Hybrid Innovation. The Italian Machine Tool Industry Case

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Abstract

The machine tool industry has a leading role in the Italian manufacturing system, and it is between the few industrial branches in which Italy keeps an international primary level role, being the 4th world producer and the 3rd world exporter.
The branch innovation process has a threefold hybrid characterisation: it is an industry that compete at a global level, so oriented towards open innovation and imitation, but, at the same time, it tries to defend its own products. Meanwhile, it strives for product innovation, but also for production systems innovation in order to achieve a greater flexibility and reconfigurability for machine tools.

Keywords: Innovation; Global Markets; Machine Tool Industry; Hybrid Innovation

1. Innovation in Global Markets

Innovation is a main competitive factor for the high-tech sectors such as the machine tool industry. This industrial branch sees Italy among the main world players, despite his firms have a smaller size than that of competitors such as German and Japanese ones (about 200 employees, on average).

The innovation theme is one of the scholars' focusing points, starting from the seminal works of Schumpeter (1912; 1942), from different perspectives. First of all, the choice to implement innovation processes is led by many aspects that must be taken into account in a preliminary way, such as the organizational group form and the reference market (Piga, Vivarelli 2003); moreover, innovation has a key role in improving businesses' performances (Rosenberg 1991; Crépon et al. 1998; Janz et al. 2004; Snowdon, Stonehouse 2006; Chen et al. 2009; Hall et al. 2008 and 2009; Huang 2011). An increasing trend towards "networking" also emerges, with particular attention to those themes that are crucial for firms survival and

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competitiveness: as regards Italy, this phenomenon is increasingly spreading over, mainly about R&D and production. In fact, cooperation in innovation and product development fields, turns out to be very effective (Valle, Vázquez-Bustelo 2009). This behaviour can be highlighted in particular in industrial districts (Chiarvesio et al. 2004), and in medium-tech and high-tech productions, in order to better compete on global markets with a very intense rivalry (Brondoni 2008).

The innovation process sees the presence of differences and common points at different levels. First of all, the firm dimensions (Rizzi et al. 2012; Conte, Vivarelli 2005; Piergiovanni et al. 1997): this feature affects the kind of technological innovation, which can be distinguished into product innovation and technology acquisition (Conte, Vivarelli 2005). The former is strictly bounded to formal R&D (made mainly by big enterprises, which carry out it internally), while the latter is primarily about process innovation (SMEs), and it is achieved through technology acquisition or cooperation agreements. Another factor of differentiation is the geographical location (primarily at a regional level), which includes elements such as infrastructures, business environment, clusters, etc., that could determine significant differences between the performances of firms from different regions (Sternberg, Arndt 2001; Crevoisier 2004; Piva, Vivarelli 2005; Conte, Vivarelli 2005).

Moreover, there exist important common points. It is well recognized that innovation, especially if characterized as internal formal R&D, allows the creation of products more capable of meeting the market needs, and it also produces highly positive spillovers and synergies (Catozzella, Vivarelli 2007; Valle, Vázquez-Bustelo 2009), also from the point of view of the employees' number and qualification (Piva, Vivarelli 2009). So, human capital turns out to be one of the most important hallmarks of the Italian firms in the machine tool industry, so that the statement "made by Italians" has been proposed instead of the more classical "made in Italy" (Rizzi et al. 2012).

Finally, the innovation processes made by the businesses of this field impress significantly their performances, in terms of turnover, profitability and productivity (Bottazzi et al. 2008); at the same time, also the business organization can benefit from innovation (Azadegan, Wagner 2011; Oke 2012), which helps in giving birth to the so-called "competitive triangle" (i.e. human capital development, R&D, and business organization) that can generate a virtuous circle for the businesses.

The present work is structured in the following way: the first part analyzes the performances of the machine tool industry in Italy, while the second one shows data (collected through a specific purpose survey) about innovation processes in a significant sample of 102 businesses. Finally, some final considerations are given.

2. Industrial Performances in the Machine Tool Industry in Italy

The outlook of the macroeconomic dimension and commercial performance for the Italian machine tools industry in recent years (2007-2011) allows us to highlight the relevant international role of Italy, which is the 4th world producer (6.5% of total production) and the 3rd world exporter (9.2% of total exportations).

The effects of the global economic crisis on the production and export are also evident: in 2009 the decrease in production was about 20%, mainly due to the drop of deliveries on the domestic market. In the following years the recovery has been

slow, but there has been an improvement in the last two years thanks to exportations.

