Abstract

Purpose – This paper aims to empirically explore the influence that different factors have on the creation of university spin-offs.

Design/methodology/approach – This is an exploratory study that uses a multilevel design. The study follows a purposive sampling method where data are gathered from a variety of sources. The hypotheses are tested with a sample of 52 universities from the Latin American region using multiple hierarchical regression analysis.

Findings – The results indicate that entrepreneurial orientation, incubators or entrepreneurship support programs and goods market efficiency are the factors that positively influence the creation of university spin-offs.

Research limitations/implications – The results of this study should be observed in light of some limitations. The sample size is an important factor, as a bigger sample could allow for examination of cross-institutional variation in the context of different countries. In addition, the lack of records or public databases makes it difficult to incorporate more information on spin-offs creation, including features or firm performance.

Originality/value – This study is the first to empirically explore the university spin-offs creation phenomenon in the Latin American region. Hence, it contributes to university entrepreneurship literature, specifically to better understand this phenomenon from a more holistic perspective across different levels of analysis at the same time that it incorporates previous proposals to explain entrepreneurial orientation at universities.

Keywords Entrepreneurial orientation, University entrepreneurship, Entrepreneurial university, University spin-offs

Paper type Research paper

Introduction

At the heart of university entrepreneurship literature lies the concept of an entrepreneurial university, which views entrepreneurial activity as a step in the natural evolution of a university system that emphasizes economic development in addition to the more traditional mandates of education and research (Etzkowitz, 2003). According to Clark (2004), an entrepreneurial university can generate a focused, strategic direction, both in formulating academic goals and in translating the knowledge produced within the university into economic and social utility.
The literature on entrepreneurial university demonstrates that it is a relevant topic within the field of entrepreneurship, although the literature is fragmented (Cunningham and Link, 2015). Most of the studies in this research stream have attempted to reveal different internal elements that inhibit or enhance the commercialization activity of the university (Rothaermel et al., 2007). However, at the same time, universities are embedded in a larger environmental context, and the feedback from the external environment continuously influences the way in which the universities participate in entrepreneurial activities (Sternberg, 2014).

Among the instruments available for universities, new firm creation (i.e. university spin-offs) appears to be one of the most important mechanisms to measure their entrepreneurial activity (Audretsch, 2014; Avnimelech and Feldman, 2015; Di Gregorio and Shane, 2003; Rasmussen et al., 2011). University spin-offs are important to the commercialization of academic knowledge (Rothaermel et al., 2007) and are presumed to be an important mechanism for regional economic development (Astebro and Bazzazian, 2011; Hayter, 2015).

As such, this study focuses on the effect of both external environment and the academic internal environment on the rate at which spin-offs are created to exploit university knowledge, technology or research results. This study can clearly benefit from a more holistic perspective across different levels of analysis (Hitt et al., 2007). Hence, the objective of this study is to explore the multilevel interactions of different factors involved in an entrepreneurial university. It is expected that the results can aid in moving beyond understanding the individual pieces of the entrepreneurial university puzzle toward a more holistic understanding of this complex and multifaceted process. If this is possible, this study will make two main contributions to the field of entrepreneurship.

First, this study contributes by investigating to what extent previous proposals are suitable in explaining the entrepreneurial posture of universities (Todorovic et al., 2011; Riviezzo, 2014), as such proposals were developed for universities operating in completely different contexts. Second, in the academic community, there is no general agreement on the main factors involved in the creation of university spin-offs. According to Hitt et al. (2007), studies should start from a multilevel model that includes the organization level and the environment level to further examine the interrelationships between factors. Therefore, this study contributes to this gap by exploring multilevel interactions between department, university and national factors that may jointly influence the creation of university spin-offs.

The structure of this study is arranged as follows. After the introduction, the literature review and hypotheses are developed. Next, the methodology and main results are presented. The study concludes with a discussion of the main results and contributions, as well as proposals for future research.

**Literature review and hypotheses**

*Entrepreneurial orientation in universities*

The concept of an entrepreneurial university emerged from the new social and economic landscape in which universities seek to contribute to innovation, competitiveness and the economic growth of the territories in which they are located (Guerrero et al., 2016). Universities contribute to economic growth through different mechanisms, such as creating pre-conditions for regional learning systems, generating technology based spin-offs, collaborating in R&D with companies, commercializing research activities and establishing corporate research contracts and training scientists, engineers, researchers and other graduates (Uctu and Jafta, 2012). In this sense, according to Guerrero et al. (2015), the role of universities is dichotomous, because they focus on both innovation and entrepreneurship. Based on this competitive landscape, universities should change their traditional orientation
to an entrepreneurial orientation (EO) to meet regional economic and societal needs (Kirby et al., 2011).

EO can help universities to be more creative and innovative and be prepared to take risks in addition to strategically aligning their structure to respond quickly to market needs (Bhayani, 2015). However, the roots of EO can be traced to the strategy-making process literature and have been considered a strategic construct at the firm level. EO considers administrative practices, philosophies and styles in making decisions that are of an entrepreneurial nature (Anderson and Eshima, 2013). In essence, EO characterizes the practice of entrepreneurship in the organization and the strategic posture of the firm as a whole (Anderson et al., 2015).

Although the past 30 years have demonstrated significant advances in the study of EO (Martens et al., 2016; Wales, 2016), application of the concept in other organizational contexts remains an underexplored area, and there is still no precise definition of what it means (Morris et al., 2011). Thus, it is convenient to study the application of EO in an especially distinctive context, like that of the universities, and then adopt a definition of the construct that is different from that used for private and profit-oriented organizations.

