Innovation barriers and the role of institutional context in emerging economies

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Abstract

Understanding innovation barriers is critical for innovation policy to design better incentives to innovation. On line with previous studies by Hadjimanolis (1999), this study conducts an analysis of innovation barriers in two emerging economies, Mexico and Turkey. In addition, we evaluate the institutional context to determine if it plays a role in the innovation barriers for firms located in Mexico and Turkey. We conduct our analysis using three sources of data to then build a comprehensive database. For Mexico, we use data from the ESIDET, 2010; for Turkey, we use data from TurkStat, 2010; while the institutional country context indicators were gathered from a set of international databases. Our results suggest that firm and context characteristics matter to tackle innovation barriers, and there are also differences between successful innovators and unsuccessful innovators. This paper contributes to the literature on innovation barriers in providing a comparative analysis of barriers in two emerging economies, Mexico and Turkey. The paper also contributes to the discussion on the role of the institutional context on innovation barriers.

Keywords: Innovation barriers, successful innovators, unsuccessful innovators, emerging economies, institutional context, Mexico, Turkey.

JEL codes: O31, O32, O54

1. Introduction

Understanding the nature of determinants to innovation at a firm level is key to strengthen those determinants that can contribute to firms' innovation. Several studies have contributed to provide a better understanding of the determinants to innovation (Crespi & Zuniga, 2012; Mairesse & Mohnen, 2010; Pierre Mohnen, Mairesse, & Dagenais, 2006; Polder, Leeuwen, Mohnen, & Raymond, 2009), and have contributed to direct implications for policy making. Understanding innovation barriers is also critical to policy making, as it focus on providing a better understanding regarding the core issues that prevent firms to pursue an innovative behavior or to innovate (D'Este, Rentocchini, & Vega-Jurado, 2014; Pellegrino & Savona, 2017). From a management perspective, research on innovation barriers is expected to shed light on different scenarios to foster innovation, as well as the issues that either slow down or lead those processes to fail within the firm (Feldens, Maccari, & Garcez, 2012). Research on innovation barriers can assist managers in fostering an innovation culture inside organizations by supporting new ideas, or by avoiding resistance to new ideas (Madrid-Guijarro, Garcia, & Van Auken, 2009; F. Santiago, 2016).

Several authors have contributed to this growing body of literature and have focus their studies on several aspects of innovation barriers. For example, P. Mohnen, Palm, van der Loeff, and Tiwari (2008), and Álvarez and Crespi (2015) have analyzed financial barriers to innovation. Pellegrino and Savona (2017) and F. Santiago (2016) analyze financial and non-financial barriers to innovation differentiating those firms that are not willing or do not need to innovate from those that choose to devote resources to innovation, but do not manage to produce an innovation due to innovation barriers. In particular, F. Santiago (2016) differentiates from the type of innovation i.e. product, process, market, or organizational. Other set of studies has focused on the analysis of barriers differentiating deterring barriers from perceived barriers (e.g. D'Este, 2012: D'Este, 2014). These studies contribute to identify the perception to barriers and differentiate firms that actually engage in innovation activities, from those that do not engage as they are discouraged to carry out innovation activities. Findings from these studies have been key to understand the extent to which the population of potentially innovative firms is being deterred by entry barriers to innovation and to identify the factors that contribute to reducing the deterrent effects of certain barriers to innovation activity (D'Este et al., 2014).

Despite the progress on this body of literature, Hueske and Guenther (2015) argue that it remains empirical in nature, and call for a more integrated research in barriers that is context specific. They argue that it is necessary to advance research that informs how the perception of barriers differs among firms in developing, newly industrialized or developed countries. These elements can help inform policy makers on how to decrease innovation barriers that might be affected by context specificities. We contribute to build knowledge around this area, first by including in our analysis two emerging economies, Mexico and Turkey, and second, by considering the effect of the institutional context on innovation barriers. Therefore, our focus on two emerging economies is consistent with Hueske and Guenther (2015). Understanding innovation barriers in emerging economies is necessary to design and implement policy incentives targeted to foster innovation in firms that are embedded in a different institutional context from that of developed economies. Thus, this study will contribute to provide a better understanding of how firms in two emerging economies perceive innovation barriers (Feldens et al., 2012; Santiago et al. 2017).

This study aims to build on this body of literature by developing a comparative analysis of innovation barriers in two emerging economies, and identify the effect of internal firms' characteristics, and institutional context characteristics. The main contribution from this study is the attention to the effect that institutional context characteristics have on different types of barriers. The introduction of institutional context characteristics can provide relevant information for the development of policy programs aiming to reduce innovation barriers.

The reminder of this paper is structured as follows; section 2 provides a theoretical discussion on contributions to the framework on innovation barriers and institutional context, and sets up the main elements for this study. Section 3 presents the methodology used in this paper, including the

data description and methods of analysis. Section 4 provides the empirical analysis, and section 5 concludes.

