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Technological Innovation: Concept, Process, Typology and Implications in the Economy

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Abstract. *Growing interest worldwide to boost innovation in business sector activities, especially the technology, is intended to maintain or increase national economic competitiveness, inclusively as an effect of awareness concerning the effects resulting from economic activity on consumption of resources and environment, which requires design of new patterns of production and consumption. In this paper we review the most important contributions in the literature in terms of the implications of technological innovation in the economy, at the micro- and macroeconomic level, viewing the organization's ability to generate new ideas in support of increasing production, employment and environmental protection, starting from the concepts of innovation, innovation process and, respectively, from the innovation typology analysis.*

Keywords: technological innovation; innovation process; eco-innovation; research and development; economic development.

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1. Introduction

Which are the implications of innovation in economic and social life? The answer to this question, as one can argue, is based on the meaning of the term innovation. A widespread perception on innovation is one that refers to advanced technology solutions offered by using the latest knowledge. Such innovations are mainly considered to be the result of highly skilled workforce and businesses activity with significant research and development intensity, having close linkages to the most important centers of excellence in the scientific world. The significance of innovation is, however, broader and includes innovations that are not achieved within high-tech industry mentioned above. From this last perspective, innovations do not include only new products or processes, but also cover the improved ones resulted from the so-called low-tech sectors, which may have cumulative economic and social effects as important.

Growing interest worldwide to boost innovative activity of enterprises, especially technological innovation, is intended to maintain or enhance the competitiveness of national economies, but also is a result of awareness of the effects on consumption of resources and environment impact resulted from economic activity, which requires design of new patterns of production and consumption. In this paper, we discuss the ways in which technological innovation contributes to economic development. In the context of this analysis, we look to sustainable development of organizations as a result of their ability to generate new ideas in support of increasing production, employment and environmental protection. Therefore, section 2 is allocated to the concept of technological innovation and innovation process, taking into account attributes recently incorporated into the symbolic reflecting the impact of different types of innovations obtainable on the economic and social life. Since the implications of different types of technological innovation in the economy still comprise a controversial topic in the literature, especially in the empirical one, we consider first to analyze the types of innovations in section 3, from different points of view. In section 4 we outline the theoretical and empirical existing framework regarding the incidence of technological innovation in the economy by reviewing the most important contributions to literature and section 5 concludes.

2. Technological innovation concept and innovation process

The Schumpeterian point of view approaches economic development as a qualitative changes process, as consequences of innovation. Thus, J. Schumpeter addresses innovation as a function of entrepreneurial activity, in which "new combinations" of existing resources occur. The definition offered by Schumpeter in the *Theory of Economic Development* (1934) is continuing to be referential in associating "new combinations" of production factors of new products and services, introducing new production processes, marketing and business organization.

In principle, the literature operates with distinguishing invention from innovation. For example, F. Malerba (1997) defines *invention* as a new idea, a new scientific discovery or a technological newness (which has not been implemented and diffused), while *innovation* refers to a tradable application of an invention, as a result of invention integration into economic and social practice. Innovation is regarded, therefore, being a result of a process that starts with an idea genesis and continues with its materialization. In the same Schumpeterian context, Oslo Manual (2005) defines innovation to be an activity that produces new or significantly improved goods (products or services), processes, marketing methods or business organization. In this framework, according to Frascati Manual (OECD, 2002), technological innovations comprise new or significantly modified technological products and processes, where *technological* novelty emerges, unlike improvements, from their performance characteristics.

Consequent to afferent processes interrelations, dissociating invention from innovation is not always possible, especially for technological innovation. Nevertheless, the fact that there may be differences even of some decades between the occurrence of innovation and of invention, which reflects different demands of coming over upon an idea and its implementation into practice is known, including due to fact that certain conditions are not fulfilled for diffusing (still insufficient demand, production impossible consequent to lack of input or production complementary factors that are not available yet). In addition, an invention implementation might need, in its turn, supplementary inventions and innovations for the innovation process success.

As K. Pavin (1987, p. 9) notes, "most technologies are complex and are cumulative. They are specific for companies at whose level technologic activity predominantly occurs". While inventions may result from different economic and social environments, innovations are mainly a result of the firm's activity. To be capable to utilize an invention and turn it into innovation, the firm should efficiently combine information, human, financial and material resources and existence of a functional distribution system is needed. From such perspective, the inventor's role differs from that of innovator's (person or organization unit responsible for required factors combination, in Schumpeterian vision named "entrepreneur").

