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Perception of innovation barriers by successful and unsuccessful innovators in emerging economies

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Abstract
Understanding innovation barriers is critical for innovation policy to design better incentives to innovation. This study explores the factors that influence the perception of innovation barriers in two emerging economies, Mexico and Turkey. The analysis integrates three sources of data into a comprehensive database. For Mexico, we use data from the ESIDET, 2010; for Turkey, we use data from TurkStat, 2010; while institutional country context indicators were gathered from a set of international databases. Our results suggest that firm and context characteristics matter as determinants of a firm's perception of innovation barriers, while there are differences between successful innovators and unsuccessful innovators. This paper contributes to the empirical and theoretical debate on innovation barriers through the analysis of how successful and unsuccessful innovators in two emerging economies perceive innovation barriers. It also contributes to the discussion on the role of the institutional context on innovation barriers.

Keywords Innovation barriers · Emerging economies · Institutional context · Mexico · Turkey

JEL Classification O31 · O32 · O54

1 Introduction

Several studies have contributed to provide a better understanding of the determinants of innovation (Mohnen et al. 2006; Polder et al. 2009; Mairesse and Mohnen 2010; Crespi and Zuniga 2012), with direct implications for policy making. Understanding innovation barriers is critical for policy making, as it sheds light on issues that prevent firms to pursue innovative behaviors and to innovate (D'Este et al. 2014; Pellegrino and

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Savona 2017). Public initiatives and policies can help to reduce the perception of innovation barriers.

From a management perspective, research on innovation barriers is expected to shed light on different scenarios to foster innovation, and on issues that either slow down or lead those processes to fail within the firm (Feldens et al. 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 et al. 2009; Santiago 2016).

Several authors have contributed to this growing body of literature focusing their studies on several aspects of innovation barriers. For example Mohnen et al. (2008) and Álvarez and Crespi (2015) have analyzed financial barriers to innovation. Pellegrino and Savona (2017) and Santiago (2016) analyze financial and non-financial barriers to innovation differentiating firms that are not willing or in no need to innovate from those that choose to devote resources to innovation, but do not manage to produce successful innovation due to innovation barriers. In particular, 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 et al. 2012, 2014). These studies contribute to identify the perception to barriers and differentiate firms that 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 important 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).

Hueske and Guenther (2015) argue that the discussion on innovation barriers remains empirical in nature; they recommend more integrated research in barriers that is context specific. Additionally, 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 factors can help to inform policy makers on how to decrease innovation barriers in ways that take into account context specificities. This paper contributes to studies in this area, first by analyzing the perception of innovation barriers in two emerging economies, Mexico and Turkey, and second, by considering the effect of the institutional context on innovation barriers. Our focus on two emerging economies is consistent with the need to conduct more comparative analysis emphasized by Hueske and Guenther (2015). We argue that a better understanding of the perception of 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.

Mexico and Turkey represent two pertinent country cases to conduct a comparative analysis on innovation barriers in emerging economies. Despite the implementation of structural reforms, productivity and innovation performance in both countries is weak (OECD 2016, 2017). The years of 2008 and 2009 showed the lowest levels of total factor productivity for both countries (OECD 2016). Business sector expenditure on R&D (BERD) in Mexico is below nearly all OECD and BRICS countries. During 2008–2009 Mexico's BERD was 0.1% of GDP, and it increased slightly in 2014 to 0.2% of GDP (OECD 2017). In turn, Turkey's BERD was 0.5% of GDP in 2014 (OECD 2016). The relatively low level of BERD in Mexico and Turkey is partly a result of their industrial structure, as over one-third of manufacturing R&D in Mexico and Turkey is carried out in low and medium-technology sectors, but it also reflects a low-skilled employee base.

Both countries have undergone through important structural reforms since 2008, and have implemented a set of innovation policies aiming to boost their productivity and economic growth, and address several social challenges (OECD 2016, 2017). Mexico has boosted productivity and exports across several industries, especially automotive and electronics (OECD 2017). Currently part of NAFTA, Mexico is becoming an international trade hub, but at the same time, faces an uncertain environment in terms of the global markets with the potential renegotiation or termination of NAFTA. For Turkey, major institutional and structural reforms introduced after the 2002 crisis helped overcome the earlier "boom-and-bust" cycles. Productivity in Turkey is low mainly due to the composition of its manufacturing sector. On the one hand, there is a set of high quality and modern corporations, and on the other hand, there is a large set of low-quality semi-formal and informal firms that slow down productivity. Turkey's engagement in global value chains is limited; probably result of a low skilled human capital and unreflective investment in innovation, and low R&D and knowledge-based capital (OECD 2016). Firms in Turkey are also affected by pressures arising from illicit practices, non-level playing competition and political unpredictability (OECD 2016).

While previous studies have studied innovation barriers faced by service and manufacturing firms in Mexico (Santiago et al. 2017), and for small manufacturing firms in Turkey (Demirbas et al. 2011), further research is necessary to understand the role of contextual factors on the perception of innovation barriers. This study contributes to the current theoretical and empirical debate of the perception of innovation barriers identifying the effect of firms' characteristics and institutional context characteristics. The introduction of institutional context can provide relevant information for the development of policy programs aiming to reduce innovation barriers in emerging economies, and foster innovation at the firm level.

The reminder of this paper is structured as follows; Sect. 3 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 Sect. 5 concludes.

2 Literature review

2.1 Barriers to innovation main contributors and perspectives

The literature on barriers to innovation has grown in the past few years. There is significant progress in our understanding of financial barriers (Mohnen et al. 2008) and non-financial barriers (D'Este et al. 2012). For example, Galia and Legros (2004) show the existence of complementarities between innovation barriers for firms located in France. Iammarino et al. (2009) and D'Este et al. (2012), have focused on the role of barriers on innovation engagement for firms in the UK, and analyze cost, knowledge, market, and regulation barriers. Blanchard et al. (2012) have analyzed the impact of obstacles to innovation, and treated obstacles as a dummy variable in their analysis. Antonili et al. (2017) provide an analysis of how firms engage in collaboration with other organizations to address innovation barriers. They included cost, knowledge, and market barriers as independent variables. 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.