2. Theoretical framework
2.1. Barriers to innovation main contributors and perspectives

The literature of barriers to innovation has grown in the past few years. The current literature has made progress in terms of providing a better understanding of financial barriers (P. Mohnen et al., 2008) and non-financial barriers (D'Este, Iammarino, Savona, & Tunzelmann, 2012). More specific, Galia and Legros (2004) provided a better understanding on the complementarities of innovation barriers for firms located in France. Iammarino, Sanna-Randaccio, and Savona (2009) and D'Este et al. (2012), have focused on better understanding the role of barriers on innovation engagement for firms in the UK. Blanchard, Huiban, Musolesi, and Sevestre (2012) have analyzed the impact of obstacles to innovation. In terms of methodology Pellegrino and Savona (2017) highlight the need to address the selection bias of innovative and non-innovative firms and divide their sample accordingly.

Progress has also been made in terms of considering different types of innovation outputs, with the premise that the firms that engage in certain types of innovation have to tackle different types of barriers. Madrid-Guijarro et al. (2009) focus on the relation between innovation barriers and distinct innovation outputs for the case of Spain. They analyze the effect of barriers on different innovation outputs. F. Santiago (2016); Fernando Santiago et al. (2017) focus on the relationship between the perceived importance of innovation barriers, and the type of innovation output pursued by the firm, namely product, process, marketing or organizational innovation for firms in Mexico. These studies analyze the differences of perceived innovation barriers that firms confront in order to innovate.

The literature has also pointed the importance to using data from the Community Innovation Surveys. D'Este et al. (2012) emphasize the difference between revealed barriers and barriers as deterrents. They argue that revealed barriers reflect the degree of difficulty of the innovation process and the learning experience consequent on the firm engaging in innovation activity. Barriers as deterrents encompass the obstacles that prevent firms from committing to innovation. D'Este et al. (2012) found that firms that engage heavily in innovative activities are more likely to assess barriers as important compared to firms that do not engage in innovation activities. In addition, they find that the revealed or learning effect from more intensive innovation activity is more pronounced in the case of cost and knowledge barriers, showing that innovation experience generally helps to reduce uncertainty. In terms of the variables, D'Este et al. (2012) found that firms with more internationalized customer bases overcome innovation-related barriers. They argue that internationalization seems to promote learning effects within firms. The main contribution from D'Este et al. (2012) helps us understand that as firms engage more in

innovation activities, their perception on barriers to innovation will also increase, as they will have to overcome more complex hurdles as their innovation process increase in complexity.

With emphasis on the difference between deterring barriers and revealed barriers, D'Este et al. (2012) identified deterring and revealing barriers by assessing the impact of revealed barriers on the translation of innovation activity into actual innovation output. In addition, D'Este et al. (2014) focus on the role of human capital in reducing the barriers to firms' engagement in innovation activities and they distinguish between firms facing barriers that stop them from engaging in any innovation activity, and firms that face impediments in the course of their innovation activity.

Pellegrino and Savona (2017) provide comparative evidence on whether access to knowledge, a concentrated market structure, uncertain demand or regulation have comparable or more substantial effects than finance on constraining firms' ability to translate innovation investments into new outputs. They also differentiate firms that are successful innovators from those that need or are willing to innovate and invest in innovation (potential innovators), and from those that fail to introduce a new product/process (failed innovators).

Literature on innovation barriers has also contributed to the understanding of differences between the manufacturing and service sector. Fernando Santiago et al. (2017) explored differences in the perceived importance of innovation barriers between manufacturing and services firms in Mexico; those differences could be explained by the distinct nature of innovation activities that can be observed in both those sectors. The authors found that firms perceived that financial-related barriers were just as important as obstacles related to knowledge, market and the regulation environment. Differences in innovation barriers resulted from firm characteristics and technological behaviors across and within sectors. Fernando Santiago et al. (2017) identified that innovation barriers related to the cost of innovation were considered more important by firms that had engaged in innovation, and less important for firms that had not carried out innovation at all.

Most studies that focus on the factors affecting firms' perceptions of the importance of barriers, show that the greater the firm's involvement in R&D and other innovation activities, the greater will be the importance attached to the impediments to innovation (D'Este et al., 2012; Iammarino et al., 2009; Pierre Mohnen & Rosa, 2001). All these studies find that firms that engage in more innovation efforts, encounter more barriers to innovation, and are more familiar to their implications. This study builds in previous contributions around the literature on the perception of innovation barriers, and seeks to contribute with providing a better understanding of the interplay between innovation barriers and institutional context in two emerging economies.

2.2. Context characteristics, why to consider institutional characteristics for further analysis on barriers

Innovation studies argue that country specific characteristics are important determinants of innovation, as these characteristics might facilitate the production of knowledge, its dissemination, use and implementation. Moodysson, Trippl, and Zukauskaite (2016) discuss how regional strategies that are inspired by smart specialization influence path renewal and new path creation and how they are related to and aligned with policy strategies implemented at other scales (local, regional, national, supranational). Srholec (2010) conducted one of the first quantitative multilevel analysis to study geography of innovation, and studied firms in the Czech Republic using firm level data from the Community Innovation Survey. His results indicate that the strength of the innovation system influences the likelihood of a firm to innovate, although this effect decreases with firm size. In addition, Srholec (2011) published a study analizing multilevel data for firms in 32 developing countries using data from the World Bank, providing a multilevel analysis on innovation and building on the knowledge of the role of country context characteristics have an impact on the likelihood to innovate.

