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**BARRIERS TO INNOVATION: CAN FIRM AGE HELP LOWER THEM?**

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**Cities and Innovation**

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**ABSTRACT:** This paper examines how firm age can affect a firm's perception of the obstacles (detering vs. revealed) that hamper and delay innovation. Using a comprehensive panel of Spanish firms for the period 2004-2011, the empirical analysis conducted shows that distinct types of obstacle are perceived differently by firms of different ages. First, a clear-cut negative relationship is identified between firm age and a firm's assessment of both the internal and external shortages of financial resources. Second, young firms seem to be less sensitive to the lack of qualified personnel when initiating an innovative project than when they are already engaged in such activities. By contrast, the attempts of mature firms to engage in innovation activity are significantly affected by the lack of qualified personnel. Finally, mature incumbents appear to attach greater importance to obstacles related to market structure and demand than is the case of firms with less experience.

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## 1. Introduction

According to the Schumpeterian tradition, firm age, along with firm size, is a fundamental factor in determining and differentiating a firm's innovation ability, with the degree of novelty and imitation of its innovation varying significantly over the firm's life cycle. Indeed, the Austrian scholar in his two most notable works assigns distinct but equally relevant roles to small, newly established and large, mature firms. In Schumpeter Mark I (Schumpeter, 1934), new entrepreneurial firms, by investing in R&D and launching new radical innovations favour a renewing process of 'creative destruction'. In contrast, in Schumpeter Mark II (Schumpeter, 1942), the main contribution to innovation is made by large, more experienced firms, which, by means of a process of 'creative accumulation', represent the main engine of change (see Malerba and Orsenigo, 1996; Breschi et al., 2000; Acemoglu and Cao, 2010).

Despite the unquestionable influence of Schumpeterian models in innovation studies, surprisingly, much of the related empirical literature has systematically neglected to investigate the relationship between innovation and firm age (with the relevant exceptions of Klepper, 1996, and Huergo and Jaumandreu, 2004<sup>1</sup>). More importantly, there is practically no evidence of the relationship between a firm's evolution and the effects (relevance) that certain firm and market factors can have in hindering its innovative process. Indeed, as would appear to be the norm in the innovation literature, much more emphasis is given to analysing the factors that determine the success of innovation than those that can lead to failure.

In recent years, a new stream of literature has begun to analyse the role played by barriers to innovation in deterring or hampering a firm's innovative efforts (Mohnen

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<sup>1</sup> Klepper proposes a theoretical model for studying the evolution in a firm's innovation activities over the industry life cycle. Huergo and Jamandreu empirically examine the way in which the probability of innovation by manufacturing firms changes at different stages in their lives.

and Rosa, 2001; Galia and Legros, 2004; Segarra-Blasco et al., 2008; Savignac, 2008) and to examine the factors affecting a firm's perception of these barriers (Iammarino et al., 2009; D'Este et al., 2012; Hölzl and Janger, 2013, 2014). In fact, most have tended to mainly focus on the impact of financial constraints on a firm's innovative behaviour (see Hall, 2008 for a review of this subject). Without calling into question the fundamental role played by the availability of internal and external financial resources in determining the firm's innovative decision, other factors have recently been shown to be significant hindrances of a firm's innovative process (see, for example, D'Este et al., 2012; Blanchard et al., 2012; Pellegrino and Savona 2013; Coad et al., 2014). Among these, particular attention needs to be paid to such factors as the shortage of adequate skills, the lack of appropriate information on technologies and on markets, and the lack/uncertainty of demand.

Crucially, the deterrent or hampering effect of these factors can vary over the firm's life cycle: for example, new-born or young firms may be more markedly affected than incumbents by a lack of financial resources or a shortage of adequate skills for the implementation of the innovative process, while the lack/uncertainty of demand might be more of a deterrent to firms with more experience and which, in all probability, operate in highly saturated markets.

Within this context, the main aim of this study is to conduct an empirical investigation of the impact of firm age on a firm's perception of the various obstacles to innovation. Building on the conceptual framework first proposed by D'Este et al. (2012), this relationship is examined by distinguishing between firms that face *revealed* barriers and those that face *detering* barriers<sup>2</sup>. To do so, univariate and multivariate

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<sup>2</sup> The distinction is based on the relationship between the engagement in innovation activity and the perceived importance of constraints to innovation. *Detering* barriers prevent firms from engaging at all in innovation activities;

analyses are undertaken that draw on a large longitudinal dataset of Spanish manufacturing and services firms and which focus on different phases in their life cycles.

Results show that different types of obstacle are perceived differently by firms of different ages. While a clear-cut negative relationship is detected between firm age and both the internal and external lack of financial resources, a less obvious pattern is found with respect to the other obstacles. Interestingly, young firms, on average, seem to be less sensitive to the lack of qualified personnel when they have to initiate an innovative project than when they are already engaged in innovation activities. Finally, mature incumbents appear to attach greater importance to obstacles related to market structure and demand than is the case of firms with less experience.

The rest of this paper is organised as follows. Section 2 reviews the theoretical and empirical literature examining barriers to innovation and forwards various hypotheses concerning the main research questions. Section 3 provides a detailed description of the dataset and some descriptive evidence. Section 4 presents the empirical strategy and discusses the main results. Section 5 concludes.

## **2. The literature**

### ***2.1 Barriers to innovation***

Traditionally, innovation and technological change have been identified as fundamental drivers of aggregate economic growth and development (Solow, 1956; Arrow 1962; Griliches, 1979). Within this context, most of the empirical literature

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*revealed* barriers are the obstacles that firms face during the innovative process (see Section 2 for a more detailed discussion).

based on innovation surveys has, in turn, examined the drivers of innovation activities across firms and sectors, while much less importance has been attached to factors that might impede or delay a firm's engagement in innovation.

Yet, within the emerging branch of innovation literature that has begun to turn its attention to the barriers to a firm's innovation activity, two distinct empirical approaches have been adopted. The first has centred its attention on the impact of what are primarily financial barriers on the propensity and intensity of a firm's innovation activity (see Mohnen and Rosa, 2001; Savignac, 2008; Segarra-Blasco et al., 2008; Blanchard et al., 2012; Pellegrino and Savona, 2013), while the second (and comparatively smaller stream in the literature) has focused its attention on analysing firm and market characteristics that can affect a firm's perception of the importance of different types of barrier (Galia and Legros, 2004; Iammarino et al., 2009; D'Este et al., 2012; Hölzl and Janger, 2013, 2014; D'Este et al., 2014). Here, we seek to contribute to this latter approach and, to this end, the rest of this section examines methodological and conceptual aspects that are crucial to the empirical investigation of the impact of a firm's assessment of the barriers to innovation.

Most empirical studies of innovation barriers report a positive correlation between engagement in innovation and the perception of these barriers. Different explanations have been forwarded to justify this somewhat counterintuitive result. Some authors, for example, interpret this positive link as a signal of a firm's ability to overcome the obstacles to innovation (see Baldwin and Lin, 2002; Galia and Legros, 2004; Mohnen and Röller 2005). In other words, the more innovative a firm is, the more aware it is likely to be of the obstacles to innovation and so the better equipped it will be to overcome them. Recently, Savignac, (2008) has offered a more convincing theory, claiming that the positive spurious correlation between innovation intensity and

perception of obstacles can be attributed to an inappropriate selection of the sample used for the empirical analysis. The French scholar suggests restricting analyses to the cohort of so-called ‘potential innovators’, i.e., those firms that invest in innovation activity (regardless of their success) and those that do not invest but have experienced barriers to innovation. As demonstrated by later studies (see D’Este et al., 2012; Blanchard et al., 2012; Pellegrino and Savona., 2013), this selection procedure is fundamental to ensure consistent results.

Closely related to this concept of potential innovators is the crucial distinction that has been drawn between *revealed* and *detering* barriers. This important characterisation, first proposed by D’Este et al. (2012), is based on an analysis of the relationship between a firm’s engagement in innovation and its assessment of the barriers to innovation. The authors distinguish two types of firm in their sample of potential innovators: those deterred from engaging in innovation activities and those experiencing barriers that obstruct their undertaking innovative projects. In the case of the former, potential innovators may abandon their efforts to innovate as the barriers are insurmountable. Among these obstacles, a key role is played by financial constraints (both internal and external funds), as well as by the lack of qualified personnel or information on technologies and on the market, and uncertainty or lack of demand for innovative products. However, all these factors, apart from preventing a firm from engaging in innovation, can also play a significant role in slowing down its innovative process. In other words, for some firms, the perception of obstacles to innovation may be sufficient to impede/delay (while not prevent altogether) their engagement in innovation. In line with D’Este et al. (2012), such firms can be characterised as experiencing *revealed* barriers to innovation, because their impact is felt once the firm has begun its innovation activity.



Most of the empirical literature to-date however has failed to identify properly the sample of potential innovators and to disentangle the deterring from the revealed barriers to innovation. And as recent contributions stress (see D'Este et al., 2012; Pellegrino and Savona, 2013), the conceptual and empirical characterisation of the different types of barrier to innovation and, consequently, of different firm types is fundamental in terms of the broader policy implications. As such, policy interventions might seek to enlarge the population of innovative-active firms (innovation-widening), by removing or alleviating obstacles that prevent firms from engaging in innovation activities; or, alternatively, they might support the existing population of innovative-active firms (innovation-deepening), by removing or alleviating obstacles that prevent the successful completion of innovation projects and hinder adequate returns to innovation investments.