Research has also considered different types of innovation outputs, with the premise that 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. Santiago (2016) studies the relationship between the perceived importance of innovation barriers, and the type of innovation output pursued by firms, namely product, process, marketing or organizational innovation for firms in Mexico. These studies analyze the differences of perceived innovation barriers—cost, financial, market, knowledge and regulation—that firms confront in order to innovate.

The literature has also pointed the importance to using data from 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 findings, 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 revealed barriers by assessing the impact of revealed barriers on the translation of innovation activities into actual innovation outputs. 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 cost, knowledge, and market 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. 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 sectors. The authors included the following barriers to innovation in their analysis: cost, financial, knowledge, market and regulation barriers; and 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. 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 (Mohnen and Rosa 2001; Iammarino et al. 2009; D'Este et al. 2012). 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 on previous contributions from the literature on the perception of innovation barriers (D'Este et al. 2012; Pellegrino and Savona 2017), and differentiates those successful innovators and unsuccessful innovators, as suggested by Pellegrino and Savona (2017). In addition, this study 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 and innovation barriers

Innovation studies argue that country specific characteristics matter as determinants of innovation; these characteristics might facilitate the production of knowledge, its dissemination, use and implementation (Lundvall 1992; Freeman 1995). Moodysson et al. (2016) discuss how regional strategies inspired by smart specialization, influence path renewal and new path creation. They show how these two dimensions relate to and align with policy strategies implemented at other scales (local, regional, national, supranational). Srholec (2010) conducted one of the first quantitative multilevel analyses to study the geography of innovation, building on firm level data from the Community Innovation Survey (CIS) for the Czech Republic. 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. Srholec (2011) published a study analyzing 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 how country context characteristics have an impact on the likelihood to innovate, and we argue that context characteristics also have an impact on the perception of innovation barriers at the firm level.

Strategies to counteract innovation barriers may be affected by national culture and other country specific considerations (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, which 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 (Santiago et al. 2017).

The research on innovation barriers has focused on the analysis of data from CIS and Innovation Surveys from different countries. 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. 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 et al. (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. The inclusion of comparative studies that consider context characteristics can contribute to providing a more integrated approach to better understand innovation barriers in different contexts.

Context characteristics have been recognized as critical to foster innovative environments; within these, university-industry collaborations have received special attention. Guerrero et al. (2017) found for example that innovative firms in Mexico are more likely to collaborate with universities to develop radical innovations than to develop incremental innovations. Other studies have also addressed the analysis of barriers that foster university-industry collaborations. For example, Hall et al. (2001) discuss some of the barriers for university-industry collaboration. They focus in particular on intellectual property barriers that inhibit firms from partnering in research with universities. Temel et al. (2013) analyzed the impact of university collaboration on firms' profitability in Turkey and found a positive impact over the mid and long run. Ramos-Vielba et al. (2016) analyzed the barriers for university-industry cooperation from the university researchers' side. Davey et al. (2016) also provide an analysis on barriers and drivers on academic entrepreneurship and compare them in different European regions. In their research, they focus in understanding how does the regional context influence the drivers or barriers of academic entrepreneurship, and emphasize the importance of the regional and national context. Within their research, the authors found that the most common barriers include funding, and cultural barriers; while the drivers include relationship, access, and research (Davey et al. 2016).

Therefore, considering the effect of the institutional context in the analysis of innovation barriers is central to understanding the interplay between institutional context characteristics and organizational characteristics at 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 contextual characteristics of countries will contribute to another layer of analysis regarding the impact that such institutional contexts 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 (Mohnen and Rosa 2001; Iammarino et al. 2009; Madrid-Guijarro et al. 2009; World Bank 2010; Santiago et al. 2017). Our study, in line with the previous works that differentiate revealed and deterring innovation barriers (e.g. D'Este et al. 2012; Santiago 2016) considers two types of firms, successful and unsuccessful innovators (Pellegrino and Savona 2017). In addition, and on line with previous contributions from the literature on innovation barriers, 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 these types of innovation barriers in two emerging economies (see Table 1).

Table 1 Barriers to innovation addressed in previous studies. *Source*: Author's own

Barrier	Authors
Cost/financial[a]	Mohnen and Rosa (2001), Galia and Legros (2004), Mohnen et al. 2008, Madrid-Guijarro et al. (2009), D'Este et al. (2012, 2014), Álvarez and Crespi (2015), Santiago (2016), Santiago et al. (2017), Antonili et al. (2017) and Pellegrino and Savona (2017)
Economic uncertainty or economic risk	Galia and Legros (2004) and Mohnen et al. (2008)
Knowledge/qualified labor[a]	Mohnen and Rosa (2001), Galia and Legros (2004), D'Este et al. (2012, 2014), Santiago (2016), Santiago et al. (2017), Antonili et al. (2017) and Pellegrino and Savona (2017)
Lack of information in technologies and markets	Galia and Legros (2004) and Pellegrino and Savona (2017)
Market	Mohnen and Rosa (2001), Galia and Legros (2004), Mohnen et al. 2008, D'Este et al. (2012, 2014), Santiago (2016), Santiago et al. (2017), Antonili et al. (2017) and Pellegrino and Savona (2017)
Lack of customer responsiveness	Galia and Legros (2004)
Organization[a]	Galia and Legros (2004) and Madrid-Guijarro et al. (2009)
Regulation[a]	Mohnen and Rosa (2001), Galia and Legros (2004), D'Este et al. (2012), Santiago (2016) and Santiago et al. (2017)
Access to public support[a]	D'Este et al. (2014), Santiago (2016) and Santiago et al. (2017)
Obstacles as dummy (dummy for firm evaluating the obstacle as important or very important)	Iammarino et al. 2009 and Blanchard et al. (2012)

[a]Innovation barriers addressed in this study

3 Methodology

3.1 Country context Mexico and Turkey

We have included two emerging economies in this study, Mexico and Turkey. This section discusses the institutional context for Mexico and Turkey, in particular related to the five barriers addressed in this study (financial, organizational, qualified labor, regulation, and public support). Table 2 shows some country indicators associated to education, R&D system, political environment, regulatory environment, intellectual property, market sophistication, and innovative culture. These indicators show relevant gaps between these two emerging economies and also in relation to the top ranked country in each of those indicators.