Hadjimanolis and Dickson (2001) suggest that literature on innovation barriers still has to explore how the perception of innovation barriers depends on the firm's location in a developing, newly industrialized or developed country. As strategies to counteract innovation barriers may be affected by national culture and other country specific considerations (F. Santiago, 2016). Understanding the effect of country context characteristics on the determinants to innovate and on the barriers to innovate has powerful implications for policy making, that can build on the process of path renewal and path creation, as indicated by Moodysson et al. (2016). In addition, it can help explain how the interlinkage between context and firms' characteristics generate different outcomes in terms of capability building, innovation, and also how to address barriers to innovate (Fernando Santiago et al., 2017).

The research on innovation barriers has focused on the analysis of data from CIS and Innovation Surveys from different countries. Some of the studies have included components of the context in their analysis. D'Este et al. (2012), for example, include in their analysis regional dummy variables to identify the effect of the region. Madrid-Guijarro, Garcia, and Van Auken (2009) studied the relation between innovation barriers and innovation outputs in small firms in Spain. They identified differences in the effect of internal firms' characteristics and the context by type of innovation output. Hueske and Guenther (2015) emphasize the importance to keep building on the literature of innovation barriers and the importance of considering characteristics of the context in the analysis of innovation barriers. The inclusion of comparative studies that consider context characteristics cam contribute to providing a more integrated approach to better understand innovation barriers in different contexts.

Considering the effect of the institutional context in the analysis of innovation barriers is key to understand the interplay between the institutional context characteristics and the organizational characteristics at the firm level. Path dependency, technological capabilities, and country culture have a deep effect on how people innovate and how they overcome certain innovation barriers. As emphasized by Hueske and Guenther (2015), it is necessary to include into the analysis context differences among firms located in developing, emerging and developed countries recognizing the contextual differences where firms are embedded. Understanding the contextual characteristics of countries for instance, will contribute to another layer of analysis regarding the impact that the institutional context might have on the perception of barriers and also how likely are firms in a particular country to overcome those barriers. Therefore, adding a layer to understand the institutional context can provide powerful suggestions for policy implications.

Barriers to innovation are heterogeneous, of financial and non-financial nature. Some innovation barriers result from the environment in which firms operate; these include institutional constraints associated with government policy, the structure and functioning of financial markets –in particular the availability of credit for new technology-based ventures, competitive conditions at regional or industry level, or the functioning of national research and innovation systems (Bank, 2010; Iammarino et al., 2009; Madrid-Guijarro et al., 2009; Pierre Mohnen & Rosa, 2001; Fernando Santiago et al., 2017).

Our study, in line with the previous works that differentiate revealed and deterring innovation barriers (D'Este et al., 2012; F. Santiago, 2016) considers two types of firms, successful and unsuccessful innovators. In addition, our study examines five different types of barriers (financial, organization, labor, regulation, and public support), and explores the effect that the country context has on innovation barriers.

3. Methodology
3.1. Country context Mexico and Turkey

We included two emerging economies in this study for the analysis of innovation barriers, Mexico and Turkey. Mexico showed an economic growth of 2.3% in 2015, despite this growth, Mexico is facing several challenges that include falling oil production, oil prices, low productivity, high inequality, high unemployment and a large informal sector employment (Mergent, 2016a). On the other hand, Turkey, despite a rapidly growing private sector, it faces several challenges, that include volatile short-term investment, high levels of unemployment (MErgent, 2016b). As noted in Table 1, the following country indicators associated to education, R&D system, political environment, regulatory environment, intellectual property, market sophistication, and innovative culture show relevant gaps between these two emerging economies and also in relation to more advanced economies. As benchmark, we provided information from Sweden. Sweden was ranked second in the global innovation index (GII) (INSEAD, 2010).

Mexico and Turkey are ranked 69 and 67 respectively in the GII (INSEAD, 2010). Regarding education, there are significant gaps between more developed countries and Mexico and Turkey. Similarly, in terms of the R&D system, we observe significant gaps, for example, in relation to public R&D expenditure while more advanced economies like Sweden invest 3.89% of their GDP on R&D, Mexico invest 0.5% and Turkey 0.79%. Discussion around public investment in R&D has been identified as highly important to foster innovation (Crespi & Zuniga, 2012; Author et al. 2015; Mairesse & Mohnen, 2010). Another gap is around company spending on R&D. The weaknesses around capacity for R&D for Mexico and Turkey are significant and highlight the need to address them by polity initiatives, as it has been argued that investment in R&D at the country level leads to higher levels of innovation at the firm level (Hausmann et al., 2011; Lee & Lim, 2001). We also observe gaps around political environment and regulatory quality, and intellectual property. Institutional framework conditions have also been critical to foster innovation within countries (Edquist, 1997). Regarding market sophistication and culture to innovate the gaps are not as significant than those related to education and R&D system; however, it is important to note a high gap in the availability of venture capital. Venture capital has recently been emphasized as an important condition to foster innovation within firms (Kortum & Lerner).