In this paper, building upon D'Este et al. (2012, 2014) and by distinguishing between revealed and deterring barriers, we apply these conceptual frameworks to an examination of the relationship between firm age and a firm's perception of different obstacles to innovation.

## ***2.2 Firm age and barriers to innovation***

As discussed in the introduction, no previous studies provide evidence of the impact of age on a firm's perception of the barriers to innovation. Here, our goal is to go some way to filling this gap in the literature by looking beyond the typical distinction drawn between new entrants and incumbents and focusing on distinct phases in a firm's life cycle. In so doing, we do not propose any a priori hypotheses regarding the underlying research question, in the belief that no particular functional form can usefully be assigned to the relationship between firm age and the importance of the various

obstacles to innovation perceived by the firm. Having said that, however, it is undoubtedly useful to offer some insights based on relevant streams in the literature.

First, new-born firms are quite likely to be more sensitive than their more mature counterparts to cost factors when seeking to initiate a new innovation project and when wanting to devote more financial resources to an existing one. The reasons for such an assertion are varied. For example, more experienced firms are more likely to be able to rely on their own internal funds, given that they will have accumulated more profits over the years. Reid (2003) suggests the existence of an inverse relationship between a firm's age and its debt ratio, while Fluck et al. (1997) show that the ratio between external and total finance tends to fall once a firm has been operating for more than seven or eight years. Additionally, newly established or young firms, in contrast with more mature incumbents, cannot generally rely on their having developed a good reputation on the financial markets, since they will only have built a short-term relationship with the banks and their sources of collateral will be limited (see Petersen and Rajan, 1995; Martinelli, 1997; Berger and Udell, 2002). Schneider and Veuglers (2009) attempted to characterise young, highly innovative companies (firms younger than 6 years and specialising in R&D) and found that such firms appear to perceive the internal and external costs of innovation as being more important than do their mature counterparts.

A firm's skill endowment is deemed an important driver of its innovative activity (see Leiponen, 2005; Piva and Vivarelli, 2009) and a skilled workforce is a vital resource for firms dealing with complex activities (including innovation, in general, and R&D, in particular). Cohen and Levinthal (1989, 1990) claim that highly qualified employees are a firm's primary vehicle for absorbing external knowledge and, consequently, for enhancing its absorptive capacity. Florida (2002) argues that a firm's

skill base should not be confined to engineering and scientific qualifications, but should incorporate a much wider range of talent (including management, legal and design skills) as each can make a key contribution to creative problem solving. Here, also, it might be expected that young firms will face more obstacles when seeking to hire highly qualified (and costly) personnel. Yet, young firms, because of their greater financial constraints and smaller size, are more likely to turn to alternative sources of innovation (such as acquisition of machinery and equipment and outsourced R&D, see Pellegrino et al., 2012), making the contribution of highly skilled workers less relevant. However, knowledge-related obstacles may be equally insurmountable for mature firms. Indeed, companies with considerable market experience, characterised by well-established organisational routines and production practices may experience difficulties in adapting and modifying their skills and expertise to change (Nelson and Winter, 1982; Hannan and Freeman, 1984), especially when seeking to initiate an innovative project. This rigidity might also limit their capacity to react swiftly to changes in demand conditions and, so, they may appear more sensitive to market barrier factors, especially uncertain demand for innovative goods or services. For the same reasons, more experienced firms may be at a disadvantage when having to identify new technological opportunities, being limited by certain knowledge barrier factors (i.e., lack of information on technology and markets). However, according to the Schumpeterian tradition (see Schumpeter, 1942; Acs and Audretsch, 1988 and 1990) young firms can be expected to be less able to exploit the benefits deriving from market concentration and appropriability conditions and, thus, face greater barriers to innovation in markets dominated by established companies.

It is evident from this short discussion that the relationship between firm age and a firm's perception of obstacles to innovation is complex and that it is difficult to

hypothesise a clear functional form that captures the exact nature of this relationship. As we see in Section 4, the results of our empirical analyses lend considerable support to these propositions.

### **3. Data**

In this study we draw on firm level data from the Spanish Technological Innovation Panel (henceforth PITEC). PITEC is the result of the joint efforts of the Spanish National Statistics Institute (INE), the Spanish Foundation for Science and Technology (FECYT), and the Foundation for Technical Innovation (COTEC). The data are collected following the Oslo Manual's guidelines (OECD, 1997) and can therefore be considered a Community Innovation Survey or CIS-type dataset. However, one characteristic that distinguishes PITEC from most CIS-type datasets is its panel data structure. Indeed, since 2003, data have been collected systematically, providing highly representative information about the population of Spanish manufacturing and service firms over various time periods. This characteristic represents an important methodological advantage as it allows us to control for unobserved heterogeneity.

In addition to detailed information about a firm's general characteristics (including, main industry of affiliation, turnover, employment, founding year, etc.), PITEC collects data related to a large set of innovation-related aspects: assessments of engagement in innovation activity, economic and non-economic measures of the effects of innovation, self-reported evaluations of factors hampering or fostering innovation, participation in cooperative innovation activities and complementary innovation activities such as organisational change and marketing<sup>3</sup>.

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<sup>3</sup> Recent studies using this dataset include López-García et al. (2013), D'Este et al. (2014) and Segarra and Teruel (2014).

In this paper, we draw on data for the period 2004-2011. The initial sample, comprising 100,016 annual observations, was selected according to the following procedure. First, we excluded those firms operating in the primary (1,628 observations), construction (3,914 observations), utilities (720 observations) and sewage/refuse disposal (318 observations) sectors and those firms engaged in processes of mergers or acquisitions (8,543 observations)<sup>4</sup>. Additionally, given the presence of missing values for the variables employed in the empirical specification (see Section 4.2.1), a further 15,289 observations were ruled out.

In line with the discussion presented above (Section 2), we retained in our sample only the ‘Potential Innovators’. In other words, we excluded those firms that, by inference, can be defined as ‘Non innovation oriented firms’. This filtering procedure enabled us to correct a clear anomaly that characterises the design of the CIS questionnaire, whereby all firms (regardless of their willingness to innovate) are asked to respond to the questions regarding obstacles to innovation. More specifically, we excluded 6,943 observations referring to firms that did not engage in any of the seven innovation activities specified in the questionnaire (see Table A1 in the Appendix) and which, at the same time, did not experience any barriers to innovation during the period under analysis (see Table A2 in the Appendix)<sup>5</sup>. Thus, we ended up with a sample comprising 62,661 firm-year observations.

In line with our main research questions, among the potential innovators, we need to distinguish those firms that face deterring barriers from those that face revealed barriers to innovation. Following D’Este et al. (2012, 2014), the former can be

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<sup>4</sup> These firms were eliminated from the sample in the years following the merger or acquisition.

<sup>5</sup> As the proposed definition suggests, potential innovators are firms that are willing to innovate, and that either manage to engage in one of the seven innovation activities or fail in their attempt to do so, supposedly due to the effect (among other factors) of the obstacles to innovation they encounter.

identified as those companies that declare no engagement in innovation activity and yet to having faced at least one barrier item, while the latter comprises those firms that have faced at least one barrier item and which claim involvement in at least one of the seven innovation activities<sup>6</sup>. Thus, within the total sample, we identify 43,046 observations referring to firms facing revealed barriers and 18,140 observations referring to firms facing deterring barriers to innovation activity<sup>7</sup>.

## **4. Empirical analysis**

### ***4.1 Univariate analysis***

In this section we provide preliminary univariate evidence for our main research question. Specifically, we use lowess smoothing techniques to obtain non-parametric estimations of the impact of age on a firm's perception of the various obstacles to innovation. Following the PITEC questionnaire design (see Table A1 in the Appendix), we study this relationship by considering three different barrier factors: 1) cost; 2) knowledge; and 3) market, and a total of nine barrier items. However, we focus our attention on just seven of these after excluding the cost factor of 'direct innovation costs too high', and by collapsing two knowledge barrier items into one, namely 'lack of information on technology' and 'lack of information on markets'<sup>8</sup>.

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<sup>6</sup> Note that the only difference between the two groups concerns the respective degree of engagement in innovation activity.

<sup>7</sup> These figures do not, however, add up to 62,661. Indeed, there are 1,457 firm-year observations that declare involvement in innovation activity but which did not experience any kind of barrier to innovation. Since a firm's innovation activity is central to this paper, we decided not to exclude these firms and to perform our empirical analyses considering both the total sample and the two sub-samples of firms.

<sup>8</sup> We opted to exclude the cost barrier item as it is redundant when considered alongside the other two cost barriers. The same rationale applies to the decision to consider the variables related to lack of information on technology and market jointly.

Before discussing the results of the non-parametric analysis, it is useful to report some general insights from the firms' evaluation of barriers to innovation. Table 1 shows the proportion of firms (full sample and the two sub-samples) assessing each of the seven barrier items as highly important. In the case of the total sample, cost factors are, as expected, the category that presents the highest percentages (always above 30%), while market factors are, in general, deemed more important than knowledge factors. As for the two sub-samples, the proportion of firms facing deterring barriers that assess the obstacles to innovation as highly important is always higher than those facing revealed barriers. In line with the evidence provided in D'Este (2012), these figures confirm the importance of taking into account the different nature of the barriers firms face. This would appear to be particularly true for the following barrier items: 'lack of internal funds', 'lack of qualified personnel' and 'uncertain demand for innovative products'.