Difficulty to differentiate between invention and innovation also comes from the innovation process continuity, as S.L. Kline and N. Rosenberg (1986, p. 283) were to note: “it is a serious mistake to treat an innovation as if it were a well-defined, homogenous thing that could be identified as entering the economy at a precise date – or becoming available at a precise point of time. The fact is that most important innovations go through drastic changes in their lifetimes – changes that may and often do, totally transform their economic significance. The subsequent improvements in an invention after its first introduction may be vastly more important, economically, than the initial availability of the invention in its original form”. Hence, invention can be often an outcome of a long process in which numerous interrelated innovation processes are involved.

Innovation processes do not show the same characteristics regarding financial resources engaged and obtainable outcomes, but present differentiations at the enterprise level according to the innovation type, firm’s size or its strategy and experience in innovation area. Diversity of innovative processes generates difficulties in analyzing costs and results of innovation activities by using micro-aggregated data. Therefore, the study of innovative activity of companies is focused on the innovation facilitators and their effects in terms of business competitive advantages obtainable by sector or economy as a whole. Nevertheless, we depict some common features of innovation processes:

- they imply exploring opportunities for achieving new/improved goods (products and services) based upon technical knowledge as well as the market demand change or a combination of the two. Investment efforts of technological innovation predominantly correspond to “development and production engineering, in which knowledge is accumulated by experience in production, learning by using and learning by doing (Pavitt, 1987, p. 9);
- it is impossible an accurate prevision of costs and performances involved in the innovation process mainly based on research and development and the users’ reaction to the new artifacts.

Difficulties in analyzing of innovation business activity are due, in our opinion, to the fact that innovation is not a linear process consisting of sequential, time and conceptual-distinctive stages that define unidirectional causalities. Innovation is based on the use of previously acquired knowledge, on the results of new technologies, on the technological development or on the new combinations of existing technology. However, the “linear model” (Figure 1) – while it does not depict all possible connections between the stages of innovation process and, respectively, by reconsidering the earliest ones by the enterprise which, in turn, can lead to new innovations – is useful in comprehending innovation process in acceptance of dependence unfolding of each stage according to preceding one finalization.

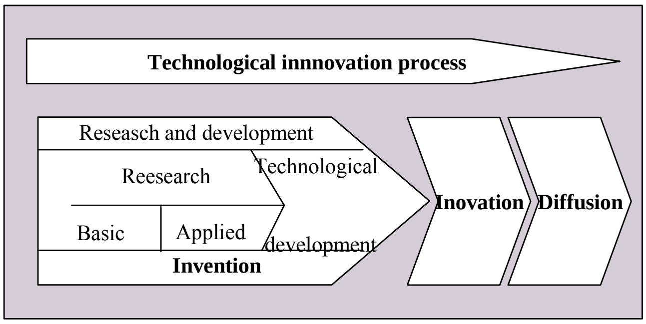

Figure 1. *Technological innovation process*

Knowledge emerged from theoretical and experimental activity in terms of fundamental or applicative aspects of phenomena, as well as the use of knowledge gained as a result of practical experience form the first stage of the innovation process, followed by the translation of knowledge into artifacts, production and diffusion. Since the implementation of the other stages depends on the achievements of research stage, its importance becoming obvious.

Not all companies, however, adopt an innovation mode based on research and development within their structures defined according to Frascati Manual as "systematic and creative activities, initiated to increase the volume of knowledge" (OECD, 2002, p. 30). R&D is only the tip of technological development and innovation process and, in addition to research and development, it requires acquisition, integration into practice and the use of technological skills to high levels of complexity, productivity and quality, but also designing, engineering and managerial abilities for acquisition of technology and to ensure a continuous flow of improvements and generate innovations. R&D is more relevant for firms near the technological frontier or at the frontier. Technology acquisition and the use of skills, on the other hand, are more relevant for firms that assimilate technology to create improved technologies.

Companies innovate consequently to demand on the market and, in principle, innovation process begins with reviewing and combining all existing knowledge, which supposes inclusively appealing to innovation users and the use of information as important innovation sources. Opening to new ideas and innovative solutions is essential, especially in the early stages of the process, allowing decision-making through ideas, knowledge and skills combination and congealing them in different ways leads to more complex innovations.

