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Entrepreneurial ecosystems' readiness towards knowledge-intensive sustainable entrepreneurship: Evidence from Brazil

Erica H.S. Siqueira [a,*], Bruno Brandão Fischer [a,b], Adriana Bin [a], Jill Kickul [c]

[a] School of Applied Sciences, University of Campinas, Brazil
[b] Higher School of Economics, National Research University, Moscow, Russian Federation
[c] Marshall School of Business, University of Southern California, United States

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ABSTRACT

Pathways to sustainable development are a key to providing innovation transitions and well-being. In this context, knowledge-intensive entrepreneurs play a pivotal role in shaping the markets for new products, services and business models. Prior literature has put emphasis on the contextual elements that shape entrepreneurial opportunities and business endeavors, i.e., entrepreneurial ecosystems. However, little is known about the extent to which these ecosystems are capable of nurturing the emergence of knowledge-intensive ventures with a sustainable orientation. Our goal in this article is to identify the 'readiness' of entrepreneurial ecosystems in terms of enablers of Knowledge-Intensive Sustainable Entrepreneurship (KISE) events in a developing country context – and how they differ from 'traditional' Knowledge-Intensive Entrepreneurship (KIE). Our empirical data comes from firms participating in the PIPE Program (Innovative Research in Small Business) funded by the São Paulo Research Foundation in Brazil. The methodological approach relies on the estimation of entrepreneurial propensity functions that assess the statistical associations between city-level features and the generation of KISE for a panel of 629 municipalities. Findings indicate strong similarities on the underlying ecosystem drivers of KIE and KISE. However, when we disaggregate KISE into four domains (Cities, Health, Education and Green Technologies), the 'ecosystem readiness' towards sustainable transitions varies from more mature (as in the case of HealthTechs with an inclusive orientation) to very incipient configurations (Cities and EdTechs).

1. Introduction

Tackling pressing issues related to social and environmental impacts can be considered a topic of great concern for development and growth both at the macro and micro levels of analysis (Neumann, 2022; Sarpong and Amankwah-Amoah, 2015). Accordingly, approaches related to sustainable development and sustainable transitions have received increased attention in the last decades not only from a conceptual perspective but also as an economic possibility with a high potential to address current global demands and challenges (Markard et al., 2012). This implies a transition in the business practices from those considered socially and environmentally unsustainable to those that generate value while respecting natural resources and promoting social inclusion (Méndez-Picazo, 2021; Ghazinoory et al., 2020).

Within this context, sustainable entrepreneurship (SE) emerges as a pivotal phenomenon in triggering economic transitions towards more inclusive and environmentally-friendly models of production (van Rijnsoever, 2022; Anand et al., 2021; Muñoz and Cohen, 2018; Hoogendoorn et al., 2019; Turker and Ozmen, 2021; Surie, 2017). Accordingly, SE is dedicated to solving social and environmental challenges in a hybrid manner by combining social, environmental and economic institutional logics (Cornelissen et al., 2021; Belz and Binder, 2017; Maibom and Smith, 2016; Klewitz and Hansen, 2014). In this article, we propose the comprehensive notion of Knowledge-Intensive Sustainable

* Corresponding author.
E-mail addresses: ericasiqueira9@gmail.com (E.H.S. Siqueira), bfischer@unicamp.br (B.B. Fischer), adriana.bin@fca.unicamp.br (A. Bin), kickul@marshall.usc.edu (J. Kickul).

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Entrepreneurship (KISE), a derived concept from Knowledge-Intensive Entrepreneurship (KIE, Malerba and McKelvey, 2020). Our assessment is based on the perspective that KISEs are embedded in Entrepreneurial Ecosystems (EE), thus being affected by contextual features of these socioeconomic structures.

The literature on EE is fruitful and embraces a diversity of discussions (Fischer and Meissner et al., 2022; Wurth et al., 2021; Bruns et al., 2017; Malecki, 2018; Bhawe and Zahra, 2017; Borissenko and Boschma, 2017; Kabbaj et al., 2016). Nevertheless, it has yet to embrace the KISE phenomenon as a driver of sustainable transitions (Pathak and Mukherjee, 2020; Tiba et al., 2020; Secundo et al., 2017; Hoogendoorn, 2016). Thus, the extent to which KISE is enabled (or constrained) by EE dimensions remains an open debate (Wurth et al., 2021; Gerli et al., 2021; Pathak and Mukherjee, 2020; Tiba et al., 2020; Bozhikin et al., 2019; Thomsen et al., 2018; Thompson et al., 2018; Roundy, 2017; Kabbaj et al., 2016).

Hence, our purpose in this article is to shed light on entrepreneurial ecosystems' readiness towards fostering KISE. Ultimately, our goal is to identify whether and to what extent the dynamics of 'traditional' entrepreneurial ecosystems can also apply to triggering sustainable transitions in terms of KISE activity. Our guiding research question can be stated as follows: *Are the local drivers of KISE aligned with the dimensions of mainstream entrepreneurial ecosystems*? In this way, we contribute to the debate on configurations of entrepreneurial ecosystems, generating inputs for research, policy and management *vis-à-vis* the urgent need to address sustainable development (Theodoraki et al., 2022; Tiba et al., 2020; Cohen, 2006).

