

Technology-based business opportunity identification in a Latin American country

Identificación de la oportunidad en negocios de base tecnológica en un país latinoamericano

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Abstract

In recent years, the number and quality of entrepreneurial projects that pursue technology-based business opportunities in Latin America, specifically in Mexico, have been growing. To support such efforts, it is important to understand the process through which entrepreneurs discover and create a technology-based business opportunity with the available resources as well as its similarities and differences regarding those processes in industrialized economies. This research analyzes technology-based business opportunity identification processes in Mexico and compares it with what is reported in the specialized literature about such processes in industrialized economies. The findings are based on content analysis of eight in-depth interviews applied to technology-based entrepreneurs. Specific contributions are discussed for the analysis of the Latin American innovation ecosystems and to the available theory about technological business opportunity identification processes. The main contribution to the specialized literature is the identification of patterns in the technology-based opportunity discovery process in contexts where knowledge resources and infrastructure are less abundant than in industrialized economies. The results illustrate the importance of the processes and skills that technology entrepreneurs must deploy to gain knowledge they know exists and those they need to master in order to take advantage of knowledge-based economic opportunities.

Keywords: Opportunity identification; technology-based business; Latin America.

Resumen

En años recientes, el número y calidad de proyectos emprendedores que persiguen oportunidades de negocio de base tecnológica en Latinoamérica, específicamente en México, han ido creciendo. Para apoyar tales esfuerzos, es importante comprender el proceso a través de los cuales el emprendedor descubre y crea la oportunidad de negocio de base tecnológica con los recursos disponibles, así como sus semejanzas y diferencias respecto a las economías industrializadas. Esta investigación analiza los procesos de identificación de la oportunidad de negocio de base tecnológica en México respecto a los procesos que se han documentado en la literatura especializada en economías industrializadas. Los hallazgos están basados en análisis de contenido de ocho entrevistas a profundidad con emprendedores de base tecnológica. Se discuten algunas contribuciones específicas para el análisis de los ecosistemas de innovación en América Latina y a teoría disponible sobre los procesos de identificación de la oportunidad en negocios tecnológicos. La principal contribución a la literatura especializada es la identificación de patrones en los procesos de descubrimiento de la oportunidad de base tecnológica en contextos donde los recursos de conocimiento e infraestructura son menos abundantes, en comparación con las economías industrializadas. Los resultados ilustran la importancia de los procesos y habilidades que el emprendedor tecnológico debe desplegar para obtener el conocimiento necesario que le permitan aprovechar las oportunidades de emprendimiento intensivas en conocimiento.

Palabras clave: Identificación de la oportunidad; negocios de base tecnológica; Latinoamérica.

Recibido: 20 de octubre de 2018

Aceptado: 15 de agosto de 2019

Publicado: 30 de octubre de 2019

Como citar: Arechavala-Vargas, R., Núñez-López, V., & Madrigal-Torres, B. E. (2019). Technology-based business opportunity identification in a Latin American country. *Acta Universitaria* 29, e2417. doi: <http://doi.org/10.15174/au.2019.2417>

Introduction

The discovery and recognition of an opportunity is an essential step in any entrepreneurial process. Even though it is frequently conceived as a step or as an event that occurs at a moment in time, it is a complex and multidimensional process that involves psychological traits and dispositions, cognitive, social, and learning events and abilities, for example. It rarely occurs as a single event even though, retrospectively, it may be viewed as such. Starting with the seminal article by Shane & Venkataraman (2000), the specialized research literature has produced several fruitful lines of research that have grown in complexity over time, giving rise to knowledge that researchers use to discern the multidimensional nature of the process that entrepreneurs undergo in order to build an opportunity glimpsed into a technology-based firm.

Even though the starting point of the process may be stated in terms of the background, dispositions, knowledge resources, and values of the entrepreneurs, the process quickly evolves into a more complex set of variables, especially when other components of the institutional environment, resources the entrepreneurs gather through his social networks, and other resources available to entrepreneurs as they transform the initial enterprise into a viable business organization. The process frequently becomes an iterative one, as several learning cycles lead the entrepreneurs to change, sometimes radically, the nature of the opportunity initially envisioned.

