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Young innovative firms and R&D strategies: is the Spanish case different?

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Abstract

This paper analyzes the profile of Spanish young innovative companies (YICs) and the determinants of innovation and imitation strategies. The results for an extensive sample of 2,221 Spanish firms studied during the period 2004–2010 show that YICs are found in all sectors, although they are more concentrated in high-tech sectors and, in particular, in knowledge-intensive services (KIS). Three of every four YICs are involved in KIS. Our results highlight that financial and knowledge barriers have much impact on the capacity of young, small firms to innovate and to become YICs, whereas market barriers are not obstacles to becoming a YIC. Public funding, in particular from the European Union, makes it easier for a new firm to become a YIC. In addition, YICs are more likely to innovate than mature firms, although they are more susceptible to sectoral and territorial factors. YICs make more dynamic use of innovation and imitation strategies when they operate in high-tech industries and are based in science parks located close to universities.

Keywords: innovation strategies, public innovation policies, barriers to innovation, multinomial probit model

JEL Codes: D01, D22 , L60, L80, O31

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1 Introduction

In recent decades, the factors that promote innovative performance and higher growth among young firms have received increasing attention from academics and policy-makers (Coad, 2011). This interest follows on from the seminal work of Joseph Schumpeter (1934), who examined the role of innovation in creating market turbulence through tension between entrants and incumbents. Entrants face high survival risks and considerable difficulties in gaining market share, while incumbents face questions about their position in a dynamic process of creative destruction.

According to Schumpeter's initial analytical model, the forces that govern the dynamics of the business cycle are provided by a limited group of firms: on the one hand is a cluster of innovative entrants, which are usually young, small firms; on the other is a cluster of incumbent firms with years of experience in the market that repeat established routines of R&D investment and innovation.

In the last decade of the twentieth century, some researchers produced empirical results on the significance of a selected group of new dynamic firms responsible for the bulk of employment expansion (Storey, 1994; Birch et al., 1995). While these initial studies adopted a descriptive approach (Birch, 1979, 1981), a second wave of analyses addressed the determinants of high-growth firms (Schreyer, 2000; Acs et al., 2008), and a third wave emphasized the behavior of firms, in particular with respect to the determinants of R&D investment and innovation (Polterovich and Tonis, 2005).

Here we adopt the European interpretation laid down in Article 35 of the General Block Exemption Regulation (GBER). The European Commission defines young innovative firms (hereafter, YICs) as firms that are less than 6 years old, have fewer than 250 employees, and spend at least 15% of their operating expenses on R&D[1]. We also adopt the criteria of Schneider and Veugelers (2010), who define R&D intensity in terms of revenues (sales) rather than expenditure.

This paper has a twofold aim. First, we analyze the profile that characterizes young, small firms in Spain and the factors that govern whether these firms become YICs. Second, we observe the determinants that condition the choice of innovation and/or imitation R&D strategies by an extensive sample of Spanish firms inmanufacturing and service sectors. Both

[1]EU State Aid Rules define YICs as small enterprises, less than 6 years old, having being "certified" by external experts on the basis of a business plan as capable of developing products or processes which are technologically new or substantially improved and which carry a risk of technological or commercial failure, or have R&D intensity of at least 15% in the last three years or currently (for start-ups).

topics are particularly important in countries like Spain, where public financial support for innovative, fast-growing new firms is scarce, despite the fact that these firms generate a larger share of new jobs than other types of firms.

This has an important bearing on public policies to stimulate employment generation and facilitate sectoral change. The European Commission actively promotes the growth of YICs in EU countries because of their capacity to generate jobs and new opportunities in emerging markets. Similarly, national governments ensure that public funding is available for YICs, given their importance to growth and renewal across manufacturing and service industries. While public policies aimed at all types of firms have received growing criticism, public funding has tended to be allocated to those regions and industries with the greatest concentration of YICs (Greene et al., 2004; Van Stel and Storey, 2004).

Finally, some scholars have analyzed patterns of R&D strategies in YICs. However, these studies focus on innovation performance and disregard imitation, despite the fact that the latter approach is more widely adopted than innovation. In fact, imitation strategies have received little critical attention until very recently (Shenkar, 2010; Luo et al., 2011). Notably, imitation is not exclusive to small firms and is also widely used by larger firms. Corporations like Apple apply imitation strategies to the personal computer market, Toyota and GM to the automobile industry, Holiday Inn to the tourism industry, and Inditex to textile distribution, to give a few examples. Imitation strategies are generally more widespread than innovation and are a more common path to business growth and profits.

For the econometric analysis, we apply a two-step approach. In the first step, we use a probit model to analyze the characteristic profile of YICs. In the second step, we estimate a multinomial probit model to analyze the factors that determine the adoption of innovation and imitation strategies.

For the empirical work, we analyze exhaustive data from the Spanish Technological Innovation Panel (hereafter, PITEC), which brings together in a collaborative venture the Spanish National Institute of Statistics (INE) and the Foundation for Technological Innovation (COTEC). The panel presents data on an exhaustive sample of Spanish firms over the period 2004–2010. The data are taken from the Community Innovation Survey (CIS) and include information on innovation activities that is comparable to innovation microdata from many other European countries. PITEC covers a broad range of sectors and includes the activities of both manufacturing and services firms. Most importantly, it allows longitudinal data to be compiled for 2,221 firms over the period 2004–2010.