Our empirical setting involves firms participating in the PIPE Program (Innovative Research in Small Business) funded by the São Paulo Research Foundation (FAPESP) in Brazil. The methodological approach relies on the estimation of entrepreneurial propensity functions that assess the statistical associations between city-level socioeconomic features and the generation of KISE for a panel of 629 municipalities. Findings indicate strong similarities on the underlying ecosystem drivers of KIE and KISE. However, when we disaggregate KISE into four domains (Cities, Health, Education and Green Technologies), the 'ecosystem readiness' towards sustainable transitions varies from more mature (as in the case of HealthTechs with an inclusive orientation) to very incipient configurations (Cities and EdTechs).

The remaining of the article is structured as follows. Section 2 discusses the literature review contributing to the debate about KISE and their connections with the Entrepreneurial Ecosystem concept. Section 3 presents the data and method. Section 4 outlines the empirical fndings, and Section 5 discusses results and outlines some implications for theory and practice. Section 6 concludes with final remarks.

2. Literature review

2.1. Knowledge-intensive entrepreneurship: a sustainable perspective

Following Malerba and McKelvey (2020), Knowledge-Intensive Entrepreneurship comprehend new organizations that use and transform knowledge to generate new forms of adding value. This conceptualization encompasses relationships between the entrepreneur, the organization, knowledge, and the broader social and economic context. According to the authors, there are four critical characteristics of these ventures: (i) they are innovative; (ii) they have significant knowledge intensity; (iii) they are embedded in entrepreneurial ecosystems; and (iv) they exploit innovative opportunities involving different sectors and actors. KIE ventures can derive value from interactions with myriad organizations such as incumbent firms, universities, non-governmental entities, as well as from the public sector (Malerba and McKelvey, 2020; Lassen et al., 2018; Mocelin and Azambuja, 2017). These elements show that scientific and technical areas are proeminent expressions of this kind of enterprise and demonstrate how the concept can be adaptative to different areas.

Sustainable entrepreneurship can be understood under the *entrepreneurship for sustainable development* umbrella (Johnson and Schaltegger, 2020) and focuses on a triple-bottom-line perspective (Elkington, 1998). Cohen and Winn (2007), in their seminal article, define SE as how entrepreneurial opportunities are discovered, created, and exploited by individuals generating social, environmental, and economic impact. This approach has many similarities with social entrepreneurship (Turker and Ozmen, 2021; Surie, 2017; Saebi et al., 2019; Dees, 2001), since both typologies are oriented to discovering market opportunities to solve societal and/or environmental issues as the key to generating value creation in a broad sense (Hoogendoorn et al., 2019). Considering them as the promising venue of research (Anand et al., 2021), we are following the plausible complementarity from Sustainable and Social Entrepreneurship and using academic literature from the both interchangeably. We understand sustainable businesses as 'hybrid' organizations in the sense of combining different institutional logics inside their business practices (Doherty and Kittipanya-Ngam, 2021; Bianchi, 2021; Park and Bae, 2020; Battilana, 2018; Agarwal et al., 2018; Maibom and Smith, 2016).

Based on these definitions, the concepts of KIE and SE can be merged as a function of the increasing intensity of knowledge and technology required to generate social and environmental impacts (Ibáñez et al., 2021; Vo-Thanh et al., 2021; Mora et al., 2021; Alsaleh et al., 2021; Gidron et al., 2021; Manos and Gidron, 2021; Scillitoe et al., 2018). Therefore, in this article we follow the complementarities between the KIE and SE concepts to analyze the Knowledge-Intensive Sustainable Entrepreneurship (KISE) phenomenon. From this perspective, KISE is compatible with social, environmental and economic goals given that these ventures aim at promoting social and/or environmental agendas while contributing to economic development by undertaking knowledge-intensive activities in myriad sectors.

As outlined, knowledge-intensive new firms are deeply embedded in entrepreneurial ecosystems. We now turn to these contextual features and try to make sense of their connection with the dynamics of value creation for society and the environment.

2.2. Entrepreneurial ecosystems and the emergence of Knowledge-Intensive Sustainable Entrepreneurship

Both KISE events and entrepreneurial ecosystems are fields that have drawn significant attention from scholars, practitioners and policymakers (Spigel, 2017; Borissenko and Boschma, 2017; Cheah et al., 2019; Gali et al., 2020; Maalaoui et al., 2020; Pathak and Mukherjee, 2020; Wurth et al., 2021). Yet, overlaps between these concepts have seldom received systematic attention (Roundy, 2017). In this section, we dedicate efforts to bring these two phenomena together and build a conceptual rationale to address EE readiness towards KISE activity.

The use of the ecosystem concept places emphasis in identifying the crucial components of localized entrepreneurial structures, the linkages among these components, and their influence on the emergence and development of entrepreneurial ventures (Isenberg, 2010; Mason and Brown, 2014). Spigel (2017) defines entrepreneurial ecosystems as the combination of social, political, economic and cultural elements, embedded in a region that supports the emergence and growth of innovative ventures. In this sense, they are commonly understood by their main dimensions or pillars, including markets, human capital, education, support system, culture, finance, infrastructure, and policy (Isenberg, 2010; Stam, 2015; Spigel, 2017; Alves et al., 2021).

