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# The triple helix and the quality of the startup ecosystem: a global view

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## Abstract

**Purpose** – The ongoing business dynamics show two aspects for generating innovation: first, high-impact innovations are developed jointly by several actors, such as universities, enterprises, and governments. Second, startups are better suited to develop innovation during crises or periods of low growth as experienced at the moment. Based on these aspects and drawing on the constructs of the triple helix, this study analyzes the influence between the characteristics of the actors on the quality of the startup ecosystem from a global view.

**Design/methodology/approach** – The study examines the cross-section data of 35 countries between 2017 and 2018 and applies the partial least squares structural equation modeling (PLS-SEM) for assessing the relationships between the triple helix on the quality of the startup ecosystem on a country-level.

**Findings** – The findings suggest that each actor of the triple helix individually does not positively affect the quality of the startup ecosystem. Yet, when analyzing the actors jointly by creating a second-order latent variable (i.e. triple helix), the study found out that in this way, the triple helix construct has a positive effect on the quality of the startup ecosystem.

**Originality/value** – Although a large body of prior literature indicates the importance of generating interrelationships among the different entities involved in ecosystems, few studies provide empirical evidence from a global perspective of the need for these entities to act in an overlapping manner. The present study supports previous research and reinforces the importance of the triple helix for a more innovative environment.

**Keywords** Startup ecosystem, Triple helix, Innovation, Entrepreneurship

**Paper type** Research paper

## Introduction

The global social, environmental, and economic challenges urge firms to find a way of generating sustainable innovation to improve or maintain their position or, failing that, to ensure their survival. The ongoing business dynamics show two particular aspects for generating innovation: first, the need for integrating different actors in the innovation processes (Hernández-Trasobares & Murillo-Luna, 2020) and second, the predominant role of new enterprises or startups in addressing disruptive innovations (Archibugi, 2017).

Regarding the first aspect, we can find several examples of innovations – particularly high-impact ones – developed in a collaborative way amidst universities, research centers, incumbent firms, incubators, accelerators, public institutions, and startups, or example, the



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Google autonomous car and China's High-Speed Rail. Notwithstanding, to coordinate such innovation efforts, new structures of economic and value relationships are required. Traditional approaches, like firm–supplier relation or integrated hierarchies, are not suitable for this type of collaborative innovation, which is more in line with ecosystem orchestration (Adner, 2017) and requires interdependency, coopetition, complementarity, and collaboration configurations (Jacobides, Cennamo, & Gawer, 2018). Therefore, the concept of ecosystem emerges to explain how different actors interact with various relationships to consolidate the value creation cycle.

The second aspect unveils the crucial role of startups as drivers for innovation (Bower & Christensen, 1995). Archibugi (2017) argues that newcomers are more willing to undertake radical innovation projects during crises than incumbent firms, which are more involved in exploitation-oriented projects. Additionally, new enterprises are responsible for creating jobs, boosting the economy, improving quality of life, and improving competitiveness.

Therefore, startups require ecosystems appropriate for developing innovations. We have identified that a large part of the literature has pointed out several factors that affect the development of a healthy startup ecosystem "characterized by its ability to produce, support, and nourish high-growth entrepreneurship" (Song, 2019, p.570). For instance, the synergy between academic institutions and firms (Pugh, 2017), the policies and entrepreneurship incentive programs, governmental efforts to reduce taxes and bureaucracy during the creation of new enterprises, institutional support, and access to critical infrastructure (Cheah, Ho, & Lim, 2016). Furthermore, some studies (e.g. Saad & Zawdie, 2005) have analyzed the impact of all these factors jointly, considering the effects of integration among them on regional entrepreneurial activities.