In technology-based firms, the discovery and enactment of a business opportunity involves variables and processes significantly different from those in traditional enterprises. In a traditional firm, for example, financial resources are usually a necessary precondition for a business opportunity, while in a technology-based firm knowledge is usually the most critical resource: sufficiently innovative technologies may become a solid foundation in order to gain access to other resources, including financial resources. The opportunity discovery and enactment process, therefore, occurs under a different set of conditions, and evolves differently.

To study this process, this research is framed with the aid of the psychological and the Austrian entrepreneurship theoretical frameworks. The first one assumes that the "fundamental attributes of people, rather than information about opportunities, determine who becomes an entrepreneur and (2) this process depends on people's ability and willingness to take action" (Shane, 2000). From the Austrian perspective, "information about opportunities, (...) determine who becomes an entrepreneur". Even though these theoretical approaches may seem incompatible, it is shown that a combination of them helps build a better and more comprehensive view of entrepreneurial behavior.

This research builds upon contributions from several streams from the specialized literature on the discovery and construction of entrepreneurial technology-based opportunities, in order to set forth a dynamic view of the process that helps in the assessment of nine case studies of Mexican knowledge-based firms. The aim is to use this model to identify and understand similarities and differences between entrepreneurial opportunity recognition processes in technology-based firms in emerging economies and those that occur in industrialized countries, and to understand the ways in which Mexican entrepreneurs overcome the limitations that they face. In order to achieve this goal, the focus is on the following variables.

A dynamic view of entrepreneurial opportunity discovery

Knowledge plays a key role in the process through which an opportunity is identified and exploited (Davidsson & Honig, 2003; Li, Wang & Liang, 2015; Tang, Kacmar & Busenitz, 2012). Its role is obviously very important for any firm, whether it is a traditional or a technology-based one. In technology-based firms, however, knowledge gives rise and shapes the nature of the opportunity itself. Since technology-based

opportunities are generated on the basis of a technology's capacity to provide a product or service with better attributes than those already available in the market, technological knowledge and market knowledge are crucial in order to be able to perceive and identify a business opportunity (Choi & Shepherd, 2004; Wiklund & Shepherd, 2003).

Knowledge is therefore inextricably tied to the entrepreneurial team's background. Individually, her tacit and her explicit knowledge, and her absorptive capacity determine, not only those opportunities she can perceive and identify, but also the additional knowledge she must have or acquire in the process. Knowledge and absorptive capacity may also be obtained by incorporating new personnel into the entrepreneurial team.

Entrepreneurs discover opportunities based on knowledge and information they already possess (Shane, 2000). Individual differences determine those opportunities that can be perceived, those that will be pursued, and the ways in which entrepreneurial resources and efforts are organized.

Discovery, recognition, exploration, development, and exploitation of an entrepreneurial opportunity will frequently become a learning process that goes beyond the first entrepreneurial effort (García-Cabrera & García-Soto, 2009; Rerup, 2005; Wang & Chugh, 2014). Specifically, exploration and exploitation of the opportunity in any entrepreneurial effort will require a set of abilities, capabilities, and evolving knowledge, as opportunity exploration will usually demand more knowledge than was initially available.

Even more than in established or traditional firms, technology entrepreneurs must have the ability to identify a problem they can solve with their own resources (among which technological knowledge is a vital component), but they must also have the ability to identify and solve unforeseen problems through the acquisition of new knowledge.

Furthermore, entrepreneurs must also have a significant agility in finding new ways to solve newly found problems. In the manner proposed by Zahra and his group (Zahra, Sapienza & Davidsson, 2006), entrepreneurs must also rapidly develop and master dynamic capabilities in their organization (O'Reilly & Tushman, 2004; O'Reilly & Tushman, 2008; Teece, 2007; Teece, Pisano & Shuen, 1997), in order for his effort to be successful, and the development of those capabilities demands from them a steep learning curve, and the ability to rapidly identify and acquire relevant knowledge.