In fact, the innovation process depends essentially on external conditions; designing of new technologies results from interactions with customers, suppliers, competitors and various other public and private organizations. This explains why clusters, competition and other business linkages are so important for the process of technological development. In this context, innovation seen as a system, in terms of spatial, at the regional or national level, allows understanding and analysis of these interactions, with impact on innovation propensity and performance of innovation activity.

However, technological competitiveness resulted from innovation based on in-house R&D activity is an economic development moving force. An innovative company will achieve a high profit rate, giving a signal to other companies, including imitators who, if they have market entrance conditions, will pursue to share profit, resulting in diminishing initial innovator advantage. Such imitators ”spreading” at the industrial or sector level tackle technologic development in a time interval, after which emerged effects from new technologies upon growth will slow down. Taking this idea of Marxist origin, Schumpeter was to note the importance of innovations diffusion, arguing that imitators can be successful if they improve the original innovation, that is, if they become themselves innovators. In this framework, it becomes obvious that the technology acquisition cannot be simply assimilated with purchasing from suppliers. Companies must have the ability to identify the appropriate technologies they need, to assess technological options for using or their modification and, last but by no means to least, to integrate new technologies into production processes. With other words, companies that practice this type of innovation must have skills to purchase and use new or substantially improved technologies.

In fact, innovations tend to facilitate achieving other innovations in close fields. In this way, *innovation-diffusion* is a creative process, in which innovation becomes input in other innovation processes without being a passive process, but an adaptive one. Systemic interdependence between original and induced innovator also implies the fact that innovation processes tend to concentrate in certain sectors resulting their development (Schumpeter, pp. 200-201). Schumpeter regarded this dynamic, explaining thus “business cycles” length and “long waves” in the economy.

In this framework, Vernon R. (1966) observes that industrial development is driven by product innovation, induced by product competition on the market. Over time, however, the products are affected by obsolescence, fact supposed to be accompanied by a higher accent on process innovation as a consequence of market competition in reducing costs. It was argued that these changes of competitive conditions may favor the transfer of technology associated with foreign capital flows as foreign direct investments, from one innovative country to countries with marketing potential. In this context, the "absorption capacity", namely the ability to recognize, assimilate and exploit new information becomes essential in the transfer of technology being, however, a function of research and development expenditure previously made by firms, which increase their capacity to exploit opportunities arising from external relations (Cohen, Levinthal, 1990).

3. Innovation typology

Schumpeter (1934) distinguished five innovation types: new produces, new production methods, exploitation of new markets, new ways to offer products on the market and new ways of business organization. In his turn, J. Schmookler (1966) differentiated "technological product" from "technological production" by defining the first innovation type in terms of how to create or improve products, and the last concerns how to produce them, and Pavitt (1987, p. 9) notes that "technologies are specific to product and process innovation".

Similarly, "product innovation" and "process innovation" terms were used later in Oslo Manual (2005) as types of technological innovations. In this sense, *product technological innovation* is the result of producing and commercialization of new goods (products or services) or with improved performance characteristics, while *process technological innovation* corresponds to the implementation or adoption of a new or improved production process. We can admit that most innovative companies introduce both types of innovations in the same time, aiming price competitiveness (especially through process innovation) or technological competitiveness (associated with product innovation).

By definition, all innovations must contain a certain novelty degree, whether they are technological (product or process) or non-technological (marketing and organizational). The novelty distinguishes goods or processes as innovations and non-innovations. In Figure 2 we present the degree of novelty of goods (products or services) and processes recognized by the Oslo Manual in defining innovation and also the innovation typology.

			INNOVATION			Not innovation
			Maximum	Intermdiate	Minimum	
			New to the world	New to the country/region	New to the firm	Alrewady in firm
Technological (product or process) innovation	Technologically new	Product				
		Production process				
		Delivery process				
	Significantly technologically improved	Product				
		Production process				
		Delivery process				
Other innovation	New or improved	Purely organisation				
Not innovation	No significant change, change without novelty, or either creative improvements	Product				
		Production process				
		Delivery process				
		Purely organisation				

Technological (product or process) innovation ☐ Other innovation ☐ Not innovation ☐

Source: OECD (1996, p. 36).