However, there is still a need for more studies of statistical models using different techniques (Guerrero & Urbano, 2017), especially to analyze the impact of the relationships among all these factors jointly on the quality (understood as the healthiness) of the startup ecosystem from a global perspective. In an attempt to contribute to these studies, we drew upon the framework of the triple helix (i.e. the university–industry–government interaction, Etzkowitz, 2008) to analyze the influence among the actors and their interrelations on the development of a healthy startup ecosystem, which is capable of producing, supporting and nurturing high-growth entrepreneurship. The research question addressed by this study is "Is there evidence of the influence of the triple helix on the quality of startup ecosystems from a global perspective?" To address this question, we examine the cross-section data of 35 countries by using partial least squares structural equation modeling (PLS-SEM). Our results show that none of the latent variables individually have a considerable impact on the quality of the startup ecosystem. However, when analyzed together, the results were significant. This finding corroborates the existing literature on the triple helix that argues that the university–industry–government interactions enable innovation creation (Cai & Etzkowitz, 2020).

We contribute to the innovation and entrepreneurship literature in different manners: first, by proposing a set of latent variables to operationalize the constructs of the triple helix and the quality of the startup ecosystem and second, by providing empirical evidence about the influence of the triple helix from a global perspective, based on the analysis of the innovation efforts of 35 countries.

The remainder of the paper is structured as follows. The next section summarizes the theoretical background supporting this study. In the following section, we present our conceptual framework and hypotheses. Next, we describe the research methods, including data sources, data modeling and data analysis. The findings are then presented and discussed. Finally, concluding remarks, limitations and further research opportunities are outlined.

## Theoretical background

### *Ecosystems in entrepreneurship*

The term ecosystem has been copiously used to describe how firms and institutions create a competitive environment to develop innovations (e.g. Adner, 2017; Jacobides *et al.*, 2018). "Ecosystem" refers to an interdependently but nonhierarchically related multi-actor network that develops an innovative offering (Adner, 2017; Tsujimoto, Kajikawa, Tomita, & Matsumoto, 2018). From a structuralist perspective, five key elements configure an ecosystem: activities, actors, positions, links and artifacts (Adner, 2017). The activities are the complementary and interdependent actions undertaken by ecosystem members to create and capture value (Tsujimoto *et al.*, 2018). The actors, or community, refer to the entities that undertake such activities, e.g. suppliers, complementors, and customers (Adner, 2017). The positions specify where the actors are located regarding the activities, i.e. upstream or downstream from the focal firm (Adner, 2017). The links specify the transfer or transaction of materials, information, funds, or influence among the actors (Adner, 2017). Finally, artifacts are the products, services, or resources (tangible or intangible) required to develop the offering (Adner, 2017).

The general use of the term "ecosystem" in the literature has resulted in a plethora of different constructs, in many cases redundant, overlapping, conflicting, and, in others, complementary. Fundamentally, the entrepreneurship literature has distinguished five labels for ecosystems: knowledge ecosystem, entrepreneurial ecosystem, innovation ecosystem, business ecosystem, and startup ecosystem.

According to Clarysse, Wright, Bruneel and Mahajan (2014, p. 7), the knowledge ecosystem refers to the clusters and organizations, which "facilitate collective learning and increase the speed of innovation diffusion." This type of ecosystem entails a combination of academic, research institutions and other support organizations that create, promote, and disclose knowledge. On the other hand, the entrepreneurial ecosystem centers on the interacting "social, political, economic, and cultural elements within a region that support the development and growth of innovative startups and encourage nascent entrepreneurs and other actors to take the risks of starting, funding, and otherwise assisting high-risk ventures" (Spigel, 2017, p. 50). Innovation ecosystem relates the actors and their relationships that are involved "to enable technology development and innovation" (Oh, Phillips, Park, & Lee, 2016, p. 1). The main concern for this type of ecosystem is the connection and efforts to develop the research economy (driven by fundamental research) and the commercial economy (driven by the marketplace).

On the other hand, the business ecosystem and startup ecosystem focus on the firms and their environment. Furthermore, the business ecosystem concentrates on the business context and the central partners and activities that create and capture value (Tsujimoto *et al.*, 2018). Finally, the startup ecosystem is a label widely promoted among practitioners and entails the actors and the efforts of different organizations involved in developing the startups (StartupBlink, 2019). Deeb (2019) posits that the key players of the startup ecosystem are the entrepreneurs, mentors, investors, incubators, universities, corporations, associations or events, the government, and the service providers. Therefore, this study has considered the construct of the startup ecosystem.