Just as knowledge and other personal resources determine the capabilities and disposition of entrepreneurs to identify and establish business opportunities, their resource network will have a determinant role in the identification, configuration, and filtering of what they select, and the mobilization of necessary resources for exploiting opportunities (García-Cabrera & García-Soto, 2009; Hoang & Antoncic, 2003). Resource networks may include mentors, technology transfer organizations, and public research laboratories, among others. In industrialized economies, the agglomeration of technology firms gives rise to a talent pool where people share technological capabilities, as well as explicit and tacit knowledge about what the technology commercialization process entails. In such environments, collaboration networks increase the possibilities for combining complementary capabilities in order to discover new technology-based business opportunities (Cooper & Park, 2008). Networks are in themselves a means to access knowledge (Owen-Smith & Powell, 2004; Powell, Koput & Smith-Doerr, 1996; Salavisa, Sousa & Fontes, 2012) and technological capabilities, a key resource in technology-intensive entrepreneurial projects (Haeussler, Patzelt & Zahra, 2012).

Business opportunity identification is not a one step process. In most cases, it is a process of discovery and adaptation, in which entrepreneurs discern or perceive an opportunity, obtain the resources they need to exploit it, and assess the likelihood for success. While conducting this assessment, and trying out available resources and their configurations, they will repeatedly assess the technological viability of the original concept and the likelihood of it being accepted in the market. Each of these cycles may result in necessary changes to the originally envisioned opportunities, any of which may turn out to be more attractive or viable. In such cases, entrepreneurs will make changes to the original concept, changes in the target market, or both. Availability of resources will also give rise to resource and business model reconfigurations.

In pursuing opportunities that frequently present themselves as moving targets, technology-based firms will likely be forced to develop dynamic capabilities for discovering, exploring, and exploiting specific business opportunities (Jantunen, Puumalainen, Saarenketo & Kylaheiko, 2005; Teece, Pisano & Shuen, 1997).

Technological entrepreneurship in Latin America

Most of the specialized literature on the identification and enactment of a technology-based opportunity deals with the process as it occurs in industrialized economies. Latin America, however, is still in a more basic level in terms of the development of the necessary conditions to promote the development and survival of technology-based firms. The maturity level of institutions in Latin America is still much behind those of industrialized economies (Katz, 2001). Even countries like Colombia, Brazil, Argentina, and Mexico, the biggest economies in the region, are still struggling to build mature intellectual property regimes (Li & Kozhikode, 2009); their universities and public research laboratories still struggle to develop relevant technologies (Kalergis, Lacerda, Rabinovich & Rosenstein, 2016) and to transfer them to industry (Arocena & Sutz, 2000; 2001; Katz, 2000). Venture capital is scarce (Bruton, Ahlstrom & Puky, 2009), and firms usually have little demand for technology as a strategic resource.

For advanced economies, in contrast, specialized literature on the development of regional innovation systems, industrial districts, innovative milieu or innovation clusters is abundant. Also, the subject of how these systems influence the capacity to attract and develop human talent, their impact on the generation of entrepreneurial opportunities and the process and conditions for the development of technology-based firms are plentiful. Also, copious is the literature on how these environments foster the right conditions for the development and spillover of explicit and tacit knowledge about technological capabilities and their commercialization (Harrison, Cooper & Mason, 2004; Keeble, Lawson, Moore & Wilkinson, 1999; Longhi, 1999). This knowledge finds its way into entrepreneurial efforts and into those organizations that support them (Cooper & Park, 2008).

Transition and emerging economies are environments in which many of the factors that enable and shape the recognition and construction of technology-intensive entrepreneurial opportunities are significantly different from those in industrialized economies (Bruton & Rubanik, 1997; Bruton, Ahlstrom & Puky, 2009; Bruton, Dess & Janney, 2007; González-Pernía, Jung & Peña, 2015): their institutional frameworks are not solid enough, R&D infrastructure is much less developed, and knowledge availability is much lesser. All these factors make technology entrepreneurship less likely, and those that occur are more fragile (González-Pernía, Jung & Peña, 2015).