Figure 2. *Innovation typology*

Products/services and processes may be "new to firm" or "new to market" (at the regional/country or global level). The products or processes degree of novelty is a useful tool in calculation of innovational output indicators that incorporate data on the enterprise local, national or international market. Also, the proportion of turnover from new to firm or new to market products of total business turnover allows industrial or international comparisons. However, if one considers that the new to firm products refers to the less developed firm's market, incorporating innovations already available on other markets, comparing the levels of this indicator may lead to an inadequate appreciation of the innovation performance of enterprises. We consider, therefore, that the products or processes novelty can be highlighted more appropriate if we take into account turnover from new to firm's market innovations that correspond also to new to international market innovations. In this framework, we assume that firms that operate on international markets introduce products or processes with a higher degree of novelty than those that activate on the local or national level. Such a synthetic indicator of innovation output based on the enterprise market allows also, in our opinion, the indicator comparability for different states or regions.

Novelty, as a result of innovative activities, has significance in analyzing innovation modes of enterprises. A question regarding different context of introducing innovations appears. If, for example, an agent A introduces an innovation for the first time and another agent B introduces the same innovation on the market later, are both to be characterized as innovators? Following Schumpeter, the term “innovator” should be reserved for agent A, while B is an “imitator”. We could argue, however, that agent B can be regarded also as being innovative, by introducing innovation in a new context for the first time if we look novelty as Oslo Manual defines it, but admitting an “active imitation” process, where products are made by modifying or improving existing ones. In fact, as Kline and Rosenberg (1986) note, many innovation processes with economic significance unfold after products or processes diffusion. Introducing new products of processes into a certain context considerably simplifies the adaptation process of (incremental) innovation, facilitating increasing productivity and maintaining competitiveness.

Another similar approach of innovation typology from novelty viewpoint refers to “incremental” (“marginal”) innovations, as a result of continuous improvements to products and processes, or “radical” innovations based on new concepts, leading to “technological revolutions” and to a considerable economic impact. Schumpeter considered innovation inclusively from this perspective, seen to be more important. We believe, however, that the economic and social impact of cumulative incremental innovations can be at least as important if one considers that the benefits realization from radical innovation requires incremental improvements.

A special attention is given, however, to radical innovation in terms of its contribution to environmental performance. Many countries consider *eco-innovation* as an important factor in solving contemporary challenges, including climatic ones, energy and natural resource security. In the same time, firms regard *eco-innovation* as a potential source of competitive advantage on the market of industrial goods and services.

Eco-innovation is a new term, referring to more favorable environmental impact exercised through production processes or by the use of goods. The term was for the first time used by C. Fussler and P. James in 1996 (in *Eco-Driving Innovation*), referring to “new products and processes which provide customer and business value but significantly decrease environmental impacts”, closely linked to a variety of related terms as “environmental innovation”, “innovation for sustainable development” or “sustainable innovation”. In the same time, eco-innovation is associated with different concepts such as eco-efficiency (increasing production of goods and services under natural resources and energy low consuming conditions), with “cleaner” production (as strategic activity to reduce pollution and continuous waste of resources) and eco-design (redesigning products and processes to reduce environmental impact during life cycles).

Nevertheless, defining eco-innovation was not lacking difficulties for the fact that products supposed to be friendly to environment may determine, by their excessive usage, a growth of resources consumption, recording "rebound effect". Consequently, in defining eco- innovation European Commission (Project MEI, 2005) includes all innovation forms that diminish the impact upon environment and/or optimize resource consumption face to relevant alternatives during activities life cycles. Thereby, eco-innovation (i) reduces environmental risks, pollution and resources consumption; (ii) refers to goods (products and services), manufacturing processes or business models; (iii) includes, with no limitations, the green technologies and without limiting at these ones and without an environmental origin or contain technological components; (iv) may be radical and systemic (by replacing polluting materials with the friendly to environment ones) or incremental (by a lower consumption of resources when using products).

In the light of the same features, eco-innovation includes "the creation or implementation of goods (products or services), processes, marketing or organizational methods that – with or no intention – result to environmental improvements face to relevant alternatives" (OECD, 2009, p. 9). However, according to Oslo Manual, firms can eco-innnovate/innovate, also through acquiring cleaner technologies and their implementation in production.

Technological eco-innovations correspond to products or processes incorporating technological progress that contribute to improving environmental conditions and can be analyzed using their mechanisms and impact they create. Thus, in terms of *mechanisms*, technological eco-innovations are: (i) small and gradual changes brought to products or processes; (ii) re-designing, by operating significant changes brought to the existing products or processes; (iii) introducing alternatives (products or processes) with the same functional characteristics but which operate as replacements of existing products; (iv) creating, designing and introducing of completely new products or processes. In principle, the environmental benefits of new products or production processes or existing alternatives are superior to those resulting from modification or re-designing of existing ones. In its turn, the i*mpact* of technological eco-innovations may be curative, by the use of technologies that allow polluting material elimination already released into the environment or a preventive one.