### *The triple helix model*

The triple helix is constituted by a spiral model of innovation where the interactions among the three institutional spheres – university, industry, and government – enable communication flows and joint efforts, allowing the creation of new organizational formats for the generation of innovation, and thus contribute to the development of the knowledge-based economy (Etzkowitz, 2008). One of the central ideas of this model is that, in addition to the interinstitutional collaborations, which take place through their traditional roles, each sphere "takes the role of the other" (Cai & Etzkowitz, 2020, p. 18). For instance, industries continue producing goods and services but, at the same time, devote efforts to developing research and providing instruction to their collaborators, as some kind of university.

Champenois and Etzkowitz (2018) point out that universities have a prominent role in the model due to their capacity of generating and transferring knowledge and technology (e.g. medical technologies or nanotechnology). The authors highlight the transformation of the traditional role of universities (merely as a source of human resources and knowledge) as a key innovation stakeholder. Therefore, universities also enable the creation of intermediary institutions, such as technology transfer offices or science parks, that facilitate the capitalization of knowledge through formal channels. For instance, during the outbreak of the COVID-19 pandemic in 2020, Chinese universities responded rapidly and not only by performing talent training functions and scientific research but also contributing to the development and production of detection kits and providing psychological assistance services, among other functions (Wang, Cheng, Yue, & McAleer, 2020).

It is important to note that the triple helix structure's "balanced configuration" required overlapping the three institutional spheres. The three spheres act in partnership, take joint initiatives and form hybrid organizations that promote innovations (Champenois & Etzkowitz, 2018).

## Conceptual framework and hypothesis development

Innovation literature suggests that different initiatives and cooperative university–industry–government interactions lead to differential growth (Guerrero & Urbano, 2017). Traditionally, growth has been sustained by incumbent firms. However, given the current unstable context, startups seem more willing to undertake radical innovation projects, thus being responsible for economic growth (Archibugi, 2017). In this scenario, part of the efforts must be geared towards enhancing entrepreneurship and startup ecosystems, which is, in fact, one of the concerns of the triple helix (Etzkowitz, 2008). Based on these arguments and following prior studies (Saad & Zawdie, 2005; Guerrero & Urbano, 2017), we expected that the integration of the triple helix spheres produces a positive effect on the quality of the startup ecosystem. The quality of the startup ecosystem indicates how healthy an ecosystem is; in other words, how capable of producing, supporting, and nurturing high-growth entrepreneurship it is. Accordingly, we expect that the quality of each of the three institutional spheres positively affects the quality of the startup ecosystem.

To explain how this relationship occurs, we present our hypotheses considering each actor of the triple helix model in the following section.

### *Industry and the startup ecosystem*

The industry refers to the private entities, which directly or indirectly are responsible for producing goods and services (Etzkowitz, 2008). According to the United Nations (2008), these entities are classified regarding their activity, such as agriculture, mining, manufacturing, construction, financial intermediation, real estate, and health. In the traditional view, the industry is vested with the responsibility of capturing the value of the innovation process. Notwithstanding, other mechanisms, such as the spin-offs, can increase the efforts to capitalize on the knowledge created at universities (Clarysse *et al.*, 2014). In the triple helix model, industries also contribute to producing, supporting, and nourishing entrepreneurship by aiding the structure of new firms as clients, providers of specialized infrastructure and test markets, mentors, investors, enablers of incubators and accelerators, among others.

Livesey (2006, p. 1) points out that high-value manufacturing (HVM) industries have strong financial performance and might be "significant contributors to national R&D (research and development) investment", a situation that may be appropriate for sustaining programs of innovation and new ventures. Additionally, high value-added companies tend to use disaggregated production systems in which the value can be shared between various actors; thus, new entrants can obtain some benefits (Linden, Kraemer, & Dedrick, 2009).