Latin America still struggles to develop the right set of institutions and programs to support new technology-based firms (Arocena & Sutz, 2001; Casas, De Gortari & Santos, 2000; Cimoli & Katz, 2003; Cimoli, Ferraz & Primi, 2009; Katz, 2001). Some of these factors operate in a similar fashion in small open

economies (Autio & Yli-Renko, 1998; Yli-Renko, Autio & Sapienza, 2001) but, to one's knowledge, there is preciously little research that helps understand the similarities and differences in the ways in which technology-based entrepreneurial opportunities appear and develop in these two different contexts.

Generally speaking, because of similar development patterns, countries in Latin America share a history of economic dependence on the exploitation of natural resources (Alcorta & Peres, 1998; Amorós, Fernández & Tapia, 2012; Blanco & Grier, 2012; Cimoli, Ferraz & Primi, 2009). Industrial development is a relatively recent phenomenon, and scientific and technological capabilities are still relatively weak (Casas, De Gortari & Santos, 2000; De Gortari & Santos, 2004).

Despite these sharp differences between the industrialized and the Latin American contexts, several countries in the region, Mexico among them, are deploying considerable efforts and resources to develop technological capabilities and innovative entrepreneurship. Even though significant success is being achieved, a better comprehension is needed regarding the process through which technology-based firms appear and survive.

How do technology entrepreneurs identify and pursue technology-based business opportunities? How do these processes differ from those in more industrialized economies? In which ways do the relatively weaker institutional contexts and the relatively less abundant technological capabilities and infrastructure affect the apparition and development of technology-intensive entrepreneurial endeavors?

The goal in this research has been to study and assess the process through which technology-based entrepreneurial opportunities are identified and pursued in Latin American countries and, particularly, in Mexico.

Although this is done on the basis of established knowledge about the process in more industrialized economies, the focus is specifically on variables that are expected to behave differently, mainly those that reflect the availability of knowledge resources, and those that reflect the solutions that Mexican entrepreneurs deploy in order to achieve success in that context.

Method

A systematic content analysis of in-depth interviews in eight case studies of technology-based entrepreneurs is carried out. Firms selected for participation were required to have been founded within the last five years, based on a knowledge-based opportunity. Holding intellectual property rights was not a requirement, in that it is not necessarily the best strategy to develop and maintain a competitive advantage in contexts where intellectual property right institutions are still in development, and where high technology business opportunities are not yet a common occurrence.

Procedure

Content analysis of interview transcripts was done using NVivo 11 Pro qualitative analysis software. Coding is based on the theoretical categories explained above. Inductively discovered categories were also used when the variables of interest were found to be in close relationship with the research focus. The grounded theory (Corbin & Strauss, 1990; Eisenhardt & Graebner, 2007; Glaser & Strauss, 1967) approach was used at this exploratory stage in order to generate empirically testable theory for future research. The grounded theory approach seeks to explain as well as to describe phenomena. In the content analysis, references (interview fragments) are used not only to identify variable relationships, but to explain the how and why those relationships hold in the cases studied.

In content analysis, under this approach, coding is done under the assumption that change and variability is inherent in the processes under study. The aim is to describe, understand, and explain variable relationships in terms of the role they play in the entrepreneurial discovery process itself. In doing so, this analysis aims to identify *patterns* in those variable relationships and to build theory from them. Patterns are identified through a process of systematic comparisons to highlight similarities and differences among cases.

Although coding categories are derived from research on technology-based firms in high-technology contexts, the purpose is to document the specific differences that the process exhibits in contexts where knowledge resources, networks, and infrastructure are less abundant. In order to discover variables and patterns not necessarily connected to categories derived from the literature about these issues in industrialized economies, the data (interview transcriptions) is explored with the help of NVivo's *Word Cloud* tool. An example of this data visualization is given in figure 1.



Figure 1. 200-word cloud.

Source: Made from interview transcripts using NVivo software.

A three-stage approach was used, successively restricting the number of words, in order to highlight patterns in the data not necessarily related to theoretical categories initially considered. Thus, it is identified the relevance of alliances and collaboration networks with public laboratories and universities, as well as *hiring more talent* as important patterns in the data, which further help in the content analysis and identification of relationships among variables in the process studied. As further coding proceeds, these variables enable the identification of issues such as *local market preference for foreign goods* as problems that need to be overcome in emerging economies, in order to realize technology-based business opportunities.