Table 1: *Machine Tool Industry in Italy (Values in Millions of Euros and Annual % Variations)*

	Millions of Euros					% Variation in Current Terms				
	2007	**2008**	**2009**	**2010**	**2011**	**2007**	**2008**	**2009**	**2010**	**2011**
Production	5,330	5,352	3,770	3,789	4,250	17.0	0.4	-29.6	0.5	12.2
Export	2,969	3,206	2,399	2,462	3,070	12.1	8.0	-25.2	2.6	24.7
Deliveries on the Domestic Market	2,361	2,146	1,371	1,327	1,180	23.9	-9.1	-36.1	-3.2	-11.1
Import	1,403	1,470	642	691	806	25.8	4.8	-56.3	7.6	16.7
Consumption	3,764	3,617	2,013	2,018	1,986	24.6	-3.9	-44.3	0.2	-1.6
Trade Balance	1,566	1,735	1,757	1,771	2,264	2.2	10.8	1.2	0.8	27.8
	% Share									
Import on Consumption	37.3	40.6	31.9	34.2	40.6					
Export on Production	55.7	59.9	63.6	65.0	72.2					
	Number of Employees									
Employment	28,560	29,250	28,710	28,900	28,820					

Source: UCIMU, 2011

Also analyzing data at firm level provided by the *AIDA*[1] database (Bureau Van Dijk), we can observe a sharp decline of about 34% in turnover in 2009, which is bigger more than two times than the data recorded about the whole manufacture (MUSP, 2010).

3. Industrial Innovative Processes Between Invention and Imitation

The machine tool industry in Italy has a patchy territorial distribution, with a high concentration in Northern Italy, above all in Lombardy and Emilia Romagna. In a recent survey carried out on a significant sample of 102 firms[2] of the analyzed industrial branch (MUSP, 2010) a high propensity to innovation emerged (which can be measured through metrics not related to the classical performance ones, well described in Garbelli (2008)), despite the fact that most companies are SMEs (in fact, about 60% of the firms have less than 50 employees). The most active way to compensate this weakness, is the creation of networks together with other firms and/or with research centres, in order to reach a greater critical mass; this fact can be traced mainly in Lombardy and Emilia Romagna: in fact, in the first one more than 50% of firms' total cooperate with other firms, while in the second one more than 40% of firms' total cooperate with research centres. Another important feature is the fact that in 75% of cases the group (or network) headquarters are settled in Italy, although in the last years a greater propensity to internationalization can be detected, regardless of the firms' size. This phenomenon is relevant, above all, for companies from Emilia Romagna, more focused on multi-localization, especially when the firm has more than 50 employees. In relation to networks, regional differences exist: in fact, Emilia Romagna aims to a mix of joint production and R&D, while in Lombardy there are cooperation networks in order to create, sell and

export products. This trend can be easily traced in particular among medium-sized firms (between 50 and 100 employees).

In regards to innovation processes (Table 2), it is notable that product innovations (both at the market and at the company level) represent turnover shares much more higher in the machine tool industry than in the whole manufacture (47% and 15% respectively), but, above all, there is a positive trend for the last decade for the machine tool industry (from 33% to 47%).

Table 2: *Revenues Share of the Different Categories of Product Innovation in the Last Three Years (% of the Total Turnover of Enterprises)*

Products or Services	**Machine Tool 2010***	**Machine Tool 2000***	**Manufacture 2008****
New to the Market	30.6	24.7	7.7
New Only to the Company	16.3	8.1	7.1
Not Modified or Partially Modified	53.7	67.2	85.3
Total	**100**	**100**	**100**

*Source: * MUSP 2010 elaborations; ** Community Innovation Survey 2008*

About process innovations (Table 3), those about design processes are particularly noticeable (53% of the enterprises) than those about production processes (33%) and production management (38%). Innovations about logistics (16% of the businesses) are not so diffused, especially in comparison with the whole manufacture (about 39%).

Table 3: *Types of Process Innovations Introduced in the Last Three Years (% of Total Enterprises with Process Innovations)*

	Machine Tool 2010*	**Manufacture 2008****
Design Processes Technologically New	53.3	n.a
Production Processes Technologically New	33.3	n.a.
New Processes of Production Management	37.8	n.a.
New Logistics Systems and Supply of New Products	15.6	38.8

*Source: * MUSP 2010 elaborations; ** Community Innovation Survey 2008*
(n.a.: not available)

Firms settled in Lombardy are the most oriented towards the realization of product innovations, while process innovation is less diffused. In this field, the best practice is that of Emilia Romagna, which prove to be involved in fostering design and production processes. Also in this case, this trend is more strong for medium-sized businesses.