Figures A1 to A3 in the Appendix illustrate the results of the lowess estimations obtained when considering the total sample of firms. As can be seen, the only factor that shows a clear overall linear trend is the cost factor, with the two barrier items (lack of internal and external funds) showing a monotonic decreasing relationship with firm age. The knowledge factor presents a less clear-cut pattern. Of the three barrier items considered, only one ('difficulties in finding partners for innovation') presents a negative (albeit not particularly marked) relationship with age. In the case of the market factors, a U-shaped relationship is detected for the item 'market dominated by established firms', with a decreasing relationship being recorded until around a firm's sixtieth year and with mature firms appearing particularly sensitive to this barrier item. This trend is not, however, observed for the second market item 'uncertain demand for innovative products', where the curve describing its relationship with age is practically flat.

< INSERT TABLE 1 >

## ***4.2 Multivariate analysis***

### ***4.2.1 Variables and econometric methodology***

In the two subsections that follow, we investigate further the preliminary evidence discussed above by undertaking multivariate analyses that allow us to determine the impact of firm age on the firm's perception of obstacles to innovation after controlling for observed and unobserved factors.

For the univariate analysis, we consider seven binary indicators as dependent variables, each identifying firms that assess the selected cost, knowledge and market barriers as highly important. Each of these factors is regressed on a set of control variables and on a set of dummy variables identifying different age classes. The choice of these main control variables was made taking into account both the information obtained from the questionnaire and the main insights provided in the literature.

First, we control for firm size by taking the natural logarithm of a firm's total number of employees. Previous evidence shows that larger firms are less sensitive to barriers to innovation than are their smaller counterparts (see D'Este et al., 2012; D'Este et al., 2014). Indeed, large companies are able to rely more fully on internal funds, enjoy easy access to external funds and a high level of appropriability and are able to exploit economies of scale; all of which are important in alleviating the negative impact of obstacles to innovation (Schoonhoven et al., 1990; Katila and Shane, 2005). Since, these same favourable effects may apply to firms that form part of an industrial group (see Mairesse and Mohnen, 2002), we include a variable that identifies such enterprises.



Second, we control for the degree of internationalisation achieved by a firm by considering a variable that is equal to 1 if the firm's most significant destination market is international and 0 otherwise. As D'Este et al. (2012) show firms operating in foreign countries may be less affected by knowledge-related obstacles to innovation as a result of the so-called learning-by-exporting process (see Clerides et al., 1998), but more affected by market-related obstacles as they are exposed to fiercer competition.

We also control for appropriability conditions, by identifying those firms that make use of patents and informal methods to protect their innovations, and for the possible beneficial effects of public policy instruments, by singling out those companies that have received public subsidies for their innovation activity.

Finally in order to check for possible macroeconomic trends and for sectoral peculiarities we also consider a set of industry and year dummies.

Table 2 shows the descriptive statistics (mean and standard deviation) for the above variables for the pooled sample and for the two sub-samples of firms facing deterring or revealed barriers, respectively. As expected, the two groups of firms present some notable differences. Specifically, firms that have experienced revealed obstacles are much more oriented to foreign markets, more likely to use formal and informal methods of protection and present a higher probability of receiving public subsidies than firms that have experienced deterring barriers. All in all, these descriptive statistics further corroborate the importance of taking into account the different nature of the barriers firms face.

**< INSERT TABLE 2 >**

In order to provide a more comprehensive picture of the impact of firm age on a firm's perception of the different obstacles to innovation and so as to control for

possible nonlinear effects, we consider a set of dummy variables that identify a different phase in the firm's life cycle. In selecting the different age thresholds, we sought to represent the different phases in the firm's life course while avoiding any great disparities (in terms of the number of firms) across the different age categories. Thus, we selected the following five age classes: from 1 to 8 years, from 9 to 20 years, from 21 to 30 years, from 31 to 50 years, and more than 51 years<sup>9</sup>.

Table 3 shows the composition of the different samples by age category, while Figure A4 in the appendix shows the proportion of firms that assess the seven obstacles as highly important by age category and by sub-sample (i.e., revealed vs. deterring). In line with the results from the non-parametric estimations, a clear negative relationship is found between firm age and a firm's perception of cost barriers to innovation, with a notable difference being recorded between the percentages reported by the first and last age categories. In contrast, the differences between the five age classes are much less marked for the other two barrier factors. Interestingly, in the case of firms facing deterring barriers, the market factor 'uncertain demand for innovative goods' appears to be more relevant for more experienced firms than for those in the early stages of their life.

**< INSERT TABLE 3 >**

In order to verify how the above variables might affect a firm's assessment of the barriers to innovation we estimate the following equation:

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<sup>9</sup> In selecting the cut-off for the first age class we referred to recent contributions that, in order to identify and explore the innovative peculiarities of young companies, use a threshold of 8 years (see Pellegrino et al., 2012, and García-Quevedo et al., 2014; see also Van Praag and Versloot, 2007). Robustness checks were performed assuming alternative thresholds or different age groups. Results – available upon request – are consistent (both in terms of the sign and statistical significance of the estimated coefficients) with those discussed in Section 4.2.2.

$$Y_{jit} = I [\beta'X_{it} + \sum \delta'_k Age_{kit} + c_i + \varepsilon_{it} > 0] \quad (1)$$

where  $I[\cdot]$  is an indicator function that takes a value of 1 if the argument in brackets is true, and zero otherwise,  $Y_{jit}$  ( $j = 1, \dots, 7$ ) denotes the seven binary obstacle variables,  $X_{it}$  is the vector of control variables described above,  $Age_{kit}$  ( $k = 1, \dots, 5$ ) represents the set of dummies identifying the five age categories,  $c_i$  is the unobserved time-invariant individual effect, and  $\varepsilon_{it}$  an idiosyncratic error term.

Equation (1) is estimated by applying a standard random effect probit model<sup>10</sup>. As is standard, to avoid the dummy trap problem associated with the inclusion of the set of age dummies a reference category should be dropped, its effect on the dependent variables being captured by the intercept. However, in the case of more than one set of mutually exclusive dummies<sup>11</sup>, the intercept captures the aggregate effect of all the excluded dummy variables, so that the separate effects of the various excluded dummy variables cannot be estimated. Further, the results of the estimations are sensitive to the choice of the ‘left-out’ reference category. Taking into account that the effect of firm age is central to our analysis, to deal with these problems we use the well-known methodology proposed by Suits (1984). According to this simple approach, once the equation has been estimated, a value  $k$  can be chosen and added to each of the coefficients of the age dummies and subtracted from the constant term (including of

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<sup>10</sup> Alternatively we could have considered a fixed effect specification. However, due to the small degree of variation in the dependent variables, the use of this econometric model would have notably reduced the sample of firms considered for analysis. Therefore, we have preferred to preserve the representativeness of the sample by implementing a random effect model.

<sup>11</sup> The econometric specification includes a set of eight time and 34 industry dummies.

course the zero coefficient of the ‘left-out’ industry)<sup>12</sup>. The effect of each age category can thus be interpreted as a deviation from the average age effects.

#### **4.2.2 Results**

Tables 4, 5 and 6 show the econometric results of the random effect probit model for the total sample and the two sub-samples of firms experiencing deterring and revealed barriers to innovation<sup>13</sup>.

The most obvious outcome reported in Table 4 (total sample) is the negative relationship between firm age and a firm’s assessment of the cost factor. Indeed, in line with the discussion above (section 2.2), young firms (up to 20 years) report the lack of internal and external financial resources a significant obstruction to their innovative activity, whereas firms in the last three age categories appear to be considerably less hampered by these barrier items. While the estimations in Table 6 (sample of firms coping with revealed barriers) fully corroborate these results (see columns 1 and 2), a number of interesting insights emerge when we examine the sample of firms facing deterring barriers to innovation. As can be seen from Table 5, the deterring effects of both cost factors appear to be relevant only for the youngest firms (1 to 8 years), while the coefficient of the firms in the next age group (9 to 20 years) is no longer significant. Indeed the only negative and highly significant coefficient for the cost factors is

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<sup>12</sup> The value  $k$  is chosen so that the new age dummy coefficients average zero. Estimating the equation with all the age dummies and this restriction would produce identical statistical properties as the original estimation (see Suits, 1984, for more details).

<sup>13</sup> As a robustness check, in order to control for any correlation among the error terms of the regressors for the different obstacle variables we implement a multivariate probit regression. The results, available upon request, are in line with those reported in Tables 4, 5 and 6.

recorded by firms that have been operating for between 31 to 50 years. Besides demonstrating the importance of distinguishing between different groups of firms when analysing barriers to innovation, these results confirm our hypothesis that newly created firms are especially hampered in their efforts to innovate by a lack of internal and external funds.

An interesting relationship is also found between firm age and the barrier item labelled 'lack of qualified personnel'. The parameter estimates in column 3 of Table 5 show that this knowledge factor is significantly less important in deterring engagement in innovation among those firms in the early stages of their life (1 to 8 years) than it is among those firms with ages around the sample mean. In contrast, the only category of firms for which the lack of qualified personnel appears to be a relevant deterrent to their innovative efforts are those in the last age category (more than 51 years). This result seems to suggest that mature firms (typically characterised by well-established organisational and production practices) are at a disadvantage when it comes to reorganising themselves and adopting the skills and expertise required to initiate a new innovative project. New-born and young companies, on the other hand, that enter the market with an innovative idea appear to be well-equipped in terms of skilled workers and human capital. Different results, however, are detected among the sample of firms facing revealed barriers to innovation. In this case, while the parameter for firms in business for more than 51 years is no longer significant, a positive (albeit barely significant) association between the youngest firms (1 to 8 years) and the barrier item 'lack of qualified personnel' is detected.

In the case of the two market factors, the only notable result is the highly significant association between firms in the last age category facing revealed barriers and the barrier item labelled 'uncertain demand for innovative goods/services'.