Table 1. Country level indicators (2009-2010)

Indicator	Mexico	Turkey	Sweden
Global innovation index (score)	2.96	2.99	4.85
Global innovation index (rank)	69	67	2
1. Education			
Enrolment in tertiary education	2.63	3.17	5.99
Investment in education	3.89	3.26	5.13
Quality of educational system	2.8	3.36	5.28
Quality of management schools	4.39	3.84	5.40
2. R&D system			
Public R&D expenditure (% of GDP)	0.5	0.79	3.89
Company spending on R&D	2.9	2.91	5.90
Quality of scientific research institutes	3.71	3.65	5.71
3. Political environment			
Political stability	3.88	3.73	5.42
Government Effectiveness	3.54	3.58	6.21
4. Regulatory environment			
Regulatory quality	4.77	4.44	6.55
Burden of government regulation	2.58	2.92	3.99
Efficiency of legal framework	3.16	3.34	6.16
5. Intellectual property			
Number of patents	1.02	1.05	3.65
Intellectual property protection	3.19	2.68	6.11
Trademark	1.77	1.94	2.32

6. Market sophistication			
Financial market sophistication	4.55	4.98	6.44
Time to start a Business	5.93	6.80	6.44
Intensity of local competition	4.6	5.4	5.62
7. Culture to innovate			
Culture to Innovate	3.29	4.55	6.37
Investor Protection Index	4.12	3.88	3.88
Venture capital availability	2.39	2.27	4.29

Sources: Global Innovation Index; The Global Competitiveness Report 2009-2010, World Economic Forum; The World Bank provided information regarding Public Research & Development Expenditure; The Worldwide Governance Indicators (WGI)

3.2. Dataset

For this analysis, we relied on three datasets. Two of them provide information at the firm level for Mexico and Turkey, and the third one provides information at country level.

Data from Mexico comes from the Survey on Innovation and Technology Development (ESIDET) conducted by the National Institute of Geography, Informatics and Statistics (INEGI) on behalf of the Council for Science and Technology (CONACYT). This paper used data from the event 2010, with information for the period 2008-2009. In ESIDET the unit of analysis is the firm with 20 or more employees. The survey uses a stratified random sample for each of the industries according to the OECD classification. The raw data consists of a representative sample of 3,694 firms in manufacturing, services and other sectors. It could be some positive bias towards large manufacturing firms as three quarters of firms in the sample are firms with more than 501 employees. A group of firms is considered a forced inclusion: those with 751 or more employees, and a set of 1,271 firms registered by CONACYT as eligible to receive public support for R&D. The questionnaire request information regarding firm's general characteristics, research and development, and innovation activities. This last section contains questions based on the Oslo manual.

Data from Turkey provides information for the periods 2008 and 2009. The data was gathered by TurkStat, and includes firm level information from different areas of manufacturing. A total of 1,000 firms were invited to participate, and only 734 firms answered the survey. After data screening by TurkStat, only 692 responses were reliable, while 42 responses were not included in the dataset due to missing information. The data was collected by TurkSTAT via experts that visited each firm's premises. Before the data collection the experts received training about the methodology and survey. The data provides information about firm's innovation capacities, and innovation barriers that firms in Turkey face.

The third dataset provides information at a country level on Quality of Educational System, Intensity of Local Competition, Regulatory Quality, Public Research and Development Expenditure (%DGP), and Venture capital availability. These country level indicators were selected based on two principles, first that there were relevant to the innovation barriers studied in this paper (financial, organization, labor, regulation, and public support); and second, that these indicators were available for both countries analyzed here (Mexico and Turkey). These indicators were gathered from different original sources. The Global Competitiveness Report 2009-2010, World Economic Forum, provided information regarding Quality of Educational System, and Intensity of Local Competition. The World Bank provided information regarding Public Research & Development Expenditure. The Worldwide Governance Indicators (WGI) provided information regarding Regulatory Quality. As a first step of the data collection, we search relevant indicators in the Global Innovation Index (INSEAD, 2010), after we selected the indicators; we conducted a search in the original sources and build a comprehensive database that included all the indicators previously selected.

We merged the three sets of data in a comprehensive database to facilitate the analysis. To merge the two datasets that provide firm level information from Mexico and Turkey, first we compared the two datasets and we identified the common variables. The variables included in the combined dataset include information on firm size, R&D intensity and organization of R&D activities, productivity, net income, % of sales from new products, public support, sources of information to innovate, number of patent applications, obstacles for innovation, and level of innovation. Even though both countries base their questionnaires on the Oslo Manual, and have comparable questions, we had to eliminate a high number of questions as they were not comparable across surveys. After selecting comparable variables, we then we homogenized them to have them under the same format, e.g. dummy variables, or same Likert scale. Our country database contains 32 variables for Mexico and Turkey.