In addition to the function of supporting the creation and growth of new ventures (Bhawe and Zahra, 2017), entrepreneurial ecosystems with high levels of readiness towards KISE also foster the engagement of entrepreneurs with social needs and environmental problems through an intensive use of knowledge and innovation in their activities (Znagui and Rahmouni, 2019). When ecosystems become effective in driving contextual conditions that steer the bulk of entrepreneurial activity in the direction of sustainable practices, literature identifies the existence of full-fledged sustainable entrepreneurial ecosystems (Cohen, 2006; Bischoff, 2021; Gali et al., 2020). However, these are likely exceptions within the dynamics of EE worldwide (Fischer, Bayona-Alsina et al., 2022). That is why considering a broader spectrum of 'readiness levels' towards fomenting KISE events can better inform our knowledge on how – and to what extent - EE agents and interactions are shaping the conditions for sustainable entrepreneurs to emerge.

In this vein, the following subsections discuss the main dimensions of Stam's (2015) entrepreneurial ecosystems framework and their respective articulations (or lack thereof) with the KISE phenomenon. Our research hypotheses are derived from these theoretical, conceptual and empirical insights.

2.2.1. *Framework conditions*

Stam (2015, p. 1766) defines framework conditions as a pillar of entrepreneurial ecosystems comprising "social (informal and formal institutions) and the physical conditions enabling or constraining human interaction". Although some of these elements are inherently complex to assess from a analytical point of view, efforts in terms of addressing components of the framework conditions have proven to qualify our understanding of EE underlying mechanisms (e.g. Fischer et al., 2018; Radosevic and Yoruk, 2013).

In this respect, a first framework condition of interest concerns Formal Institutions. This pillar of entrepreneurial ecosystems is strongly connected to local levels of socioeconomic development – a key enabler of knowledge-intensive entrepreneurship (Mello et al., 2022; Stam, 2015; Keeble and Walker, 2006). Second, Stam (2015) refers to cultural attributes of the ecosystem. Cultural processes are attached to feedback loops in terms of entrepreneurial behavior, affecting regional trajectories towards the intensity of entrepreneurial activity (Fotopoulos, 2014; Fritsch et al., 2019). According to Spigel (2017), cultural attributes involve risk tolerance, success stories, research culture, a positive image of entrepreneurship (a similar argument is also posed by Audretsch and Belitski, 2017).

A third framework condition comprises the quality of Physical Infrastructure available in the ecosystem. Such features provide support for early-stage organizations and operates in the background to enable the creation and growth of new businesses (Spigel, 2017). This physical arena provides a mechanism for start-ups' development and ranges from basic infrastructure – such as access to water and energy – to telecommunication/broadband facilities, office spaces, transportation, and so on (World Economic Forum, 2013; Audretsch and Belitski, 2017; Cohen, 2006). A fourth and final framework condition in Stam's (2015) model of entrepreneurial ecosystems makes reference to demand dynamics in the ecosystem. Here, knowledge-intensive entrepreneurship seems to be intrinsically associated to income levels, a driver of demand sophistication towards innovative products and services (Fischer et al., 2018; Radosevic and Yoruk, 2013; Naude et al., 2008; Wang, 2006; Santarelli and Tran, 2012). Complementarily, Stam (2015) states that exogenous demand conditions (i.e. beyond the local scope of the ecosystem) have an important role to play. Accordingly, the level of ecosystem openness to foreign markets can be a critical driver of demand for new ventures (Spigel, 2017).

Yet, KISE ventures have specifities that go beyond the 'traditional' logics of EE framework conditions. This happens because these businesses comprise a more diverse group of stakeholders to improve SE performance, address unmet social and environmental needs, and spur sustainable transitions (Theodoraki et al., 2022; Pandey et al., 2017; Bozhikin et al., 2019; Znagui and Rahmouni, 2019; Guerrero et al., 2021; Cohen, 2006). This results in more challenges than those faced by traditional organizational forms that fit into existing institutions relatively well (McMullen, 2018; Thompson et al., 2018; Villegas-Mateos and Vázquez-Maguirre, 2020).

Recent contributions (Fischer, Bayona-Alsina et al., 2022; Kabbaj et al., 2016; Purkayastha et al., 2020; Villegas-Mateos and Vázquez-Maguirre, 2020) assert the view that ecosystem configurations leading to KISE activity face different challenges *vis-à-vis* KIE in general. This is a function of a lack of the EE readiness to address matters associated with social and environmental aspects of entrepreneurial activity. As a result, EE framework conditions have demonstrated more limited impacts in triggering KISE than they have in nurturing innovative startups in general (Fischer, Bayona-Alsina et al., 2022). This leads to our first set of hypotheses:

H1a. There is a positive association between Framework Conditions of entrepreneurial ecosystems and the emergence of KISE events.

H1b. The association between Framework Conditions and KISE events is weaker than the association between Framework Conditions and 'traditional' KIE activity.