Regarding education, there are significant gaps between more developed countries and Mexico and Turkey. Country studies from the OECD (2016, 2017) emphasize that some of the main obstacles to boosting a country's innovative potential include a weak domestic research and skills base, and an underdeveloped knowledge-based start-up environment (OECD 2017). Obstacles for developing a strong knowledge-based capital are significant in both countries, as both countries still need to foster their education systems. Students' foundation skills remain weak in Mexico and Turkey, not many students in these countries

Table 2 Country level indicators (2009–2010). *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); Organization for Economic Cooperation and Development (OECD)

Indicator	Mexico	Turkey	Top country
1. Education			
Enrolment in tertiary education (enrollment per 100,000 inhabitants)	2.63	3.17	8.59 (Cuba)
Investment in education (%GNI)	0.23	2.85	5.13 (Sweden)
2. R&D system			
Public R&D expenditure (% of GDP)	0.5	0.38	3.89 (Sweden)
Business R&D expenditure (% of GDP)	2.9	2.91	5.90 (Sweden, Japan)
Scientific production (percentage among the world's 10% most cited publications)	4	4.5	15.5 (Switzerland)
3. Political environment			
Political stability (indicator 1–7)	3.88	3.73	7 (Luxemburg)
4. Regulatory environment			
Regulatory quality (indicator 1–7)	4.77	4.44	6.88 (Singapore)
5. Intellectual property			
Patent applications (thousand units)	2	10	59 (Sweden)
Intellectual property protection (indicator)	3.19	2.68	6.11 (Sweden)
6. Market sophistication			
Intensity of local competition (indicator)	4.6	5.4	5.8 (UK)
Productivity (Value added per employee, US PPP)	39	41	

reach and complete tertiary education. In 2009, only 2.63 per 100,000 of adults in Mexico had attained tertiary education, and only 3.17 per 100,000 of adults in Turkey had attained tertiary education, some of the lowest shares across OECD countries. Student expenditure remains low, and linkages between the business sector and education institutions in these two countries are among the lowest in the OECD (see Table 2).

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 1%. Discussion around public investment in R&D has been identified as highly important to foster innovation (Mairesse and Mohnen 2010; Crespi and Zuniga 2012; De Fuentes et al. 2015). Another gap is around company spending on R&D and scientific production. The weaknesses around capacity for R&D in Mexico and Turkey are significant and highlight the need to address them by policy 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 and Lim 2001).

We also observe gaps around political environment, regulatory quality, and intellectual property. These institutional framework conditions have also been discussed as critical to foster innovation within countries (Edquist 1997). One particularly important dimension related to innovation is the ability of companies to protect their intellectual assets (OECD 2011). Patenting in Mexico has increased steadily over the last decade, together with industrial design and trademarks. Patenting and intellectual property protection in Turkey has

remained low in comparison to other countries (see Table 2). In both countries, but in particular for Turkey, a large set of firms suffer from stringent local regulations, weak legal institutions, rooted informality, corruption and insufficient financial development (OECD 2016, 2017) (see Table 2). In addition, lack of formalization and transparency hampers firms' access to banking and financial services especially for firms in Turkey (OECD 2016).

Regarding market sophistication and culture to innovate there are significant barriers that prevent the development of a more productive and innovative business setting in both countries. Despite several industrial and structural reforms, both countries still face weak levels of productivity and innovation performance in the business sector in part due to the manufacturing industrial structure, but also related to low levels of skills, low investment in R&D, high levels of informality, and complex regulation systems. For instance, in both countries there are a number of programs of public support to innovation available for firms; however, due to complex rules and regulation as well as the lack of qualified employees, access to those programs remains relevant only for a number of firms (see Table 4). For the particular case of Turkey, the OECD (2016) indicates a high level of informality in manufacturing firms. The productivity gap is large between formal and informal firms. While formal firms present high levels of productivity; the set of informal firms show low levels of productivity and low skilled employees, increasing the low productivity trap (OECD 2016).

3.2 Dataset

For this analysis, we relied on two separate datasets that provide information at the firm level for Mexico and Turkey. 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 3694 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 1271 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 manufacturing. A total of 1000 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 perceive.

Both surveys follow the guidelines from the Oslo Manual and contain common questions regarding the innovation process and obstacles to innovation. We merged these two

datasets in a comprehensive database to facilitate the analysis. Before merging the datasets, we conducted specific efforts to make both databases as similar as possible. The main differences are related to the set of firms in the survey. The survey from Mexico captures information of firms from the manufacturing, services and other sectors, while the survey from Turkey captures information from the manufacturing sector. For purposes of this analysis we focused only on those firms from the manufacturing sector. The second difference was the number of employees in the samples. While for the case of Mexico, the unit of analysis are firms with 20 or more employees, for the case of Turkey, the unit of analysis are all manufacturing firms, including micro firms. We tested our model using firms with 20 or more employees and also including all the micro firms from Turkey, and found no significant differences.

The key questions for this study asked in the innovation surveys are: (1) if the firm engages in innovation activities, (2) if the firm is successful innovator, and (3) if the firm perceives barriers to innovation. Both surveys request data on the expenditure in innovation activities. Even though the survey from Mexico collects information regarding expenditures on eight different types of innovation activity—including R&D, training, acquisition of technology, acquisition of machinery and equipment, software, and expenditure on launching new goods or services—, the survey from Turkey only requests information on the expenditure on R&D. For purpose of this analysis, we used only data on R&D expenditure. Both surveys asked if the firm has introduced a technological innovation (product or process). Also both surveys ask the share of sales of new or improved products. In both cases, firms answered with a percentage that adds 100 for the share of sales of new products, improved products, and existing products. This is an output measure of innovation, and it is expected that the share of innovative sales increases as the innovation effort increases (Mohnen and Therrien 2005).