Zhang et al. (2014) developed a new scale for measuring EO, which is neutral with regard to industry context and type of organization. However, according to Todorovic et al. (2011) and Riviezzo (2014), it is possible to apply the concept of EO within organizations that are not profit-oriented, such as universities, because they may pursue the strategic aim of creating value and opportunity through a continuous search for innovative activities. However, this application must take into account the peculiarities of the universities and then propose adjustments to the scale to measure EO. Moving from this point, Todorovic et al. (2011) developed a scale designed for the context of Canadian universities that considered four dimensions: research mobilization, unconventionality, industry collaboration and university policies. Later, Riviezzo (2014) showed that the operationalization of Todorovic et al.’s (2011) scale is slightly different when applied to an Italian context.

There are many forces influencing universities to seek more entrepreneurial approaches to diversify revenue and contain costs (Clark, 2004). Commercialization of university research has become one way to increase university revenue through revenue sharing with inventors or patent-based royalties (Baldini, 2010a; Savva and Taneri, 2015). However, more recently, universities have played a direct role in the creation of new firms. The new firms that emerge from the university context and which are created to commercially exploit knowledge, technology or research results that were developed within the university are known as university spin-offs (Karnani, 2013; Pirnay et al., 2003; Rasmussen and Borch, 2010).

University spin-offs exhibit a performance premium and produce a larger stream of social benefits and greater dynamic capabilities than industry start-ups (Czarnitzki et al., 2014; Ortin-Angel and Vendrell-Herrero, 2014). Previous studies have considered these spin-offs as a measure of potential commercial outcomes of an entrepreneurial university (Audretsch, 2014; Avnimelech and Feldman, 2015; Rasmussen et al., 2011; Román-Martínez et al., 2017). Therefore, based on the previous arguments, this study states that:

**H1.** A university’s EO is positively related to the creation of university spin-offs.

**The influence of university-level factors**

The influence of university-level factors has been important in spin-off activity. Besides educational support, universities can also support the spin-off creation process by creating an environment conducive to entrepreneurship. Kraaijenbrink et al. (2009) argue that such
supportive environments may give students (and academics) the confidence to initiate their own businesses. Recently, Mustafa et al. (2016) demonstrated that in the Malaysian context, the university support environment was a significant predictor of entrepreneurial intentions among students.

The university entrepreneurship literature provides some theoretical reasons to suppose that the interaction between EO and university-level factors should increase spin-off creation. However, previous research has not been conclusive, and the results have been diverse (Harrison and Leitch, 2010; Meoli and Vismara, 2016). Among the university-level factors that have been associated with an entrepreneurial university and that have been well established in literature are the use of incubators or entrepreneurship support programs (Di Gregorio and Shane, 2003; Meoli and Vismara, 2016). Some universities offer incubation services, which create a supportive environment to increase the potential of spin-offs (Clarysse et al., 2011). According to Jensen and Thursby (2002), most university technologies or research results are embryonic, requiring further development before they can be sold in the marketplace. Slavtchev and Göktepe-Hultén (2016) revealed that spin-offs supported by the parent organization in the early stages (i.e. nascent and seed) were able to generate their first revenues sooner.

Incubators or support programs not only help entrepreneurs to improve their business proposals around the technologies, thus obtaining a better commercial impact, but also determine the performance of spin-offs (Epure et al., 2016; Soetanto and Jack, 2016). Rasmussen and Wright (2015) argued that universities can promote spin-offs by suggesting that the nature of the support depends on the specific demands of the spin-offs. In some instances, university incubators or programs may be independently operated while still working jointly with the university (Fini et al., 2011). In other cases, the incubators or programs may be units of the university (Van der Sijde et al., 2002; Menzies, 2002). Whatever model the university follows, the study conducted by Ikebuaku and Dinbabo (2018) in Nigeria suggests that to enhance entrepreneurial capabilities, business incubation and entrepreneurship education should be integrated. Therefore, the use of incubators or support programs should increase spin-offs creation.

Another university-level factor in fostering spin-off creation that has been documented in the literature is the role of technology transfer offices (TTOs). For example, Huyghe et al. (2014) have studied TTO activities and how these activities help nascent spin-offs during the pre-spin-off process. Although the creation of university spin-offs typically represents the main route to research commercialization, the studies of Lockett and Wright (2005), Nosella and Grimaldi (2009) and Macho-Stadler et al. (2008) have shown that TTOs engage in various support services for the commercialization of academic research. Among the main services that these studies have identified are advising, mentoring and networking with organizations involved in technology-transfers activities. However, Rasmussen and Wright (2015) show that these kind of services in fact have minimal impact on spin-off creation.

On the other hand, Avnimelech and Feldman (2015) suggested that the higher the share of royalties received by the investor and the more efficient the TTO in terms of licensing revenues, the higher the formation rate of spin-offs. Additionally, Goel et al. (2017) declared that there are not only qualitative differences among the different modes of university–industry collaboration but also differences in the intrinsic motivations and reward structures of academia and of industry. Still, Rasmussen and Borch (2010) have pointed out that if TTOs do not represent a high priority across all hierarchical levels of the university (i.e. president, deans and directors), then the university is not likely to create many spin-offs from this policy. Moreover, Goel and Göktepe-Hultén (2018) found that under certain
circumstances, researchers are more likely to bypass a TTO to commercially exploit their research results.