This paper makes four principal contributions. First, unlike many other authors, we do not focus exclusively on innovation but also analyze the adoption of imitation strategies. Second, our empirical analysis looks at manufacturing and services, whereas other studies focus specifically on manufacturing. Third, our study takes a specific look at the case of Spain, which complements other work in the literature on countries such as Belgium, Germany and Italy. Fourth, we use panel data that allow us to make a more in-depth analysis than studies based on cross-sectional data.

Our results for Spanish firms corroborate that YICs are present in almost all sectors of the economy. Those firms that face the fewest financial and knowledge barriers and receive public financial support, particularly funding from the European Union, are the most likely to become YICs. In turn, YICs are generally more active innovators than other types of firms, although their innovation activities are conditioned by certain factors; YICs are more likely to innovate if they consider market information and information from public institutions to be of primary importance, if they operate in knowledge-intensive sectors, and if they are located in a science park.

The remainder of this paper is organized as follows: Section 2 is a theoretical background review; Section 3 presents the main hypotheses; Section 4 presents the empirical model; Section 5 shows the set of data and describes the variables used in the model; Section 6 provides the empirical results, and Section 7 presents the main conclusions and sets forth a political argument.

2 Theoretical background

2.1 YICs versus high-growth firms

The concept of a YIC is more restrictive than preliminary definitions focused exclusively on intensity of growth. Previous definitions in the literature classify YICs simply as fast-growing firms and make no specific reference to whether they must also be small, young or active in innovation.

In the final decades of the last century, the empirical literature began to offer new concepts such as "gazelle" firms (Birch, 1979) related to the speed of growth of a selected group of firms. The general concept of "high-growth" firms provided for a more rigorous interpretation of growth phenomena; thus, "high-growth" and "high-impact" firms (Acs et al., 2008), or "superstar'" fast-growth firms (Coad and Rao, 2008), reflect the impact of high-growth firms on job creation

and on other actors via forward and backward linkages. Finally, Cincera and Veugelers (2010) describe "young firms" that have managed to become leaders in their emerging markets without being taken over, deploying substantial R&D resources. These are referred to as young leading innovators (or "yollies") to differentiate from old leading innovators (or "ollies").

Among the concepts of high-growth firms and YICs was appearing a previous concept widely used is that of New Technology-Based firms (NTFBs). The first definition of NBTFs is described by Cooper (1971): "a firm that emphasizes research and development or that places major emphasis on exploiting new technical knowledge". A few years later, Llitle (1977) defined these firms as independent ventures less than 25 years old that supply a product or service based on the exploitation of an invention or technological innovation that involved major technological risks.

Subsequent studies of NTBFs usually adopted the broader definition of small and medium-sized enterprises (SMEs) in technology-intensive sectors (Storey and Thether, 1998). This broader definition does not encompass the concept of novelty because these firms merely adapt innovations already available on the market (Delapierre et al., 1998).

2.2 Innovation performance of YICs

In recent years, researchers, scholars and policy-makers have become increasingly interested in the strategic dimension of innovation (Atuahene-Gima and Ko, 2001). However, despite this interest, there is little empirical evidence of YIC performance in relation to firm and market conditions.

In general, the literature distinguishes between two market-oriented strategies: innovation and imitation (Zhou, 2006). Firms that adopt an innovation approach invest heavily in R&D and aspire to be the first to an innovative product or process to market (Schnaars, 1994; Green and Scotchmer, 1995). The literature labels these cases "market pioneers" (Atuahene-Gima and Ko, 2001).

Market pioneers could benefit from their innovative approach in different ways. For Kerin et al. (1992), Lieberman and Montgomery (1998), and Munuera and Rodriguez (2007), the factors that determine the advantages of innovative firms are grouped into two categories: first, the factors associated with the industrial economy (business level); second, the factors derived from theories of consumer behavior (product or brand level). However, on an empirical level it is difficult to separate the advantages associated with entry barriers from those associated with consumer behavior, since both types are correlated (Denstadli et al., 2005).

The main argument for the existence of these advantages, derived from industrial organization theory, concerns the concept of entry barriers to new competitors. The existence of barriers to entry into a market means that a firm which is not currently part of the market can only compete effectively with the pioneer by investing additional resources. The main barriers include access to economies of scale, patents or other intellectual property rights, disadvantageous access to strategic resources, and the cost of switching suppliers due to the existence of contractual clauses or the need to invest in complementary assets.

Consumer choice affects competitive advantage through a series of cognitive, affective and behavioral factors, such as the greater recognition and appreciation of innovative brands. The ability to influence the identification of important attributes and to establish a benchmark product that successive brands will be compared to is therefore important. Favorable opinions and the positive image of innovative brands are built on the market perception that they have some concern for improving the products and services offered. Other factors include the perceived risk associated with re-branding and the existence of switching costs, which favor those brands that can provide consumers with satisfactory evidence of their product. Market positioning is also an important consideration, since copycat brands that wish to differentiate themselves from incumbents will be forced to enter the market at a lower position.

However, innovation is not the only option for placing a product on the market. If we consider that only one firm can act as the pioneer in bringing a new product to the market, its rivals can reduce their initial disadvantage by applying imitation strategies. In general, imitation remains a viable and more common option than innovation (Kerin et al., 1992; Golder and Tellis, 1993; Schnaars, 1994). Rival firms are considered to have adopted an imitation strategy when they launch a product that is a copy or adaptation of an original and innovative product. The literature has labeled firms that tend towards an imitation approach as "followers", as distinct from "pioneers" (Lieberman and Montgomery, 1998; Atuahene-Gima and Ko, 2001).