Both surveys have a dedicated section to innovation barriers; however, the type of barriers and the collection of answers differed. For the case of Mexico, firms were asked to identify a set of 14 innovation barriers and rank their importance using a Likert scale (1–5). The barriers in the survey from Mexico included cost barriers, excessive economic risk, and excessive cost of innovation, organizational rigidities, financial barriers, insufficient public support, lack of adequate funding sources, market barriers, regulation barriers, knowledge barriers, lack of qualified labor force, lack of information about technology, and lack of information about markets. For the case of Turkey, firms were asked to identify a set of nine innovation barriers and also rank their importance using a Likert scale (1–5). The barriers in the survey from Turkey included financial barriers, organizational barriers, regulation barriers, qualified labor, intellectual property barriers, barriers on collaboration with universities, access to knowledge, access to market and public support. Following previous studies on innovation barriers (see Table 1), and to homogenize this set of variables, we relied on a previous work by Santiago et al. (2017), as they use factor analysis to reduce the number of barriers from 14 to five for the case of Mexico. Thus, for the case of Mexico we have five innovation barriers: financial barriers, organizational barriers, regulation barriers, qualified labor, and public support. This set of barriers where comparable with the survey information form Turkey.

In addition, both surveys provided a set of variables that could explain the innovation barriers in these two countries. To select those variables, first we compared the two surveys and we identified the common variables, then we confirmed with other relevant studies those variables that have been commonly used to analyze innovation barriers. The common variables in both surveys include firm size, R&D activities, productivity, net income, access to public support for innovation, sources of information to innovate, number of

patent applications, and level of innovation. Even though both countries base their questionnaires on the Oslo Manual, and have comparable questions, we had to eliminate a large number of variables, as they were not comparable across surveys. After selecting comparable variables, and then we homogenized them to have them under the same format, e.g. dummy variables, or same Likert scale. The final database contains 2820 observations for manufacturing firms, 2128 of those observations are for Mexico, and 692 are for Turkey, and 32 homogenized variables.

We also built a sub-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. This sub-dataset provides information at country level on education, R&D system, political environment, regulatory environment, intellectual property, market sophistication, and culture to innovate. These country level indicators were selected based on two principles, first that there were relevant to the innovation barriers studied in this paper (financial, organizational, qualified labor, regulation, and public support); and second, that these indicators were available for both countries. 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 R&D expenditure. The Worldwide Governance Indicators (WGI) provided information regarding regulatory quality. The Country Surveys from the OECD provided information on attainment of tertiary education, scientific production, and productivity. These indicators serve as a reference for the institutional context in Mexico and Turkey. We also included data from the top and bottom ranking countries for most of the categories (see Table 2).

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. We followed D'Este et al. (2012, 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. For this study, we differentiate those firms that have been successful innovators, from those that have not been successful. Those firms that reported the introduction of new products or services or reported sales from new or improved products were considered as successful innovators. Those firms that have not been successful in introducing innovations, but still report innovation barriers were considered as unsuccessful innovators. As indicated in Fig. 1, our full sample consists of 2819 observations; of those only 570 are successful innovator firms in terms that they have introduced technology innovations or reported sales from new or improved products.

From our total sample 2127 firms are located in Mexico, and 692 located in Turkey. From those 570 successful innovators, 395 are located in Mexico, and 175 located in Turkey. From those 1881 firms that are unsuccessful innovators, but report innovation barriers, 1469 are located in Mexico, and 412 are located in Turkey. From those 368 unsuccessful innovators that do not report innovation barriers, 263 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

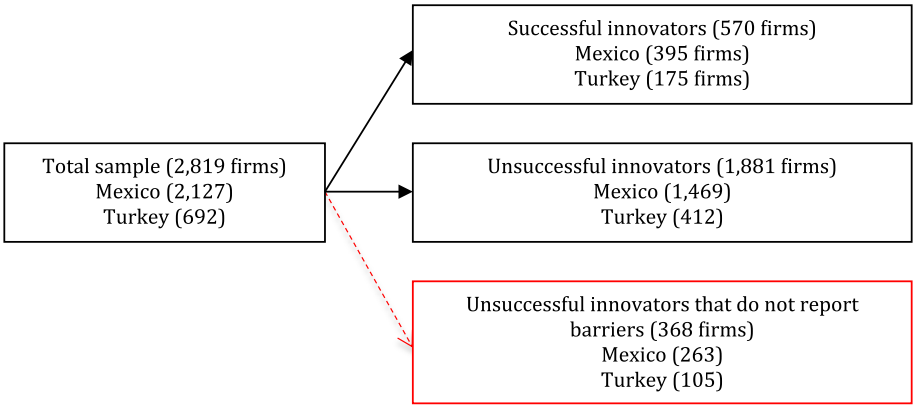

Fig. 1 Sample size, successful innovators and unsuccessful innovators that report barriers

countries are unsuccessful innovators. In line with previous work on innovation barriers (D'Este et al. 2012, 2014; Pellegrino and Savona 2017), we excluded all firms that do not report any innovation during the period 2008 and 2009 and that do not report innovation barriers, and we only consider in our sample those firms with innovation potential.

3.4 Variables and descriptive statistics

Following those studies that aim to identify the role of firm's characteristics on innovation barriers (see for example D'Este et al. 2012, 2014), our dependent variables are those innovation barriers reported by firms. Innovation barriers in this study are: financial, organizational, qualified labor, regulation, and public support. Financial barriers represent the firm's difficulty to access internal or external financial resources; organizational barriers represent the firm's lack of organizational capability; qualified labor represents the difficulty to find, attract or retain qualified personal; regulation barriers represent the level of rules and regulations at the country level; and public support barriers represent the difficulty to identify and apply for government grants or incentives to innovation. Both surveys from Mexico and Turkey include a section on perception of innovation barriers. Firms had to answer if they have faced different innovation barriers from a roster of innovation barriers, and had to provide their perception to that specific barrier on a Likert scale 1–5. Table 3 indicates the number of firms that perceive each one of these barriers, and differentiate by successful and unsuccessful innovators.

In general, firms located in Turkey report a higher perception of innovation barriers than firms located in Mexico. In addition, those firms that are unsuccessful innovators perceive higher innovation barriers than successful innovators in both countries. However, both successful and unsuccessful innovators in both countries perceive the financial barriers as the most frequent barrier to innovation and organizational barrier as the least frequent.

