



Radical innovation, incremental innovation and training: Analysis of complementarity



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ABSTRACT

This paper analyzes the connection between labour productivity and variables such as radical innovation, incremental innovation, production technology embodied in new machinery and equipment, utilization of productive capacity and training. Furthermore, we test the existence of complementarity between radical innovation, incremental innovation and training. The data used are from Spanish manufacturing and service companies and have been collected by the Business Environment and Enterprise Performance Survey (BEEPS). The results indicate that radical innovation and training have a positive and significant impact on labour productivity. The influence of production technology embodied is also significant but negative. We did not find evidence of complementarity or substitutability between the variables analyzed.

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1. Introduction

Productivity gains have an influence on improving the incomes of workers, on the profits of the company and on the purchasing power of consumers (competition between producers partially transfers these productivity gains to the market, causing a price reduction of goods and services that consumers buy). Therefore, productivity is the key driver of long-term wealth and the welfare of nations [1]. Hence, it is crucial to know what the main determinants of productivity are, as this knowledge can help managers in the design and implementation of those company policies that further contribute to increased productivity and can also help policy makers in the design of public policies that seek to improve corresponding national productivity.

In this regard, there is abundant evidence in the literature about the existence of a positive relationship between innovation and productivity [e.g. Refs. 2,3]. However, there are different types of innovation, so the effects that innovation has on productivity may depend on whether different types of innovation operate independently or together [4]. In this sense, authors such as [5,6] have argued that each type of innovation can only be understood in

terms of interdependence with other types. So presumably there is complementarity between different types of innovation, which implies that the simultaneous action of different types of innovation on the productivity of firms is greater than the sum of the independent action of each type of innovation. Given the limitations of the database we use in this study, one of our main objectives is to test the existence of complementarity between radical innovation and incremental innovation, using business productivity as the performance variable.

Furthermore, we are also interested in exploring the influence of the acquisition of production technology embodied in new machinery and equipment on productivity, which is the external source of knowledge most commonly used by technology-follower countries. In addition, the acquisition of new production technology forces companies to incorporate new skills and best practices, which impact positively on productivity [4].

Moreover, from the basics of the experience curve it has been stressed that improvements in productivity depend not only on technological innovation, but also on the growth rate of output from companies. Thus, the experience curve indicates that companies can improve productivity from two different sources, incorporating more efficient innovations or increasing their respective levels of production and sales. In the 70s and 80s of the last century there have been empirical studies that have analyzed the influence of production increases on the productivity of firms [e.g. Refs. 7,8]. Also, there are empirical studies that emphasize that

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the most innovative and fastest growing companies often achieve better economic results [9,10].

Moreover, there is a high degree of consensus about the positive influence that skilled workers have, directly and indirectly, on the productivity of firms. On the one hand, there is empirical evidence that companies with a higher proportion of skilled workers tend to be more productive [11]; on the other hand, there is also empirical evidence that firms with higher proportions of more educated workers have a positive impact on innovation performance [12]. As innovation affects productivity, it is inferred that the policy skills at level of firm also indirectly influence business productivity. Through this double influence, the direct one and through innovative performance, we can infer the existence of complementarities between innovation and skills policy. That is, we can expect that the simultaneous action of both variables has a greater impact on productivity than the sum of their separate actions. In general, the mechanisms through which both variables interact remain somewhat opaque [13]. We will try to shed some light on this issue by carrying out a review of the degree of complementarity between the two variables. To do this, we use the training policy of the company as a proxy of the corresponding skills policy, as the economic literature recognizes that investments in training increase the skills of workers and produce innovative improvements in performance [14].