Paying now our attention to organizational and marketing innovations (Table 4), we can see that in the last years this issue has recorded great efforts by firms. Both for new management techniques and new ways of organizing work, and changes in relationships with companies and institutions, the machine tool industry firms show

innovations much more diffused (about two times) than Italian manufacture in general. Compared to the previous decade, we can observe an increase in organizational innovations about new management techniques, and a weakening about new ways of organizing work and institutional relationships.

Unexpectedly, also marketing innovations involve a greater number of firms in the machine tool industry than in the whole manufacture, especially for new techniques to communicate (53% against 18%).

Table 4: *The Introduction of Organizational and Marketing Innovations in the Last Three Years (% of Total Enterprises)*

		Machine Tool 2010*	**Machine Tool 2000***	**Manufacture 2008****
Organizational innovations	New Management Techniques	53.8	25.0	23.8
	New Ways of Organizing Work	42.9	50.0	27.6
	Changes in Relationships with Companies or Institutions	27.5	36.7	13.8
Marketing innovations	Changes in Product's Appearance	31.9	51.7	19.5
	New Trade and Distribution Practices	16.5	n.a.	8.3
	New Techniques to Communicate and Marketing	52.7	30.0	17.9

*Source: * MUSP 2010 elaborations; ** Community Innovation Survey 2008*

If we have a look to know-how protection (Table 5), we can see that the trend is positive, in the last years: in fact, we can observe a general increase in the use of these instruments, in particular for confidentiality agreements, registration of trademarks and patents; as a consequence, the machine tool sector has a general expenditure in this fields higher than the average for Italian manufacturing industry. Also in this case, the best performance is the one for Emilia Romagna.

Table 5: *The Adoption of Instruments of Protection of Company Know-How in the Last Three Years (% of Total Enterprises, Several Answers Possible)*

	Machine Tool 2010	**Machine Tool 2000**
At least one Patent Application Field	46.2	21.7
Recorded at least a Design or a Model Protection Design	5.5	20.0
Recorded at least one Brand	23.1	11.7
Required Copyright (Also for Software Protection)	5.5	5.0
Used Confidentiality Agreements to Protect Know-How	31.9	18.3
Patents Acquired from Third Parties	5.5	n.a.
Operated under License from Third	8.8	n.a.

Source: MUSP 2010 elaborations

As already said, the machine tools industry has the highest total innovative expenditure among the manufacturing branches, with an annual average of 9% on revenues (7% in manufacture); in absolute value, the innovative expenditures are about € 18,000 per capita, 10 time greater than the one for the whole manufacture. The items that contribute the most to this result are those about internal R&D (41%) and machinery acquisition (21%), compared with external R&D (%) and with the participation in research programs and industrial design (%).

Table 6: *Partnerships for Innovation Activities by Geographical Location and Type of Organization (% of Total Enterprises)*

Location Type of Organization	Region of firm	Rest of Italy	European Union	Other Countries
Other Group's Firms	13,5%	15,7%	11,2%	7,9%
Suppliers	48,3%	40,4%	24,7%	5,6%
Customers	23,6%	43,8%	56,2%	29,2%
Firms of the Same Branch	4,5%	13,5%	19,1%	5,6%
Consultants	30,3%	19,1%	2,2%	3,4%
Private Research Institutions	21,3%	15,7%	7,9%	1,1%
Universities	18,0%	20,2%	10,1%	2,2%
Public Research Institutions	11,2%	6,7%	4,5%	2,2%
Trade Associations	25,8%	16,9%	4,5%	2,2%

Source: MUSP 2010 elaborations

Partnership aimed at innovation activities explain how this kind of relationships is thicker for suppliers and customers, with differences about locations. Relationships with consultants and trade associations are the most diffused at a regional level, while collaborations with customers and firms of the same branch take a national and, in many cases, also a European horizon. Moreover, only about 20% of machine tool industry firms share partnerships with universities and research institutes, especially at a national level than at a local one.

An important role in innovation is played by human capital. The machine tool industry is a high-intensive human capital sector, given the fact that more than 70% of employees have a university degree or a technical high school degree. We can also note the existence of a "cluster effect", due to the fact that about 90% of the employees come from the same geographic area where the enterprise is settled. This fact, which denotes the presence of a local productive culture and localization externalities, is fostered by a low payroll substitution rate and a low employees' average age (under 40 years). This draw a particular dynamic, featured by the hiring of workers at a young age (better if highly skilled), who grow professionally and then can create spin-off enterprises. Business operators expect that graduated workforce share importance will increase, given the need of gaining continuously new knowledge and increasing competitiveness.