Finally, previous studies have shown that spin-off activity is positively related to research productivity and quality (Avnimelech and Feldman, 2015; Colombo et al., 2010; Di Gregorio and Shane, 2003). Universities that are more intellectually eminent could be more likely to generate spin-offs because intellectual eminence allows schools to produce new technologies of perceived higher quality. Di Gregorio and Shane (2003) found that spin-offs from top universities were more likely to attract venture capital than those from less prestigious institutions. They also found that the university’s ranking positively influences academic spin-off formation rates, and that it is easier for academics from top-tier universities to assemble resources to create start-ups owing to their increased credibility, which is consistent with Avnimelech and Feldman’s (2015) study results. This is because the prestige of a university is related to the prestige of its researchers, who, to reap the benefits of their valuable intellectual property, are more likely to create spin-offs (Powers and McDougall, 2005). Decision makers increasingly use rankings to evaluate and improve the quality of university (Guerrero and Urbano, 2012). Thus, being at a top position in university rankings can be expected to be positively associated with universities’ technology transfer activity and consequently with the spin-offs created. Previous studies at universities in Spain (Román-Martínez et al., 2017), Italy (Baldini, 2010b; Meoli and Vismara, 2016), Hong Kong (Uctu and Jafta, 2012), Singapore (Wong et al., 2007), Norway (Rasmussen and Borch, 2010) and Taiwan (Hsu et al., 2015) have showed either directly or indirectly that universities occupying higher positions in rankings were also the most active in terms of creating university spin-offs. From a similar perspective, O’Shea et al. (2005) found that faculty quality has a positive and statistically significant impact on the number of university spin-offs created, whereas the numbers of faculty and research students are not significant. Zhang (2009) found that a university’s research quality is the most significant variable in explaining the number of academic entrepreneurs emerging from a university. Therefore, this study suggests that the higher the ranking of the university, the higher the spin-offs creation. According to these previous arguments, this study suggests that:

H2. University-level factors (i.e. incubators, TTOs and intellectual eminence) positively moderate the relationship between EO and university spin-offs creation.

The influence of national-level factors

According to previous studies, among the determinant factors in the creation of spin-offs are the environmental factors (Audretsch et al., 2012; Fini et al., 2011; O’Shea et al., 2008). These studies emphasized that university entrepreneurship is influenced by the larger environment, which encourages or inhibits entrepreneurial behavior. Drnovsek and Erikson (2005) proposed that the external environment in which entrepreneurs operate can indirectly affect their entrepreneurial tendencies through entrepreneurial attitude. According to the Global Entrepreneurship Monitor (GEM, 2017), there is an interdependency between entrepreneurship and economic development that is influenced by the social, cultural, political and economic conditions in which it takes place.

The World Economic Forum (WEF, 2016) stated that a set of institutions, policies and factors determine a nation’s competitiveness, which, in turn, has a strong bearing on a firm’s competitiveness and growth. At the national level, previous research has suggested different explanations for variation in university spin-offs activity (Hayter, 2013, 2015; Monge et al., 2016; Sternberg, 2014; Baldini, 2010b). Hence, it is important take into account the influence
that the context and the institutions that work within that context have on the creation of university spin-offs.

One contextual factor that has been considered in the literature is the efficiency of the goods market (Li and Liu, 2013; Tracey and Phillips, 2011). Countries with efficient goods markets are well positioned to produce the right mix of products and services, given their particular supply-and-demand conditions, and to ensure that these goods can be most effectively traded in the economy, both domestic and foreign (WEF, 2016). Market efficiency also may force firms to be more innovative and customer-oriented, thus imposing the discipline necessary for efficiency to be achieved in the market. Fundamental to this is the recognition that new venture creation is a function of interdependences with the entrepreneurial system, which, in turn, recognizes the importance that individual components of the system may have in the overall development of an economy (Neck et al., 2004; Spilling, 1996).

Another factor that has shown to be important is the financial market. Entrepreneurial finance literature has recognized that access to financial resources has a significant influence on the propensity to start academic spin-offs (Chen et al., 2010; Zhan, 2009). According to the WEF (2016), economies require sophisticated financial markets that can make capital available for private-sector investment from such sources as loans from a sound banking sector, well-regulated securities exchanges, venture capital and other financial products. Insufficient financial resources is regularly cited by nascent-entrepreneurs as a major barrier to starting a business (Da Rin et al., 2006). Venture capital has been recognized as the main source of finance for entrepreneurship (Gompers and Lerner, 2004; Zook, 2004), and at the regional level, the availability of early-stage investors influences the decision to create a university spin-off (Lockett and Wright, 2005). Di Gregorio and Shane (2003) and Avnimelech and Feldman (2015) commented that venture capitalists not only provide capital but also serve as “market makers” by connecting new technology firms with potential suppliers, customers and employees.

Finally, innovation is particularly important for economies as they approach the frontiers of knowledge, where firms must design and develop cutting-edge products and processes to maintain a competitive edge and move toward even higher value-added activities (WEF, 2016). This progression requires an environment that is conducive to innovative activity in general and university spin-offs in particular. Zhang and Duan (2010) and Alba et al. (2013) found that the positive impact of innovative activity on firm creation is affected by the market structure in which firms are included and how their innovation is generated and spread through the economic system. In this order of ideas, the university spin-off formation rate has often been seen as a key indicator of the quality of the industry–science link within a country (Macho-Stadler et al., 2008). Likewise, previous studies have found that universities’ technology transfer activities influence their spin-off creation (Karnani, 2013; O’Shea et al., 2005). Also, the strength of the intellectual protection in a specific technological area influences the decision to create new ventures (Avnimelech and Feldman, 2015). Therefore, based on the above considerations, this study suggests that:

\[ H3. \] The consequences of the interaction between EO and university-level factors (i.e. incubators, TTOs and intellectual eminence) on university spin-off creation are moderated by national-level factors (i.e. goods market efficiency, financial market development and innovation).