2.3 Imitation performance of YICs

Imitation should not carry a negative connotation. Imitative firms are not necessarily pure copycats; rather, they can be creative imitators that improve on pioneers' originals and add further value for customers (Lee and Zhou, 2012). Additionally, firms that adopt an imitative approach tend to incur lower costs. Mansfield et al. (1981) found that imitation costs are approximately 65% of innovation costs in comparable cases. Meanwhile, Levin et al. (1984) found that in 80% of business lines studied, imitation costs were on average less than 75% of the costs registered by the firms responsible for the original innovation.

In general, previous research describes imitation as a complex and multi-dimensional process, distinguishing between two principal subtypes: pure and creative (Grahovac and Miller, 2009; Shenkar, 2010). A pure imitation strategy is used to introduce a new product that is a direct replication of a rival's existing product and is sold at much lower prices. Thus, pure product imitation enables a firm to enter a market quickly and at limited cost. A creative imitation strategy is used to replicate and also improve on a competitor's product. While creative imitation does not involve invention, it enables firms to take advantage of the R&D carried out by market leaders and to learn from their mistakes.

Although imitative firms compete with rivals with a major market share, they also have a number of advantages that can be harnessed as important competitive tools. These advantages are largely related to "free-rider" behavior, a concept that refers not to fraudulent or illegal behavior but to the attempt to make a profit at the expense of the effort of others.

Imitation strategies generally require less investment in basic research than the innovation strategies adopted by predecessors in the market, saving a considerable part of R&D spending by copying the original product. Imitation can also be used to take advantage of investments in human capital and training by the precursor, by attempting to hire some of its key employees. In addition, the imitative approach can harness the value of investments in communication made by innovative firms, aimed at stimulating demand and educating buyers about the use of the new product; by using this information, imitative firms have a more precise understanding of the potential market and can choose to enter it once they have verified that it responds appropriately to marketing actions. Finally, the existence of scale economies in R&D reduces the cost and risk of imitation, particularly when basic research requires substantial resources and returns are not appreciated for a number of years.

3 Main Hypotheses

In line with previous research we adopt the European Union definition, which states that YICs must be young (less than 6 years old), small (fewer than 250 employees), and R&D-intensive (R&D spending representing more than 15% of sales). YICs can therefore have varied profiles provided that they are young, small and intensively engaged in innovation activities.

Empirical papers that apply a more restrictive definition of YICs have found a lower proportion of this type of firm in all industries and service sectors. For instance, in a study by Schneider and Veugelers (2010) of a sample of German innovative firms, YICs have a share of only 3.8%; similarly, in the study by Czarnitzki and Delanote (2012) of a sample of manufacturing

and business sectors in Flanders, YICs accounted for a share of only 2.2%; Pellegrino et al. (2009) used a more relaxed definition based on firm age, according to which YICs must be less 8 years old, and found for a sample of Italian manufacturing firms that YICs accounted for 10.8%; Garcia-Quevedo et al. (2011) applied the same age criterion to a Spanish manufacturing sector and found that the proportion of YICs rose to 33.4%.

To simplify the study, we focus on four hypotheses based on the contributions made by previous works.

1. YICs are present in all manufacturing industries and service sectors, but the proportion is higher in high-tech manufacturing and knowledge-intensive services.

Young innovative firms are found in all industries and all regions (Schreyer, 2000), but their share varies between sectors according to the importance of the knowledge factor. Young small firms are more important in less concentrated markets and in the first stages of the life-cycle of a mature industry (Acs and Audretsch, 1987). The first analysis of the drivers of R&D activities and market structure was carried out by Joseph Schumpeter, who states in Capitalism, Socialism and Democracy: "The atomistic firm in a competitive market is the suitable vehicle for static resource allocation, but the large firm operating in a concentrated market is the most powerful engine of progress and [...] long run expansion of output [...] perfect competition [...] has no title to being set up as a model of ideal efficiency." (Schumpeter, 1934).

The Schumpeterian framework has inspired a vast body of theoretical and empirical literature that analyzes the links between firm size, market structure and innovation. Empirical evidence points to a direct association between firm size and innovation and an inverse U-shaped relationship between competition and innovation. As a general summary, innovation increases with the rate of entry of new firms in markets with lower entry barriers; R&D investment and innovation increase with firm size; the number of innovations tends to increase less than proportionally with firm size; and the relationship between innovation and competition is positive when the competition level is low, but negative when the competition level is high (Gilbert, 2006).

In line with previous literature, we expect YICs to have a greater presence in markets with lower entry barriers and low concentration levels. We also assume that the likelihood of becoming a YIC increases in high-tech industries and, in particular, in the KIS sector.

2. The likelihood of becoming a YIC is low when there is a high presence of barriers to innovation (for example, financial, knowledge and market barriers).

One of the most commonly discussed aspects of innovation is the role of financial and knowledge barriers in deterring firms from engaging in R&D. Research and development programs entail a degree of risk, require specific factors, and incur significant sunk costs and high investment cost. In the case of young, small firms, R&D investment is particularly conditioned by several factors, including access to financial resources, the need to train highly-skilled workers, and market incentives to promote R&D activities and innovation (Hall, 2002). Consequently, firms affected by one or more of these obstacles may have to conduct their R&D activities at a sub-optimal level, slowing the implementation of R&D programs or forcing them to abandon certain projects.

External barriers to R&D activities do not affect all firms equally. Small entrants, particularly YICs, are more likely to have difficulty accessing external funding, training high-skilled workers or operating in markets conducive to innovation. However, the effect of external barriers on the capacity of new firms to invest in R&D is not clear. Empirical evidence shows that a significant proportion of firms with high innovative capability are financially constrained, both internally and externally (Hottenrott and Peters, 2012). In one extensive sample of Spanish firms, YICs were found to be more sensitive to credit constraints than the sub-sample of mature firms (García-Quevedo et al., 2011).