In the survey it results clear that the machine tool industry is made object of attention by policymakers (both at local and national level), with growing support to innovation activity. These policy determines a large use of public subsidies (55% of enterprises) more than in manufacture (23%). The trend for the last years is a strongly increasing one, so demonstrating growing interest and public involvement.

In relation to those companies benefiting from public subsidies, also in this case size matters: in fact, above the 70% of firms with more than 100 employees receives support, while SMEs less (33% of small and 47% of medium enterprises receives subsidies to innovation). This trend is common to all the regions, while differences emerge about the authority that pay out subsidies. In fact, firms from Emilia Romagna receive support primarily by the local authority; in the other regions, there is a lower support from local authorities (above all in Lombardy), a fact that is compensated by the recourse to funds from the European Union. Moreover, there is in every region the intention to give subsidies to sustain internal R&D (mainly in Lombardy), but Emilia Romagna pay more attention to research made in collaboration with other firms (national or foreign) and/or institutions.

Trying to give a comprehensive interpretation of the above showed data, we could say that the machine tool industry in Italy features a particular and, in a certain way, hybrid set of characteristics about innovation. In fact, sector's businesses compete at a global level because of the international dimensions of their main customers, first of all in automotive and aeronautics. In this perspective, the firm's success depend mainly on the level of sophistication of its intangible corporate assets (Brondoni 2009). So, they are more oriented towards open innovation, imitation and spread knowledge (Brondoni 2012), as also figures about partnerships for innovation activities seem to suggest, mainly for firms settled in Northern Italy. At the same time, Italian machine tool industry's firms show some characteristics attributable to businesses focused on local competition (Brondoni 2012), such as defensive intellectual property (i.e. confidentiality agreements, patents, R&D expenditure). A possible explanation to this apparent dichotomy could be find in the small dimensions of Italian firms and the particular nature of the analyzed industrial branch, which is a capital goods supplier. In fact, it is evident the tendency to protect as much as possible every competitive technological advantage that could emerge from the innovation activity, but in the same time the source of innovation result from thick and a strong networks of partnerships in particular with clients and suppliers. The imitation becomes in this perspective a frequent mode of innovation.

Secondly, concerning the kind of innovation activity carried out, we must acknowledge that machine tool firms in Italy, given their particular focus on customization, do mainly incremental/continue innovation (Abernathy, Utterback 1978; Tushman & Anderson 1986; Porter 1986), in particular market pull ones (Corniani 2012). The typical case, in fact, is the one of a customer asking for a machine tool with better performances than the previous ones, stimulating so the producer to innovate. However, in this industrial sector innovation can be made only resorting to the so-called technological one, which involves R&D and engineering, explaining the existing network with universities, public research institutes and private laboratories (above all in Emilia Romagna).

The third, and last, hybrid feature of innovation processes in the machine tool industry is about the propensity for both product innovations (the single machine)

and production systems innovations, given the particular flexibility and re-configurability of the machines for industrial automation.

The above described analysis helps us to give some brief policy implications, considering also the current economic framework. Given the particular nature of the industrial branch analyzed, and given the above described peculiarities that it displays in Italy, we think that a certain kind of "hybrid-ness" is needed also for those policies that deal with this sector. As a consequence, policymakers have to draw plans able to maintain the existing competitive advantages in the global value chain through the internationalization promotion, and, at the same time, capable of sketching local cooperation networks. Furthermore, we can hypothesize that the ongoing review of the public expenditure would lead to a decrease in the number and size of public subsidies as a support for innovation activity. Given the different intervention schemes in the two leading regions for the analyzed industrial branch (Lombardy and Emilia Romagna), we would like to suggest a merger between these two patterns, in order to integrate the positive aspects in both the schemes. If the expected cuts in public budget will affect also those funds to support innovation activity in firms, therefore resorting to EU funds (as many Lombardy's firms already do) will be a strategic policy guidance. At the same time, given the prevalent presence of SMEs, relying mainly on internal R&D is not the most appropriate innovation policy, while the creation of specific-purpose networks involving different subjects (i.e. universities, enterprises, research centres), as occurs in Emilia Romagna, would be an interesting way of overcoming the existing difficulties. In this regard, it would be desirable to extend at the national level the High Technology Networks set up by Emilia Romagna in order to give support to industrial enterprises and foster the company innovation attitude.