Following the grounded theory approach, sampling proceeds on theoretical grounds: cases are selected in which instances of technology-based entrepreneurial opportunities are being followed, aiming to study interviewees' accounts of their discovery process. Participating firms come from different sectors, including health biotechnology, pharmaceutical products, functional foods, electronics, engineering and design services, animal health, financial services and bioremediation.

Results

The first focus is on those results related to the Austrian view of the role of knowledge in opportunity recognition, and, after that, results more related to entrepreneurs' traits and dispositions (the psychological approach) are presented.

Knowledge is a key resource for this kind of entrepreneurial endeavours. It may be about solutions to market needs, about the availability of solutions for them, or about the possibility of developing solutions for them based on specific technologies.

In contrast to what has been reported in the literature about opportunity recognition in industrialized economies, it is found that, in Mexico, opportunity recognition is more dependent on less structured knowledge sources available to the entrepreneurs.

Sources of knowledge used in the recognition of opportunities

1) Market Knowledge through Informal Networks

Opportunity recognition may be based on market knowledge about the existence of a need that can be fulfilled using technology. This knowledge is not necessarily part of the entrepreneurs' background, whether formal education or working experience. It can be shared with them through informal contacts in their network:

I make it a point to mingle with people older than me, who have more business experience. I like to learn from them. I met a person that told me about the project, and I found it very interesting. I knew I had the possibility of investing, and he told me that it was a business model that could bear results in the medium to long range, not a short range one, but that it came with a lot of future possibilities. (L).¹

2) Formal Education

Formal education is frequently, however, the principal source of knowledge that leads directly to the recognition of the business opportunity:

(After getting a PhD degree in England) I came back to my country. Being here, I approached several universities just to see what was going on, and how the academic environment was. I noticed rather that I would have more impact if I created my own company and started to work with all these academic institutions and research laboratories in order to bring things out to market, that would really have an impact in society. (I)

(The business idea) comes from talks between a cousin and me. He had created a firm, and things had gone good for him. As I graduated there was a recession, I searched for a job, but I ended studying for a specialty diploma. Once I finished, my cousin and I talked. He put forth the idea that we create a company, instead of me searching for a job. That's when we explored markets and began to look for an interesting niche, where I could use my engineering knowledge. (N).

3) Market Knowledge Gained from Work Experience

Work experience is an important source of market knowledge that enables the recognition of business opportunities:

¹ To protect confidentiality, in what follows, specific firms are identified only by a letter at the end of each interview fragment.

The idea for the firm emerged while working in another business, in a different firm that we had, we used to sell publicity to small businesses; we needed to collect our fees through credit card and, realizing how complicated it was to obtain a traditional bank terminal, we decided to develop a more convenient solution. (B)

(The firm) was born out of the need we found in the market for biotechnology tools to control diseases, both animal and human diseases. The firm originates from that need we saw there is, in some market niches, an underuse of technology to solve certain problems. (U)

We discovered this because some of the products that we were manufacturing as chemicals would use some of these products to make them a little less noble and to help in the biodegradability of the by-products (...) But after certain process that we carried out we realized that we were not solving the root of the problem (...) somebody said: 'Well, it can be done with microorganisms'. So, we started to do research all of this stuff, and all of it came out, we dove completely into biotechnology. (Bs)

In Latin America, access to cutting edge technology is not easy. Research infrastructure is not abundant, and researchers working on high technology projects are not easy to come by. Products with significant technology components tend to be manufactured by large firms that usually are subsidiaries of MNC that exploit technologies developed abroad. Many technology enterprises are founded by entrepreneurs that know the feasibility of developing comparable solutions with equivalent technologies from other sources, with a cost advantage and avoiding direct competition with incumbent firms.

Network and talent pool development

As the opportunity begins to be realized, from the initial idea into a viable organization, the initial concept usually requires more technology to be developed with more specific goals in mind. The entrepreneurs' resources quickly become insufficient, and they will need to tap other knowledge sources.

1) Alliances and collaboration networks with public and university laboratories.