As for the other firm characteristics, large firms and firms belonging to an industrial group appear, as expected, to perceive the various obstacles to innovation as being less relevant than do their counterparts. In addition, the ‘subsidy’ variable is mainly positive and significantly correlated with a greater degree of importance being attached to barriers to innovation.

No effects are detected among firms facing deterring barriers in relation to appropriability conditions. But both patent and informal protection appear to be positively associated with higher levels of relevance of the various obstacle items in the case of firms facing revealed barriers.

Finally, firms with a greater foreign market orientation seem not to suffer so greatly the effects of a ‘lack of qualified personnel’, indicating perhaps the beneficial effects of learning from direct experience of the exporting mechanism. Interestingly, these firms seem to be more strongly affected than their counterparts by the lack of external funds.

**< INSERT TABLES 4, 5 AND 6 >**

## **5. Conclusions**

In this paper our aim has been to contribute to the developing literature on barriers to innovation by empirically investigating the impact of firm age on the perception of obstacles to innovation. By building on a theoretical framework first proposed by D’Este et al. (2012), this specific relationship has been investigated by distinguishing between firms that face either revealed or deterring barriers. In so doing, we have performed both univariate and multivariate analyses of a large representative sample of Spanish manufacturing and services firms for the period 2004-2011.

Our results, in addition to confirming the need to distinguish between deterring and revealed barriers, show that different obstacle types are perceived differently by firms of different ages.

First, a clear-cut negative relationship has been identified between firm age and a firm's assessment of both the internal and external shortage of financial resources, especially in the group of firms facing revealed barriers to innovation. As such, this result confirms the importance of policy interventions that seek to finance the innovative projects of newly created firms, but at the same time it points to the need for policy schemes that can financially sustain firms already engaged in innovation activity and that have recently entered the market (less than 20 years ago).

Second, firms in the early stages of their life seem to be less sensitive to the effects of a lack of qualified personnel when having to initiate an innovative project, but more markedly affected by an obstacle of this type when already engaged in innovation activities. In contrast, mature firms are significantly affected in their attempts to engage in innovation activity by a lack of qualified personnel. It would seem that this outcome might be linked to the organisational rigidity and structured routines that come to characterise incumbents and which might lead to a certain degree of resistance when having to adjust staff skills and expertise.

Finally, mature firms appear to attach greater importance to obstacles related to market structure and demand than is the case of firms with less experience.

Although it lies somewhat outside the scope of this paper to provide guidelines for policymakers, our results have obvious policy implications. In this regard, evidence of the distinction that exists between deterring and revealed barriers in relation to firm age, combined with a consideration of the many factors obstructing innovation, is

critical for specifying the nature of policy actions and strategic decisions in relation to the firm's life cycle.

Future research should certainly look beyond the simple distinction that assigns firms to different age groups and explore more deeply the relationship between firm age and firm perception of obstacles to innovation. This might be tackled by employing non-parametric techniques, which would allow us to consider the entire age distribution without assigning any particular functional form to the relationship of interest. Furthermore, to complement the present findings, it would also be interesting to examine the impact the various obstacles to innovation have in hindering the innovation activity (on both the input and output sides) of firms of different ages.



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**Table 1. Proportion of firms assessing obstacles to innovation as highly important**

	Total	Deterring	Revealed	Mean comp. test	
Cost obst.(int.)	0.33	0.36	0.33	0.02***	(5.09)
Cost obst.(ext.)	0.32	0.31	0.33	-0.02***	(-5.09)
Know obst.(skill)	0.12	0.15	0.11	0.04***	(11.61)
Know obst.(info.)	0.13	0.13	0.12	0.01**	(2.61)
Know obst.(coop.)	0.12	0.14	0.12	0.02***	(6.83)
Mkt. obst.(incum.)	0.20	0.21	0.20	0.01	(1.52)
Mkt. obst.(demand)	0.23	0.26	0.23	0.03***	(8.06)
Observations	62,661	18,140	43,046		

**Table 2. Descriptive statistics (mean, sd) for the pooled sample and for the two sub-samples**

	Total sample		Deterring		Revealed	
	Mean	SD	Mean	SD	Mean	SD
Foreign markets	0.63	0.48	0.48	0.50	0.70	0.46
Industrial group	0.36	0.48	0.31	0.46	0.38	0.48
Informal protection	0.24	0.42	0.11	0.31	0.29	0.46
Patent	0.12	0.33	0.02	0.14	0.17	0.38
ln(Size)	4.09	1.56	4.05	1.67	4.08	1.50
Subsidy	0.36	0.48	0.05	0.22	0.49	0.50
Observations	62,661		18,140		43,046	

**Table 3. Composition of the different samples by age category**

Firm age (years)	Total sample		Deterring		Revealed	
	Freq.	%	Freq.	%	Freq.	%
1-8	7,844	12.52	1,544	8.51	6,124	14.23
9-20	24,359	38.87	7,774	42.86	16,061	37.31
21-30	14,132	22.55	4,654	25.66	9,147	21.25
31-50	11,420	18.23	3,046	16.79	8,084	18.78
>51	4,906	7.83	1,122	6.19	3,630	8.43
Total	62,661	100	18,140	100	43,046	100

**Table 4. Probit random effect estimations for the whole sample**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cost.(int.)	Cost.(ext.)	Know.(skill)	Know.(info)	Know.(coop)	Mkt.(incum.)	Mkt.(uncer.)
1-8	0.258*** (0.031)	0.216*** (0.030)	0.031 (0.039)	0.042 (0.038)	0.049 (0.035)	0.051 (0.034)	-0.026 (0.031)
9-20	0.065*** (0.021)	0.054*** (0.020)	-0.007 (0.026)	0.043 (0.026)	-0.015 (0.024)	-0.009 (0.023)	-0.038 (0.020)
21-30	-0.084*** (0.023)	-0.069*** (0.022)	0.016 (0.029)	0.042 (0.028)	-0.013 (0.027)	-0.017 (0.025)	-0.020 (0.022)
31-50	-0.132*** (0.029)	-0.088*** (0.028)	-0.040 (0.035)	-0.059* (0.035)	-0.005 (0.033)	-0.047 (0.031)	-0.012 (0.027)
>51	-0.106*** (0.047)	-0.114*** (0.045)	-0.000 (0.057)	-0.068 (0.056)	-0.017 (0.052)	0.022 (0.050)	0.097** (0.044)
Foreign markets	0.039 (0.025)	0.100*** (0.025)	-0.105*** (0.032)	-0.014 (0.031)	-0.034 (0.029)	0.025 (0.028)	0.046* (0.025)
Industrial group	-0.232*** (0.029)	-0.218*** (0.028)	-0.268*** (0.036)	-0.187*** (0.035)	-0.259*** (0.033)	-0.171*** (0.031)	-0.140*** (0.028)
Informal protection	0.074*** (0.022)	0.107*** (0.022)	0.078*** (0.028)	0.076*** (0.028)	0.064** (0.027)	0.077*** (0.024)	0.087*** (0.022)
Patent	-0.001 (0.030)	0.066** (0.029)	-0.012 (0.039)	0.052 (0.037)	0.133*** (0.036)	0.018 (0.033)	0.009 (0.030)
ln(Size)	-0.247*** (0.012)	-0.184*** (0.011)	-0.085*** (0.014)	-0.107*** (0.014)	-0.138*** (0.013)	-0.107*** (0.012)	-0.133*** (0.011)
Subsidy	0.042** (0.020)	-0.052*** (0.019)	-0.032 (0.026)	0.103*** (0.025)	0.018 (0.024)	-0.006 (0.022)	0.021 (0.020)
Constant	0.161 (0.101)	-0.113 (0.095)	-1.779*** (0.122)	-1.743*** (0.120)	-1.193*** (0.106)	-1.293*** (0.110)	-1.278*** (0.099)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sectoral Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	62,661	62,661	62,661	62,661	62,661	62,661	62,661
lnL	-29,342.81	-29,902.75	-17,563.16	-17,922.78	-18,495.99	-24,000.03	-27,260.02
Sigma	1.389*** (0.019)	1.288*** (0.017)	1.396*** (0.025)	1.374*** (0.024)	1.222*** (0.022)	1.373*** (0.021)	1.214*** (0.017)
Rho	0.659***	0.624***	0.661***	0.654***	0.599***	0.653***	0.596***
LR test rho	16,051.335	14,465.923	9,457.699	9,564.103	7,779.108	13,021.988	11,610.164
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