3. Firms that receive public financial support are more likely to become YICs.

Many empirical studies have estimated the effect of public R&D subsidies aimed at promoting innovation activities (Negassi, 2004). According to these studies, firms with access to public subsidies aimed at promoting R&D activities (Cassiman and Veugelers, 2002; Segarra and Arauzo, 2008). Most recent studies that examine the impact of R&D subsidies (González et al., 2005 for the Spanish case) have provided empirical evidence indicative that government funding are moderately successful in stimulating R&D activities. However, some contributors (see, for example, Wallsten, 2000) have questioned these results on the grounds that very few studies explicitly consider the potential endogeneity of public funding.

Colombo et al. (2010), using Italian data, provide evidence for different effects of funding depending on the stage of development of the recipient. They find that new technology-based firms benefit more in terms of growth than mature firms, especially if public funds are allocated through a selective evaluation process.

In agreement with the literature, we assume that a new firm receiving public financial support as the result of a selection process will have greater incentives to implement innovative R&D programs.

4. YICs are more likely to innovate than larger or mature firms, but are more susceptible to sectoral and territorial factors.

YICs are present in all sectors and territories but are not uniformly distributed. Young, small firms are more sensitive to environmental conditions (Acs and Audretsch, 1990). YICs are more concentrated in high-technology sectors, especially KIS, but are also predominantly located in high-density urban areas with skilled workers and close to universities. Some Spanish YICs decide to locate their operations in dedicated science and technology parks close to universities and major technological infrastructure.

Science parks offer distinct advantages over alternative locations, in particular the spillover benefits, the proximity to research facilities, and access to management support services (Ferguson and Olofsson, 2004).

In general, empirical research has suggested that firms located in science parks grow more rapidly than those based in other locations (Westhead and Storey, 1994). However, the results are not conclusive. In Sweden, Lindelöf and Löfsten (2004) found that the science park has a positive impact on sales and employment figures, whereas Ferguson and Olofsson (2004) did not observe significant differences in growth rates. The wider range in growth rates of new firms based in science parks and the better survival rates suggest that these parks may be favorable locations for firms in the development stage. It has been suggested that a science park location positively affects survival rate but is not a significant determinant of growth, whereas a location associated with cooperation with universities has a positive effect on growth (Ferguson and Olofsson, 2004).

4 Empirical model

In this section we present the methodological foundations of the econometric estimations. The econometric work was performed in two steps. In the first step, we used a probit model to analyze the determinants of whether market entrants become YICs. The dependent variable is a categorical variable that takes the value 1 if the firm is a YIC and the value 0 if it is not.

The estimated equation is as follows:

$$P(Y/C = 1)_{i,t} = \alpha_1 + \beta_1 Z_{1i,t-1} + \mu_{1i,t}$$

where Z_1 represents the delay-independent variables, α_1 and β_1 are the coefficient estimates, and μ_1 is the error term.

In the second step, we estimate a multinomial probit model to analyze the determinants that govern the choice of innovation or imitation strategies, where the dependent variable takes a value of 0–2 according to the innovative practices adopted by the firm in question: a value of 0 indicates a firm that does not innovate or imitate (non-innovating/imitating firms); a value of 1 indicates a firm that has introduced an innovation that is new to the firm but not to the market (imitative firm); and a value of 2 indicates a firm that has introduced a change to its products that is innovative to the market (innovative firm). In other words, the dependent variable adopts three discrete values according to the innovation intensity of the firm, $Y \in (0, 1, 2)$.

The empirical specification assumes that the dependent variable shows the different ways in which a firm can choose to innovate. The choice adopted by each firm i is conditioned by a set of observed explanatory variables x_i, which can be correlated. If we represent the multinomial probit model in terms of a latent variable, we obtain:

$$y_i = \begin{cases} 0 & \text{if } Y_i^{0*} > Y_i^{1*}, ..., Y_i^{m*} \\ 1 & \text{if } Y_i^{1*} > Y_i^{2*}, ..., Y_i^{m*} \\ 2 & \text{if } Y_i^{2*} > Y_i^{3*}, ..., Y_i^{m*} \end{cases}$$

5 Data

5.1 Sample

Data on the sample of Spanish firms are taken from PITEC for the period 2004–2010. This dataset was jointly developed by the INE and the COTEC foundation with the aim of providing Spanish panel data for the Community Innovation Survey (CIS). PITEC compiles information from CIS-4, CIS-2006 and CIS-2008 for Spanish firms.

One of the benefits of the PITEC database over cross-sectional data sources from technical innovation surveys is its temporal nature, which enables much more accurate estimation of firm progress and provides more robust data that better reflect the heterogeneous nature of the firms. By using this database we are able to introduce variables with delays. This is an important methodological factor, since most of the studies performed to date have used cross-sectional data (referring to just one phase of the survey), which creates a series of difficulties for identifying causal relationships. It should be noted that any survey dependent on the answers given by a member of a firm's R&D staff presents certain limitations, as the interpretation of a particular innovation project is partially conditioned by the role of the respondent. Nevertheless, the evidence offered by Mairesse and Mohnen (2004) suggests that subjective evaluations of

innovation tend to be consistent with more objective evaluations.

Our final database was subject to a filtering process, which reduced the initial sample from 12,813 to 2,221 firms. The most important filtering criteria were as follows: a) the survey data should cover the period 2004-2010; b) the data should correspond to manufacturing and service sectors; c) the sample should only include firms that have appeared in the database for at least four years; d) the sample should only include firms that have not undergone a merger or takeover; and e) all firms should have 10 or more employees.