The need for more knowledge quickly leads entrepreneurs into a search for alliances and collaborations with university laboratories and with other R&D organizations, starting from a local search, and promptly reaching national and international levels.

(...) So, then I approached the state university, with its researchers, because I knew the kind of services they could provide me, because what is important is to go and talk with them, and see what they have, and join them into the project that I already had in mind. The same happened with the (public research center), I had a need, and I approached them, and then, because of those relationships, new collaborations with other private and foreign universities, through a colleague of mine, from England. (I)

We started empirically, with no critical mass. First, we approached the National Nutrition Institute, looking for Dr. (...) who at the time was the maximum authority in Latin America in the subject of probiotics. We sought people who had a name in the field (...) as we began to know about bacteria and nutrition we started joint development efforts with different research centres in the field. And, so, our network kept growing, until we reached people in Germany, Brazil, and universities in the US and other countries. (K)

Our products have what is known as a biological function. When ingested, they cause changes in the microbiota and, therefore, in the metabolism of the people who consume them. But we want to be responsible and have proof of what we say when we get to market, that it has been verified and proven previously. We have four protocols running with the Mexican National Nutrition Institute, in Mexico City, with different clinics over there; with the Cardiovascular Disease Clinic, with Food Science and Technology; another one with Gastroenterology, another one with a private university, and a very interesting one with Nutritional Physiology, with new concepts in nutritional issues; and we have a validation protocol running at Reading University in England (...) with our

State University, with whom we have collaborated for more than three years, and that we are very happy with.
(Bs)

2) Hiring more talent

Frequently, knowledge needed to evaluate, explore, and exploit an opportunity can only be acquired by hiring personnel with the needed experience:

(...) we hire people that has experience and expertise, a certain profile, and an interest in the area. We seek experts that may help us. (N)

(...) besides hiring suitable personnel in each area, and having them in constant training through participation in conferences (...). (L)

I started to hire highly trained personnel, young scientists with a passion for what they were doing, with the background that I needed (...) (a recent hire) had the right background, she had worked with materials and biomaterials, she was working with new materials, she was a chemical engineer, with plenty of experience in laboratories. 'Come for an interview', I told her, and she came, and she has all the capabilities that I need (...). (I)

Business model change

However, since the opportunity evolves rapidly, and since the right expertise is usually not available locally, entrepreneurs realize that, rather than looking for specific knowledge, they must bring in people able to learn quickly. Entrepreneurs rapidly become aware that, to take advantage of the opportunity, learning skills and absorptive capacities are more important than specialized knowledge stocks. Their business model itself changes rapidly, so an agile team, able to change the business model, must be built. Sometimes, a business model with shorter time to market, or a significant change in technology, is needed, while still seeking the long-range goals, markets, and business model.

(...) starting from our initial experience and seeing that the solution that we proposed initially did not solve the pain that at the time we had detected, the pain was still there, and accepting card payments was still complicated, and when we realised that, beyond the device, it was the manner in which registration proceeded, the manner in which the service was provided, was what changed the outlook that a business could have when accepting payment cards. (B)

At first, I really wanted to build a product from scratch, a bone implant from start to market in little time, but I realised that, because of regulations and everything, it was going to take a little more. Then, at the same time that I am developing an implant, I am developing other things on the basis of the same technology that, even though they have a lot to do with health, they are not directly implants (...). (I)

The greatest challenge was at the beginning, due to the number of people who were part of the team, to balance the technical and the marketing parts. If we sold something, we had to develop it too, and that stood in the way of growth. We also lacked, when we started, to keep an eye on scalability; that is, to build a business model that enables us to grow into a growing market niche, as well as into a market niche that provides margins big enough to support that growth. (...) so, now we want to be attractive by offering more aggregated value. Specifically, we are trying to go from being a service enterprise to become a firm with a business model based on products. (N)