**Table 5. Probit random effect estimations for the sample of firms experiencing deterring barriers to innovation**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cost.(int.)	Cost.(ext.)	Know.(skill)	Know.(info)	Know.(coop)	Mkt.(incum.)	Mkt.(uncer.)
1-8	0.349*** (0.059)	0.263*** (0.058)	-0.160** (0.072)	-0.049 (0.073)	-0.011 (0.069)	0.067 (0.063)	-0.061 (0.059)
9-20	0.030 (0.036)	0.037 (0.036)	-0.020 (0.044)	0.014 (0.045)	0.025 (0.042)	-0.072** (0.040)	-0.061* (0.036)
21-30	-0.088** (0.041)	-0.059 (0.040)	0.011 (0.049)	-0.007 (0.050)	0.016 (0.047)	-0.067 (0.044)	-0.002 (0.040)
31-50	-0.156*** (0.050)	-0.156*** (0.049)	-0.062 (0.060)	-0.032 (0.062)	-0.011 (0.058)	-0.055 (0.055)	0.059 (0.049)
>51	-0.136* (0.081)	-0.085 (0.079)	0.231*** (0.093)	0.074 (0.099)	-0.019 (0.094)	0.128 (0.086)	0.065 (0.078)
Foreign markets	0.035 (0.044)	0.096** (0.044)	-0.133** (0.054)	-0.085 (0.056)	-0.020 (0.051)	-0.035 (0.049)	0.097** (0.044)
Industrial group	-0.463*** (0.052)	-0.436*** (0.051)	-0.433*** (0.065)	-0.415*** (0.067)	-0.486*** (0.062)	-0.375*** (0.058)	-0.385*** (0.052)
Informal protection	0.007 (0.056)	0.056 (0.055)	-0.004 (0.069)	0.002 (0.071)	0.001 (0.068)	-0.056 (0.062)	0.087 (0.056)
Patent	-0.009 (0.111)	0.117 (0.108)	-0.299* (0.153)	-0.197 (0.151)	-0.058 (0.139)	-0.053 (0.129)	-0.216* (0.115)
ln(Size)	-0.211*** (0.018)	-0.159*** (0.017)	-0.067*** (0.021)	-0.089*** (0.022)	-0.119*** (0.020)	-0.058*** (0.019)	-0.134*** (0.018)
Subsidy	0.040 (0.068)	-0.117* (0.068)	0.008 (0.086)	0.195** (0.086)	0.051 (0.082)	0.068 (0.077)	0.082 (0.068)
Constant	0.304** (0.148)	-0.119*** (0.145)	-1.509*** (0.182)	-1.470*** (0.185)	-1.299*** (0.170)	-1.349*** (0.169)	-1.046*** (0.151)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sectoral Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	18,140	18,140	18,140	18,140	18,140	18,140	18,140
lnL	-9,141.34	-8,975.99	-6,009.37	-5,621.47	-6,042.00	-7,517.59	-8,593.64
Sigma	1.392*** (0.035)	1.329*** (0.034)	1.441*** (0.044)	1.454*** (0.047)	1.309*** (0.042)	1.435*** (0.040)	1.288*** (0.034)
Rho	0.659***	0.638***	0.675***	0.679***	0.631***	0.673***	0.624***
LR test rho	3,436.704	3,059.805	2,573.406	2,357.487	1,967.900	3,055.102	2,862.483
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

**Table 6. Probit Random Effect estimations for the sample of firms experiencing revealed barriers to innovation**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cost.(int.)	Cost.(ext.)	Know.(skill)	Know.(info)	Know.(coop)	Mkt.(incum.)	Mkt.(uncer.)
1-8	0.227*** (0.039)	0.200*** (0.037)	0.088* (0.047)	0.046 (0.046)	0.059 (0.043)	0.041 (0.041)	-0.031 (0.038)
9-20	0.106*** (0.027)	0.075*** (0.025)	-0.000 (0.033)	0.048 (0.032)	-0.028 (0.030)	-0.002 (0.029)	-0.029 (0.025)
21-30	-0.099*** (0.030)	-0.087*** (0.028)	0.037 (0.037)	0.080** (0.035)	-0.039 (0.034)	-0.043 (0.032)	-0.049* (0.028)
31-50	-0.144*** (0.037)	-0.071** (0.034)	-0.025 (0.044)	-0.082** (0.043)	0.000 (0.040)	-0.051 (0.039)	-0.028 (0.034)
>51	-0.090 (0.059)	-0.117** (0.055)	-0.099 (0.070)	-0.092 (0.068)	0.008 (0.063)	0.054 (0.060)	0.138*** (0.053)
Foreign markets	0.047 (0.033)	0.119*** (0.031)	-0.083** (0.041)	0.009 (0.040)	-0.013 (0.037)	0.061* (0.036)	0.027 (0.032)
Industrial group	-0.172*** (0.036)	-0.165*** (0.034)	-0.196*** (0.045)	-0.109** (0.043)	-0.192*** (0.041)	-0.102*** (0.039)	-0.064* (0.035)
Informal protection	0.082*** (0.026)	0.102*** (0.025)	0.116*** (0.034)	0.104*** (0.032)	0.085*** (0.031)	0.100*** (0.028)	0.091*** (0.026)
Patent	-0.009 (0.033)	0.068** (0.032)	0.011 (0.043)	0.089** (0.040)	0.156*** (0.039)	0.038 (0.036)	0.030 (0.033)
ln(Size)	-0.277*** (0.016)	-0.213*** (0.015)	-0.088*** (0.019)	-0.136*** (0.018)	-0.139*** (0.017)	-0.148*** (0.016)	-0.143*** (0.015)
Subsidy	0.065*** (0.024)	-0.062*** (0.023)	0.024 (0.031)	0.119*** (0.030)	0.075*** (0.028)	0.036 (0.026)	0.058** (0.024)
Constant	0.285** (0.132)	0.145 (0.123)	-2.000*** (0.160)	-1.882*** (0.158)	-1.215*** (0.136)	-1.222*** (0.143)	-1.400*** (0.130)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sectoral Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	43,046	43,046	43,046	43,046	43,046	43,046	43,046
lnL	-20,045.61	-20,699.53	-11,526.93	-12,275.36	-12,412.60	-16,362.09	-18,426.70
Sigma	1.553*** (0.026)	1.420*** (0.023)	1.515*** (0.033)	1.476*** (0.031)	1.321*** (0.028)	1.503*** (0.028)	1.320*** (0.023)
Rho	0.707***	0.669***	0.697***	0.686***	0.636***	0.693***	0.635***
LR test rho	11,728.104	10,727.916	6,294.189	6,699.466	5,376.083	9,419.943	8,321.637
p-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

## Appendix

**Table A1. PITEC questionnaire: barriers to innovation**

*During the three-year period, how important were the following factors as constraints to your innovation activities or influencing a decision to innovate?*

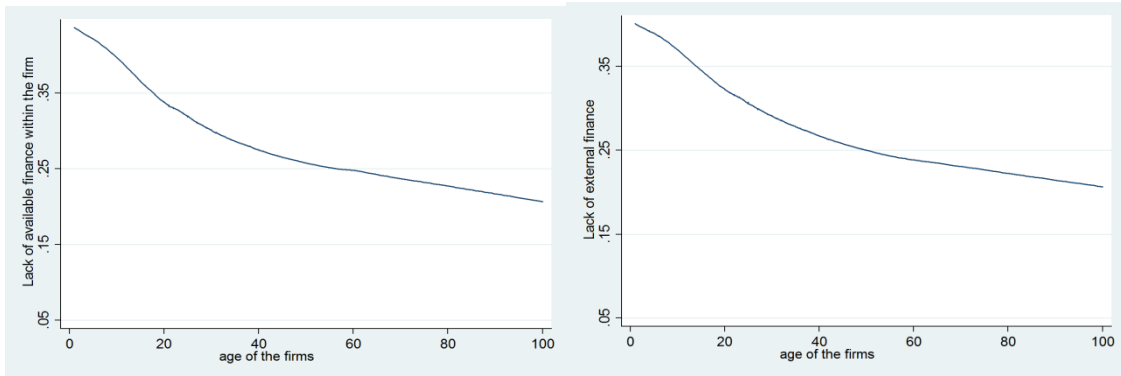
Barrier factors	Barrier items	Factor not experienced	Degree of importance		
			Low	Med.	High
Cost factors	Lack of available finance within the firm	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Lack of available finance from other organisations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Direct innovation costs too high	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Knowledge factors	Lack of qualified personnel	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Lack of information on technology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Lack of information on markets	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Difficulties in finding partners for innovation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Market factors	Market dominated by established enterprises	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Uncertain demand for innovative goods or services	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



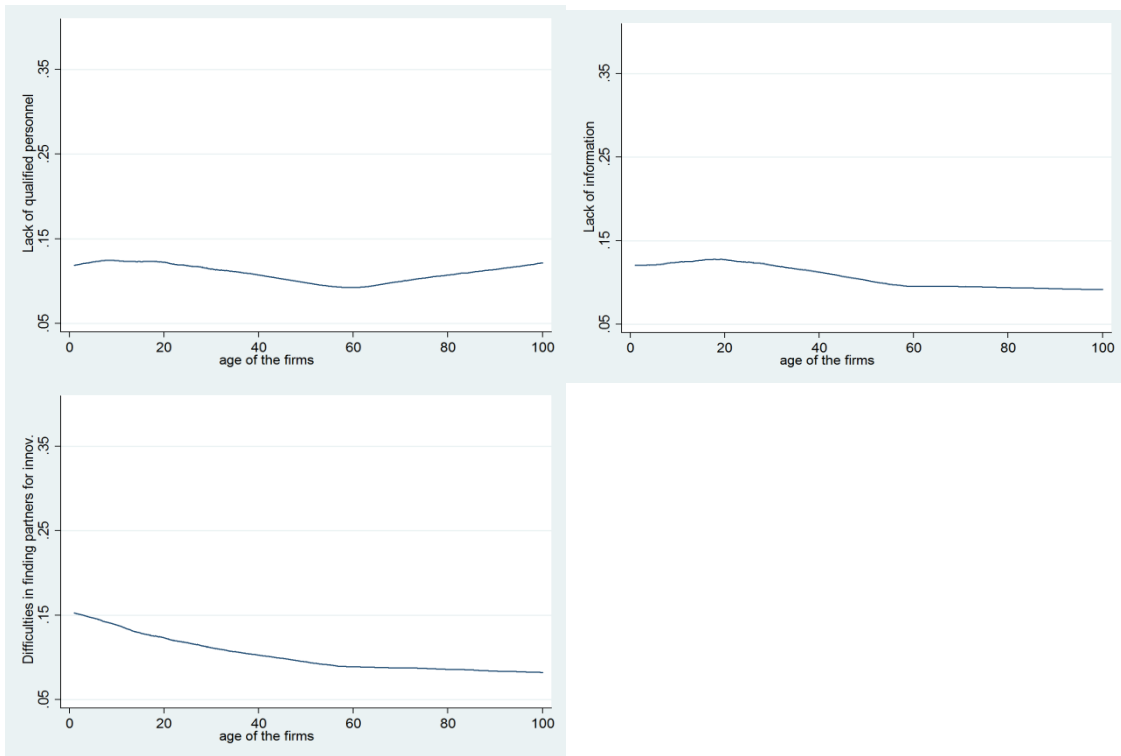
**Table A2. PITEC questionnaire: engagement in innovation activity**