For the dataset that provides information at a country level, we first identified the indicators that were relevant for the different innovation barriers, and then we downloaded the information from original sources, making sure that the institutional country context indicators were available for both, Mexico and Turkey. Once we had all the country level indicators, we included those indicators in our dataset. The final database provides information about i) firm's general characteristics, ii) innovation activities, iii) barriers to innovation, and iv) institutional context characteristics. The final database contains 2,820 observations for manufacturing firms, 2,128 of those observations are for Mexico, and 692 are for Turkey.

3.3. Sample size

We differentiated firms by their innovative behavior, in order to conduct a more controlled analysis of the effect of innovation barriers on firms following D'Este et al. (2012), D'Este et al. (2014), and Pellegrino and Savona (2017) in order to eliminate selection bias of those firms that do not innovate and do not report innovation barriers in the survey. As indicated in figure 1. Our full sample consists of 2,820 observations; of those only 516 are innovative firms in terms that they have introduced technology innovations (product, service, process), or non-technology innovations (marketing, organizational). For this study, we differentiate those firms that have been successful in introducing technology innovations from those that have not been successful in introducing innovations, but still report innovation barriers.

Figure 1. Sample size, successful innovators and unsuccessful innovators that report barriers
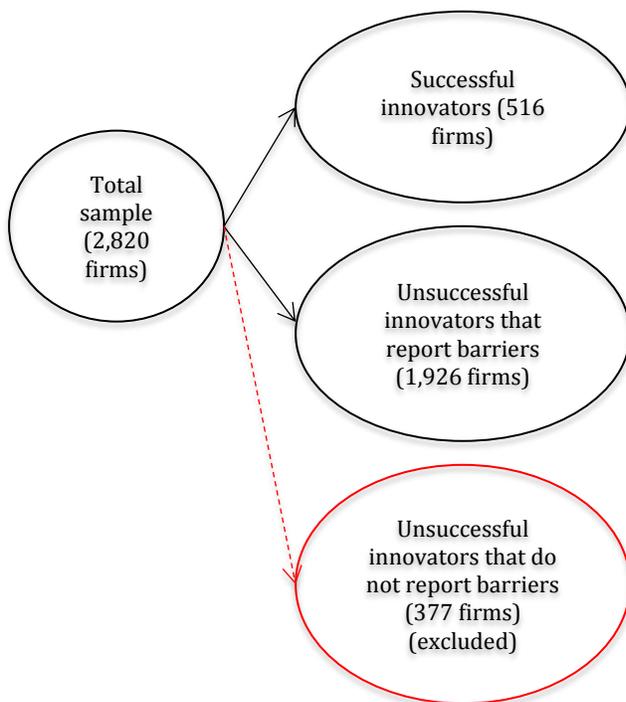
From our total sample 2,128 firms are located in Mexico, and 692 located in Turkey. From those successful innovators, 342 are located in Mexico, and 174 located in turkey. From those firms that are unsuccessful innovators, but report innovation barriers in the survey, 1,513 are located in Mexico, and 413 are located in Turkey. From those unsuccessful innovators that do not report innovation barriers, 272 are located in Mexico, and 105 are located in Turkey. As shown by previous studies that focus their analysis on innovation barriers or innovation determinants in developing countries, we observed a low number of firms that successfully introduce innovations, while a higher number of firms in both countries are unsuccessful innovators.

In line with previous work on innovation barriers (Pellegrino and Savona 2017, D'Este et al. 2014, D'Este et al. 2012), we eliminated from our sample firms that do not engage in innovation activities and do not report innovation barriers, and we only consider in our sample those firms with innovative potential. The innovation barriers that firms reported in the surveys are financial, organizational, lack of qualified personal, regulation, and public support. Table 2 indicates the number of firms that face each one of these barriers, and differentiate by successful and unsuccessful innovators.

Table 2. Percentage of firms facing barriers to innovation in Mexico and Turkey

Barrier	Total sample	Successful innovators		Unsuccessful innovators	
		Mexico	Turkey	Mexico	Turkey
Financial barriers	65%	62%	80%	78%	85%
Qualified labour	53%	47%	74%	62%	75%
Organizational barriers	47%	38%	41%	59%	66%
Regulatory barriers	58%	53%	58%	73%	68%
Lack of public support	56%	53%	79%	66%	75%

Firms located in Turkey report higher innovation barriers than firms located in Mexico. In addition, those firms that are unsuccessful innovators report higher innovation barriers than successful innovators in both countries.

3.4. Variables and descriptive statistics

For our analysis, we excluded all firms that do not report any innovation during the period 2008 and 2009 and that do not report innovation barriers. Following those studies that aim to identify the role of firm's characteristics on innovation barriers (see for example D'Este et al. 2012; D'Este et al. 2014), our dependent variables are those innovation barriers reported by firms. Innovation barriers in this study are: financial, organization, labor, regulation, and public support. Both surveys from Mexico and Turkey include a section on innovation barriers. Firms had to answer if they have faced different innovation barriers, and had to provide their perception to that specific barrier on a Likert scale 1 to 5.[1] Firms had to choose the number that best represented their perception to each specific barrier.