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, employees in R&D activities, government support, and access to external information. We used the number of employees in its logarithm form as firm size. It has been argued that large firms have a larger pool of resources, and in general they can use more of their resources to engage in innovative activities (Crespi and Zuniga 2012). Therefore, we argue that larger firms might

Table 3 Percentage of firms that perceive barriers to innovation as important or highly important in Mexico and Turkey

Barriers	Total sample (%)	Successful innovators (%)		Unsuccessful innovators (%)	
		Mexico	Turkey	Mexico	Turkey
Financial	65	60	80	77	84
Qualified labour	53	46	73	60	75
Organizational	48	37	41	59	65
Regulation	58	53	58	71	67
Public support	56	52	79	64	75

be able to tackle innovation barriers using a better mix of their human capital and other financial and knowledge-based resources. The innovation barriers literature has in general used this variable (e.g. D'Este et al. 2012, 2014; Pellegrino and Savona 2017). 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). We used the percentage of employees in R&D activities. The role of government support has been studied in the literature of innovation determinants, these studies suggest in general, that the effect of public support has played a critical role to engage in innovation activities and boost the innovation effort (Mairesse and Mohnen 2010; Crespi and Zuniga 2012; De Fuentes et al. 2015). 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). In particular Antonili et al. (2017) analyze the relationship between the perception of barriers to innovation and the propensity of a firm to cooperate to mitigate their effect.

This study also includes the role of country context. As suggested by Hadjimanolis (1999) and Santiago (2016), strategies to counteract innovation barriers may be affected by national culture and other country specific considerations.

Table 4 provides the descriptive statistics of the independent variables used in this study, and Table 5 provides a correlation matrix for firm level independent variables.

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 barriers (see Table 1). Following D'Este et al. (2012, 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.

Table 4 List of independent variables, descriptive statistics

Independent variables	Total sample (1)	Successful innovators		Unsuccessful innovators	
		Mexico	Turkey	Mexico	Turkey
Firm size (ln employees)	1.05	0.17	1.73	2.06	1.99
Percentage of employees in R&D activities	0.108	0.481	0.287	0.028	0.032
Government support (dummy) [%]	21	15	10	35	18
Use of external sources of knowledge (competitors) (dummy) [%]	59	56	40	46	45
Use of external sources of knowledge (clients) (dummy) [%]	79	77	49	69	59
Use of external sources of knowledge (supplier) (dummy) [%]	66	65	37	58	40
Use of external sources of knowledge (university) (dummy) [%]	39	36	27	29	32

(1) The total sample considers only those successful innovators and those unsuccessful innovators that report innovation barriers

Table 5 Correlation–firm level independent variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Firm size (1)	1						
Percentage of employees in R&D activities (2)	0.676	1					
Government support (3)	0.345	0.338	1				
Use of external sources of knowledge (competitors) (dummy) (4)	0.038	0.094	0.112	1			
Use of external sources of knowledge (clients) (dummy) (5)	0.044	0.114	0.116	0.516	1		
Use of external sources of knowledge (supplier) (dummy) (6)	−0.005	0.054	0.078	0.425	0.527	1	
Use of external sources of knowledge (university) (dummy) (7)	0.070	0.104	0.123	0.365	0.346	0.367	1

We conduct a Probit model for each innovation barrier, differentiating successful innovators from unsuccessful innovators that report barriers. We conducted the model over the full sample, and then on each country for successful and unsuccessful innovators.

$$\text{Innovation\_barrier}_{\text{iTot}} = \beta X_{\text{iTot}} + \varepsilon_{\text{i}}$$
$$\text{Innovation\_barrier}_{\text{iMex}} = \beta X_{\text{iMex}} + \varepsilon_{\text{i}}$$
$$\text{Innovation\_barrier}_{\text{iTur}} = \beta X_{\text{iTur}} + \varepsilon_{\text{i}}$$

where X_i is a matrix of explanatory variables, β represents the coefficients to be estimated and ε is a random error term.

4 Results and discussion

4.1 Empirical results

The results of the Probit regressions are reported in Table 6 for the full sample. Table 7 reports the results for successful innovators in Mexico and Turkey, and Table 8 reports the results for unsuccessful innovators in Mexico and Turkey.

As indicated in Table 4 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, large firms that perceive barriers related to qualified labor and lack of public support, are mainly large unsuccessful innovators, while firms that perceive regulation barriers are mainly small firms. In particular, unsuccessful innovators perceive that a lower number of employees in R&D is an important barrier for innovation. We found that the effect of a lower number of R&D employees can have a negative effect on access to public support, and qualified labor barriers. 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 with the conclusions of D'Este et al. (2014).

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

Table 6 Factors that influence a firm's perception of barriers to innovation. Full sample successful and unsuccessful innovators

Variables	Successful innovators total					Unsuccessful innovators total				
	Financial	Qualified labour	Organizational	Regulation	Public support	Financial	Qualified labour	Organizational	Regulation	Public support
Firm size	−0.034	−0.052*	−0.017	−0.046	−0.050	−0.006	0.118***	−0.010	−0.038	0.092***
	(0.032)	(0.031)	(0.031)	(0.031)	(0.032)	(0.030)	(0.030)	(0.027)	(0.028)	(0.030)
Employees in R&D activities	−0.076	−0.024	0.002	0.014	0.069	0.022	−0.546**	−0.113	0.206	−0.478**
	(0.173)	(0.168)	(0.168)	(0.167)	(0.171)	(0.254)	(0.229)	(0.221)	(0.243)	(0.231)
Government support	−0.010	−0.118	−0.111	−0.043	−0.052	−0.164*	−0.094	−0.055	0.175*	−0.039
	(0.124)	(0.120)	(0.120)	(0.119)	(0.121)	(0.094)	(0.088)	(0.085)	(0.094)	(0.089)
Use of external sources of knowledge (competitors)	0.245**	0.356***	0.163	0.240**	0.228*	0.076	0.208***	0.149**	0.270***	0.263***
	(0.122)	(0.120)	(0.121)	(0.119)	(0.120)	(0.079)	(0.073)	(0.071)	(0.074)	(0.073)
Use of external sources of knowledge (clients)	0.381**	0.250	0.145	0.190	0.085	−0.071	−0.156*	−0.141	−0.004	0.042
	(0.168)	(0.168)	(0.174)	(0.168)	(0.169)	(0.095)	(0.089)	(0.088)	(0.090)	(0.089)
Use of external sources of knowledge (supplier)	0.129	−0.072	0.129	0.274**	−0.015	0.177**	0.134*	0.125*	0.132*	0.036
	(0.123)	(0.121)	(0.122)	(0.119)	(0.121)	(0.081)	(0.076)	(0.075)	(0.078)	(0.077)
Use of external sources of knowledge (university)	0.212*	0.312***	0.162	−0.062	0.438***	0.392***	0.526***	0.188***	0.271***	0.464***
	(0.119)	(0.115)	(0.115)	(0.114)	(0.117)	(0.078)	(0.070)	(0.068)	(0.072)	(0.071)
Constant	−0.083	−0.190	−0.578***	−0.212	0.031	0.589***	0.051	0.156**	0.206***	0.046
	(0.166)	(0.165)	(0.172)	(0.165)	(0.166)	(0.071)	(0.067)	(0.066)	(0.067)	(0.067)
LR chi2 (8)	25.73	30.65	10.55	19.07	25.36	52.34	117.00	26.01	77.50	108.25
Prob > chi2	0.000	0.000	0.150	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pseudo R2	0.030	0.030	0.010	0.024	0.033	0.026	0.047	0.010	0.034	0.045
Observations	570	570	570	570	570	1881	1881	1881	1881	1881