The research model is illustrated in Figure 1, which posits that there are positive interactions among the variables included in the study. The model also controls for
university characteristics whose influence on university spin-offs creation has not been conclusively proven, namely, university size and type of university (private or public).

**Methodology**

*Sample and data collection*

This study examined the effect of different factors at different levels on university spin-off creation. A university is considered to be an entity that operates under a single set of policy rules (Di Gregorio and Shane, 2003). This study was based on a purposive sampling method in which universities had to meet two conditions. First, a university had to be located in a country in the Latin American region and that country, in turn, had to be included in the Global Competitiveness Report developed by the World Economic Forum (WEF, 2016). This report tracks the performance of nearly 140 countries in 12 pillars of competitiveness. The measures of national-level factors were to be taken from this report, which includes 18 countries from the Latin American region. Second, a university had to be ranked in the QS World University Rankings, one of the world’s most popular university ranking systems. The QS system comprises the overall global and subject rankings, alongside five independent regional tables (i.e. Asia, Latin America, Emerging Europe and Central Asia, the Arab Region and BRICS), and is the only international ranking to have received International Ranking Expert Group approval (IREG, 2016). The measures of intellectual eminence were to be taken from QS Latin American University Rankings. Potential participants that met these conditions yielded an initial sample of 385 universities ranked in the QS system, located in 18 different countries.

To gather data for independent and control variables, this study used a variety of available sources, including the Global Competitiveness Index Report, QS World University Rankings, university websites, an incubators database, an entrepreneurship support programs database and a survey administered to key informants who were department heads or directors in the disciplines of business or engineering. The use of key informants is a widely used approach among entrepreneurship scholars, as they can assess an organization’s strategic posture and performance (Covin and Slevin, 1989; Wiklund and Shepherd, 2003).

Table I provides a summary of each variable and its source. To obtain survey responses, the survey was administered by SurveyMonkey to key informants from the 385 universities,
who received an electronic invitation because of the geographic dispersion of respondents and to benefit from speed, ease of access and reasonable cost (Ilieva et al., 2002). Participants were selected from universities’ websites using the stratified convenience sample approach described by Creswell (1994). The electronic invitations were sent via the internet between July and October of 2017. Additionally, reminders (in the second, fourth and sixth weeks after the initial invitation) and telephone contact methods were used to improve the response rate in the survey and to gather information that complemented the survey (McDonald et al., 2015). In the end, a total of 52 universities responded to the survey and reported all relevant information, which represented a 13.5 per cent response rate. Therefore, the final sample represented 52 universities (22 public and 30 private) from 12 countries in the Latin American region: six from Chile, two from Panama, 14 from Mexico, one from Costa Rica, five from Colombia, two from Peru, nine from Brazil, one from Honduras, three from Ecuador, five from Argentina, one from Bolivia and three from Venezuela.

**Measurements**

University spin-offs, a count of the number of spin-offs created by a given university in a one-year period, was the dependent variable in the study. Given the difficulty that key informants might have had in reporting the number of spin-offs created over the last few years, they were only asked to report the number created in the last year (i.e. from July 2017 to June 2018). The study used a set of the following variables to explain the creation of university spin-offs:

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Variable description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spin-offs</td>
<td>Number of university spin-offs created from a given university in the 2016-2017 period</td>
<td>Survey</td>
</tr>
<tr>
<td>EO</td>
<td>ENTRE-U Scale that measures EO within university</td>
<td>Survey</td>
</tr>
<tr>
<td>Incu_Program</td>
<td>Taking a value of 0 if university has no incubator or entrepreneurship support program, 1 otherwise</td>
<td>University web pages</td>
</tr>
<tr>
<td>TTO</td>
<td>Taking value of 0 if university has no technology transfer office, 1 otherwise</td>
<td>University web pages</td>
</tr>
<tr>
<td>Eminence</td>
<td>The overall rating score of university</td>
<td>QS Latin American University Rankings 2016-2017</td>
</tr>
<tr>
<td>Mark_Eff</td>
<td>Scale that measures how efficient are goods markets in a country to produce the right mix of products and services given its particular supply-and-demand conditions</td>
<td>The Global Competitiveness Index Report 2016-2017</td>
</tr>
<tr>
<td>Finan-Mark</td>
<td>Scale that measures how efficient the financial sector is in a country, which allocates the resources to its most productive uses</td>
<td>The Global Competitiveness Index Report 2016-2017</td>
</tr>
<tr>
<td>Innovation</td>
<td>Scale that measures how conducive an environment is to innovative activity, which is supported by both public and private sectors</td>
<td>The Global Competitiveness Index Report 2016-2017</td>
</tr>
<tr>
<td>Uni_Size</td>
<td>Count of total students in a university</td>
<td>QS Latin American University Rankings 2016-2017</td>
</tr>
<tr>
<td>Type_Uni</td>
<td>Taking value of 1 when the university was public, 0 if the university was private</td>
<td>QS Latin American University Rankings 2016-2017</td>
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</table>
2016 to June 2017). The working definition of university spin-off in this study was adopted from Pirnay et al. (2003). Although the exact number of spin-offs created was not possible to obtain from the available databases, the key informants were asked to estimate the number of spin-offs created in the 2016-2017 period according to the following scale: 1 = 1 to 5 firms; 2 = 6 to 10 firms; 3 = 11 to 15 firms; 4 = 16 to 20 firms; 5 = 21 to 25 firms; and 6 = more than 26 firms. There is no reason to think that the average number of spin-offs created per university should be systematically biased between different institutions.