We also followed previous studies that analyze innovation barriers to select the independent variables at the firm level. In our analysis we include firm size, number of employees in R&D activities, government support, and access to external information. It has been argued that large firms have a larger pool of resources, and in general they can use more of their resources to innovative activities (Crespi & Zuniga, 2012). Therefore, we argue that larger firms might be able to tackle innovation barriers using a better mix of their human capital and other financial and

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[1] 1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree.

knowledge-related resources. The innovation barriers literature has in general used this variable (e.g. Pellegrino Savona, 2017; D'Este et al. 2012 and 2014). Similarly, firms with a higher number of employees performing R&D activities have a higher level of knowledge and potential for interaction, which can play a positive role in tackling innovation barriers, as suggested by D'Este et al. (2014). The role of government support has been studied on the literature of innovation determinants, and studies suggest in general, that the effect of public support has played a critical role on the engagement in innovation activities and the innovation effort (Crespi & Zuniga, 2012; Author et al., 2015; Mairesse & Mohnen, 2010), from the literature of innovation barriers, D'Este et al. (2014) and Santiago (2016) find that public support from local programs does play a positive role in tackling innovation barriers. It has been widely accepted that firms with open innovation strategies (Chesbrough, 2003) are able to identify and use successfully the knowledge that is produced outside the firm. Studies from the literature in innovation barriers have also contributed to identify a positive effect of external sources of information (D'Este et al. 2014; Santiago, 2016).

This study also includes the effect of country indicators, as suggested by Hadjimanolis (1999) and (Santiago, 2016), strategies to counteract innovation barriers may be affected by national culture and other country specific considerations. We include in our analysis the following country indicators: Quality of Educational System, Intensity of Local Competition, Regulatory Quality, Venture capital availability, and Public Research and Development Expenditure (%DGP) for Mexico and Turkey. Table 3 provides the descriptive statistics of the variables used in this study, and Table 4 and Table 5 provides a correlation matrix for firm level independent variables and country level independent variables.

Table 3. List of variables, descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Dependent variables				
Financial barriers	0.660	0.474	0	1
Lack of qualified labour	0.535	0.499	0	1
Organization barriers	0.483	0.500	0	1
Regulation barriers	0.583	0.493	0	1
Lack of public support	0.569	0.495	0	1
Independent variables				
Firm characteristics				
Firm size (ln employees)	2.851	1.985	0	7.874
Employees in R&D activities (ln)	3.495	1.897	0	5.298
Government support	0.200	0.400	0	1
Use of external sources of knowledge (universities)	0.358	0.479	0	1
Use of external sources of knowledge (market)	0.802	0.398	0	1
Country level indicators				
Venture Capital Availability	2.390	0.000	2.39	2.39
Public R&D expenditure	0.533	0.181	0.43	0.85

Variable	Mean	Std. Dev.	Min	Max
Quality of Educational System	2.521	0.387	2.3	3.2
Intensity of Local Competition	4.796	0.344	4.6	5.4
Regulatory Quality	0.247	0.030	0.23	0.3
Successful innovators	0.183	0.387	0	1
Unsuccessful innovators that report barriers	0.683	0.465	0	1
Unsuccessful innovators that do not report barriers	0.134	0.340	0	1

Table 4. Correlation - Firm level independent variables

	(1)	(2)	(3)	(4)	(5)
Firm size (1)	1				
Employees in R&D activities (2)	0.8998	1			
Government support (3)	0.3067	0.3269	1		
Use of external sources of knowledge (universities) (4)	-0.0414	-0.0313	0.1307	1	
Use of external sources of knowledge (market) (5)	0.0092	0.0065	0.0494	0.1566	1

Table 5. Correlation - Country Level independent variables

	(1)	(2)	(3)	(4)
Public R&D expenditure (1)	1			
Quality of Educational System (2)	1	1		
Intensity of Local Competition (3)	1	1	1	
Regulatory Quality (4)	1	1	1	1

3.5. Econometric Model

Our model identifies the effect of internal firm's characteristics and the effect of country level characteristics across different types of barriers. The different types of barriers that we analyze in this paper are on line with previous studies of innovation determinants. Following D'Este et al. (2012), D'Este et al. 2014; Santiago (2016) and Pellegrino and Savona (2017) among others in order to correct for selection bias, we discriminated the firms in our sample in two types, those that engage in innovation and are successful innovators, and those that are not successful innovators, but still perceive innovation barriers. We excluded from the model those firms that are unsuccessful innovators and have not declared any barrier to innovation.

We conduct a Probit model for each innovation barrier, differentiating successful innovators from unsuccessful innovators that report barriers. Each regression includes one country indicator related to each innovation barrier. We conducted the model over the full sample.

$$\text{Innovation\_barrier}_i = \beta \ \text{firm\_characteristic}_i + \beta \ \text{country\_characteristic}_i + \varepsilon_i$$

4. Empirical findings

The results of the Probit regressions are reported in Table 6.