4. The New Business Model Perspective

An important opportunity that manufacturing firms may consider to strengthen their competitiveness in the global market is the modernization of their business model that is able to integrate coherently and strategically the product technology, services and contractual-organizational elements. Zott et al. (2011) report that: "…to thrive in the "age of revolution," companies must develop new business models-in which both value creation and value capture occur in a value network-which can include suppliers, partners, distribution channels, and coalitions that extend the company's resources". *New Business Models* have a strategic value in the field of machine tools which lies right at the centre of many supply chains and is characterized by a relevant incidence on the national economy in terms of exports, value added and employment. In the capital goods sector, *new business models* urge entrepreneurs, partners and stakeholders to compete according to an advanced version of the Product-Service-System model and enable companies to adapt to their surrounding competitive environment. Generally speaking, a *new business model* means using a capital good based on agreements other than selling contracts (i.e. renting plus services, pay per use, pay per unit, pay for availability, wet leasing, P2P renting, BOT, buyback) integrated by services characterized by high knowledge content and/or high value added for their users. There are multiple *stakeholders* concerned in making *new business models* work: manufacturers, final users, banking and financial intermediaries – specialised in risk management and

subsequent contracts -, operation and maintenance personnel, management teams and any company operating in the renting and/or leasing field. In order to operate innovative business formats, manufacturers can take many technological solutions which relate directly to *Machine to Machine-M2M*, *condition-based maintenance and predictive maintenance*, as well as product or component reconfigurability and flexibility (*multiclient* models). Advanced monitoring and tele-surveillance technological solutions provide an insight into the behaviour of the machine, transmitting in real time these information to a remote station, and then allowing to use these information to improve machines' productivity. This kind of solution allows the setting up of quality, reliability and availability; moreover, the manufacturer and/or third parties will be able to offer "on condition" services. A rental model, for example, would increase the flexibility of the used machinery and of investments. At the same time, for every production it would help to identify the most suitable machinery.

This is clearly an opportunity still little explored and exploited by Italian companies in this industrial branch. In fact, in Italy there are only isolated experiences related to machine tools renting: it is unlikely that machine tools firms use other contractual arrangements (i.e. rental agreements) alongside the traditional sale agreement. In the Italian context there are no specialist renters (i.e. renting companies) nor special-purpose NewCo shared by the capital goods manufacturer, the financial intermediary and the workforce provider. Certainly, the innovative business models have their difficulties: among these there are the small size of Italian firms, the presence of a strong culture of machine ownership and customization, the machine tools re-configurability (in a "multiclient" logic), the need for coordination between demand, supply and machines availability, financial obstacles due to lack of credit. Given so, the traditional customization capability of Italian companies, today needs to be accompanied by organizational changes. A viable option is a special-purpose offer of machinery and related services, calibrated according to machines' features and the applications for which they are intended. In this sense, it is desirable that the suppliers will group together by machine tools typology, and the users by type of use. Subsequently, they will have to identify common strategies and related financial benefits with the help of banking intermediaries. A useful tool to investigate business concepts in the machine tools manufacturing segment is the "Morphological Box on product-service systems for the machine tools industry" (Lay et al. 2009), which provides a *New Business Models* taxonomy. This matrix identifies a series of variables: *ownership of the machinery* (during and after its use, for and after the duration of the agreement), *ownership of the operational or maintenance staff*; *location of the machinery* (at the manufacturer/user's productive site or as an intermediate option fence-to-fence to the final user), *use of the machinery* (exclusive use or parallel use for more users), *payment model* (traditional purchase, fixed instalment on a time basis, pay per unit), whose combination gives birth to the different typologies of *new business models.* Therefore *new business models*, effectively combining technology developments and contractual-organizational innovation, enable manufacturing firms to meet the increasingly fast changing investment and consumption needs in the global market as well as to face the increasing competition from emerging countries.

In conclusion, we can say that the machine tool sector, particularly in Northern Italy, appears to be a particularly strategic industry for Italian economic and

industrial dynamics, thanks to a number of features (both dynamic and structural) that make it a unique in the manufacturing panorama. Indeed, given his nature of investment goods producer, the sector is affected of the economic trends of the economy, both nationally and internationally, to a greater extent: it is therefore also a vantage point of view for understanding economy's future dynamics (and more specifically about manufacturing). The sector has also a particularly strong propensity to innovate and compete advantageously in an increasingly globalized market, which sees the growing importance of new competitors. That's because the understanding of the dynamics of innovation, their impact and their possible outcomes can be crucial for the future not only of the industry, but of the whole Italian economy.

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Notes

[1] The sample construction (1100 enterprises) has been based upon the selection of firms identified by the Ateco 2002 29.4 code ("Manufacture, installation, maintenance and repair of machine tools", MUSP 2010).

[2] Data were collected through questionnaires directly administered to enterprises. The questionnaires were similar to those used for CIS (Community Innovation Survey).