EO was measured using Todorovic et al.’s (2011) ENTRE-U scale. Originally, the scale was developed to emphasize entrepreneurial activity at the department level in the disciplines of science and engineering. Given the purposes of this study, therefore, the word "department" was changed to the word "university" and the scale was focused on the disciplines of business and engineering. These minor adjustments did not affect the reliability of the scale. The ENTRE-U scale includes four dimensions (i.e. research mobilization, unconventionality, industry collaboration and university policies) and the items are measured as follows: six research mobilization items included “Faculty member in our university emphasizes applied research” and “Many of our faculty members conduct research in partnership with non-academic professionals”; eight unconventionality items included “Compared to other similar universities in this province, we are good at identifying new opportunities” and “Cooperation with organizations outside the university significantly improves our research activities”; five industry collaboration items included “We are recognized by industry or society for our flexibility and innovativeness” and “We believe that our university should build relationships with private or public sector organizations”; and four university policies included such items as “Compared to most other universities, our university is very responsive to new ideas and innovative approaches”. Key informants used a seven-point scale ranging from 1 (strongly disagree) to 7 (strongly agree) to rate the extent to which each item from each dimension is described. Whereas the dimensions of the ENTRE-U scale can exhibit independent variance, this study followed Todorovic et al.’s (2011) recommendation in aggregating the all items into a single measure of a university’s EO by taking the average of all of them. The Cronbach’s alpha for EO was 0.756.

To measure if the presence of incubators or entrepreneurship support programs influenced the university spin-off creation, this study examined whether the university, by using incubators or support programs, provided facilities that fostered new firms. This study included a dummy variable of 1 if the response was affirmative. To measure if the presence of TTOs influenced the university spin-off formation rate, this study examined whether or not spin-offs had access to TTOs. A dummy variable of 1 was included if the response was affirmative. Finally, to measure if university eminence increased the creation of university spin-offs, this study examined the overall rating score of universities published in the QS Latin American University Rankings 2016-2017. Because the overall rating score might be very diverse, in an alternative specification, this study measured intellectual eminence according to the position of the university using the following rank scale: 1 = position 251 or beyond; 2 = position 201-250; 3 = position 151-200; 4 = position 101-150; 5 = position 51-100; and 6 = position 1-50.

The measures of goods market efficiency, financial market development and innovation were taken respectively from the 6th, 8th, and 12th pillars of the Global Competitiveness Index Report 2016-2017 for each country, whose values are on a 1 to 7 scale. According to the university size, previous studies have found that it has no significant impact on the formation rate of spin-offs (Avnimelech and Feldman, 2015; O’Shea et al., 2005; Zhang, 2009); therefore, this study included this variable only as a control variable by the total
number of students in a university according to the following scale: 1 = size < 5,000 students; 2 = size < 12,000 students; 3 = size < 30,000 students; 4 = size > 30,000 students. Finally, previous studies have not been conclusive about the influence of type of university on the formation rate of spin-offs (Avnimelech and Feldman, 2015); therefore, this study included the university type with a dummy variable of 1 if the university was public or 0 if it was private.

Reliability and model specification

First, an exploratory factor analysis was performed to validate and assess the ENTRE-U scale, which measures EO within universities. Following Carlson et al.’s (2000) recommendations, eight items were dropped from the original scale because they failed to discriminate between dimensions. Then, principal axis factoring with oblique rotation requesting four factors was performed with the remaining 15 items. As a result, four factors with eigenvalues greater than 1 were generated, and accounted for 52.07 per cent of the variance. Then, before the final data analysis, it was necessary to show measurement invariance because the survey data were gathered in 12 national settings. Additionally, if invariant measures are used, results can be biased. According to Steenkamp and Baumgartner (1998), configurational invariance (i.e. the same pattern of factor loadings across cultures) for all multi-item dimensions of ENTRE-U scale was analyzed. The results of this test confirmed good fit of the data. Moreover, the threat of common method variance was limited in this study owing to the likely inability of respondents to guess the hypothesized two- and three-way interactions and provide responses accordingly (Aiken and West, 1991). Also, using only key informants (i.e. department heads or directors in the disciplines of business or engineering) who have high levels of confidence in their responses is consistent with the guidelines for reducing common method bias provided by Rindfleisch et al. (2008).

For hypothesis testing purposes, this study performed multiple hierarchical regression analysis because this method examines the effects of additional variables above and beyond the effects of the variables in the previous model (Cohen et al., 2003). Besides, it avoids issues of model fit that can become problematic with the use of the structural equation model in small data sets (Kline, 2005). Finally, following recommended procedures by Ping (1995) and Aiken and West (1991), the study orthogonalized all variables that were involved in multiplicative interactions to reduce multicollinearity problems. There was no evidence of multicollinearity, as the variance inflation factor (VIF test) for each regression analysis was less than the recommended threshold of 5 (O’Brien, 2007).