As indicated in Table 6 above, there are substantial differences between firms that are successful innovators, and firms that are not successful innovators and report innovation barriers. Regarding firm size, firms that perceive higher barriers to access public support are mostly large unsuccessful innovators. Public support plays a determinant role for firms to engage in innovation activities. Regarding employees in R&D activities, D'Este et al. (2014) found that human capital plays an important role in reducing innovation barriers for Spanish firms. Our results are on line to those of D'Este et al. (2014), in addition, we found that the effect of human capital differs for successful innovators and unsuccessful innovators. On the one hand, for successful innovators the lack of human capital has a negative effect on financial barriers and organizational barriers. On the other hand, for unsuccessful innovators the lack of human capital has a negative effect on access to public support.

Regarding public support several works have found that firms that have access to public support do engage more in innovation activities, and actually the intensity of innovation activities increases (Crespi & Zuniga, 2012; Author et al., 2015; F. Santiago, 2016). Our results indicate that only unsuccessful innovators report that access to public support is necessary to leverage additional public support to innovate. These perceptions suggest that for firms that already enjoy some sort of public support, it is easy for them to access other types of public funds. However, firms that do not have any public support to begin with, might be in some sort of trap in terms of financing innovation activities successfully. Unsuccessful firms report that the lack of human capital and public support are key to address innovation barriers related to access to public funds. As Table 3 indicates, there is a high correlation between employees in R&D activities and public support that the firm receives. Therefore, firms with a short supply of human capital are not able to identify or attract public support to address innovation barriers.

Following the work by Chesbrough (2003), several scholars have studied the importance of open innovation, in terms of engaging with multiple sources of knowledge to innovate (K. Laursen & Salter, 2004). Our results suggest that indeed, identifying and using external sources of innovation has an effect on innovation barriers. We also observed differences between successful innovators and unsuccessful innovators. For successful innovators, access to knowledge coming from universities is key to address innovation financial barriers, organizational barriers, and barriers to access public support. Market sources of information were not significant for successful innovators. For unsuccessful innovators, access to knowledge from universities and

the market were key to address financial barriers, barriers to human capital, regulation barriers, and access to public funds.

With respect to country level indicators, our results contribute to those by Hadjimanolis (1999), as they indicate to play a role in shaping innovation barriers for both successful and unsuccessful innovators. Our results suggest that public R&D expenditure can play a positive role in the perception to innovation barriers for unsuccessful innovators. A higher level of public support at country level can alleviate the financial risk associated with performing innovation activities. The level of intensity of local competition also plays a positive role. We observe that the intensity of local competition, forces firms to innovate at the organizational level to become more efficient, and also to engage more in innovation activities to remain competitive, therefore, firms that face higher local competition are able to tackle or reduce organizational innovation barriers.

Our results contribute to the current literature on innovation barriers by including a layer of analysis. Country level characteristics do play an important role in shaping the innovation context, and also in the perception of firms to engage in innovation activities. Our results suggest that valuating the effect of country level characteristics is highly relevant in particular for emerging and developing countries.

Table 6. Innovation barriers, firm characteristics, and country level indicators

VARIABLES	Successful innovators					Unsuccessful innovators reporting barriers				
	Financial barriers	Lack of qualified labour	Organization barriers	Regulation barriers	Lack of public support	Financial barriers	Lack of qualified labour	Organization barriers	Regulation barriers	Lack of public support
Firm size	0.148	-0.033	0.08	0.01	-0.068	-0.004	0.034	0.081	-0.075	0.392*
	-0.118	-0.107	-0.102	-0.102	-0.111	-0.189	-0.185	-0.168	-0.166	-0.22
Employees in R&D activities	-0.382**	-0.117	-0.266*	-0.089	-0.034	-0.403	-0.349	-0.219	0.25	-0.601*
	-0.162	-0.149	-0.147	-0.144	-0.152	-0.287	-0.272	-0.255	-0.253	-0.324
Government support	0.123	0.14	-0.183	-0.095	0.073	-0.25	-0.196	-0.324	-0.359	0.433*
	-0.16	-0.155	-0.155	-0.151	-0.156	-0.265	-0.239	-0.227	-0.252	-0.259
Use of external sources of knowledge (universities)	0.255*	0.207	0.240*	0.055	0.290**	0.669**	0.412*	0.212	0.358	0.590**
	-0.147	-0.141	-0.141	-0.138	-0.144	-0.272	-0.245	-0.232	-0.255	-0.261
Use of external sources of knowledge (market)	0.51	0.556	0.304	-0.083	-0.065	0.49	0.325	-0.551	0.844*	1.999**
	-0.353	-0.356	-0.369	-0.351	-0.376	-0.484	-0.512	-0.5	-0.482	-0.894
Venture Capital	-1.003					-3.935**				
	-0.994					-1.932				
Quality of Educational System		0.182					-0.426			
		-0.447					-0.812			
Intensity of Local Competition			-0.953*					-0.285		
			-0.519					-0.874		
Regulatory Quality				-2.297					6.548	
				-5.653					-10.32	
Public R&D expenditure					0.856					-0.81
					-0.978					-1.973
Constant	1.108	-0.504	4.603	1.006	0.14	3.791**	2.148	2.419	-2.333	-0.866
	-0.92	-1.471	-2.824	-1.73	-0.91	-1.677	-2.594	-4.697	-3.07	-1.797
Observations	344	344	344	344	344	133	133	133	133	133

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5. Conclusions

The main aim of this paper was to perform a comparative analysis of innovation barriers in two emerging economies, and identify the effect of firm's characteristics, and country level characteristics on five different types of innovation barriers.