We admit that "in general, advanced technologies tend to be focused mainly on eco-innovation efforts. This is a typical feature associated with new products or processes, with modifying or re-designing their main mechanisms" (OECD, 2009, p. 16). In the same framework, we adhere to the opinion that "often, economic investments and environmental protection "go hand in hand", such convergence being the ideal situation" (Zaman, Zenovic, 2007, p. 137).

4. Technological innovation implications in the economy

Innovative capacity is a key determinant of economic competitiveness of nations. In the same time, innovation – the engine of economic progress and welfare – is an instrument to solve current global challenges related to environment and health domain. We treat here sustainable development of organizations as the result of their ability to generate new ideas in supporting increasing production, employment and environmental protection.

The implications of innovation in production growth has attracted the interest of economists, at least since Adam Smith (1776), not only by productivity gains from specialization through labor division, technological improvements brought to processes and capital goods but, recognizing the role exercised by R&D activities or technology transfer in the economy. Technological progress was introduced later by R. Solow in 1957 in the production growth models. In the early neoclassical models, production, Q, is expressed in terms of factors that lead to its obtaining, physical capital, K, and labor, L, without including technological progress:

$$Q = f(K, L) \tag{1}$$

Solow, however, observed that not only physical capital and labor factor have bearing on the size of production, another factor, A, technological progress determines also capital and labor productivity growth, so its inclusion as a separate factor, A, follows:

$$Q = A\, f(K, L) \tag{2}$$

However, technological progress has been admitted to be exogenous until P. Romer (1986) approached it as a result of explicit input in innovation processes: research and development expenses, R&D, and highly skilled human capital, HC, according to the following expression:

$$Q = A\, f(R\&D, HC) \tag{3}$$

Most empirical research has been allotted to relation between production, Q, and factors R&D and HC that may be substituted by technological progress, like in the expression below:

$$Q = f(K, L, R\&D, HC) \tag{4}$$

The expression (4) is used in empirical analysis to estimate the impact of research investment on the total factor productivity growth accepting that research and development activities are a source of innovation. In using the above expression, however, sources of knowledge leading to innovation must be taken into account, that may come not only as a result of research expenditures financed from enterprises resources, but also those from the government support, collaboration contracts with other companies or technology acquisitions. We consider also that the expression (4) can be used in assessing the performance of innovation activities focused on research and development; for an innovation mode based on imported knowledge (through information and technology), inclusively as a result of foreign direct investment, it should incorporate these factors in the model in predicting output growth.

Industrial dynamics models are based on expression (4) in explaining long-term development variations, using arguments of Schumpeterian origin: (i) technological competition is the main form of market competition; (ii) innovation and "new combinations" of resources determine new business opportunities and changing. For instance, V. Posner (1961) explains the difference of economic development rate between countries as being due to technological progress resulted from two sources: from innovation that generates these differences, and from imitation that tends to decrease them. His work was the basis for subsequent contributions in identifying the "technological gap" from so-called "north-south" approaches to explain differences in economic development of states, arguing the need for sustained efforts towards innovation in order to be maintained their competitiveness in the global hierarchy. Fagerberg is situated on the same position in reference to the technological gap and income reduction among states, which may be possible both through imitation, but especially involving innovation, identifying three factors affecting economic development rate of countries: innovation (based on research and development), imitation and technology diffusion efforts. The analysis suggests that reducing disparities between states becomes possible mainly through innovation, representing the most important factor in explaining differences in growth between countries (Fagerberg, 1996).

If innovation is seen to be a major determinant of production growth, a lively debate in the literature concerns the effects of technological innovation on employment. Thus, product innovation is considered to present effects in terms of improving the quality and variety of products, creating demand on the new markets, leading to production and income growth and to employment; also, new products reduce cost as a consequence of process innovation (Pianta, 2000). Process innovation – associated with reducing costs (capital and labor) – may determine total factor productivity growth as product innovation does but, inclusively through reducing employment and lowering prices (Fagerberg et al., 2006). It is argued also that, as long as process innovation leads to increasing products quality or lowering prices, increased demand may determine employment. According to some authors, the consequences in terms of employment tend to be positive in machinery production sectors or negative (when demand compensation is not enough) in industries that made new investments (Edquist, Hommen, McKelvey, 2001).