However, a significant part of the literature suggests that some industry characteristics (i.e. firms' size and density) interfere with the innovation system. Regarding the firm's size, various authors (e.g. Archibugi, 2017; Bower & Christensen, 1995) suggest that small firms possess a differential advantage for developing high-impact innovation. For instance, Goss and Vozikis (1994) argue that in high-tech industries, small firms have greater returns and are more productive than large firms in general. In the same vein, Christensen (1997) posits that besides the bureaucracy and the risk-averse culture in large firms, the organizational structure impedes firms from renewing the fundamental architecture. Additionally, these big firms are less attracted to follow new technological trajectories set by new entrants because, in the very early stages, the novelties generate only low or no value at all for the established market. Agrawal, Cockburn, Galasso and Oettl (2014) present evidence comparing two different innovative contexts: Portland, where there are plenty of small businesses, and Rochester, where there are plenty of large firms. In their results, considering the number of patents and citations, Portland outperforms Rochester.

On the other hand, authors, such as Agrawal and Cockburn (2003), suggest that large local firms have intensive R&D activities, resulting in a better regional innovation system. Moreover, these firms act as an "anchor tenant" (Agrawal & Cockburn, 2003), invigorating innovation processes. Thus, incumbent firms are good candidates for becoming clients and investors for startups. Additionally, unlike small firms, when large firms fail to innovate, they are more able to survive and continue supporting further innovative projects.

Considering these arguments, we propose that *quality of industry (IND)* is a latent variable (LV) and that its reflection can encompass the number of small companies, the number of large companies, the total value of the industry, and the percentage of medium and high-tech industries.

### *University and the startup ecosystem*

Universities hold a special role in the triple helix model as sources and "stimulants of regional economic development" (Pugh, 2017, p. 983) within the knowledge-based economies. Traditionally, universities are responsible for generating new knowledge, technology, and teaching human resources. However, one of the changes proposed by the triple helix is to augment the scope of the roles of each actor – what was designed by Cai and Etzkowitz (2020) as "take the role of the other" – and therefore, the university also becomes a source for entrepreneurship. This is done in a variety of ways, for instance, by promoting entrepreneurial initiatives through training courses, joint labs, entrepreneurship fairs, innovation contests, and incubators (Stephan, 2010).

Different mechanisms, like spin-offs, networked incubators, accelerator programs, and partnerships with the private sector, have been created to address the capitalization of knowledge produced in the universities. Nevertheless, there is a limitation in determining which knowledge should flow from universities to the industry (Stephan, 2010). For example, Fagerberg (2017) points out that formal registration and patents are not very important means for benefiting from innovation. Rather, Stephan (2010) suggests that more everyday strategies, such as networking, attending conferences, and recruitment of postgraduates and researchers, are evidence for the interaction between universities and industries.

Furthermore, other scholars (e.g. Mir-Babayev, 2015) point out that higher levels of education have a positive effect on innovation performance of firms.

Research publications are considered another mechanism for knowledge and technology transfer (Etzkowitz, 2008). This kind of publication reflects discoveries and trends related to a determined science field and reveals "the activities promoted by the academic community and the public sector" (Archibugi, 2017, pp. 6-7). Moreover, a form of associating the quality and relevance of the studies discussed is through the number of citations (Viale & Etzkowitz, 2010). Therefore, this might lead to establishing a link between the publications, citations, and the relation between the knowledge and technology developed.

Certainly, universities must have appropriate conditions (i.e. high-quality professional teaching and researching force, directly related to the number of researchers and scientists; equipment, tools, and software suitable for research activities; infrastructure, etc.) to create knowledge and technology useful for economic activities (Etzkowitz, 2008). The possibility of having their resources gives universities a sense of autonomy to set their strategic directions and formulate the problems and projects to be tackled. Following these aspects, we assume that the *quality of academia (UNI)* is formed by reflecting the citable documents with H index, R&D expenditure, and the number of researchers.