As has been indicated in previous studies (e.g. Author et al. (2015); Santiago et al. (2017) firms in developing countries have lower innovation performance. From our sample, a small percentage of firms from Mexico and Turkey are successful innovators. This study contributes to identify the level that firm's characteristics and country level characteristics interplay to address innovation barriers.

As argued by previous literature in innovation barriers, our results indicate differences between successful innovators and unsuccessful innovators. D'Este et al. (2012 and 2014) for example differentiate deterring barriers from revealed barriers. Our sample differs from that used by previous works in terms that we focus on successful innovators, i.e. those firms that have successfully introduced innovations to the market vs. unsuccessful innovators, i.e. those firms that do engage in innovation activities but do not introduce innovations to the market. We excluded from our analysis those unsuccessful innovators that do not report innovation barriers in order to eliminate selection bias, as suggested by Pellegrino and Savona (2017).

For successful innovators, employees performing R&D activities provide key knowledge and skills that are critical to address financial and organizational barriers. This result is on line with those from D'Este et al. (2014) as they found that human capital plays a critical role when analyzing innovation barriers. Highly skilled human employees do play a critical role in the process of creation and accumulation of knowledge. Our results suggest that a higher number of highly qualified employees performing R&D activities are essential to tackle innovation barriers. This finding is highly relevant especially for developing and emerging economies, as their education systems are still not fully developed in comparison to those of developed countries. Policy actions are required to strengthen the quality of education, but also to promote more university-industry interaction that allows students to engage in internship projects hosted by firms, or other forms of student mobility.

The use of open sources of innovation by firms located in Mexico and Turkey is also relevant to acquire knowledge and address several types of barriers. On line with Keld Laursen and Salter (2014), our results suggest that firms located in Mexico and Turkey with access to external sources of knowledge to innovate are better off at addressing financial barriers, lack of human capital, organizational barriers, regulation barriers, and lack of public support. University and market open innovation channels are both necessary to tackle different types of barriers. Our results suggest that a mix of knowledge sources from university and knowledge sources from the market (clients, suppliers and competitors) are needed to address different types of innovation

barriers. Some policy implications resulting from this result indicate the need to foster the knowledge that is being produced in universities and research centers in emerging economies, as more advance knowledge feeds the pipeline of applied knowledge that is later use by innovative firms. In addition, providing the system conditions for firms to interact with potential suppliers and clients has been emphasized as a key element to further innovation.

This paper contributes to better understanding the interplay between firm's characteristics and country context to address different types of innovation barriers. Country level indicators have high multicollinearity, as indicated in Table 4. Therefore, we decided to introduce in our analysis only one country level indicator for each type of barrier. The selection of the country level indicator depends of the type of barrier. Our results indicate that the level of public expenditure and the level of local competition do play a significant role in shaping the innovation barriers for both successful and unsuccessful innovators, as suggested by Hadjimanolis (1999). This result indicates that it is necessary to provide more attention to the interplay between firm and country level characteristics. Future research is needed in order to include more comparisons at country level within the literature of innovation barriers, using multilevel methodologies.

The introduction of country level characteristics in our analysis can provide relevant information for the development of policy programs. Policy programs to decrease the financial risk associated to innovation can implement new forms of sourcing by employing a mix of direct and indirect incentives, according to the characteristics of the industries in the country. Policy programs that contribute to the knowledge and capability building are necessary, as firms that engage in high competitive environments need to have a high stock of knowledge and capabilities.

Results from this paper also provide crucial insights for managers, to inform corporate strategies oriented to overcoming the obstacles to innovation. Investing in human capital is necessary if the firm wants to overcome innovation barriers. Benefiting from open sources of knowledge is also necessary; therefore, firms need to develop open innovation strategies. However, taking into account the potential risk to these strategies associated to intellectual property and increased competition.

Finally, this study has several limitations, first the dataset from Turkey only provides information from manufacturing, and therefore we were not in possibility to conduct a comparative study between service and manufacturing industries, we only focus our analysis on manufacturing firms. As indicated by Crespi and Zuniga (2012) and BARRAS (1990), amongst others, there are differences in the innovation determinants of service and manufacturing firms. Following Santiago (2016), we argue that there might be differences between manufacturing and services firms across different countries. Future studies can explore the differences of innovation barriers between manufacturing and services, and comparing them across countries. Second, the work by Galia and Legros (2004) indicates the existence of complementarities between obstacles to innovation for firms in France, our study does not focus on analyzing the complementarities of

innovation barriers, however, there is an important dimension associated to estimate the complementarities between innovation barriers and the effect of country level characteristics. Third, the two sources of data were conducted independently, and we made additional efforts to homogenize the databases from Mexico and Turkey, resulting in the loss of several variables that were not comparable between countries. A call for a more homogenized structure for innovation surveys in emerging and developing countries is required to advance the literature on innovation barriers across countries.

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