5.2 Variables definition

The variable YIC is a dichotomous variable that takes the value 1 if the firm is less than 6 years old, has fewer than 250 employees and invests more than 15% of sales in R&D. Following Czarnitzki and Delanote (2012), we consider that YICs adopt a persistent growth pattern, hence a firm defined as a YIC in any given year is assumed to adopt the same approach for the duration of that year.

The results for our samples show that 12.25% of firms are less than 6 years old, 11.00% also have more than 250 employees, and only 4.56% are YICs. We also see that YICs account for 3.81% of firms in low-tech manufacturing, 17.14% in high-tech manufacturing, 4.71% in non-KIS, and 74.29% in KIS.

In Spain, new KIS firms are more likely to become YICs. In addition, dynamic entrants are more commonly found in industries such as information and communication services than in high-tech manufacturing. The asymmetric sectoral distribution of YICs is, in part, explained by the predominance of traditional manufacturing industries in the Spanish economy. This imbalance is also found between Spain and the European Union and even between the EU and the United States.

Differences in distribution by sector partially explain the presence of a R&D gap between the EU and the United States, particularly in terms of private R&D investment by the business sector. At the firm level, the main factor behind this comparative weakness in the EU is the different sectoral composition, since new firms generally do not play a significant role, especially in new high-tech manufacturing and service sectors. The presence of young, small firms among the leading innovators is lower in the EU than in the United States (Cincera and Veugelers, 2010). This difference is primarily due to the fact that young leading innovators in the EU are less R&D intensive than their US counterparts. Empirical evidence shows that the EU-United Stated private R&D gap is largely a persistent structural issue.

The creative destruction dynamic is also impeded in the EU by significant barriers to market entry, which limits the potential of new firms to become market leaders (Aghion et al., 2007). In addition, young European firms have lower innovation capacities and higher rates of early failure, whereas the US economy has been able to generate a steadily increasing flow of YICs that not only survive but which act as leaders in their emerging markets (Bartelsman et al., 2004; Santarelli and Vivarelli, 2007).

To refine this analysis, a decomposition analysis can be performed to calculate the exact magnitude of two effects: the structural effect, which represents the differences in sectoral distribution of YICs relative to their counterparts; and the intra-sector effect, which reflects the differences in R&D intensity between the two subtypes of firms. For a sample of 1,009 European firms analyzed during the period 2004–2007, Cincera and Veugelers (2010) found that the difference in R&D intensity between YICs and other firm types was predominantly structural (stronger presence of YICs in high-tech sectors) rather than intrinsic (YICs being more R&D intensive than more mature counterparts in the sector). In this sample, YICs were found to grow faster than their counterparts, but their overall presence in the industrial structure was comparatively small. The contribution of YICs to R&D growth was 30%, to sales growth 16%, and to employment growth 20% (Cincera and Veugelers, 2010).

Taking as a starting point the work of Lööf and Heshmati (2006) and Vinding (2006), we define innovations as goods and services that are: (i) new or substantially improved to the market; and (ii) new or substantially improved only to the firm. Specifically, following Vinding (2006), we shall understand that a firm has imitated if it introduces a product or service that is only new to the firm itself and has innovated if it introduces a product or service that is new to the market.

Table 1 shows the relative proportion of firms that adopt imitation or innovation strategies and distinguishes between YICs and other types of firms, or non-YICs.

The figures show that 87% of YICs adopt imitation or innovation strategies, whereas only 46% of other firms imitate or innovate.

In the category R&D sources we consider the variable RD_intensity, defined as total spending on innovation (i.e., total spending on internal R&D, external R&D, acquisition of machinery, equipment and software, acquisition of external expertise, preparation for production or distribution, training, and the implementation of innovations) relative to the total number of employees at the firm.

Among the barriers that firms face — that is, the factors that impede the development of technological innovation activities — we consider the following variables: barriers related to lack

of funds (Financial_barriers), barriers related to the difficulty of accessing strategic knowledge (Knowledge_barriers), and barriers related to market characteristics (Market_barriers). These are dichotomous variables that take the value 1 if the firm is affected by the respective type of barrier and the value 0 if it is not.

Table 1: Number of firms by type of innovation strategy (2004–2010)

	YICs	Others	Total
Does not	14	1,131	1,145
imitate/innovate	(13.21%)	(53.48%)	(51.55%)
Imitates	35	524	559
	(33.02%)	(24.78%)	(25.17%)
Innovates	57	460	517
	(53.77%)	(21.75%)	(23.28%)
Total	106	2,115	2,221
	(100.00%)	(100.00%)	(100.00%)

Source: PITEC

Note: values in brackets show the percentage of firms in each sub-sample that carry out each type of innovation.

In the category of public financial support received by firms, we consider public funding from local or regional government (Local_funds), from the central government (Spain_funds) and from the European Union (EU_funds). These are dichotomous variables that take the value 1 if the firm has received the respective type of public funding and the value 0 if it has not.

We also consider the degree of importance given to external sources of information in a firm's innovation strategy. The variables are market sources (Market_inf), which include clients and competitors; public sources (Public_inf), which include universities, technology centers and other public research institutions; and other sources (Other_inf), which include congresses, scientific journals, technical publications, fairs, exhibitions, etc.

To analyze the market conditions, we consider the following variables: High_tech, which is a dichotomous variable that takes the value 1 if the firm belongs to a high-technology sector and the value 0 if it does not; and Market_share, which is defined as total firm sales divided by the value of sales in the corresponding sector. Data on sales for each sector are taken from the INE.