Thus, our main contribution in this paper is focused on analyzing the relationship between radical innovation, incremental innovation and training, in order to check whether these relationships are complementary, substitutive or independent in relation to their impacts on business productivity. In addition, we are also interested in analyzing the influence of the acquisition of production technology embodied in new machinery and equipment on productivity, a relationship poorly studied. Also, another of our contributions is focused on the analysis of the effect of training on business productivity, to the extent that most of the studies on productivity obviate this relationship, since skill surveys usually do not have data that allow us to construct measures of the productivity of the firms [11]. Another novelty is that our study does not focus only on industrial firms, as usually happens in most studies about innovation, but also incorporates service companies. It should also be noted that almost all studies on innovation in Spain use data from the Technological Innovation Panel (PITEC) or the Business Strategies Survey (EES). However, our contribution lies in the use of data from the Business Environment and Enterprise Performance Survey (BEEPS) from the European Bank for Reconstruction and Development (EBRD) and the World Bank Group.

2. Innovation, utilization of productive capacity, training and productivity

As we noted in the introduction, the aim of this paper is twofold: first, to analyze the influence of innovation, the effect of the utilization of productive capacity and training on business productivity; and second, to consider whether there are synergies between radical innovation, incremental innovation and training.

Regarding the influence of innovation on productivity, there is abundant literature. In general, most studies have found strong empirical evidence on the existence of a positive and significant influence [e.g. Refs. 3,15–25]. However, not all types of innovation have equal influence. In this regard, [4] and [26] analyzed a large sample of studies on productivity and innovation, and concluded that product innovations have a clear impact on productivity while the role played by process innovations is ambiguous. In Ref. [27] also found evidence that radical innovation has a positive and significant effect on productivity, whereas incremental innovation has a negative influence but statistically not significant influence.

Moreover, there is not abundant literature in relation to the influence on productivity of the acquisition of production technology embodied in new machinery and equipment. A comprehensive review and a detailed macro-level study on this issue have been made by Ref. [28]. This study found that the influence of R&D embodied in productivity growth has been particularly significant and important in the service sector.

Regarding the influence of productive capacity on productivity, the consultancy Boston Consulting Group was the first which did a study that concludes that the growth rate of experience (growth rate of cumulative production) has a positive influence on the productivity of firms since, for a given technology, the growth of production allows firms to exploit greater economies of scale. In line with this study, achieving greater market share happens to become a priority, since a higher market share leads to increased production and greater production facilitates the achievement of higher productivity [29]. Subsequently, various studies [8,30] reaffirmed the evidence that cumulative production volume (experience) has a statistically significant influence on the productivity of firms. Furthermore [31], point out that the possession of a large market share not only allows companies to achieve a position of cost leadership, but also allows them to build significant barriers to entry against potential competitors.

Analyses of the effect of skills on firm productivity are very thin. Most of the studies on productivity do not have data on skills at the firm surveys, and skill surveys typically do not have data for calculating the productivity of firms. However, in the literature it is recognized that the combination of innovation and skills acts as the twin engines of growth [32]. Thus, for example, [33] for France, [34] for the United States, and [35] for the United Kingdom found significant evidence that the most productive firms have more skilled workers. There is also empirical evidence that skill dispersion within companies also affects productivity [36].

In general, it is noted that skilled workers have a greater ability to adapt to technological change and to recognize the opportunities the global market holds. Consequently, the productivity and innovation capacity of enterprises depends heavily on the existence of a skilled workforce [37]. Companies can achieve a skilled workforce in two ways: hiring from the external labor market or training workers internally. The importance of training policy at the enterprise level is gaining prominence with the sustained growth of the marginal hiring costs [38], and, moreover, the increasing rate at which technological change is occurring provokes the external labor market to suffer a shortage of workers with specific skills that companies need. In this regard, in the literature there is empirical evidence of a positive and significant influence of training policy on business productivity and its innovative performance. In general, the most innovative companies implement training programs to a greater extent and with more continuity than the less innovative firms [39]. In this sense, there is evidence of a strong relationship between training intensity and innovation [40], and on the relationship between poor training and low average productivity [41]. A summary of the relationship between training and skill development and different measures of firm performance can be found in two international reviews: in Ref. [42] 19 studies covering 10 countries were analyzed, and in Ref. [43] 13 studies from eight countries were analyzed.

3. Data, variables and methodology

3.1. Data

The data used belong to Spanish companies, from manufacturing and service sectors, and come from the Business Environment and Enterprise Performance Survey (BEEPS) of the

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