Standard errors in parentheses

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

Table 7 Factors that influence a firm's perception of barriers to innovation. Successful innovators Mexico and Turkey

Variables	Successful innovators Mexico					Successful innovators Turkey				
	Financial	Qualified labour	Organizational	Regulation	Public support	Financial	Qualified labour	Organizational	Regulation	Public support
Firm size	−0.041	−0.0938*	0.002	−0.040	0.014	−0.265***	−0.221***	−0.108	−0.088	−0.242***
	(0.051)	(0.051)	(0.052)	(0.051)	(0.051)	(0.089)	(0.081)	(0.074)	(0.076)	(0.084)
Employees in R&D activities	0.263	0.551*	−0.069	−0.057	−0.096	−0.947***	−0.693**	−0.184	−0.084	−0.254
	(0.302)	(0.302)	(0.305)	(0.301)	(0.300)	(0.363)	(0.331)	(0.299)	(0.306)	(0.367)
Government support	0.106	−0.076	−0.069	0.112	0.167	0.148	0.326	−0.168	−0.411*	−0.189
	(0.142)	(0.141)	(0.142)	(0.141)	(0.142)	(0.294)	(0.269)	(0.242)	(0.244)	(0.259)
Use of external sources of knowledge (competitors)	0.073	0.246*	0.202	0.278*	0.223	0.728***	0.517**	0.091	0.106	0.118
	(0.144)	(0.143)	(0.145)	(0.142)	(0.143)	(0.261)	(0.240)	(0.226)	(0.233)	(0.260)
Use of external sources of knowledge (clients)	0.369*	0.203	0.021	0.252	0.077	0.308	0.234	0.397	0.074	−0.039
	(0.202)	(0.206)	(0.209)	(0.202)	(0.206)	(0.331)	(0.315)	(0.320)	(0.311)	(0.354)
Use of external sources of knowledge (supplier)	0.274*	0.043	0.107	0.166	0.149	0.134	0.088	0.278	0.610***	0.074
	(0.150)	(0.152)	(0.154)	(0.150)	(0.151)	(0.252)	(0.229)	(0.211)	(0.216)	(0.246)
Use of external sources of knowledge (university)	0.218	0.372***	0.286**	0.056	0.526***	−0.008	−0.010	−0.130	−0.362*	−0.099
	(0.142)	(0.140)	(0.140)	(0.139)	(0.140)	(0.256)	(0.232)	(0.212)	(0.215)	(0.243)
Constant	−0.420**	-0.529***	−0.594***	−0.348*	−0.537***	0.931**	0.665*	−0.414	0.197	1.455***
	(0.202)	(0.203)	(0.207)	(0.200)	(0.205)	(0.384)	(0.354)	(0.353)	(0.341)	(0.413)
LR χ^2 (8)	18.700	20.120	9.450	14.530	30.560	22.500	15.970	7.690	16.370	12.760
Prob > χ^2	0.011	0.005	0.222	0.042	0.000	0.000	0.025	0.361	0.021	0.078
Pseudo R2	0.034	0.036	0.018	0.027	0.055	0.130	0.079	0.032	0.068	0.071
Observations	395	395	395	395	395	175	175	175	175	175

Standard errors in parentheses

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

Table 8 Factors that influence a firm's perception of barriers to innovation. Unsuccessful innovators Mexico and Turkey

Variables	Unsuccessful innovators Mexico					Unsuccessful innovators Turkey				
	Financial	Qualified labour	Organizational	Regulation	Public support	Financial	Qualified labour	Organizational	Regulation	Public support
Firm size	−0.028	0.051	−0.358***	−0.033	0.052	−0.181***	0.014	−0.101**	−0.083*	−0.006
	(0.142)	(0.132)	(0.134)	(0.144)	(0.134)	(0.049)	(0.046)	(0.042)	(0.043)	(0.046)
Employees in R&D activities	0.092	−0.521	1.898**	0.370	−0.493	−0.215	−0.089	−0.327	−0.243	−0.138
	(0.846)	(0.778)	(0.793)	(0.864)	(0.791)	(0.499)	(0.475)	(0.384)	(0.405)	(0.425)
Government support	−0.048	−0.118	0.012	0.241**	−0.032	−0.482**	0.531*	−0.102	−0.015	0.225
	(0.104)	(0.095)	(0.094)	(0.104)	(0.097)	(0.242)	(0.294)	(0.219)	(0.228)	(0.258)
Use of external sources of knowledge (competitors)	0.069	0.148*	0.197**	0.230***	0.279***	0.227	0.584***	−0.075	0.516***	0.154
	(0.086)	(0.079)	(0.078)	(0.081)	(0.079)	(0.223)	(0.206)	(0.187)	(0.190)	(0.208)
Use of external sources of knowledge (clients)	0.072	−0.118	−0.052	0.059	0.122	0.034	0.024	0.067	−0.043	−0.135
	(0.107)	(0.103)	(0.102)	(0.105)	(0.085)	(0.237)	(0.207)	(0.193)	(0.194)	(0.208)
Use of external sources of knowledge (supplier)	0.292***	0.236***	0.216***	0.136	0.519***	−0.266	−0.191	−0.026	0.083	0.046
	(0.088)	(0.084)	(0.084)	(0.087)	(0.078)	(0.228)	(0.213)	(0.183)	(0.190)	(0.185)
Use of external sources of knowledge (university)	0.405***	0.543***	0.238***	0.358***	0.044	0.295	0.332*	−0.069	−0.081	0.487**
	(0.085)	(0.076)	(0.075)	(0.080)	(0.103)	(0.203)	(0.191)	(0.165)	(0.173)	(0.206)
Constant	0.311***	−0.076	−0.085	0.122	−0.094	1.344***	0.349***	0.639***	0.391***	0.377***
	(0.087)	(0.084)	(0.084)	(0.085)	(0.084)	(0.150)	(0.121)	(0.121)	(0.119)	(0.121)
LR χ^2 (8)	65.630	99.160	51.300	70.990	106.450	24.290	29.900	8.470	18.010	17.020
Prob > χ^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.292	0.011	0.017
Pseudo R2	0.041	0.050	0.025	0.040	0.550	0.068	0.064	0.016	0.034	0.036
Observations	1469	1469	1469	1469	1469	412	412	412	412	412