Results

Table II presents the summary statistics for all variables included in the sample, and Table III presents the correlation matrix of the variables used in the regressions. As expected, there is a correlation between EO and the number of university spin-offs created ($r = 0.22, p < 0.05$). Likewise, there is a correlation between EO and the existence of incubators or entrepreneurship support programs ($r = 0.12, p < 0.05$) and TTO ($r = 0.08, p < 0.10$). In addition, the existence of incubators is correlated with goods market efficiency ($r = 0.13, p < 0.05$) and financial market development ($r = 0.09, p < 0.10$). Furthermore, a correlation can be observed between financial market development and innovation ($r = 0.19, p < 0.01$). Finally, the three national-context dimensions (i.e. goods market efficiency, financial market development and innovation) are correlated with the creation of university spin-offs ($r = 0.12, r = 0.14$ and $r = 0.05$, respectively, all with $p < 0.10$).
A multiple hierarchical regression analysis with interaction terms was applied according to Aiken and West (1991). In the first model, the control variables were entered in the regression analysis with university spin-offs as the dependent variable (Table IV, Model 1). Next, the effect of EO, incubators, TTOs and intellectual eminence were entered (Table IV, Model 2). The results showed support for H1, as EO is significantly and positively related to the number of university spin-offs created ($r = 0.12$, $p < 0.05$). Next, the interaction terms were entered into the regression. In Table IV, Model 3 shows that whereas the positive interaction effect between EO and incubators is supported (thereby lending support to H2a), a negative interaction effect of EO and TTOs on university spin-offs leads to the rejection of H2b. Likewise, the interaction between EO and eminence was non-significant on university spin-offs ($b = 0.16$, non-significant), which therefore leads to the rejection of H2c.

H3 relates to the national dependency of the interaction effects examined in H2a, H2b and H2c. In testing whether national-level factors impact the relationship between the two interaction effects and university spin-offs, this study followed the procedure proposed by Kirkman et al. (2009). The analysis added to the interaction terms the scores for the national level as reported by the Global Competitiveness Index; that is, three-way interactions were built, which consisted of the two examined variables (e.g. EO and Incu_Program) and the respective scores for national-level factors. To estimate these three-way interactions, the study entered all possible two-way interactions between the relevant variables into the regression equation according to Dawson and Richter (2006).

As Table V shows in Model 3, H3a was the only significant three-way interaction that emerged from the results ($\beta = 0.18$, $p < 0.10$). Following Dawson and Richter (2006), this
result indicates that the positive moderating effect of the existence of incubators or entrepreneurship support programs on the relationship between EO and the university spin-offs creation is stronger as a consequence of goods market efficiency as a national-level factor. Thus, this result indicates that the interaction effects examined in $H3b$ are not subject to significant national-level factors variation.

Discussion

Key findings and contributions

The objective of this study was to examine, through a multilevel research model, the creation of university spin-offs within the Latin American region. By examining multilevel interactions across different factors, it was expected that through a set of hypotheses that have been derived from previous literature, this study would provide a more refined understanding of the entrepreneurial university phenomenon. The results obtained in this study show important contributions, which are discussed below according to each hypothesis.

Concerning $H1$, it was hypothesized that a university’s EO was positively related to the creation of university spin-offs, which was supported. The result of $H1$ confirms that the ENTRE-U scale developed by Todorovic et al. (2011) has the potential to support university administration efforts to develop conditions more conducive to the creation of spin-offs. This result is consistent with the proposal of Clark (2004), who argued that universities are encouraged to become more entrepreneurial and, consequently, they require changes in their culture, governance and administration. Another explanation for $H1$ is that although ENTRE-U has a high level of abstraction, it allows for a focus on aspects that really matter to improve the entrepreneurial personality of the university. Previous studies have argued that it is problematic to find the best practices for promoting entrepreneurship inside universities (Van der Sijde et al., 2002), and the result of this study confirms that research mobilization, unconventionality, industry collaboration and university policies are mechanisms that really facilitate the creation of spin-offs.

Further, the result for $H1$ is a partial explanation of the formation of university spin-offs, where EO is an important element for promoting a cultural change in the organization and

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### Table IV

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
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Notes: *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$
facilitates the commercialization of university research (Savva and Taneri, 2015). Also, this result contributes to the proposals to adapt the original conceptualization of the Miller/Covin and Slevin scale, which is predominant in the study of EO (Rauch et al., 2009; Wales et al., 2013), to different contexts (i.e. universities) and demonstrates that organizations can benefit from doing things in an entrepreneurial way (Martens et al., 2016).

Concerning the interaction hypotheses $H2a-c$, there is evidence that incubators or entrepreneurship support programs were significant as moderators in the EO–university spin-offs relationship. These results show that not all university policies are necessarily important for promoting the entrepreneurial activity. Some reasons for this may be the

<table>
<thead>
<tr>
<th>Table V. Results of the interaction term regression analysis with the role of national-level factors (dependent variable: university spin-offs)</th>
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<tbody>
<tr>
<td><strong>Independent variables</strong></td>
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<tr>
<td>EO × Incu-Program</td>
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<td>$H2c$</td>
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<tr>
<td>EO × Eminence × Mark_Effi</td>
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<tr>
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<td>$F$</td>
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</tbody>
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Notes: *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$
following: First, research results can be commercially exploited by different mechanisms when one of them is spin-offs (Audretsch, 2014; Avnimelech and Feldman, 2015). Therefore, TTOs in the universities included in the sample of this study were not a decisive mechanism for improving the creation of spin-offs. According to Swamidass and Vulasa (2009), when a university’s resources are scarce, technology transfer activity is frequently sacrificed. Additionally, Markman et al. (2008) suggested that many technologies developed in universities are going out the back door rather than through the TTOs. This result could indicate that spin-offs are not necessarily technology-based firms, but rather firms created by students to exploit, in the business sphere, tacit knowledge that they have personally accumulated during their studies (Pirnay et al., 2003; Fini et al., 2010). These findings could suggest that informal channels for the creation of spin-offs are common at universities, which is something that was previously discussed by Karnani (2013).