2.2.2. *Systemic conditions*

Although framework conditions represent key pillars upon which EE are based, the systemic conditions are what Stam (2015, p. 1766) refers to as 'the heart of the ecosystem'. A first systemic condition of interest concerns Networks. The formation of linkages amongst actors involved directly and/or indirectly with entrepreneurial endeavors is taken as the core feature of entrepreneurial ecosystems since they provide informational flows and enable the spread of talent and capital (Stam, 2015). They also allow connections between entrepreneurs, advisors, and investors, enabling the free movement of knowledge and skills (Audretsch et al., 2019; Cunningham et al., 2018; Spigel, 2017; Acs et al., 2009). The enabling role of networks appears also to be of central importance in the case of entrepreneurship with a sustainable orientation (Maalaoui et al., 2020; Surie, 2017).

Second, Stam (2015) refers to the role of Leadership in the ecosystem, an aspect derived from the existence of role models in the ecosystem that can give a sense of coherence to individuals and firms (Knox and Arshed, 2022; Tiba et al., 2020; Roundy, 2020). Third, systemic conditions comprise the availability of Finance for entrepreneurs (Stam and van de Ven, 2021; Guerrero et al., 2021). This represents not only the capacity of the ecosystems to supply new businesses with investments, but also the managerial role of investors in shaping the managerial capabilities of new ventures (Fischer et al., 2022). Literature has highlighted the challenges inherent to funding of sustainable businesses through traditional sources due to their lack of alignment with 'traditional' market perspectives (Islam, 2020; Villegas-Mateos and Vázquez-Maguirre, 2020; Hoogendoorn et al., 2019; Cheah et al., 2019; McMullen, 2018; De Lange, 2017).

Next, Stam (2015) outlines the importance of Talent and Knowledge sources. Worker talent involves the availability of highly skilled professionals that can become entrepreneurs or form part of entrepreneurial teams. These features compose core human capital assets of entrepreneurial ecosystems, particularly those with a knowledge-intensive orientation (Alves et al., 2021; Chatterji et al., 2013). In turn, the Knowledge dimension is multifaceted in nature, involving mainly universities, research institutes and firms (Qian 2018; Malecki, 2018; Spigel, 2017; Theodoraki et al., 2018; Clarysse et al., 2014; Cohen, 2006). Nonetheless, it is not clear whether knowledge infrastructures are designed (or not) to nurture knowledge production and diffusion towards generating sustainable impacts (Thomsen et al., 2018). In this respect, no automatic contributions are expected to arise. Rather, the knowledge domain needs to be steered in the direction of sustainable initiatives in order to function as a true pillar for KISE events (Eiselein et al., 2017).

A last component of the Systemic conditions concerns Support Services and Intermediaries. These are mainly represented by organizations that provide ancillary services to new ventures (Spigel, 2017). These organizations facilitate the flow of resources, the building of capabilities, the access to social networks, and the connection to funding sources. Incubators and tech parks are examples and can be specific for sustainable entrepreneurs as they can be seen as agents oriented to stimulate connections and to facilitate action amongst positive impact firms, private and public agents (Theodoraki et al., 2018; Kabbaj et al., 2016; Purkayastha et al., 2020; Guerrero et al., 2021; Pathak and Mukherjee, 2020; Villegas-Mateos and Vázquez-Maguirre, 2020; Pandey et al., 2017; Roundy, 2017). In the case of sustainable entrepreneurship, these support organizations play a prominent role in helping startups to overcome constraints in terms of ecosystem embeddedness, thus facilitating their insertion in relevant networks (Van Rijnsoever, 2022).

But despite some great examples of sustainable ventures around the world (Yunus et al., 2010; Surie, 2017; Comini et al., 2019), we cannot yet trace a prominent background in ecosystems supporting these ventures. Recent evidence has underscored a lack of 'readiness' in Systemic Conditions of entrepreneurial ecosystems in shaping KISE events when comparing with more traditional kinds of KIE. Accordingly, we propose our second set of hypotheses:

H2a. There is a positive association between Systemic Conditions of entrepreneurial ecosystems and the emergence of KISE events.

H2b. The association between Systemic Conditions and KISE events is weaker than the association between Systemic Conditions and 'traditional' KIE activity.

3. Methodological approach

3.1. Sample and data

Our methodological approach relies on the estimation of entrepreneurial propensity functions that assess the statistical associations between ecosystem-level features and the generation of Knowledge-Intensive Sustainable Entrepreneurship (KISE). The sample comprises panel information for 629 cities in the State of São Paulo, Brazil, over the period 2005–2017 (contextual features) and 2006–2018 (entrepreneurial events). Although there remains a conspicuous lack of agreement on the spatial reach of entrepreneurial ecosystems, connections and spillovers tend to be highly localized, making the city-level analysis an adequate empirical strategy (Malecki, 2018; Qian et al., 2013; Audretsch and Belitski, 2017; Bruns et al., 2017).

The State of São Paulo stands for a relevant analytical unit to gather insights on KISE events embedded in the context of a developing country. While this region stands as the leading economy in Brazil and in Latin America, it suffers from typical socioeconomic maladies that are present in catching-up countries, such as institutional voids, a difficult business environment for innovation-driven entrepreneurs, and strong agglomeration diseconomies (Fischer et al., 2018).