*Government and the startup ecosystem*

In the triple helix model, the government acts mainly as an enabler for the interactions and exchanges among the spheres and sponsorship for developing new knowledge, technology, and innovation (Etzkowitz, 2008; Pugh, 2017). Governments may contribute to producing, supporting, and nourishing entrepreneurship in several ways. For instance, the construction of infrastructure for research (e.g. science and technology parks, incubators, and laboratories) (van Weele *et al.*, 2018); the implementation of initiatives for stimulating access to external capital and foreign markets (Clarysse *et al.*, 2014); the promotion of programs and challenges to stimulate research and innovation (Boekholt, Edler, Cunningham, & Flanagan, 2009); by ensuring high quality in educational programs; by maintaining low levels of corruption (van Weele *et al.*, 2018); by developing laws, policies, standards, and regulations to promote the formation of new firms; by augmenting the provision of public venture capital; and by facilitating the patent procedures and property registration (Viale & Etzkowitz, 2010). Furthermore, Boudreaux, Nikolaev and Klein (2019, p. 183) argue that aspects of the institutional context, such as the integrity of the legal system and the efficiency of contractual institutions, moderate (i.e. facilitate or constrain) "the extent to which individuals are likely to allocate their socio-cognitive resources toward entrepreneurship."

Another way governments can contribute to the health of startup ecosystems is by facilitating the transfer of knowledge and technology (Saad & Zawdie, 2005), which new entrants may eventually leverage. This transfer can be promoted by creating programs and incentives (e.g. fiscal stimuli or taxation benefits) which encourage the transfer of knowledge and technology from multinationals to local companies and the hiring of professionals and skilled labor (see Dechezleprêtre, Glachant, & Ménière, 2009 who explore cases from Brazil, Mexico, India, and China). Furthermore, well-trained professionals bring several benefits to innovation projects. For instance, they promote the exchange of information and scientific knowledge with external institutions and community members (Motoyama & Knowlton, 2017). They may also amplify the spillover effect by mentoring their junior colleagues (Viale & Etzkowitz, 2010). Therefore, we consider *the quality of government (GOV)* as a reflection of the observable variables: government effectiveness, political stability, high-quality regulatory environment, and the enforcement of the rules of society.

*The startup ecosystem*

As explained above, the quality of the startup ecosystem involves the set of actors (e.g. entrepreneurs, mentors, investors, companies, and incubators) and the relationships between them that enable the development of high-growth entrepreneurship (StartupBlink, 2019). However, Acs, Stam, Audretsch and O'Connor (2017) noticed that there are still no consolidated mechanisms for measuring the quality of startup ecosystems. The authors suggest that *unicorns* (startups valued at more than $1 bn) can be a major indicator of a strong ecosystem as these firms emerge in very specific places in the world. Thus, unicorns can be the result of differentiated characteristics and strategies. Therefore, *the quality of the startup ecosystem (STAR)* is a construct that can be understood as a latent variable, which reflects the observable variables: number of startups, number of accelerators, number of incubators, and the sum of the value of the unicorns.

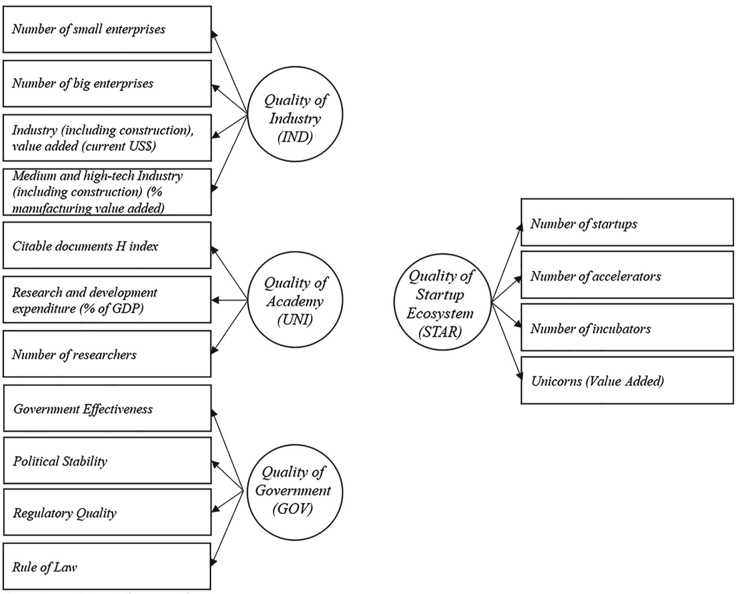
To highlight the construction, the models of the independent latent variables (UNI, GOV, and IND) and the dependent latent variable (STAR) are illustrated in Figure 1.