Second, this study considered that highly ranked universities are more likely to create spin-offs; however, the results did not confirm this assumption. An explanation of this result is that the reputation of the university and its members is not enough to assemble the necessary resources to create spin-offs, for example venture capital (Di Gregorio and Shane, 2003; Fuller and Rothaermel, 2012). In addition, not only does the quality matter, but also the quantity of human capital resources (i.e. faculty and research students) matters in determining spin-off activity. Third, both TTOs and intellectual eminence are not encouraging entrepreneurial activity, and this result can be a consequence of the fact that policies and organizational structures do not provide a greater motivation to faculty and research students to create spin-offs. Previous studies have argued the importance of influencing the propensity of the academic community for new venture creation (Baldini, 2010a; Avnimelech and Feldman, 2015).

The results obtained in H2a-c contribute to the research on spin-offs, as these show the policies that do not influence the university’s entrepreneurial activity. In other words, if the university encourages the commercial exploitation of research results by its faculty and students, this could increase the number of spin-offs created. This implies a greater involvement of TTOs and takes advantage of the good reputation of a university’s faculty. According to Chan et al. (2016), universities should promote research ambidexterity, which jointly develops both research publication and research commercialization when universities pursue more entrepreneurial and commercial activities.

Concerning the three-way interactions represented in H3a-i, the results showed that among all the combinations that were hypothesized, just one of them was significant. The result of H3a shows that the national component related to goods market efficiency indirectly and positively influences the creation of spin-offs. A more detailed analysis of this result indicates that the exchange of goods is being favorable so that companies can innovate, as well as be more customer-oriented (WEF, 2016). In addition, according to the WEF (2016), the best environment for competitiveness requires minimal intervention by the government. Therefore, from the result of H3a, it can be said that spin-offs are finding favorable conditions in the market of goods for the identification and exploitation of entrepreneurial opportunities.

The rejection of H3b-i indicates that the factors of financial market development and innovation did not show any influence on the two-way interactions. In other words, the availability of capital through financial markets proved not to be critical for the creation of spin-offs. Furthermore, this result may be related to the fact that the countries included in the sample are not designing or developing cutting-edge products or processes to maintain their competitiveness (WEF, 2016). It was previously commented that the spin-offs created were probably more related to know-how, skills and working conditions of faculty and
students. Therefore, this result may indicate insufficient investment in R&D, as well as a weak collaboration between universities and industry.

The results obtained in the three-way interaction hypotheses show that a national-level factor can influence the creation of spin-offs, as long as there are factors closer to promoting or stimulating entrepreneurial activity. This result contributes to the knowledge that previous studies (Rothaermel et al., 2007) have generated on the different conditions and factors that influence the study of university entrepreneurship.

Besides the above contributions to entrepreneurship studies, the findings of this study also make contributions to practice and policy. The ENTRE-U scale that was used in this study shows that EO can be used to develop other scales that help explain entrepreneurial results in other organizational contexts, such as that of the public sector (Morris et al., 2011). Additionally, the findings suggest that university efforts to encourage entrepreneurship may be equally important in the early stages of the entrepreneurial process. Recently, Saeed et al. (2015) identified the concept of development support, which refers to the specific provisions that universities provide to students regarding the business development of ideas and introductions to entrepreneurial role models. Such support should be provided not only by the university but also by government institutions, because it is likely to encourage individuals' motivation and thus may be a catalyst for the new firm creation process. Finally, this study fails to find adequate support for the argument that TTOs and intellectual eminence make university spin-off creation more likely. This finding is revealing not only for university authorities but also for policymakers interested in influencing economic development through technology transfer. According to Sternberg (2014), universities are a necessary but not sufficient condition for regional economic development. Only regions that can increase their entrepreneurial absorptive capacity and turn it into economic wealth will enjoy the benefits of high-quality local universities (Fini et al., 2011).

Implications

Explaining university spin-offs creation according to the different variables included in this study has different implications. First, this study assessed the EO of a university using the ENTRE-U scale. According to the results, the four dimensions of this scale (i.e. research mobilization, unconventionality, industry collaboration and university policies) had implications for making universities more entrepreneurial. Understanding that these dimensions are distinct yet related allows an improved understanding of the organizational design of the universities included in this study. For example, Reyes (2016) showed that the National University of Singapore was affected as an entrepreneurial university by institutional configuration as well as by disciplinary identity, the power of important actors and risk perceptions attached to entrepreneurial activities.