<i>During the three-year period, did your enterprise engage in the following innovation activities?</i>	YES	NO
<p><b>Intramural (in-house) R&amp;D</b> Creative work undertaken within your enterprise on an occasional or regular basis to increase the stock of knowledge and its use to devise new and improved goods, services and processes.</p>	<input type="checkbox"/>	<input type="checkbox"/>
<p><b>Acquisition of R&amp;D (extramural R&amp;D)</b> Same activities as above, but purchased by your enterprise and performed by other companies (including other enterprises within your group) or by public or private research organisations.</p>	<input type="checkbox"/>	<input type="checkbox"/>
<p><b>Acquisition of machinery, equipment and software</b> Acquisition of advanced machinery, equipment and computer hardware or software to produce new or significantly improved goods, services, production processes, or delivery methods.</p>	<input type="checkbox"/>	<input type="checkbox"/>
<p><b>Acquisition of external knowledge</b> Purchase or licensing of patents and non-patented inventions, know-how, and other types of knowledge from other enterprises or organisations.</p>	<input type="checkbox"/>	<input type="checkbox"/>
<p><b>Training</b> Internal or external training for your personnel specifically for the development and/or introduction of innovations.</p>	<input type="checkbox"/>	<input type="checkbox"/>
<p><b>All forms of design</b> Expenditure on design functions for the development or implementation of new or improved goods, services and processes. Expenditure on design in the R&amp;D phase of product development should be excluded.</p>	<input type="checkbox"/>	<input type="checkbox"/>
<p><b>Market introduction of innovations</b> Activities for the market preparation and introduction of new or significantly improved goods and services, including market research and launch advertising.</p>	<input type="checkbox"/>	<input type="checkbox"/>

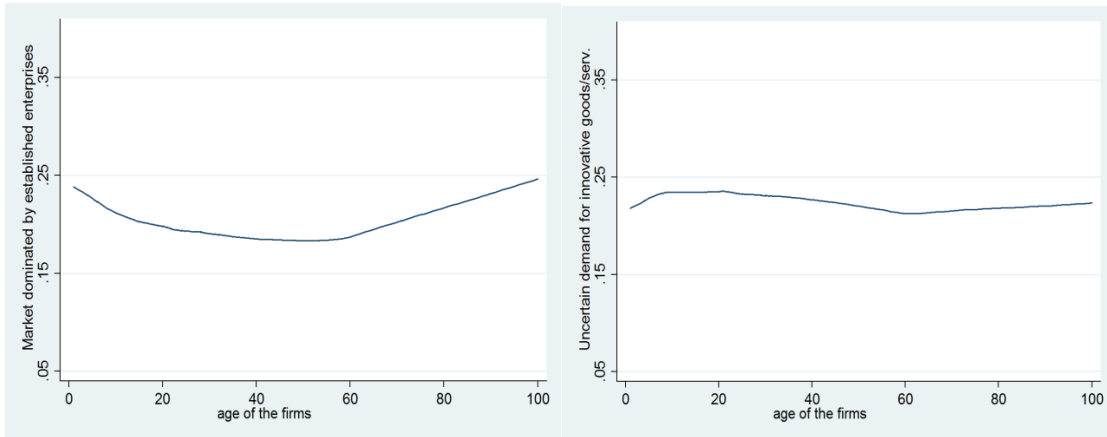
**Figure A1. Local linear smoothing (lowess): relationship between firm age and cost obstacles**



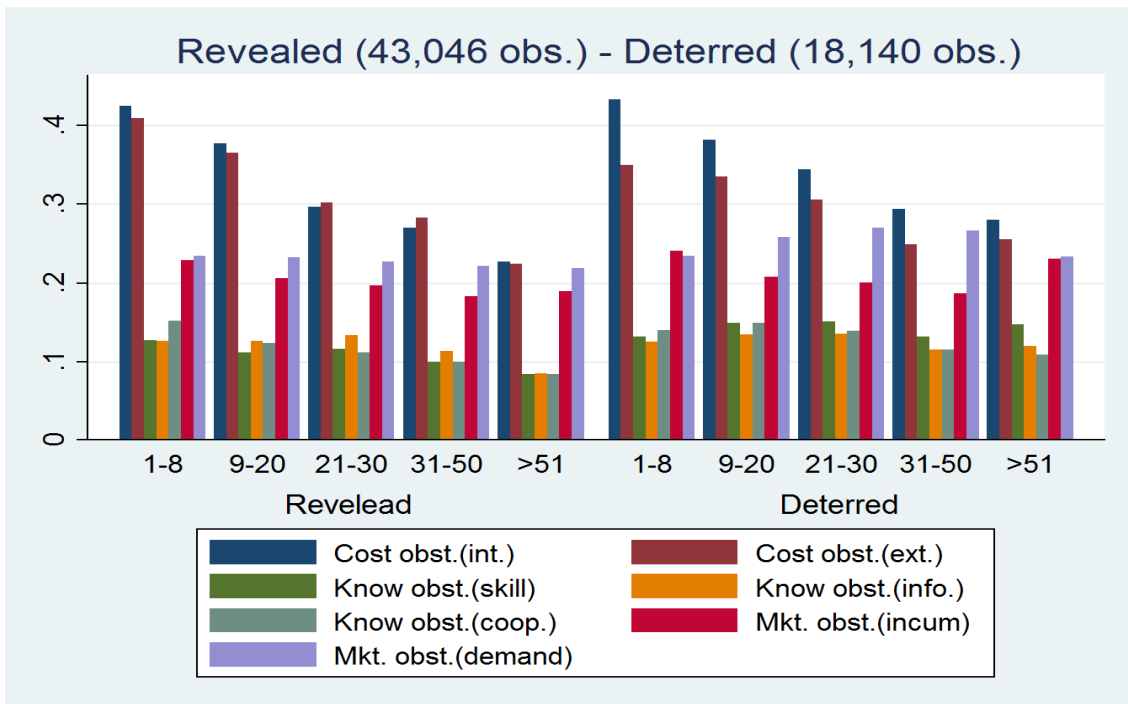
**Figure A2. Local linear smoothing (lowess): relationship between firm age and knowledge obstacles**