Standard errors in parentheses

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

activities increases (Crespi and Zuniga 2012; De Fuentes et al. 2015; Santiago 2016). However, access to public support is not significant for our full sample. However, as we will see later, access to public support is significant for some innovation barriers when we look at the two country cases in separate.

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 (Laursen and Salter 2004), or to address innovation barriers (Antonili et al. 2017). Our results suggest that indeed, identifying and using external sources of innovation has an effect on reducing the perception of innovation barriers. We also observed differences between successful innovators and unsuccessful innovators in the total sample. For successful innovators, access to knowledge coming from competitors is positive and significant for financial, qualified labor, regulation barriers, and lack of public support. While unsuccessful innovators, knowledge coming from competitors is positive and significant for labor, organization, regulation, and public support barriers. Knowledge coming from suppliers is particularly important for unsuccessful innovators, and it is positive and significant for financial, labor, and organizational barriers. In addition, knowledge coming from universities is positive and significant for all the five types of barriers for unsuccessful innovators.

Tables 7 and 8 report the results for successful and unsuccessful innovators differentiating by country. We observe several differences, and as we discuss below, the role of the context plays a significant role in the perception of these barriers. Our results contribute to those by Hadjimanolis (1999), as the country context plays a role in shaping innovation barriers for both successful and unsuccessful innovators.

Successful innovators from Mexico and Turkey perceive innovation barriers differently. The size of the firm and a lower percentage of employees in R&D are linked to lack of public support and financial barriers for Turkish firms. This can be associated to the lack of qualified human capital in Turkey, and also to the productivity gap faced between formal and informal firms. Many of small Turkish firms are informal (OECD 2016), and this set of firms can perceive that they are in a disadvantaged position to access public support in comparison to large, and in general formal firms. Associated to it, Turkish firms with no or limited access to public support for innovation, perceive high regulation barriers. Tight regulation and lack of trust remain critical deterrents of innovation and productivity for firms in Turkey, therefore this result was somewhat expected, as Turkish firms face a complex regulation environment for innovation.

Regarding the use of external sources of knowledge, our results show that successful Mexican firms are more active in finding and using knowledge from diverse sources, including competitors, clients, and universities. In particular, access to knowledge from competitors and universities is positive and significant to reduce labor and regulation barriers. Access to knowledge from suppliers is significant to reduce financial barriers. Access to knowledge from universities is significant for reducing labor, organizational, and public support barriers. These results are on line with those by Antonili et al. (2017) and Guerrero et al. (2017), and might indicate that the innovation system in Mexico is better connected, as firms identify and use knowledge coming from different sources to tackle several of the innovation barriers. As the OECD (2017) points out, there have been several policies driven to foster the innovation system in Mexico for several years.

Results from Table 8 indicate the factors that influence the unsuccessful innovators' perception of barriers to innovation. Our results show that more than successful firms, small size unsuccessful innovators feel at disadvantage regarding innovation barriers. For Mexico, smaller firms perceive organizational barriers, while for Turkey, smaller firms perceive

financial, organizational, and regulation barriers. This result might indicate a complex effect, as small unsuccessful Turkish firms might not be able to attract high quality human resources, entering in a sort of productivity trap, as indicated by the OECD (2016).

It is interesting to note that our results indicate that unsuccessful innovators mainly in Mexico recognize the importance of external sources of knowledge to tackle several innovation barriers. For example, use of knowledge from market sources (competitors, clients, and suppliers) is positive and significant for financial barriers, qualified labor barriers, organizational barriers, regulation barriers, and public support barriers. Knowledge from university is positive and significant for financial barriers, qualified labor barriers, organizational barriers, and regulation barriers.

4.2 Firms' perception of innovation barriers

This paper contributes to literature on the perception of innovation barriers by successful and unsuccessful innovators. In particular, it explored the factors that contribute to this perception in two different emerging economies, Mexico and Turkey. Based on previous contributions to the literature (see summary in Table 1), we analyzed five different types of innovation barriers, namely financial, organizational, qualified labor, regulatory, and those related to public support.

Following D'Este et al. (2012), Santiago (2016), and Pellegrino and Savona (2017), we differentiated firms between successful and unsuccessful innovators, not only because that recognizes difference in the perception of barriers across different firms, but because such distinction helps to address potential sample bias problems (see Pellegrino and Savona 2017). In addition, following Hadjimanolis (1999), we considered the role of the country context on the perception of these innovation barriers.

Our study contributes to advance the empirical and theoretical discussion on barriers to innovation from two different angles. First, consistent with previous studies, successful innovators and unsuccessful innovators perceive innovation barriers differently (D'Este et al. 2012; Santiago 2016; Pellegrino and Savona 2017), while the influence from different factors on a firm's perception of innovation barriers also differs between successful and unsuccessful innovators across different contexts. For example, we identify that firm size is an important factor for the perception of innovation barriers. Previous studies have argued that larger firms enjoy a larger endowment of financial and human capital resources (Crespi and Zuniga 2012), and they are usually more active in performing innovation activities (De Fuentes and Dutrénit 2016). Smaller firms from Mexico and Turkey tend to report more types of innovation barriers; moreover, they face a sort of circular trap as smaller firms are also associated with lower levels of productivity, in particular for the case of Turkey (OECD 2016), and they might not be able to attract highly qualified human resources. This result is even more pronounced for small unsuccessful innovators.