3.1.1. Dependent variables

The analyzed database was extracted from the PIPE Program (Innovative Research in Small Business) managed by FAPESP (The São Paulo Research Foundation). PIPE was inspired by the Small Business Innovation Research (SBIR) Program that has run in the United States since the eighties (Salles-Filho et al., 2011). The rationale behind the PIPE program is to give support to the KIE ventures as a tool to promote technological innovation, entrepreneurship development, and increase competitiveness in small businesses. There are three relevant criteria to obtain the funding: enterprises must have less than 250 employees; research proposals must demonstrate high levels of human capital; and there must be an identification of a business opportunity (Fischer et al., 2021). We acknowledge that PIPE projects do not capture the entire population of KIE and KISE ventures. However, it does offer a robust indicator to analyze entrepreneurial firms and events. Similar approaches have been undertaken for the case of the SBIR established on the premise that "a basis for firms receiving Small Business Innovation Research (SBIR) research awards to develop commercializable technologies is not only their proposed creative ideas but also their endowment of attendant knowledge necessary to develop the technology being proposed" (Audretsch and Link, 2019, p.1). Other examples include Audretsch et al. (2016) and Van der Vlist et al. (2004). Since PIPE seems to follow similar patterns (Salles-Filho et al., 2011), its use in our assessment relies on sound empirical evidence.

We analyzed the PIPE dataset to identify enterprises that could be categorized as sustainable enterprises drawing from descriptive information of each project. For this categorization, we considered KISE from a broad perspective, including companies that demonstrated social and/or environmental engagement in their entrepreneurial endeavors regardless of their profit orientation (as suggested by Neverauskiene and Pranskeviciute, 2021; Mahfuz Ashraf et al., 2019; Battilana, 2018; Defourny and Nyssens, 2017). Accordingly, in this research, we understand Knowledge-Intensive Sustainable Entrepreneurship (KISE) as innovation-driven organizations that generate positive impacts for society and natural environment whether such aspects form part of their deliberate value proposition or not.

Starting from a database with 1575 finalized projects between the years 2005 and 2018, we identify 564 projects that fall within the KISE category. To obtain this number, we analyzed each one by their titles and content descriptions looking for elements related to positive social and environmental impacts. This analysis was carried out independently by three researchers to guarantee that the projects were in accordance to the criteria established above. Discrepancies were solved through discussions among the authors.

The final sample (564 projects) was categorized according to one or more possible impact areas: (i) education, (ii) city planning and living conditions, (iii) green technologies, and (iv) health (Hollerbach and Fonseca, 2021). This categorization helped us to better understand the field distribution and main needs of each type of KISE. This is key to understand specificities associated to the effects of ecosystem features on each cohort of KISE. As recent research has demonstrated (Spigel, 2022), the dynamics of EE seem to present sectoral patterns, i.e., EE

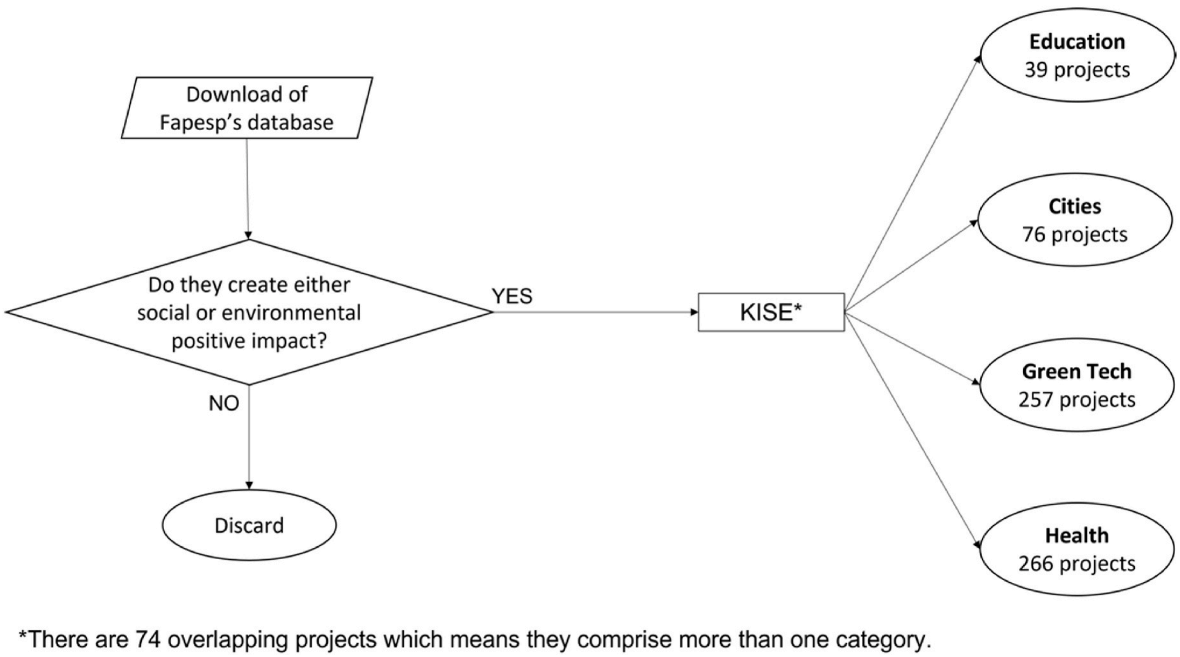

Fig. 1. A flowchart of the sample design.

configurations do not necessarily affect all entrepreneurs in a similar fashion, thus generating 'nested' ecosystems – rather than cohesive wholes. By complementing our core dependent variable with this view on specific cohorts we can dig deeper into latent differences within the KISE concept. The following flowchart (Fig. 1), describes the phases and gates used to decide what kind of enterprises were to be included under the KISE concept.