We build the hypotheses in two steps: first, by joining the independent latent variables (i.e. quality of the industry, quality of academy and quality of government) separately and impacting the quality of the startup ecosystem, and second, by joining the independent latent variables into a second-order latent variable (i.e. triple helix), which in turn impacts the quality of the startup ecosystem. To summarize, Figure 2 shows both models with the hypotheses that attempt to better understand the relationship between the triple helix (THELIX) and the quality of the startup ecosystem.

Considering these arguments, we propose the following hypotheses:

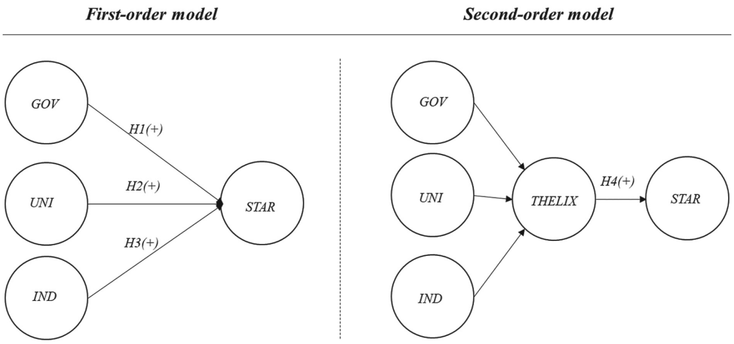
*H1*. The quality of government (GOV) positively affects the quality of the startup ecosystem (STAR).

*H2*. The quality of academia (UNI) positively affects the quality of the startup ecosystem.



**Source(s):** The authors

**Figure 1.**
Constructs and their manifest variables



**Source(s):** The authors

**Figure 2.** Conceptual models and hypotheses

*H3*. The quality of industry (IND) positively affects the quality of the startup ecosystem.

*H4*. The developed triple helix (THELIX) positively affects the quality of the startup ecosystem.

## Methods

Management studies have used PLS-SEM to investigate latent phenomena (Nascimento & Macedo, 2016). In this sense, this method has presented itself with an excellent possibility for evaluating constructs in social sciences, especially for using constructs with formative variables (Sarstedt, Ringle, Smith, Reams, & Hair, 2014; Bido & Da Silva, 2019). Therefore, we chose this approach to analyze the triple helix's relationship to the quality of the startup ecosystem at country level.

The relationship was analyzed in two ways: first, we analyzed the direct relationship among the first-order latent variables (GOV, IND, and UNI) with the latent dependent variable (STAR). Then, we analyzed the relation between the three independent latent variables together – by forming a new latent variable (THELIX) – over the latent dependent variable (STAR) using second-order PLS-SEM.

## Data sources and data modeling

The latent independent and dependent variables (Table 1) were constructed by reflecting the data of the manifest variables and were extracted from the World Governance Indicator (Kaufmann & Kraay, 2018), World Bank (World Bank, 2017), OECD data (OECD, 2017), Global Innovation Index (Cornell University *et al.*, 2018), Crunchbase platform (Crunchbase, 2018) and the CB Insights platform (CBInsights, 2018). In total, 35 countries limited by base crossing were used for the analysis, specifically, Austria, Belgium, Brazil, Bulgaria, Chile, Colombia, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Portugal, Romania, Russian Federation, Serbia, Slovenia, Spain, Sweden, Turkey, United Kingdom (UK), and the USA.

Next, the missing values were processed using the mean of the dependent variable. Missing values correspond to less than 4.21% of the dependent variables used. Using data from different sources from secondary and open data allows the research transparency (Piwowar & Vision, 2013; van Raaij, 2018) but limits the analysis of some specific clippings.

