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Technology and industrialization at the take-off of the Spanish economy: New evidence based on patents

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ABSTRACT

The aim of the paper is to contribute to a better knowledge of the existing relationship between the incorporation of technology and the industrial take-off, based on the case study of the sectoral dynamism of the Spanish industry during its period of highest development. The main hypothesis is that only an appropriate combination of the introduction of foreign technology and the creation of domestic technology guarantees the acquisition of the technological knowledge required for developing and less developed countries to reach a level closer to that of more developed countries. An evolutionary perspective has been applied considering that industrial growth depends on three types of variables: innovation or technology creation, dissemination potential and absorption capacity potential. The results confirm that the introduction of imported technology has been significant, both for unincorporated knowledge, shown in the growth of patents in the period 1960–1966, and that introduced through the importation of production technology by companies in the process of modernization.

1. Introduction

Economists have devoted a lot of attention to the international movement of standard factors of production, such as capital and labor, and to what these movements imply for growth. The spread of technology among countries gets far less attention even though decompositions of the sources of growth show that technological innovation is a major contributor. A reason for this gap is the difficulty of observing either the creation or diffusion of inventions. While we can observe inputs into the inventive process, such as R&D expenditure or R&D scientists and engineers, we have no direct measure of the output.

Patents indicate research output, and where patent protection is sought reflects where inventors expect their ideas to be used. In order to isolate patterns of invention and technology diffusion from patent data we distinguish among various influences on the decision to patent. The level of patenting of one country in another depends on the following factors: the source's research effort, the destination's market size, how rigorously the destination country protects intellectual property, the cost of patenting in the destination country, and the likelihood that invention from the source can be adopted into the destination's technologies.

Several authors from different theoretical backgrounds have acknowledged the role of technology in economic development. Some of the most significant studies have been the neoclassic growth models [1,2], the historic studies [3,4], the endogenous growth models [5–7], and the evolutionary studies [8–11].

Empirical evidence based on conventional growth models is hardly conclusive. If we compare the countries with the highest growth rates in the world with the rest, they seem to show stronger technological efforts, evidenced in the resources allocated to R&D. However, when analyzing the group of countries with a higher growth rate, it is not clear that those with the strongest growth are also those allocating more resources to R&D. In fact, comparatively less developed and smaller countries have shown the highest growth rates in the last decades without actually making any significant R&D effort [12].

On the other hand, the endogenous growth models imply positive relations between R&D intensity, the rate of patenting and the growth rate of output per worker. These models predict a constant level of R&D expenditure or number of scientist and engineers during periods of steady growth. Moreover, the evidence points out to technological spillovers from aggregate research intensity to industry-level innovation success.

To clarify these issues, some authors have adopted a broader perspective of technical progress. The school of evolutionary economy has developed some appreciative theories of a less formal nature for the study of growth as a qualitative change and the

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essential role of technology. Technology is regarded in a broader perspective, not merely as the production of domestic knowledge, as other forms of adapting and disseminating technologies developed by external agents are included. In this sense, a critical factor determining a country's relative productivity level is its ability to adopt technology, whether the technology was developed abroad or at home. The country's level of education is significant in explaining this ability [9–11].

From the perspective of developing and less developed countries, these studies have highlighted the essential role of technology [3,13,14]. In these countries, the lack of resources for the creation of technology leads to an intensive use of foreign technologies as a way of promoting growth and coming closer to more developed economies [15,16]. In this respect, there has been a clear change in the specialized literature from more traditional thesis on technology transfer as a development factor, going from the traditional debate on the convenience of creating rather than buying technology, to confirming that only an appropriate combination of these two actions can guarantee the acquisition of the technological knowledge required [17–21].

This is why the theory of innovation has been fundamental. This theory has shown the double function of R&D [22]: the conventionally acknowledged function of creating new technologies and its role in providing elements for knowledge building and therefore creating the capacity of absorbing technology developed in other contexts.

The case of the Spanish economy is particularly important for these issues as its recent industrial growth – in the 1960s Spain still received development aid – allowed the change from a very closed-up and national economy to a highly competitive economy on the international market. This expansion took place throughout several decades, reaching its high point in the 1960s. In this period, after a radical change towards economic liberalization and benefiting from an extremely favorable international environment, the Spanish industry experienced its period of maximum growth, ranking among the more dynamic economies worldwide [23].