To meet our research goal, we have also added KIE companies that do not qualify as KISE as a dependent variable in our analysis. This procedure was also adopted by Fischer et al. (2022) to generate a benchmark for comparing the dynamics of 'traditional' EE with what goes on in the case of KISE. This is a key step in assessing hypotheses H1b and H2b, allowing a verification of ecosystem 'readiness' when contrasting KIE and KISE events.

3.1.2. Independent variables

Drawing from Stam's (2017) framework, our set of independent variables comprise two main EE dimensions, namely Framework and Systemic conditions. Although we were not able to fully capture each and every condition, our EE representation covers eight of the ten conditions outlined in Stam (2015). The full set of variables is described in Table 1. Some cautions are needed. We were not able to generate reasonable proxies for EE-level leadership (a typically qualitative event) and Finance. In the latter case, data coverage was only available for loans from retail banks, a poor proxy for entrepreneurial sources of funds (Alves et al., 2021).[1] In any case, our entire sample is representative of entrepreneurial ventures that received access to public investments to undertake their activities. While this generates bias in our analyses, it also warrants Finance as a necessary condition of all locations under scrutiny.

In terms of the Framework conditions, the quality of institutions was assessed through the use of the city-level Human Development Index, a composite indicator that comprises health, knowledge and income, thus offering a strong *proxy* for the quality of policies and institutions (Suri et al., 2011; Binder and Georgiadis, 2010). Culture is addressed with a 1-period lead of the applicable independent variable. This offers an idea of the persistence of entrepreneurial activity in cities (Sternberg, 2021). The quality of infrastructure is represented both by Public Investments in infrastructure and an indicator of Energy consumption (Agénor, 2015; Geginat and Ramalho, 2018; Fischer et al., 2018). Demand conditions are represented by local levels of income per capita (Radosevic and Yoruk, 2013) and global connections via trade (Lee et al., 2021) and FDI (Ryan et al., 2021).

For the Systemic conditions, we use intensity of Technology Transfer agreements (Rondé and Hussler, 2005) and University-Industry interactions (Schaeffer et al., 2021) to approximate the density of local networks. Talent is measured as a function of tertiary enrollment, a typical indicator of human capital (Fischer et al., 2018). Knowledge conditions involve the presence of eminent research universities located in the State of São Paulo (based on the Scimago institutional ranking) and cross-checked results with data from the São Paulo Research Foundation Grants and Scholarships database. All selected locations/year corresponded to the group of leading cities in terms of research funding, warranting robustness to our selection of academic units. As identified in prior literature, Research Universities play a pivotal role in shaping the conditions for knowledge generation and dissemination at the local-level, an aspect that creates opportunities for entrepreneurs to exploit (Guerrero et al., 2016; Schaeffer et al., 2018). We complemented this academic view with the inclusion of a variable for Technological Activity, i.e. domestic patent deposits. This offers information on the innovation capabilities of cities (Kuckertz, 2019), a feature that has been previously associated with entrepreneurial events in developing countries (Tran and Santarelli, 2017). A last Systemic condition comprises incubators and tech parks as typical innovation habitats dedicated to foment innovation-driven entrepreneurship (Alves et al., 2021; Giner et al., 2016).

As control variables, we included three vectors. First, we added city-level Population to mitigate statistical effects associated with the sheer size of cities. Second, we added Population density as it provides a view on levels of human agglomeration in cities. Such conditions bring a perspective on key aspects associated with social distress and depletion of natural environments, considering the observed dynamics of urban

[1] We used this variable to test our models, but its lack of statistical significance combined with its poor representation of the condition at stake justified its exclusion from our models.

Table 1
Analytical variables.