We started everything with the idea of a product, specifically for the animal health market. Our original idea was that we develop the product, we manufacture it, and we sell it to producers here in Mexico, regionally. It didn't work because producers do not buy from small firms, much less when they are composed of only four people! So we changed our business model, and we thought: 'If producers only buy from big pharma, join forces with one of them so that it sells them'. We got (a big MNC). We changed the business model. We own the technology, we would manufacture the product, and they would sell it nationally and internationally. Then we got interested also in the human health market. So, we changed our business model: we are not a product company, we are a

technology firm: we develop technology to solve problems. So, we changed our business model, where now we identify problems, we tie them to technologies that we can develop, we develop and launch them together with someone else. So, it worked, but we found out that it was not a good idea to leave all of the market in the hands of a third party, so we now participate also seeing how we can capture more of the product's value. So, we change the business model: now we have a hybrid one: for very big clients, such as the government and international organizations, we sell it to them by ourselves. For others, we develop strategic alliances, for those markets that are more difficult to enter, where a larger sales force is needed. (U)

Factors that are specific to emerging economies

While building the opportunity, entrepreneurs must face a series of issues of varying kinds. According to the psychological theory, entrepreneurs deploy specific traits and skills that enable them to succeed in their endeavour. The following interview excerpts are illustrative of the kinds of issues that entrepreneurs face and the traits that enable them to deal with unforeseen challenges. Resilience and perseverance are as important as for any entrepreneur, but for technology-based firms in Latin America, the odds are not as positive in obtaining the necessary resources, for example. A will to learn the necessary knowledge must also be a salient trait in the entrepreneurial teams.

I choose correctly, I think, those people whom I befriend, and I have learned a lot from them. (...) My friends are over 60, on average. I am 38, and I tend not to befriend people my age. I learn a lot from older people, about how they manage their businesses, about how they achieve stability, about their successes. I think that has been key. (...) I met a person that told me about the project, and I found it very interesting. He knew I had the possibility of investing, and he told me that it was a business model that could bear results in the medium to long term, not in the short term, that [the business] came with a lot of future possibilities. (...) So, I started to attend scientific conferences without being myself in that business sector. I had a construction enterprise, and I have always dedicated myself to construction projects, and to other activities that have nothing to do with health. (L)

Since we had little money, we had to work in a very orderly fashion, and were forced to rely on help from public R&D and from the universities. (...) We were short on resources but had a clear goal. (...) we started to build the most powerful technology network in Latin America. We worked out alliances with the national university, with the biggest technological institute, and with the most prestigious private university, and with the most prestigious public national research institute. We have forged alliances with German research institutes, with institutes in the United States with a Brazilian university (...) Researchers have not only been helping us in the developments but have also provided us research issues with which we have generated a synergy in developing products that go from basic science to the supermarket. (K)

Engineering schools teach you technical things, but they don't teach you much about business. It was a real challenge. But I came through, with my cousin's help, who had a lot of experience and knowledge, that's how we got the enterprise going. (...) After that, because of specialization, another challenge was selecting and recruiting personnel, because we were competing with big firms, such as X, that are very attractive among engineers. Even as we have them with us, we are worried because they can recruit them any moment. Last December, one of these big firms recruited two of our employees, because their profile is valuable for them, it is compatible with what they do. (...) Projects have also been a challenge, since they are not usually the same. They can be based on different technologies. (N)

I had to explain step by step to a public research centre representative the reasons why my idea was going to work, and the importance of it working. After two hours, I managed to have him understand, and he said: 'Ok, we will partner with you, we go together. We will get started with the Project and see how it goes'. (...) The instrument supplier would not answer my calls, he would not answer my emails. Zero. (...) it is a laser, it is not a simple equipment, maybe that is why they would not pay me any attention. So, I went to one of these international conferences on materials and say: 'can I get in touch with somebody, or how do I buy one?'. About a week later I had six emails from (a company) offering their services and apologizing for not responding to my requests. That is the issue, to keep trying, to not give up. (...) It took us three months to buy a software, with interviews with the developer, interviews with distributors, answering questions about why we needed that

software, since nobody in Mexico or Latin America wanted it, about what we wanted it for. (...) We wanted to control all of those internal structures, in order for bone to be assimilated, and that software only could provide that. And we were very happy to have found it, to have tried it, and to talk with the developer, but they would not sell it to us, until we said: 'Ok, where do I transfer the funds? Another month went by, and finally they provided it to us. (I).