As a proxy for firm location, we use the variable Science_park, which is a dichotomous variable to distinguish between firms that are based at a science or technology park, which take the value 1, and firms that are not, which take the value 0.

To describe firm characteristics, we consider the following variables: Age, which gives the number of years from the founding of the firm to the current tax year, t; Size, which is defined as the number of employees; Group, which is a binary variable that takes the value 1 if the firm belongs to a group and 0 if it does not; and Export, which represents the total volume of exports (More details on variable construction are given in Table 6.)

Table 2 shows the main descriptive statistics for the period 2004-2010, differentiating between YICs and other types of firms.

Table 2: Descriptive statistics for 2004–2010 by firm type

	YICs	**Others**
R&D sources		
RD_Intensity	39,090.84	7,744.52
(R&D spending per employee, in euros)		
Barriers to innovation		
Financial_barriers (% firms)	46.26	34.69
Knowledge_barriers (% firms)	28.63	22.91
Market_barriers (% firms)	40.20	30.39
Public financial support		
Local_funds (% firms)	64.78	27.15
Spain_funds (% firms)	58.42	27.34
EU/_funds (% firms)	30.83	5.77
Firm characteristics		
Age (years)	4.36	29.38
Size (employees)	38.36	250.74
Group (% firms)	32.16	40.96
Total observations	709	14,158
Total firms	106	2,215
Source: PITEC		

Comparison of the YICs and their counterparts shows that YICs invest more intensively in R&D (39,090.84 euros compared to 7,744.52 euros), face greater difficulties to carry out innovation activities (financial barriers, 46.26% compared to 34.69%; knowledge barriers, 28.63%

compared to 22.91%; and market barriers, 40.20% compared to 30.39%, and receive more public financial support (from local or regional government, 64.78% compared to 27.15%; from the central government, 58.42% compared to 27.34%; and from the EU, 30.83% compared to 5.77%). YICs also tend to be younger (an average age of 4.36 years compared to 29.38 years) and smaller (an average workforce of 38.36 compared to 250.74). However, YICs are less likely to form part of a group (32.16% compared to 40.96%).

Table 3 shows the descriptive statistics for YICs and other firms by type of innovation strategy. In the case of YICs, the firms that adopt imitation strategies are those with the highest level of R&D spending per employee (45,384.57 euros); by contrast, in the case of other firms, it is the firms that innovate that spend the most on R&D per employee (14,359.41 euros).

With respect to external sources of information, we see that in the case of YICs the imitative firms give the greatest importance to market information (2.05); by contrast, the innovative firms give the greatest importance to information from public sources (2.56) and from other external sources (2.58). If we look at other firm types, the firms that adopt innovation strategies give the greatest importance to market information (2.18), public information (3.00) and information from other external sources (2.61).

If we examine market conditions, in particular the technological intensity of each sector, we see that YICs are more likely to be found in high-technology sectors than other firm types. Among YICs, the firms that do not innovate or imitate have the largest market share (0.11); by contrast, among other firm types, it is the innovative firms that have the largest market share (0.31). For YICs, the capacity to innovate is not directly related to market position, whereas in other firm types there is a strong and direct relationship between market share and innovation.

With respect to firm location, in the case of Spain there is no evidence that firms based in science parks behave differently to their counterparts located outside such settings. However, it should be noted that many Spanish YICs are located in science parks and university facilities and clearly benefit from the pecuniary knowledge externalities that are generated in these high-technology environments.

Looking at firm characteristics, in the case of YICs, the firms that imitate are generally younger (3.91 years) and more likely to form part of a group (35.26%); by contrast, the firms that innovate are larger (39.61 employees) and export more (12.39%). In the case of other types of firms, those that innovate are younger (27.65 years), larger (267.08 employees) and export more (25.75 %); by contrast, those that imitate are more likely to form part of a group (43.65%).

Table 3: Descriptive statistics for 2004-2010 by type of innovation strategy

YICs (106 firms)			
	Does not imitate/innovate	**Imitates**	**Innovates**
R&D sources			
RD_intensity (R&D spending per employee, in euros)	29,885.08	45,384.57	39,450.93
External information sources			
Market_inf	2.45	2.05	2.14
Public_inf	2.86	2.91	2.56
Other_inf	2.79	2.59	2.58
Market conditions			
High_tech (% firms)	78.36	93.64	95.77
Market_share (%)	0.11	0.08	0.10
Firm location			
Science_park (% firms)	14.93	19.65	27.61
Firm characteristics			
Age (years)	4.74	3.91	4.43
Size (employees)	34.73	38.27	39.61
Group (%)	19.40	35.26	35.07
Export (%)	10.00	10.45	12.39
Total observations	134	173	403
Others (2,115 firms)			
	Does not imitate/innovate	**Imitate**	**Innovate**
R&D sources			
RD_intensity (R&D spending per employee, in euros)	3,922.83	8,774.08	14,359.41
External information sources			
Market_inf	2.31	2.19	2.18
Public_inf	3.15	3.16	3.00
Other_inf	2.76	2.71	2.61
Market conditions			
High_tech (% firms)	41.09	62.27	70.12
Market_share (%)	0.18	0.27	0.31
Firm Location			
Science_park (% firms)	2.28	4.50	5.94
Firm characteristics			
Age (years)	30.37	29.12	27.65
Size (employees)	246.72	240.21	267.08
Group (%)	40.06	43.65	40.57
Export (%)	16.80	25.64	25.75
Total observations	7,344	3,045	3,769

Source: PITEC

6 Results

6.1 What are the factors that determine whether a firm becomes a YIC?

Our first aim is to analyze the characteristic profile of YICs. If we look at the data for barriers to innovation in Table 4, we see that the three types of barriers do not have the same impact on a firm's capacity to become a YIC. Hypothesis 2 stated that the different barriers to innovation reduced the capacity to innovate and become a YIC. The empirical results show that the hypothesis is corroborated in the cases of financial and knowledge barriers, but not in the case of market barriers. In other words, if a firm is affected by financial or knowledge barriers its capacity to become a YIC is reduced. By contrast, a firm affected by market barriers remains more likely to become a YIC. This suggests that market barriers do not deter YICs from innovating.