**Table 1.**
Latent dependent and independent variables and their manifest variables

| Latent variables | Manifest variables | Data source | Year |
|---|---|---|---|
| Government competence (GOV) | Political stability and absence of violence | World Governance Indicators | 2018 |
| | Regulatory quality | World Governance Indicators | 2018 |
| | Rule of law | World Governance Indicators | 2018 |
| | Government effectiveness | World Governance Indicators | 2018 |
| Healthy industry (IND) | Medium and high tech industry | World Bank | 2017 |
| | Small business | OECD data | 2017* |
| | Industry, value added | World Bank | 2017 |
| | Big companies | OECD data | 2017* |
| Quality of academia (UNI) | Citable documents H index | Global Innovation Index | 2018 |
| | Number of researchers | Global Innovation Index | 2018 |
| | Research and development expenditure | World Bank | 2017 |
| Quality of startup ecosystem (STAR) | Number of startups | Crunchbase | 2018 |
| | Number of accelerators | Crunchbase | 2018 |
| | Number of incubators | Crunchbase | 2018 |
| | Unicorns (value added) | CB Insights | 2018 |

**Note(s):** *Some of the data in some countries correspond to previous years (between 2014 and 2016) due to availability

Thus, to ensure article consistency, the data were normalized using *Z*-score to ensure uniformity of the unit of analysis. This study also performed a confirmatory component analysis (CCA) to validate the measurement model (Hair, Risher, Sarstedt, & Ringle, 2019) and present a correlation matrix at the latent variable level to analyze the composite reliability and average variance. The cross-loading matrix was presented at the indicator level to validate indicators.

## Data analyses

We performed a CCA to validate the measurement model. The result at the latent variable level presented in Table 2 and the result at the indicator level were valid, developing the cross-loadings matrix, and considering the averages of 0.917 for GOV variables, 0.830 for IND, 0.854 for UNI and 0.877 for STAR, enabling the realization of the structural model (Sarstedt *et al.*, 2014; Bido & Da Silva, 2019).

**Table 2.**
Correlation matrix between latent variables

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1. GOV | *0.883* | | | |
| 2. IND | 0.185 | *0.841* | | |
| 3. STAR | 0.213 | 0.688 | *0.890* | |
| 4. UNI | 0.673 | 0.641 | 0.528 | *0.856* |
| Composite reliability | 0.866 | 0.904 | 0.937 | 0.891 |
| Average variance extracted | 0.781 | 0.708 | 0.793 | 0.732 |

**Note(s):** Diagonal values are the square root of the stroke, as they are larger than the correlations between the latent variables, with discriminant validity

## Findings and discussion

The first processed structural model (first-order model) did not present statistical significance in any latent variables analyzed. Thus, none of the null hypotheses that would validate the alternative hypotheses (H1, H2, and H3) were shown, as presented in the first part of Table 3. This finding is in line with previous studies (e.g. Hernández-Trasobares & Murillo-Luna, 2020) in which the positive effect on business innovation performed between two or even within a single helix was more variable and not fully clear.

Further, we use the same observable variables and their respective effects on the latent variables, focusing on triple helix's new construct. According to Champenois and Etzkowitz (2018), the three spheres must necessarily overlap to promote innovation. Therefore, we performed the second-order PLS-SEM, creating the triple helix latent variable that receives the incidence of the first-order variables and impacts the latent dependent variable STAR (Sarstedt *et al.*, 2014; Bido & Da Silva, 2019).

The second-order model proved to be statistically relevant, refuting the null hypothesis that triple helix has no effect on the quality of the startup ecosystem and accepting the alternative H4, as presented in the second part of Table 3.

In other words, our results showed that none of the latent variables individually have a considerable impact on the quality of the startup ecosystem. However, when analyzed together, the results were significant.

This finding supports prior research that analyzed the triple helix impact on innovative ecosystems at regional or national level (Guerrero & Urbano, 2017; Pugh, 2017). Furthermore, our results provide evidence of this positive impact from a global perspective and emphasize the need for the different helices to act overlapping. In this line, recent studies highlighted the predominant role of the triple helix in the effective handling of the COVID-19 pandemic. The coordinated efforts by government, academy, and industry have yielded positive results in controlling the pandemic in Southeast Asia (Upe, Ibrahim, Arsyad, Sumandiyar, & Jabar, 2021). In contrast, when the interrelations among these actors are not well addressed, efforts to combat the pandemic fall short, leading to catastrophic results, as in the case of Nigeria (Adegbami & Adesanmi, 2020).