The role of employees in R&D has been emphasized by D'Este et al. (2014), who argue that highly qualified human capital plays a positive role in the perception of innovation barriers. Our results show that employees in R&D contribute to a positive perception of organizational barriers for unsuccessful innovators in Mexico, while successful Turkish innovative firms recognize the lack of employees in R&D as a negative influence on their perception of innovation barriers. This result has important policy and managerial implications. While it is necessary to strengthen education systems, firms need to be able to attract and retain highly qualified human resources, which can be a challenge for smaller firms in these two economies.

The analysis of open access to knowledge has been analyzed from different angles. Generally, access to external sources of knowledge is recognized as helping to advance knowledge production and innovation within firms. For example Antonili et al. (2017) show that university-industry interaction helps to reduce the perception of innovation barriers by firms. Our results are consistent with this finding. But also, the context plays a significant role. Access to external sources of knowledge contributes to reduce the perception of innovation barriers by successful and unsuccessful innovators from Mexico, while similar effects are not evident among successful and unsuccessful firms from Turkey. This result resonates with Hadjimanolis and Dickson's (2001) who suggest the relevance to explore how the perception of innovation barriers depends on firm's location. Strategies to counteract innovation barriers may be affected by contextual factors, including interactions between different agents in the relevant system of innovation.

5 Conclusions

This paper performed a comparative analysis of innovation barriers in two emerging economies to learn about the influence of country level characteristics on five different types of innovation barriers. In regards to innovative behavior, our findings coincide with previous studies (e.g. De Fuentes et al. 2015; Santiago et al. 2017) in noting the limited number of firms in developing countries that tend to perform innovation. From our sample, about 20% of firms from Mexico and Turkey were successful innovators.

Our results indicate differences in the perception of innovation barriers between successful innovators and unsuccessful innovators (D'Este et al. 2012, 2014). In our case however, the sample of firms considered for the study focuses on successful innovators, i.e. firms that have successfully introduced innovations to the market or indicate sales of new or improved products versus unsuccessful innovators, i.e. firms that have not introduced innovations to the market or do not report sales of new or improved products, but still report innovation barriers. We excluded from our analysis those unsuccessful innovators that do not report innovation barriers in order to eliminate selection bias.

Our findings indicate that for successful innovators, R&D employees provide key knowledge and skills that are critical to address financial and organizational barriers. This result is in line with those from D'Este et al. (2014) in the case of Spanish firms. Highly skilled employees underpin processes of knowledge creation and accumulation. From a management perspective, enhancing the number of highly qualified employees involved in R&D activities becomes essential to tackle innovation barriers, particularly knowledge-related barriers. For developing countries like Mexico and Turkey, where education systems tend to underperform relative to those of developed countries, public policies could help to face shortages in highly qualified human resources. Policy actions should continue to strengthen the quality of education systems and their connections to the needs of firms. Moreover, interventions could enhance programs that foster university–industry interactions through student internships at firms, or other forms of student mobility in particular targeting smaller firms. Initiatives that help adult population to engage in formal education to formalize skills acquired on the job may supplement small firm efforts at retaining personnel.

Coincident with Laursen and Salter (2014) and Antonili et al. (2017), we found that firms located in Mexico with access to external knowledge sources as input to their innovation processes are better off at addressing innovation 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. Firms in Turkey need more explicit strategies to capture and benefit from external sources of knowledge.

Our results suggest the need to foster access to the knowledge produced at universities and research centers in emerging economies, as more advance knowledge feeds the pipeline of applied knowledge that is later used by innovative firms. In addition, providing the system conditions for firms to interact with potential suppliers, competitors, and clients has been emphasized as a key element to further innovation.

Despite different forms of public support for innovation and R&D in Turkey and Mexico, firms still report access to public support as an innovation barrier. This has important policy implications that require conducting dedicated services to increase awareness of public support, especially among small business. Improving conditions of access to public support may also contribute to reducing the perception of lack of public support as a hindrance to innovation. Secondly, and in particular for the case of Turkey, to increase accessibility of public funds, it is necessary to reduce bureaucracy, and to provide additional support and training for the relevant staff in government agencies. At the firm level, it is pertinent to seek further information and advice regarding government support for innovation, and at the same time to build skills within firm employees to seek and build linkages with government agencies.

Regarding the interplay between firm's characteristics and country context as sources of innovation barriers, our study provides 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.

The level of intensity of local competition can play a positive role, as more intense competition forces firms to innovate at the organizational level to become more efficient, and also to engage more in innovation activities to remain competitive. Policies that improve the business environment and help firms compete in a more leveled playing field can make an important impact to boost innovativeness at the firm level. However, given the complex industrial setting of manufacturing firms in Mexico and Turkey, a comprehensive upgrading of the business environment might be needed to boost productivity and allow the most promising firms to grow faster.

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, in particular for smaller firms, fostering skills of their owners and employees. Benefiting from open sources of knowledge is also necessary; therefore, firms need to develop open innovation strategies. Therefore, firms, and in particular smaller firms can identify and establish linkages with universities to develop internship programs, benefiting from the best and brightest students, and also having access at an earlier stage to the best potential future employees. This strategy can also contribute to build linkages with universities and benefit via other channels of interaction (De Fuentes and Dutrénit 2012).

Finally, this study has several limitations, first the TurkStat dataset from Turkey provides information from the total population of manufacturing firms—formal and informal—indicating that there are productivity gaps between the total sample and the "fully formal" manufacturing firms part of the central bank database, while the dataset from

Mexico provides information of firms with more than 20 employees. Second, as the survey from Turkey only provides information on manufacturing firms, 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 Barras (1990), Crespi and Zuniga (2012) and Santiago (2016) amongst others, there are differences in the innovation determinants of service and manufacturing firms. 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. Third, 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. Fourth, the two surveys are independent, 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 developing and developed countries. Finally, future research is needed in order to include more comparisons at country level within the literature of innovation barriers, using multilevel methodologies.

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