With respect to public financial support in the form of subsidies or loans, the results show that firms which receive public funding have a greater capacity to invest in R&D and are therefore more likely to become YICs. This bears out hypothesis 3. We can also see that firms which receive funding from the European Union have a higher probability of becoming YICs, whereas those receiving funds from the Spanish government are far less likely to innovate.

6.2 Determinants of innovation strategies

Our second aim in this study is to analyze the determinants that drive the choice of imitation and innovation strategies. YICs and other firm types were analyzed, to obtain comparative data and identify differences between the two groups.

The figures in Table 5 for external information sources show that market information is considered important for both innovation and imitation in YICs and other firm types, although it is given greater importance by YICs and is more significant for imitation than innovation in this sub-group. By contrast, information from public sources is only considered important for innovation, both in YICs and other firm types; as with market information, it is given greater importance by YICs. Information from other external sources is only considered important by YICs for imitation; by contrast, other firm types consider it important for both imitation and innovation, although to a greater degree in the case of innovation.

In terms of market conditions, both YICs and other firm types that belong to knowledge-intensive sectors are more active innovators. In the specific case of market share, we see that a

Table 4: Probit estimation of factors determining likelihood of becoming a YIC

R&D sources	
RD_intensity	71.900
(R&D spending per employee, in euros)	(0.9750)***
Barriers to innovation	
Financial_barriers	-0.1373
	(0.0975)
Knowledge_barriers	-0.0577
	(0.1057)
Market_barriers	0.1720
	(0.1028)*
Public financial support	
Local_funds	0.6563
	(0.1001)***
Spain_funds	0.2603
	(0.1094)****
EU_funds	0.6858
	(0.1528)***
Firm characteristics	
Age	-0.4890
	(0.0252)***
Size	-9.552
	(1.064)***
Group	0.0020
	(0.1164)
Sectorial dummies	Yes
Time dummies	Yes
Pseudo-R2	0.7662
Total observations	8,603

Source: PITEC

Notes: R&D spending in euros per employee and size in employees.

****Significant at 1%; **significant at 5%; *significant at 10%*

Table 5: Estimation of multinomial probit model for determinants of innovation strategy

	YICs		**Others**	
	Imitates	**Innovates**	**Imitates**	**Innovates**
R&D sources				
RD_Intensity	20.4000	0.9740	52.6000	115.0000
(R&D spending per employee, in euros)	(20.1000)	(19.6000)	(1.3400)***	(1.2500)***
External information sources				
Market_inf	-0.4994	-0.2830	-0.0948	-0.0390
	(0.1308)***	(0.1190)***	(0.0245)***	(0.0241)*
Public_inf	0.2471	-0.1857	0.0586	-0.0506
	(0.1156)**	(0.1044)*	(0.0257)**	(0.0249)**
Other_inf	-0.1564	0.0438	-0.0330	-0.1139
	(0.1476)	(0.1374)	(0.0287)	(0.0281)***
Market conditions				
High_tech	0.7489	12.147	0.2673	0.4550
	(0.3079)***	(0.2912)***	(0.0401)***	(0.0396)***
Market_share (%)	-16.894	-11.597	0.0609	0.0084
	(0.5818)***	(0.4799)***	(0.0291)**	(0.0279)
Firm Location				
Science_park	0.2129	0.3951	0.1666	0.1830
	(0.2337)	(0.2115)*	(0.1005)*	(0.0959)**
Firm characteristics				
Age	-0.1048	-0.0495	-0.0045	-0.0068
	(0.0346)***	(0.0319)	(0.0092)***	(0.0009)***
Size	49.765	28.168	-0.0280	0.0737
	(2.9714)*	-27.869	(0.0362)	(0.0317)**
Group	0.5177	0.5673	-0.1265	-0.2355
	(0.2053)***	(0.1893)***	(0.0402)***	(0.0394)***
Export	-0.0042	0.0016	0.0038	0.0041
	(0.0044)	(0.0040)	(0.0007)***	(0.0007)***
Sectorial dummies		Yes		
Time dummies		Yes		
Total observations	609		10,726	

Source: PITEC

Notes: R&D investment in euros per employee and size in employees.

****Significant at 1%; **significant at 5%; *significant at 10%*

YIC with greater market share is less likely to innovate and even less likely to imitate. Surprisingly, the relative weight of market entrants is not a determinant of the innovative capacity of YICs, whereas other firm types are more likely to innovate and even more likely to imitate the greater their market share.

The data for firm location show that firms located in a science park are more likely to innovate than imitate and that this likelihood is greater in the case of YICs than for other firm types.

These results tend to confirm hypothesis 4, which suggests that YICs are more likely to innovate than other types of firms but that they are also more susceptible to sectoral and territorial factors.