Other studies show that companies with innovative activity mainly technological (product and process) recorded a higher profit growth rate than other firms, so that the impact on employment is positive, regardless of industry, size or other characteristics of firms (Van Reenen, 1997). However, enterprise-level studies can not capture whether the results of innovation, including enhancing employment, are not recorded to the detriment of competitors or the net effect on the aggregate industry level. Industry level analysis can better meet the requirements for assessing direct and indirect effects of innovation (in terms of changes of output or employment, which firms with more intense innovative activity are in a competitive advantage over the firms less engaged in innovation) and the indicator dynamics as a result of lowering prices driven by innovation activity. This creates the possibility of comparing innovation indicators that may reflect the demand dynamics across sectors, allowing international comparisons.

Addressed differently, by types of technological innovation, it is shown that the impact of product innovation on employment is positive in industry (especially in manufacturing and services), while process innovation is associated with jobs losses. The total effect of innovation related efforts varies from one period or one country to another but, in general, increasing demand stimulates innovation in industry, particularly product innovation, with positive impact on employment (Pianta, 2006). Other empirical studies based on questionnaires showed also that, in Europe, employment was affected by the dynamics of demand and by the type of technological innovation and, in the same time, a higher R&D intensity showed an adversely impact on employment, suggesting replacing labor with machineries to be predominant. In the context of a modest industrial development in Europe in the 1990s, countries with emphasis on process innovation have registered a negative impact on employment. This effect was due to the fact that increasing international competition has led some countries in restructuring processes and process innovations, resulting labor cost reduction effects, while product innovation had a positive impact on output and employment (Antonucci, Pianta, 2002).

A more comprehensive image of innovation incidence on employment may be provided by the macroeconomic framework, which integrates all the indirect effects of technological change on employment. Such an approach is concerned, typically, about the “compensation mechanisms”, the most important being by reducing prices, usually associated with introducing of new technologies. According to the "compensation theory" (named in this way by K. Marx in *Capital*, 1961), market forces should offset the initial impact resulted in the reduction of jobs through process innovation. Hence, it may be distinguished the following compensation mechanisms:

- "via reducing prices"; if process innovations determine jobs losses, they lead, on the other hand, to reducing the unit costs of production on an efficient market. The latter stimulates products demand, leading to increasing production and employment. The result is conditioned, however, by the decisions of firms to transfer the productivity gains in lower prices as results of innovation (Sylos, 1969);
- "via new equipment" in acceptance that if process innovations release labor in technology driven sectors they create other jobs in producing equipment sectors;
- "via new investments", framework in which additional profits registered as a result of innovation can be used to finance either new investments to increase production capacity and employment or replacement investments and labor savings;
- "via reducing wages" which is, typically, a neoclassical point of view. The initiation of technological unemployment contributes to decreasing wages that later result in increasing the capacity of firms to employ. This mechanism is based, however, on the assumption that that firms can perform any combination of capital and labor, efficient markets, flexible wages and employment;
- "via new products" resulting from product innovation, which is stimulatory for setting up of economic entities that can create new jobs.

Aggregate level studies performed by W. Baumol and E. Wolff (1998) on the US case, by analyzing five innovation indicators related to the unemployment structure and changes between 1950 to 1995, led to the conclusion that through innovation activity is recorded a higher "natural rate of unemployment" and longer periods of unemployment. R. Lavard and S. Nickell (1985), on the other hand, have shown that compensation mechanisms may reduce unemployment in the UK. In turn, M. Vivarelli (1995) developed a simultaneous equations model to test the compensation mechanisms in the US and Italy, finding that the price reduction is more efficient in determining employment growth in the US, but not in Italy. This approach was subsequently considered by R. Simonetti and K. Tancioni (2002), who developed a model for an open economy taking into account the UK and Italy cases, finding a differentiated impact of the compensation mechanism between the two countries.

While this approach is broadest, explaining the impact of technological change on employment in the national economy, the complexity of building such a model, problems encountered in specifying relations between variables and data availability constrains reduce its feasibility. Taken together, these studies show a differentiated impact of product innovation from process innovation on employment, depending on countries macroeconomic conditions and institutional factors. We conclude that, although the compensation mechanisms are functional, re-balancing mentioned above can not be ex-ante assumed, but we admit that the impact of innovation on employment is mostly, in general, a positive one.