We tried to go directly to poultry farmers to sell them the product. They would not buy it, saying they did not buy from small firms (...), so we had this crazy idea and we said: 'Well, if we cannot sell it, why not partner up with a big pharmaceutical firm, and have them sell the product. We went directly to the multinational corporation. One meeting. And they said: 'Yes, we are interested'. I remember, at the very beginning, we would go to research labs and they would look at us as if saying: 'What do you want to do? You are four guys with little money, wanting to do something.' (...) Now I do not feel frustrated because, first, we have now more abilities, we have more contacts (including contacts abroad) that can help us get resources. Second, because I now know that, if I get annoyed, I am not going to get anything. (...) I believe that one of the most important things that an entrepreneur learns is resilience. (...) If you are not able to solve your problems, able to find alternative ways of getting things done, able to endure stress, and everything that can go wrong, then your business is not going to prosper. We have gone through every error in the book and, even so, we are here because we have endured and we have learned. (U)

Discussion

Even though Latin American technology-based firms rarely develop high technology, and they tend to rely more on scientific publications, opportunity discovery is seldom a single event, but a gradual and iterative process. The entrepreneurs' initial knowledge stock is only enough to glimpse a potential opportunity, and that knowledge is rarely enough to establish a new firm. The perceived opportunity is usually a moving target that demands a steep learning curve, to sharply focus and define the opportunity.

One of the outstanding differences with technology-based firms from more advanced economies is usually the availability of knowledge sources and the level of knowledge that entrepreneurs can tap from their environment. The search for needed knowledge starts locally and tends to quickly reach international sources. This search, however, tends to avoid direct competition with incumbent firms from industrialized economies and tends to limit itself to more widely available knowledge that help to maintain a cost advantage.

Emerging economies represent an environment with substantial constraints for technology-based entrepreneurship. Given that resources are not as widely available as in industrialized countries, entrepreneurs must redefine the opportunity continually, and they must quickly learn to adapt their strategies and business model, while (at the same time) learning and acquiring new market knowledge, and new technical knowledge. They will repeatedly change their business model to accommodate the need to gather more resources, whether financial or knowledge resources, and to shorten time to market that enables them to obtain resources needed to survive while pursuing their long range goals.

This requires the entrepreneurs to build agile management teams where, more than established expertise, the ability to learn and the ability to switch business models along the way are important assets. This agility depends more on entrepreneurial traits and dispositions (the psychological view) than on available resources (the Austrian view). However, it is the interplay of these two dimensions that shape the entrepreneurs' chances of success.

However, whether similar conditions and processes apply in other Latin American countries that share similar institutional contexts and resource constraints is still to be established. However, similar

patterns of economic development, and similar patterns in cultural business values and skills, make it likely that entrepreneurs need similar skill sets, traits, and dispositions to be successful. Latin American countries share also similar patterns of development in their scientific and technological capabilities. Their R&D infrastructure shows similarities as well, and these similarities are likely to affect their entrepreneurial ecosystems in a comparable fashion. However, given that technology enterprises tend to rapidly enter global markets, firms from the region will need to rapidly develop stronger scientific and technological capabilities to be competitive.

Thus, the main contribution to the specialized literature relies in documenting and identifying patterns in the technology-based opportunity discovery process in contexts where knowledge resources and infrastructure are less abundant than in industrialized economies. More generally, results illustrate the importance of the process and skills that technology entrepreneurs must deploy in order to gain knowledge they know exists, and that they need to master in order to carry on with the realization of knowledge-based economic opportunities. An obvious limitation is that results presented here correspond to entrepreneurial accounts provided by Mexican respondents only. Parallel case studies are currently conducted in other Latin American countries. It is also conceivable that similar conditions will prevail in other emerging economy contexts, and even in relatively less-developed regions within more advanced economies.

Further research may usefully also address the role of variables relating to other resources where significant differences exist with regards to more advanced economies: angel and venture capital availability is one of them, but other institutional differences such as intellectual property right protection and avenues to internationalization are important policy issues in countries where there is an interest in fostering the development of the knowledge economy.

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