Ecosystem Dimension	Ecosystem Conditions	Variable	Description	Source
Entrepreneurial Events		KIE (excluding KISE)	Total count of Knowledge-Intensive Entrepreneurship (in the city in a given analytical period (excluding those cases classified as KISE).	São Paulo Research Foundation
		KISE	Total count of Knowledge-Intensive Sustainable Entrepreneurship in the city in a given analytical period.	
		KISE Cities	Sub-group of KISE with impacts oriented to city planning and living conditions.	
		KISE Health	Sub-group of KISE with impacts oriented to the health sector.	
		KISE Education	Sub-group of KISE with impacts oriented to educational issues.	
		KISE Green	Sub-group of KISE with impacts oriented to the mitigation of environmental hazards.	
Framework Conditions	Institutions	HDI	Human Development Index for each city in a given analytical period.	Industry Federation of the State of Rio de Janeiro
	Culture	DV t-1	In each model we approximated the Cultural aspect through the insertion of a 1-period lead (t-1) of the corresponding dependent variable in each model.	São Paulo Research Foundation
	Infrastructure	Public Investments	Total investments per capita in infrastructure implemented by city-level governments in a given analytical period. Values in 2019 Brazilian Reais.	São Paulo Statistical Foundation
		Energy Consumption	Average consumption of electric energy (MWh) per capita in the city in a given analytical period.	
	Demand	GDP per capita	Average GDP per capita in the city in a given analytical period. Values in 2019 Brazilian Reais.	São Paulo Statistical Foundation
		Export-Import activity	Average share of companies involved with export and/or import activity in the city in a given analytical period.	Brazilian Ministry of Economics
		FDI	Occurrence of at least one Foreign Direct Investment event in the city in a given analytical period. Binary variable.	São Paulo Statistical Foundation
Systemic Conditions	Networks	Technology Transfer	Average number of technology licensing agreements per capita registered at the Brazilian Institute of Industrial Property in the city in a given analytical period.	Brazilian Institute of Industrial Property
		U–I interactions	Sum of reported university-industry interactions in the city in a given analytical period.	Brazilian Research Council - Directory of Research Groups
	Talent	Tertiary enrollment	Average share of city-level population enrolled in Higher Education Institutions in a given analytical period.	São Paulo Statistical Foundation
	Knowledge	Research University	Presence of at least one high-quality university campus in the city in a given analytical period. Binary variable.	Scimago Institutional Ranking
		Technological Activity	Average number of patent deposits per capita registered at the Brazilian Institute of Industrial Property in the city in a given analytical period.	Brazilian Institute of Industrial Property
	Support Services	Incubators & Tech Parks	Presence of at least one incubator or Tech Park in the city in a given analytical period. Binary variable.	São Paulo Investment Agency
Controls		Population	Number of inhabitants in the city in a given analytical period.	São Paulo Statistical Foundation
		Population Density	Average rate of inhabitants per square kilometer in the city in a given analytical period.	São Paulo Statistical Foundation
		Distance to main economic hub	Road distance from each municipality to the main economic hub, the city of São Paulo.	Google Maps

Table 2
Estimations – Full sample (637 cities) – GEE Negative Binomial.

EE dimensions	Variables	Model					
		KIE (exclud. KISE)	KISE Total	KISE Cities	KISE Health	KISE Education	KISE Green
Framework Conditions	HDI	0.399***[0.136]	0.649***[0.151]	−0.266 [0.341]	0.938*** [0.225]	0.317 [0.484]	0.580***[0.195]
	DV t-1	0.126***[0.031]	0.127***[0.024]	0.086 [0.105]	0.239*** [0.056]	0.341*[0.207]	0.231***[0.052]
	Public Investments	0.113 [0.076]	−0.026 [0.091]	−0.341 [0.264]	0.034 [0.115]	−0.006 [0.294]	−0.142 [0.136]
	Energy Consumption	0.016 [0.064]	−0.109 [0.222]	−1.816 [2.222]	−0.173 [0.595]	−6.254 [3.971]	−0.056 [0.176]
	GDP per capita	0.128**[0.059]	0.177***[0.051]	0.261*[0.135]	0.207*** [0.061]	0.361*** [0.108]	0.104 [0.09]
	Export-Import activity	0.160*[0.096]	0.148 [0.105]	0.441**[0.219]	0.150 [0.14]	0.359 [0.297]	0.114 [0.144]
	FDI	0.072 [0.216]	0.033 [0.214]	0.083 [0.42]	−0.100 [0.272]	−0.717 [0.56]	0.043 [0.276]
Systemic Conditions	Technology Transfer	−0.002 [0.058]	0.105**[0.045]	0.127 [0.1]	0.111*[0.059]	0.153 [0.117]	0.092 [0.066]
	U–I interactions	0.112***[0.041]	0.072*[0.04]	0.157***[0.059]	0.087*[0.045]	0.173**[0.08]	0.105**[0.044]
	Tertiary enrollment	0.229***[0.077]	0.410***[0.059]	0.467***[0.154]	0.294*** [0.099]	0.509**[0.223]	0.454***[0.065]
	Research University	1.882***[0.279]	1.503***[0.27]	2.484***[0.72]	1.777*** [0.382]	1.941**[0.905]	0.989***[0.348]
	Technological Activity	0.135***[0.051]	0.135***[0.044]	0.228***[0.069]	0.152*** [0.051]	0.225**[0.092]	0.093 [0.08]
	Incubators & Tech Parks	1.149***[0.263]	0.986***[0.257]	1.091 [0.693]	0.883*** [0.340]	0.397 [0.866]	1.311***[0.339]
Controls	Population	−0.065*[0.036]	0.007 [0.039]	0.389**[0.189]	−0.018 [0.044]	−0.033 [0.106]	0.022 [0.058]
	Population Density	−0.074 [0.063]	−0.177**[0.083]	−2.079*** [0.787]	−0.076 [0.094]	−0.414 [0.336]	−0.391**[0.183]
	Distance to main economic hub	−0.763*** [0.163]	−0.399*** [0.148]	−1.309*** [0.499]	−0.241 [0.201]	−1.113** [0.52]	−0.498*** [0.185]
	Valid N	7491	7491	7491	7491	7491	7491
	Wald chi sq.	781.09***	703.01***	186.62***	441.30***	122.79***	533.56
Std. Errors in brackets					*sig. at 10%; **sig. at 5%; ***sig. at 1%		

Table 3
Estimations – Megalopolis (173 cities) - GEE Negative Binomial.