The aim of this paper is to contribute to a better knowledge of the existing relationship between the incorporation of technology and the industrial take-off, based on the case study of the Spanish economy during its period of highest industrial development. For the first time, it is possible to use a detailed indicator of the technological activity in Spain during this period, as the most used indicator up-to-date relating to R&D is only available in its aggregate form for two years: 1964 (of an experimental nature) and 1967. So the original contribution of this paper is twofold. The first contribution is a description of the role of registered patents in Spain in such a crucial period of industrialization, providing new and more detailed knowledge on the technological activity undertaken during those years. The second contribution is an econometric analysis that tries to measure its importance in relation to the sectoral growth in the Spanish industry.

The remainder of this paper is organized as follows: Section 2 describes some stylised facts of the Spanish industrialisation in the 1960s. Section 3 summarises, according to the academic literature, a set of factors or determinants that influence the considerations of patents as technological indicators. Section 4 describes the characterization of the technological activity in Spain and the evolutionary model that explains its economic growth. The final section consists of a summary of the conclusions and suggestions related to technological policy.

2. A brief reference to the opening-up and structural change of the Spanish industry

After a long period of nationalist and protectionist involution that began in the last decades of the 19th Century and was further enhanced in the years following the Spanish Civil War (1936–1939), the Spanish economic policy began to open up during the 1950s, consolidating and showing its most important results in the 1960s: a decade characterized by a very high growth rate and extremely significant structural changes.

The introduction of technology became an essential factor for the high growth rates in industrial production, reaching similar o higher growth rates than during most of the 1950s. As we will argue below, the capacity needed for the domestic production of technology was clearly insufficient and foreign sources were incorporated, both in an "embodied" way, through equipment and direct investments, or in a "disembodied" way through technology transfer agreements or patents.

The framework of economic opening-up and liberalization described above also appeared in the more limited context of industrial policy. The general reference of the policy was to maintain the previous model mainly based on the domestic market, but with an increasing interest in foreign markets as the previous experience of autarchy had led to a dead end. All this was slightly out of step with the general liberalizing measures of the 1950s and within an increasing opening-up philosophy.

Changes in industry could be seen quickly and the growth rate of the Industrial Gross Product in constant values experienced between 1960 and 1966 the most dynamic period in the 20th Century[1] [24]. This strong dynamism resulted in the industrial sector gaining in importance in the national production, going from 19.6% in 1958 to 28.4% in 1974. In this way, the contribution of the industrial sector to the economic growth in the period of 1958–1974 can be estimated in 33.7%, the most important growth in the longer period from 1954 to 1998 [25].

Apart from other factors, the one we would like to highlight in this summarized vision is technology. The Spanish economy, in its process of strong growth and industrialization, required much more and much better technological resources. However, the capacity of producing domestically such resources was very limited and, therefore, turning to foreign technology became an extremely important factor. As a result of such a scarce internal activity, the strong demand of technology due to the growth and diversification of the industry was to be covered to a great extent by imported technologies. In fact, as already indicated [26], a great part of the companies involved in the few national programs available were also important buyers of foreign technology, indicating that the domestic effort played a clear complementary role to guarantee the incorporation of imported technology [27].

The purchase of foreign technology is reflected in a strong increase of the payments registered in the balance of payments and in the imbalance in terms of incomes. Indeed, the payments went from 19.3 million dollars in 1958 to 199.6 millions in 1972, and the deficit in income during this same period went from 17.5 million dollars to 179 million dollars. In addition, we must point out that the ratio between R&D spending and payments for imported technology were very low (0.25) while in developed countries it is usually higher than 1, ranging from 1.3 in Italy to 200 in the United States [28].

3. Methodological considerations on patents as indicators

Since the interest of economic analysis on the study of the problems associated to technological change, there is a search for appropriate indicators that may help to explain technological activities and their relationship to economic efficiency in a coherent way. For some time, the focus has been on analyzing research

[1] The year-on-year growth rate in real terms was 13.6% in 1961, 10% in 1962, 11.5% in 1963, 13.3% in 1964, 9.4% in 1965 and 9.6% in 1966.