7 Conclusion

In this paper we highlight the crucial role of young, small and research-intensive firms in generating dynamic innovation processes in the markets. The contribution of these firms is particularly important in countries like Spain, where barriers to competition are high and only moderate incentives for change and innovation exist. Although market productivity is primarily associated with changes brought by incumbents, the entry of small, innovative firms generates a scenario of "creative destruction" that expels inefficient firms from the market and forces the remaining incumbents to improve their efficiency levels.

We analyze two main parameters related to the innovative capacity of new innovative firms. Firstly, we examine the presence of YICs in manufacturing and service sectors and the factors that affect the capacity of new firms to become YICs. Secondly, we identify determinants of the choice of innovation strategies between YICs and their counterparts.

The presence of YICs in the Spanish economy is similar to that observed in other countries. In our Spanish sample, 12.25% of firms are less than 6 years old, 11.00% also have fewer than 250 employees, and only 4.56% are YICs. The concentration of YICs is greater in high-technology sectors and, in particular, KIS activities.

We found that the YICs in our study are principally involved in knowledge-intensive services: 74.29% of the total sample are YICs involved in KIS, whereas only 4.71% are YICs involved in other types of services. The presence of YICs in manufacturing is far more moderate: 17.14% of the sample are YICs operating in high-tech manufacturing industries and only 3.81% are YICs operating in low-tech manufacturing.

In terms of barriers to innovation, we identify three main constraints that limit the capacity to become a YIC: financial barriers, knowledge barriers, and market barriers. Interestingly, although the theoretical interpretation suggests an inverse relationship between barriers to innovation and the likelihood of becoming a YIC, the empirical results are ambiguous. Financial and knowledge barriers negatively impact an entrant's capacity to become a YIC, whereas the presence of market barriers increases the likelihood. These results show that financial barriers to innovation derive from financial market failure and suggest that policy-level intervention is required to provide financial incentives to innovate, in the form of subsidies or loans.

Interesting results were obtained regarding the effect of public subsidies on R&D performance in our study sample. Public funds directly impact the probability that an entrant will become a YIC, and funds from European institutions are particularly important in boosting an entrant's capacity to carry out R&D activities.

As stated in the economic literature, young, small firms are more sensitive to their environment. YICs in high-tech manufacturing and KIS firms have a greater capacity to innovate than their counterparts in other sectors and market share is less important to YICs since when a firm's market share increases its capacity to innovate decreases. With respect to firm location, we observe that YICs located in a science park are more likely to innovate. In addition, territorial location has a greater effect on YICs than on mature, larger firms.

The empirical evidence clearly shows that YICs are found in all economic sectors but have a stronger presence in high-tech manufacturing and KIS. Financial and knowledge barriers to innovation alter the capacity of an entrant to become a YIC, and public financial support increases the capacity of a new firm to become a YIC. In countries like Spain, these results illustrate the need to design proactive industrial policies geared towards R&D investment in new and dynamic firms. These policies must target those firms with the greatest potential for innovation, in particular YICs, and therefore require broad parliamentary consensus capable of resisting the inevitable swings of the political cycle.

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9 Appendix

Table 6: The variables: acronyms and definitions

Variables	Definition
R&D sources	
RD_intensity	Total spending on innovation relative to number of employees.
Barriers to innovation	
Financial_barriers	Lack of funds in the firm or group. Lack of external funding for firm spending on R&D. Dichotomous variable that takes the value 1 if the firm is affected by these barriers and 0 if it is not.
Knowledge_barriers	Lack of qualified staff. Lack of adequate information on technology. Lack of information about markets. Difficulties finding innovation partners. Dichotomous variable that takes the value 1 if the firm is affected by these barriers and 0 if it is not.
Market_barriers	Market dominated by established firms. Uncertainty over the demand for innovative goods and services. Dichotomous variable that takes the value 1 if the firm is affected by these barriers and 0 if it is not.
Public financial support	
Local_funds	Local/regional government. Dichotomous variable that takes the value 1 if the firm has received funding from local/regional government and 0 if it has not.
Spain_funds	Central government. Dichotomous variable that takes the value 1 if the firm has received funding from the Spanish government and 0 if it has not.
EU_funds	European Union. Dichotomous variable that takes the value 1 if the firm has received funding from the EU and 0 if it has not.
External information sources	
Market_inf	Importance of external sources of information in driving innovation by the firm: market sources, which include clients and competitors. This variable takes a value of between 1 and 4, where 1 indicates that market information is of great importance and 4 indicates that market information is of little importance.
Public_inf	Importance of external sources of information in driving innovation by the firm: public sources, which include universities, technology centers and other public research institutions. This variable takes a value of between 1 and 4, where 1 indicates that public information is of great importance and 4 indicates that public information is of little importance.
Other_inf	Importance of external sources of information in driving innovation by the firm: other sources, which include conferences, scientific journals, technical publications, fairs, exhibitions, etc. This variable takes a value of between 1 and 4, where 1 indicates that other external information is of great importance and 4 indicates that other external information is of little importance.
Market conditions	
High_tech	Dichotomous variable that takes the value 1 if the firm belongs to a high-technology sector and 0 if it does not.
Market_share (%)	Total firm sales divided by the value of sales in the corresponding sector (data obtained from the INE).
Firm location	
Science_park	Dichotomous variable to distinguish between firms that are based at a science or technology park, which take the value 1, and firms that are not, which take the value 0.
Firm characteristics	
Age	Number of years from the founding of the firm to the current tax year.
Size	Number of employees.
Group	Binary variable that takes the value 1 if the firm belongs to a group and 0 if it does not.
Export	Volume of exports.