**Figure A3. Local linear smoothing (lowess): relationship between firm age and market obstacles**



**Figure A4. Average firm's perception of obstacles to innovation by age category (revealed and deterring samples)**



## 2011

- 2011/1, **Oppedisano, V; Turati, G.:** "What are the causes of educational inequalities and of their evolution over time in Europe? Evidence from PISA"
- 2011/2, **Dahlberg, M; Edmark, K; Lundqvist, H.:** "Ethnic diversity and preferences for redistribution"
- 2011/3, **Canova, L.; Vaglio, A.:** "Why do educated mothers matter? A model of parental help"
- 2011/4, **Delgado, F.J.; Lago-Peñas, S.; Mayor, M.:** "On the determinants of local tax rates: new evidence from Spain"
- 2011/5, **Piolatto, A.; Schuett, F.:** "A model of music piracy with popularity-dependent copying costs"
- 2011/6, **Duch, N.; García-Estévez, J.; Parellada, M.:** "Universities and regional economic growth in Spanish regions"
- 2011/7, **Duch, N.; García-Estévez, J.:** "Do universities affect firms' location decisions? Evidence from Spain"
- 2011/8, **Dahlberg, M.; Mörk, E.:** "Is there an election cycle in public employment? Separating time effects from election year effects"
- 2011/9, **Costas-Pérez, E.; Solé-Ollé, A.; Sorribas-Navarro, P.:** "Corruption scandals, press reporting, and accountability. Evidence from Spanish mayors"
- 2011/10, **Choi, A.; Calero, J.; Escardíbul, J.O.:** "Hell to touch the sky? Private tutoring and academic achievement in Korea"
- 2011/11, **Mira Godinho, M.; Cartaxo, R.:** "University patenting, licensing and technology transfer: how organizational context and available resources determine performance"
- 2011/12, **Duch-Brown, N.; García-Quevedo, J.; Montolio, D.:** "The link between public support and private R&D effort: What is the optimal subsidy?"
- 2011/13, **Breuilé, M.L.; Duran-Vigneron, P.; Samson, A.L.:** "To assemble to resemble? A study of tax disparities among French municipalities"
- 2011/14, **McCann, P.; Ortega-Argilés, R.:** "Smart specialisation, regional growth and applications to EU cohesion policy"
- 2011/15, **Montolio, D.; Trillas, F.:** "Regulatory federalism and industrial policy in broadband telecommunications"
- 2011/16, **Pelegrín, A.; Bolancé, C.:** "Offshoring and company characteristics: some evidence from the analysis of Spanish firm data"
- 2011/17, **Lin, C.:** "Give me your wired and your highly skilled: measuring the impact of immigration policy on employers and shareholders"
- 2011/18, **Bianchini, L.; Revelli, F.:** "Green politics: urban environmental performance and government popularity"
- 2011/19, **López Real, J.:** "Family reunification or point-based immigration system? The case of the U.S. and Mexico"
- 2011/20, **Bogliacino, F.; Piva, M.; Vivarelli, M.:** "The impact of R&D on employment in Europe: a firm-level analysis"
- 2011/21, **Tonello, M.:** "Mechanisms of peer interactions between native and non-native students: rejection or integration?"
- 2011/22, **García-Quevedo, J.; Mas-Verdú, F.; Montolio, D.:** "What type of innovative firms acquire knowledge intensive services and from which suppliers?"
- 2011/23, **Banal-Estañol, A.; Macho-Stadler, I.; Pérez-Castrillo, D.:** "Research output from university-industry collaborative projects"
- 2011/24, **Lighthart, J.E.; Van Oudheusden, P.:** "In government we trust: the role of fiscal decentralization"
- 2011/25, **Mongrain, S.; Wilson, J.D.:** "Tax competition with heterogeneous capital mobility"
- 2011/26, **Caruso, R.; Costa, J.; Ricciuti, R.:** "The probability of military rule in Africa, 1970-2007"
- 2011/27, **Solé-Ollé, A.; Viladecans-Marsal, E.:** "Local spending and the housing boom"
- 2011/28, **Simón, H.; Ramos, R.; Sanromá, E.:** "Occupational mobility of immigrants in a low skilled economy. The Spanish case"
- 2011/29, **Piolatto, A.; Trotin, G.:** "Optimal tax enforcement under prospect theory"
- 2011/30, **Montolio, D; Piolatto, A.:** "Financing public education when altruistic agents have retirement concerns"
- 2011/31, **García-Quevedo, J.; Pellegrino, G.; Vivarelli, M.:** "The determinants of YICs' R&D activity"
- 2011/32, **Goodspeed, T.J.:** "Corruption, accountability, and decentralization: theory and evidence from Mexico"
- 2011/33, **Pedraja, F.; Cordero, J.M.:** "Analysis of alternative proposals to reform the Spanish intergovernmental transfer system for municipalities"
- 2011/34, **Jofre-Monseny, J.; Sorribas-Navarro, P.; Vázquez-Grenno, J.:** "Welfare spending and ethnic heterogeneity: evidence from a massive immigration wave"
- 2011/35, **Lyytikäinen, T.:** "Tax competition among local governments: evidence from a property tax reform in Finland"
- 2011/36, **Brühlhart, M.; Schmidheiny, K.:** "Estimating the Rivalness of State-Level Inward FDI"
- 2011/37, **García-Pérez, J.I.; Hidalgo-Hidalgo, M.; Robles-Zurita, J.A.:** "Does grade retention affect achievement? Some evidence from Pisa"
- 2011/38, **Boffa, f.; Panzar, J.:** "Bottleneck co-ownership as a regulatory alternative"

- 2011/39, **González-Val, R.; Olmo, J.:** "Growth in a cross-section of cities: location, increasing returns or random growth?"
- 2011/40, **Anesi, V.; De Donder, P.:** "Voting under the threat of secession: accommodation vs. repression"
- 2011/41, **Di Pietro, G.; Mora, T.:** "The effect of the l'Aquila earthquake on labour market outcomes"
- 2011/42, **Brueckner, J.K.; Neumark, D.:** "Beaches, sunshine, and public-sector pay: theory and evidence on amenities and rent extraction by government workers"
- 2011/43, **Cortés, D.:** "Decentralization of government and contracting with the private sector"
- 2011/44, **Turati, G.; Montolio, D.; Piacenza, M.:** "Fiscal decentralisation, private school funding, and students' achievements. A tale from two Roman catholic countries"

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2012

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- 2012/1, **Montolio, D.; Trujillo, E.:** "What drives investment in telecommunications? The role of regulation, firms' internationalization and market knowledge"
- 2012/2, **Giesen, K.; Suedekum, J.:** "The size distribution across all "cities": a unifying approach"
- 2012/3, **Foremny, D.; Riedel, N.:** "Business taxes and the electoral cycle"
- 2012/4, **García-Estévez, J.; Duch-Brown, N.:** "Student graduation: to what extent does university expenditure matter?"
- 2012/5, **Durán-Cabré, J.M.; Esteller-Moré, A.; Salvadori, L.:** "Empirical evidence on horizontal competition in tax enforcement"
- 2012/6, **Pickering, A.C.; Rockey, J.:** "Ideology and the growth of US state government"
- 2012/7, **Vergolini, L.; Zanini, N.:** "How does aid matter? The effect of financial aid on university enrolment decisions"
- 2012/8, **Backus, P.:** "Gibrat's law and legacy for non-profit organisations: a non-parametric analysis"
- 2012/9, **Jofre-Monseny, J.; Marín-López, R.; Viladecans-Marsal, E.:** "What underlies localization and urbanization economies? Evidence from the location of new firms"
- 2012/10, **Mantovani, A.; Vandekerckhove, J.:** "The strategic interplay between bundling and merging in complementary markets"
- 2012/11, **García-López, M.A.:** "Urban spatial structure, suburbanization and transportation in Barcelona"
- 2012/12, **Revelli, F.:** "Business taxation and economic performance in hierarchical government structures"
- 2012/13, **Arqué-Castells, P.; Mohnen, P.:** "Sunk costs, extensive R&D subsidies and permanent inducement effects"
- 2012/14, **Boffa, F.; Piolatto, A.; Ponzetto, G.:** "Centralization and accountability: theory and evidence from the Clean Air Act"
- 2012/15, **Cheshire, P.C.; Hilber, C.A.L.; Kaplanis, I.:** "Land use regulation and productivity – land matters: evidence from a UK supermarket chain"
- 2012/16, **Choi, A.; Calero, J.:** "The contribution of the disabled to the attainment of the Europe 2020 strategy headline targets"
- 2012/17, **Silva, J.I.; Vázquez-Grenno, J.:** "The ins and outs of unemployment in a two-tier labor market"
- 2012/18, **González-Val, R.; Lanaspá, L.; Sanz, F.:** "New evidence on Gibrat's law for cities"
- 2012/19, **Vázquez-Grenno, J.:** "Job search methods in times of crisis: native and immigrant strategies in Spain"
- 2012/20, **Lessmann, C.:** "Regional inequality and decentralization – an empirical analysis"
- 2012/21, **Nuevo-Chiquero, A.:** "Trends in shotgun marriages: the pill, the will or the cost?"
- 2012/22, **Piil Damm, A.:** "Neighborhood quality and labor market outcomes: evidence from quasi-random neighborhood assignment of immigrants"
- 2012/23, **Ploeckl, F.:** "Space, settlements, towns: the influence of geography and market access on settlement distribution and urbanization"
- 2012/24, **Algan, Y.; Hémet, C.; Laitin, D.:** "Diversity and local public goods: a natural experiment with exogenous residential allocation"
- 2012/25, **Martínez, D.; Sjögren, T.:** "Vertical externalities with lump-sum taxes: how much difference does unemployment make?"
- 2012/26, **Cubel, M.; Sanchez-Pages, S.:** "The effect of within-group inequality in a conflict against a unitary threat"
- 2012/27, **Andini, M.; De Blasio, G.; Duranton, G.; Strange, W.C.:** "Marshallian labor market pooling: evidence from Italy"
- 2012/28, **Solé-Ollé, A.; Viladecans-Marsal, E.:** "Do political parties matter for local land use policies?"
- 2012/29, **Buonanno, P.; Durante, R.; Prarolo, G.; Vanin, P.:** "Poor institutions, rich mines: resource curse and the origins of the Sicilian mafia"
- 2012/30, **Anghel, B.; Cabrales, A.; Carro, J.M.:** "Evaluating a bilingual education program in Spain: the impact beyond foreign language learning"
- 2012/31, **Curto-Grau, M.; Solé-Ollé, A.; Sorribas-Navarro, P.:** "Partisan targeting of inter-governmental transfers & state interference in local elections: evidence from Spain"

- 2012/32, **Kappeler, A.; Solé-Ollé, A.; Stephan, A.; Väilä, T.:** "Does fiscal decentralization foster regional investment in productive infrastructure?"
- 2012/33, **Rizzo, L.; Zanardi, A.:** "Single vs double ballot and party coalitions: the impact on fiscal policy. Evidence from Italy"
- 2012/34, **Ramachandran, R.:** "Language use in education and primary schooling attainment: evidence from a natural experiment in Ethiopia"
- 2012/35, **Rothstein, J.:** "Teacher quality policy when supply matters"
- 2012/36, **Ahlfeldt, G.M.:** "The hidden dimensions of urbanity"
- 2012/37, **Mora, T.; Gil, J.; Sicras-Mainar, A.:** "The influence of BMI, obesity and overweight on medical costs: a panel data approach"
- 2012/38, **Pelegrín, A.; García-Quevedo, J.:** "Which firms are involved in foreign vertical integration?"
- 2012/39, **Agasisti, T.; Longobardi, S.:** "Inequality in education: can Italian disadvantaged students close the gap? A focus on resilience in the Italian school system"