Processes of efficient combination of human, material, financial, information resources and new value and welfare creation through innovation gain a growing interest, especially in recent years, in the context of finding irreversible reduction of natural resources potential as a result of human activity. In fact, many studies (since series of reports by *the Club of Rome*) "showed that our optimization criteria are inconsistent with economic growth based on natural resources" (Dinga, 2009, p. 40). It also shown that the processes of industrial processing and the use of goods, including in households were responsible for one third of the natural resources and energy consumption and carbon dioxide emissions achieved globally by the year 2004 (OECD, 2009), which imposed a reconsideration of manufacturing processes and producing new products more friendly to environment.

Environmental benefits through innovation and therefore to humanity require to reduce resource consumption and/or emissions of pollutants and thereby avoiding environmental damage, maintaining quality of life, access to natural resources of next generations and preservation of intergenerational economic potential. At the same time, manufacturing of new products or implementation of new friendly to environment processes in a given sector involves development of other sectors, leading to sustainable economic development. Thus, innovation is seen as the engine of sustainable development in the last decade.

So far, manufacturing industries have adopted different measures in this regard, inclusively under the regulation pressure, toward a greater responsibility of companies and home users regarding their impact on the environment. Also it can be highlighted the increasing interest of firms to voluntary improve business environmental performance, aiming to obtain profit from eco-innovation activities oriented on markets characterized by increasing demand. Gradual shift from pollution control to more effective integrated solutions through eco-innovation can provide a relatively low environmental impact; however, positive effects can be obtained while growth rates of emissions and resource consumption are lower than production growth rate, and also decreasing in absolute terms.

5. Conclusions

Undoubtedly, the role of innovation in economic and social life results from the function of innovation regarding introducing newness and variety in the human activity. In the absence of innovation processes, the economy would enter a "stationary stage", characterized by modest growth or no growth. As a result, innovation is crucial for sustainable (long term) economic development.

The intensity of innovation is an explanatory factor of differences in economic performance between companies, regions and countries. Innovative organizations which record successes in innovation activities are prosperous at the expense of the more modest competitors involved in innovation. Catching-up the countries or regions situated in a innovation leaders position involves efforts to enhance innovative activity, both through research and development and diffusion in the manifested interest to increase production, employment and environmental protection, justifying the concern of many states in stimulating innovation.

Innovation capacity of enterprises is a function of their ability to develop coherent technological strategies, to acquire and absorb technologies, to form and exploit linkages with third parties and to develop other useful skills for innovation. From this perspective, at the highest level are firms that absorb cutting-edge technologies and innovate in high-tech industries and at the lowest level are firms without technological capacity. Non-R&D dimensions of technological development are, in particular, beneficial for enterprises that are not engaged in R&D, are far away from the technological frontier, and do not require cutting-edge R&D to improve their competitive position. For these firms, we believe that assistance in building skills related to acquisition and the use of technologies may be more relevant than additional public R&D funding. A different approach from this point of view requires eco-innovation domain, where radical innovations focused on R&D register the highest efficiency in the environmental protection and are based on R&D activities, in which higher costs are involved on a longer time horizon, increased uncertainty in obtaining incomes and low supply of financial resources.

The studies orientation on the input R&D costs at the enterprise level is due to the key role exercised by research and development as a source of invention in the "linear model" of innovation. Firms do not innovate, however, in isolation but through a continuous interaction with the operating environment, so that “systemic model” allows a better understanding of the role played by the actors involved into innovation processes, the effects obtainable by government policy and possible options to increase the proportion of innovative enterprises of total enterprises.

The impact exercised by the different types of innovations and their determinants have received a particular attention in recent years. Studies in innovation activity, especially based on research and development at the enterprise level, have been intensified in the last two decades in analyzing innovation indicators, in order to be identified innovation modes and performance in different sectors that are indispensable for innovation policies. Emphasizing intensity and effects resulting from the diffusion of knowledge, also an essential aspect of innovation, for both R&D and non-R&D performing firms, has not been so widely debated. These include the acquisition of knowledge that does not require interaction with the source (purchase of capital goods or services, including the licensing of intellectual property) and the acquisition of knowledge that is available from the source (scientific publications or through attendance at trade fairs) or the acquisition of knowledge obtained directly from other entities through collaboration. However, increasing production, employment and environmental protection are the result both of R&D applications and diffusion of new technologies (R&D or non-R&D involved).

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