relations that we should interpret the recent good performance of medium-sized Italian firms (Unioncamere 2007).

Medium-sized businesses, in fact, are based on a system of relations that brings together, on average, each firm and 244 suppliers of raw materials, semi-finished goods and services (other than administrative services), a system that produces over 5.2 million relations, primarily with small firms or even microfirms.

In particular, the survey shows how the segment of small businesses included in the sample manages complex relationships with at least 27 larger contractors.

The analysis of the informal research paths undertaken by small businesses (Censis), shows that 13% of the human resources of the companies is engaged in research activities: an average of at least 1 employee every 9, in small companies, is employed in research, testing, modeling and prototyping activities.

Compared to the universe examined here, the number of employees engaged in conducting "informal" research activities is much higher than those employed in the "formal" R&D operations, in small firms, as recorded by the official statistics. In addition, the survey also shows that there is a significant

proportion of small innovative firms, equal to 7.4% of the total, which has either directly patented an innovation or has transferred it to its client firm for patenting.

Thanks to the flexibility and ability to adapt to the market needs, through this pattern of networking and supply chain integration – consisting of a mix of external consulting and in-house activities – which allows the large-scale integration of innovation into the corporate culture, these small dynamic companies have become the true 'guardians of quality and innovation of Made in Italy products', thanks to their capacity to steer innovation towards the improvement of product quality, expansion of the customer base, and improvement of the firm image, not to mention the loyalty-enhancement of existing customers and increased productivity.

CONCLUSIONS

In recent years there have been signs that, while remaining uncertain, investments in R&D are nevertheless improving. The signs consist in the shoring up of the country's competitiveness, with respect to the emerging economies; mixed product-process innovations, in line with the other countries; the role of medium-sized firms as drivers of growth, in the field of medium/high technology. However, the procedures for delivering public resources tend to penalize the private research centers

With regard to the capacity of SMEs to innovate, the analyzed data highlights the gap that exists between Italy and the other European countries. Italian SMEs, in fact, have focused on process innovation, although, in recent years, they have also increased product innovation. The growing trend by SMEs to develop R&D projects is reflected in their increased access to national and regional incentive tools.

In the context of a positive evolution towards research as a means for supporting the development of SMEs, there is the need to institutionally strengthen the propensity for collaboration between the public sector and SMEs, also through the temporary mobility of the persons involved.

Integration is the key for building a more constructive market penetration capacity, improving leadership by companies, enhancing the performance of Italian research teams, in terms of the opportunities related to the practical implementation of high-profile innovative patents, prototypes and processes.

Based on the analyses exposed above, it emerges how the role of innovation in the Italian industrial system has remained substantially unchanged, compared to the past. We have seen how, despite the fact that Italy invests in research and development to a lesser extent than its main European partners, this has not prevented it from becoming an innovative nation. On the whole, innovation in Italy is less systematic, more flexible and features mostly incremental improvements in its products, enabling small and medium-sized Italian exporting companies to maintain a high level of competitiveness in the world market.

This applies in particular to its pronounced weakness in high-tech products, reflecting the competitive problems encountered by the large Italian companies, in this field, on the oligopolistic markets worldwide. However, the intensity of the comparative advantages and disadvantages of Italian industry has changed over the years. In particular, over the last decade, its specialization in low-tech products

has weakened, eroded by the competitive success of emerging countries, while strengthening its specialization in intermediate technology products. In other words, the specialization model of the Italian economy has been technologically overhauled and improved, albeit with the limitations inherent in the aggregate nature of the classification.

The challenges that the globalised world poses today to Italian companies are certainly tough, but at the same time very exciting and involve the capacity to implement radical transformations, in terms of outlook, organization and technology. The road ahead is a difficult one, but it's the only one there is.

The results of the study show the determination of Italian manufacturing companies in dealing with change, based on the awareness that, in order to grow once again, they need to produce innovative and high quality goods at competitive prices.

Nor should we forget that the strong growth in disposable income in emerging countries, the increasing number of countries participating in international trade and the variety of goods traded have profoundly changed the global economic landscape, and above all the patterns of consumption and production in worldwide.

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