Second, universities are an important source of knowledge creation, and understanding the different mechanisms by which knowledge from universities spills over is important to understanding technology transfer and economic growth. The results of this study show that spin-offs were a good indicator of entrepreneurial activity in universities and that incubators supported this activity. However, the support of the TTO was not significant. Based on these results, university authorities should reflect on the role that TTOs play in the commercialization of research generated in universities, in such a way that their function would be more effective and support the creation of spin-offs. Although this study did not analyze the specific reasons why TTOs were not significant, other studies have identified factors that significantly influence the decisions of academic inventors to bypass TTO (Goel and Göktepe-Hultén, 2018; Thursby et al., 2009). Additionally, in the context of a Chinese university, Malik (2013) argued that managerial decisions, flaws in communication and
organizational culture were all factors that contributed to failure at different stages of the technology commercialization process.

Third, successful university spin-offs can generate wealth through intellectual property, and universities are interested in capturing part of this wealth to diversify revenue and maintain the sustainability of their economic models and organizations. However, the results showed that the TTOs and the intellectual eminence of the universities included in this study did not contribute to the creation of wealth. To improve this, it is necessary to both individually and collectively strengthen these two factors in such a way that research publication and research commercialization genuinely contribute to the creation of wealth in the Latin American region.

Fourth, university spin-offs tend to be located geographically close to the institutions that supported them, making them valuable entities for local economic development and agglomeration economies. An implication of great importance for firms in general and university spin-offs in particular is the support space, understood as everything that, being territorialized, helps firms to function. The support space is local and is a creator of externalities, and therefore, the governments of the different countries included in this study should promote this essential universe of externalities in such a way that opportunities can be commercially exploited. For example, Yao et al. (2016) found that university students’ perceived social and economic environment in China had a positive influence on their entrepreneurial tendency. Similarly, Ikebuaku and Dinbabo (2018) showed that in Nigeria, entrepreneurs increased access to infrastructures and resources necessary for entrepreneurial success through business incubation.

Finally, universities make different decisions than private firms; therefore, the creation of spin-offs and intellectual property can generate important questions about university norms and policies. The results of this study would be sufficient to lead one to suppose that not all the organizational designs of universities are capable of establishing a fruitful link with the environment or properly carry out their function of commercially exploiting research results through the creation of spin-offs. Therefore, for a university to contribute to economic development, it needs an organizational transformation and thus, in turn, a cultural transformation. Other studies have reached similar conclusions in Asia. For example, Wong et al. (2007) studied the case of the National University of Singapore and commented that the role of the university requires a significant reform and transformation of the structure and incentive system of the traditional university system. The studies by Sharma (2015) in India and Tang et al. (2014) in China showed that university entrepreneurship education did not fully satisfy students’ needs. Therefore, these results show that the role played by universities needs to be reviewed to make it more effective in spin-off creation.

Limitations and suggestions for future research
The results of this study make important contributions to the study of university entrepreneurship. However, these should be observed in light of some limitations that offer opportunities for future research. First, the size of the sample is an important factor. Although the statistical analysis offers reliable results, it would be interesting if future research works considered a larger sample and a greater diversity of universities. These kinds of studies could focus more on cross-institutional variations in spin-off creation in the context of different countries. Second, the lack of records or databases to identify the exact number of spin-offs created by universities was an important limitation. Given this, it was necessary to develop a range scale to obtain a better approximation of the number of spin-offs created. This limitation meant that only one year of data was analyzed, as obtaining data from a longer period was very complicated and unreliable. With this limitation, it was
not possible to identify more characteristics of the spin-offs. Therefore, future research should overcome this limitation to attain an authentic classification of spin-offs according to previous studies (Pirnay et al., 2003; Druilhe and Garnsey, 2004; Mustar et al., 2006). Having more specific information about the spin-offs, future studies could also, as previous studies (Sullivan and Meek, 2012; Goel et al., 2015) have done, analyze whether gender influences the creation of this type of firm.

Third, this study only considered spin-offs creation without considering what may happen to them during their start-up stage. Future studies should examine the performance of spin-offs and identify if they really contribute to the economic development of the region. These studies would complement the results obtained in this paper, as this would give a more complete description of the spin-offs phenomenon. Finally, the results of this study show variables that did not influence the creation of spin-offs (i.e. TTOs and intellectual eminence). Although this study was exploratory, future research could examine each factor in a more fine-grained manner to identify the reasons why it had no contribution. Future studies can consider other variables that this study did not contemplate, for example the university’s policy on venture capital or its technological readiness, as other factors of national context. In addition to other factors, it may also be interesting for future studies to consider new theoretical perspectives on the study of the creation of spin-offs. The resource-based view can help illuminate how the resources and capabilities of the university contribute to this process (Powers and McDougall, 2005; Malik, 2013). Organizational theory can also help to explain how the university adapts its strategy and structure to the requirements of the environment (Bercovitz and Feldman, 2008; Siegel et al., 2007).

Conclusion
There is a growing interest in entrepreneurial activity and research commercialization within universities. Consistent with previous research, this study contributes by confirming that it is suitable to explain the entrepreneurial posture of universities with the EO construct and that EO, in turn, influences the creation of university spin-offs to exploit knowledge, technology or research results. However, the findings also show that relying solely on the main effect of EO provides an incomplete understanding of spin-offs creation. Hence, this study contributes by suggesting that a multilevel model that involves the appropriate alignment of an EO, incubators or entrepreneurship support programs and goods market efficiency might provide an opportunity to gain a deeper understanding of the complex process of spin-offs creation. More research needs to be conducted into multilevel models, especially those that involve EO, university-level and national-level factors. It is hoped that the results of this study will be useful for fellow researchers in the field of university spin-offs.

References


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