## Conclusion

This study aims to identify evidence of the influence of the triple helix on the quality of startup ecosystems from a global perspective, expanding the scope of regional analyses from previous studies (e.g. Guerrero & Urbano, 2017; Pugh, 2017; Hernández-Trasobares & Murillo-Luna, 2020). By analyzing the cross-section data of 35 countries using PLS-SEM, we provide evidence for this query. We also used CCA to validate the measurement model and performed two models with the same observable variables: first, the three actors (i.e. industry, government, and university) act separately on the startup ecosystem, and second, analyze the actors jointly. One of the most remarkable findings was to confirm prior literature, such as Champenois and Etzkowitz (2018). They argue that the three spheres (i.e. government, industry, and university) must necessarily overlap to promote innovation. After analyzing the independent latent variables separately, we did not find statistical significance influencing the startup ecosystem. However, when analyzing these variables jointly, the impact on the startup ecosystem has a significant coefficient of determination (0.338), in line with previous literature advocating the triple helix's importance for a more innovative environment.

Additionally, we found differences between USA, UK and Germany from others. These countries have several aspects in common, for instance, the remarkable interaction between big firms, such as Google or Microsoft, and startups, the development of policies and government programs that promote entrepreneurship and high-quality education, and the

**Table 3.**
First-order and second-order model result

| | Hypothesis | VIF | $F^2$ | Original sample | Standard deviation | *T* statistics | *P* values | $R^2$ | $R^2$ adjusted |
|---|---|---|---|---|---|---|---|---|---|
| GOV → STAR | H1(+) | 2.0 | 0.013 | −0.103 | 0.182 | 0.564 | *0.573* | *0.592* | *0.553* |
| IND → STAR | H2(+) | 2.7 | 0.153 | 0.381 | 0.369 | 1.121 | *0.263* | | |
| UNI → STAR | H3(+) | 4.1 | 0.125 | 0.463 | 0.317 | 1.437 | *0.151* | | |
| THELIX → STAR | H4(+) | – | 0.511 | 0.582 | 0.180 | 3.226 | *0.001* | *0.338* | *0.318* |

interaction between universities and firms. That can be noticed by the highest citable documents, H index, being in the top ten in government effectiveness and the top five in industry value-added. Finally, these initiatives rebound in the startup ecosystem with the most significant number of startups, incubators, and unicorns.

Accordingly, our results also highlight the importance of policies and multilateral agreements that allow the collaborative development of innovations and the creation, support, and nourishment of high-growth entrepreneurial initiatives. Countries with healthy startup ecosystems, such as the USA, are constantly developing policies and laws that directly or indirectly favor the ecosystem. For example, according to the Silicon Valley Competitiveness and Innovation Project Report (Melville & Kaiser, 2018), a series of public policy programs have been proposed aiming to enhance the performance of the Silicon Valley cluster. These programs include "the housing policy" which aims "to address the impact of California's housing crisis on low-income residents" (Melville & Kaiser, 2018, p. 24), "transportation policy" to enhance the quality of California's transportation system, and "research and development policy", one of the federal R&D tax credit initiatives that is considered as best policy tool for encouraging investments in R&D in the USA.

This study still has several limitations that might represent possibilities for future studies. First, our study did not consider the types of cooperative relationships that are established among the helices. Thus, future research could analyze these relationships and contribute to the ongoing debate on the most effective type of government cooperation and its impact at different levels (i.e. regional, national, and supra-national) (Hernández-Trasobares & Murillo-Luna, 2020). Second, the definition of the observable variables has been conditioned by the information available in several repositories with some information gaps regarding specific periods and countries. For instance, this limitation excludes the analysis of regions that traditionally do not report information in these databases (e.g. Middle and East Asia, Latin America, and Africa). Future research may focus on creating a specific classification in the analysis factors and the qualitative analysis about the main initiatives that the countries with the most promising startup ecosystems have carried out. This aspect is particularly important for future reflections, suggestions, and debates around public policies and institutional responsibility to enhance startup ecosystems.

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