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2013

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- 2013/1, **Sánchez-Vidal, M.; González-Val, R.; Viladecans-Marsal, E.:** "Sequential city growth in the US: does age matter?"
- 2013/2, **Hortas Rico, M.:** "Sprawl, blight and the role of urban containment policies. Evidence from US cities"
- 2013/3, **Lampón, J.F.; Cabanelas-Lorenzo, P.; Lago-Peñas, S.:** "Why firms relocate their production overseas? The answer lies inside: corporate, logistic and technological determinants"
- 2013/4, **Montolio, D.; Planells, S.:** "Does tourism boost criminal activity? Evidence from a top touristic country"
- 2013/5, **García-López, M.A.; Holl, A.; Viladecans-Marsal, E.:** "Suburbanization and highways: when the Romans, the Bourbons and the first cars still shape Spanish cities"
- 2013/6, **Bosch, N.; Espasa, M.; Montolio, D.:** "Should large Spanish municipalities be financially compensated? Costs and benefits of being a capital/central municipality"
- 2013/7, **Escardíbul, J.O.; Mora, T.:** "Teacher gender and student performance in mathematics. Evidence from Catalonia"
- 2013/8, **Arqué-Castells, P.; Viladecans-Marsal, E.:** "Banking towards development: evidence from the Spanish banking expansion plan"
- 2013/9, **Asensio, J.; Gómez-Lobo, A.; Matas, A.:** "How effective are policies to reduce gasoline consumption? Evaluating a quasi-natural experiment in Spain"
- 2013/10, **Jofre-Monseny, J.:** "The effects of unemployment benefits on migration in lagging regions"
- 2013/11, **Segarra, A.; García-Quevedo, J.; Teruel, M.:** "Financial constraints and the failure of innovation projects"
- 2013/12, **Jerrim, J.; Choi, A.:** "The mathematics skills of school children: How does England compare to the high performing East Asian jurisdictions?"
- 2013/13, **González-Val, R.; Tirado-Fabregat, D.A.; Viladecans-Marsal, E.:** "Market potential and city growth: Spain 1860-1960"
- 2013/14, **Lundqvist, H.:** "Is it worth it? On the returns to holding political office"
- 2013/15, **Ahlfeldt, G.M.; Maennig, W.:** "Homevoters vs. leasevoters: a spatial analysis of airport effects"
- 2013/16, **Lampón, J.F.; Lago-Peñas, S.:** "Factors behind international relocation and changes in production geography in the European automobile components industry"
- 2013/17, **Guío, J.M.; Choi, A.:** "Evolution of the school failure risk during the 2000 decade in Spain: analysis of Pisa results with a two-level logistic model"
- 2013/18, **Dahlby, B.; Rodden, J.:** "A political economy model of the vertical fiscal gap and vertical fiscal imbalances in a federation"
- 2013/19, **Acacia, F.; Cubel, M.:** "Strategic voting and happiness"
- 2013/20, **Hellerstein, J.K.; Kutzbach, M.J.; Neumark, D.:** "Do labor market networks have an important spatial dimension?"
- 2013/21, **Pellegrino, G.; Savona, M.:** "Is money all? Financing versus knowledge and demand constraints to innovation"
- 2013/22, **Lin, J.:** "Regional resilience"
- 2013/23, **Costa-Campi, M.T.; Duch-Brown, N.; García-Quevedo, J.:** "R&D drivers and obstacles to innovation in the energy industry"
- 2013/24, **Huisman, R.; Stradnic, V.; Westgaard, S.:** "Renewable energy and electricity prices: indirect empirical evidence from hydro power"
- 2013/25, **Dargaud, E.; Mantovani, A.; Reggiani, C.:** "The fight against cartels: a transatlantic perspective"
- 2013/26, **Lambertini, L.; Mantovani, A.:** "Feedback equilibria in a dynamic renewable resource oligopoly: pre-emption, voracity and exhaustion"

- 2013/27, Feld, L.P.; Kalb, A.; Moessinger, M.D.; Osterloh, S.: "Sovereign bond market reactions to fiscal rules and no-bailout clauses – the Swiss experience"
- 2013/28, Hilber, C.A.L.; Vermeulen, W.: "The impact of supply constraints on house prices in England"
- 2013/29, Revelli, F.: "Tax limits and local democracy"
- 2013/30, Wang, R.; Wang, W.: "Dress-up contest: a dark side of fiscal decentralization"
- 2013/31, Dargaud, E.; Mantovani, A.; Reggiani, C.: "The fight against cartels: a transatlantic perspective"
- 2013/32, Saarimaa, T.; Tukiainen, J.: "Local representation and strategic voting: evidence from electoral boundary reforms"
- 2013/33, Agasisti, T.; Murtinu, S.: "Are we wasting public money? No! The effects of grants on Italian university students' performances"
- 2013/34, Flacher, D.; Harari-Kermadec, H.; Moulin, L.: "Financing higher education: a contributory scheme"
- 2013/35, Carozzi, F.; Repetto, L.: "Sending the pork home: birth town bias in transfers to Italian municipalities"
- 2013/36, Coad, A.; Frankish, J.S.; Roberts, R.G.; Storey, D.J.: "New venture survival and growth: Does the fog lift?"
- 2013/37, Giulietti, M.; Grossi, L.; Waterson, M.: "Revenues from storage in a competitive electricity market: Empirical evidence from Great Britain"

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2014

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- 2014/1, Montolio, D.; Planells-Struse, S.: "When police patrols matter. The effect of police proximity on citizens' crime risk perception"
- 2014/2, García-López, M.A.; Solé-Ollé, A.; Viladecans-Marsal, E.: "Do land use policies follow road construction?"
- 2014/3, Piolatto, A.; Rablen, M.D.: "Prospect theory and tax evasion: a reconsideration of the Yitzhaki puzzle"
- 2014/4, Cuberes, D.; González-Val, R.: "The effect of the Spanish Reconquest on Iberian Cities"
- 2014/5, Durán-Cabré, J.M.; Esteller-Moré, E.: "Tax professionals' view of the Spanish tax system: efficiency, equity and tax planning"
- 2014/6, Cubel, M.; Sanchez-Pages, S.: "Difference-form group contests"
- 2014/7, Del Rey, E.; Racionero, M.: "Choosing the type of income-contingent loan: risk-sharing versus risk-pooling"
- 2014/8, Torregrosa Hetland, S.: "A fiscal revolution? Progressivity in the Spanish tax system, 1960-1990"
- 2014/9, Piolatto, A.: "Itemised deductions: a device to reduce tax evasion"
- 2014/10, Costa, M.T.; García-Quevedo, J.; Segarra, A.: "Energy efficiency determinants: an empirical analysis of Spanish innovative firms"
- 2014/11, García-Quevedo, J.; Pellegrino, G.; Savona, M.: "Reviving demand-pull perspectives: the effect of demand uncertainty and stagnancy on R&D strategy"
- 2014/12, Calero, J.; Escardíbul, J.O.: "Barriers to non-formal professional training in Spain in periods of economic growth and crisis. An analysis with special attention to the effect of the previous human capital of workers"
- 2014/13, Cubel, M.; Sanchez-Pages, S.: "Gender differences and stereotypes in the beauty"
- 2014/14, Piolatto, A.; Schuett, F.: "Media competition and electoral politics"
- 2014/15, Montolio, D.; Trillas, F.; Trujillo-Baute, E.: "Regulatory environment and firm performance in EU telecommunications services"
- 2014/16, Lopez-Rodriguez, J.; Martinez, D.: "Beyond the R&D effects on innovation: the contribution of non-R&D activities to TFP growth in the EU"
- 2014/17, González-Val, R.: "Cross-sectional growth in US cities from 1990 to 2000"
- 2014/18, Vona, F.; Nicolli, F.: "Energy market liberalization and renewable energy policies in OECD countries"
- 2014/19, Curto-Grau, M.: "Voters' responsiveness to public employment policies"
- 2014/20, Duro, J.A.; Teixidó-Figueras, J.; Padilla, E.: "The causal factors of international inequality in CO<sub>2</sub> emissions per capita: a regression-based inequality decomposition analysis"
- 2014/21, Fleten, S.E.; Huisman, R.; Kilic, M.; Pennings, E.; Westgaard, S.: "Electricity futures prices: time varying sensitivity to fundamentals"
- 2014/22, Afcha, S.; García-Quevedo, J.: "The impact of R&D subsidies on R&D employment composition"
- 2014/23, Mir-Artigues, P.; del Río, P.: "Combining tariffs, investment subsidies and soft loans in a renewable electricity deployment policy"
- 2014/24, Romero-Jordán, D.; del Río, P.; Peñasco, C.: "Household electricity demand in Spanish regions. Public policy implications"
- 2014/25, Salinas, P.: "The effect of decentralization on educational outcomes: real autonomy matters!"
- 2014/26, Solé-Ollé, A.; Sorribas-Navarro, P.: "Does corruption erode trust in government? Evidence from a recent surge of local scandals in Spain"
- 2014/27, Costas-Pérez, E.: "Political corruption and voter turnout: mobilization or disaffection?"

**2014/28, Cubel, M.; Nuevo-Chiquero, A.; Sanchez-Pages, S.; Vidal-Fernandez, M.:** "Do personality traits affect productivity? Evidence from the LAB"

**2014/29, Teresa Costa, M.T.; Trujillo-Baute, E.:** "Retail price effects of feed-in tariff regulation"

**2014/30, Kilic, M.; Trujillo-Baute, E.:** "The stabilizing effect of hydro reservoir levels on intraday power prices under wind forecast errors"

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**2015/1, Foremny, D.; Freier, R.; Moessinger, M-D.; Yeter, M.:** "Overlapping political budget cycles in the legislative and the executive"

**2015/2, Colombo, L.; Galmarini, U.:** "Optimality and distortionary lobbying: regulating tobacco consumption"