EE dimensions	Variables	Model					
		KIE (exclud. KISE)	KISE Total	KISE Cities	KISE Health	KISE Education	KISE Green
Framework Conditions	HDI	0.289*[0.162]	0.438**[0.197]	−0.554 [0.437]	0.368 [0.300]	−0.166 [0.503]	0.717*** [0.276]
	DV t-1	0.019 [0.038]	0.052*[0.028]	0.061 [0.109]	−0.043 [0.070]	0.267 [0.221]	0.195*** [0.062]
	Public Investments	−0.033 [0.126]	−0.167 [0.145]	−0.294 [0.315]	−0.055 [0.197]	−0.592 [0.507]	−0.284 [0.201]
	Energy Consumption	−0.736**[0.319]	0.030 [0.162]	−0.118 [0.713]	−0.052 [0.255]	−2.699 [1.663]	0.135 [0.164]
	GDP per capita	0.289***[0.104]	0.247*** [0.087]	0.394 [0.246]	0.352*** [0.105]	0.845*** [0.306]	0.038 [0.169]
	Export-Import activity	0.224 [0.173]	0.188 [0.192]	0.504 [0.373]	0.057 [0.266]	0.602 [0.592]	0.171 [0.257]
	FDI	0.093 [0.247]	0.128 [0.248]	0.038 [0.484]	0.137 [0.333]	−0.702 [0.656]	0.078 [0.324]
Systemic Conditions	Technology Transfer	0.126*[0.068]	0.141**[0.063]	0.177 [0.173]	0.150*[0.090]	0.263 [0.2]	0.132 [0.086]
	U–I interactions	0.203***[0.054]	0.102*[0.054]	0.188**[0.084]	0.197*** [0.064]	0.216*[0.129]	0.097 [0.059]
	Tertiary enrollment	0.278**[0.124]	0.459*** [0.089]	0.541**[0.268]	0.341**[0.157]	0.607 [0.464]	0.486*** [0.099]
	Research University	1.210***[0.344]	0.693*[0.389]	3.799***[1.113]	−0.300 [0.617]	3.487*** [1.293]	0.452 [0.462]
	Technological Activity	0.055 [0.119]	0.199***[0.06]	0.403***[0.13]	0.228*** [0.085]	0.438*** [0.169]	0.126 [0.088]
	Incubators & Tech Parks	1.649***[0.374]	1.585*** [0.427]	−0.224 [1.011]	1.882*** [0.618]	−1.38 [1.305]	1.853*** [0.511]
Controls	Population	−0.192**[0.087]	0.042 [0.089]	1.018**[0.476]	−0.019 [0.098]	−0.034 [0.252]	0.101 [0.129]
	Population Density	−0.212 [0.138]	−0.278 [0.191]	−5.333** [2.183]	−0.186 [0.227]	−1.081 [0.798]	−0.649 [0.408]
	Distance to main economic hub	−0.289 [0.211]	0.031 [0.244]	−1.426*[0.791]	−0.409 [0.376]	−0.758 [0.683]	0.201 [0.284]
	Valid N	2034	2034	2034	2034	2034	2034
	Wald chi sq.	478.99***	326.74	107.50***	230.52***	70.52***	270.25***
Std. Errors in brackets					*sig. at 10%; **sig. at 5%; ***sig. at 1%		

Table 4
Configurational summary of estimations.

EE Dimensions	Entrepreneurial Event											
	KIE (exclud. KISE)		KISE Total		KISE Cities		KISE Health		KISE Education		KISE Green	
Framework Conditions	Institutions	⬢	Institutions	⬢	Institutions	⊗	Institutions	⬡	Institutions	⊗	Institutions	⬢
	Culture	⬡	Culture	⬢	Culture	⊗	Culture	⬡	Culture	⬡	Culture	⬢
	Infrastructure	⊗	Infrastructure	⊗	Infrastructure	⊗	Infrastructure	⊗	Infrastructure	⊗	Infrastructure	⊗
	Demand (Local)	⬢	Demand (Local)	⬢	Demand (international)	⬡	Demand (Local)	⬢	Demand (Local)	⬢	Demand	⊗
Systemic Conditions	Networks	⬢	Networks	⬢	Networks	⬢	Networks	⬢	Networks	⬢	Networks	⬡
	Talent	⬢	Talent	⬢	Talent	⬢	Talent	⬢	Talent	⬡	Talent	⬢
	Knowledge (Academic)	⬢	Knowledge	⬢	Knowledge	⬢	Knowledge	⬢	Knowledge	⬢	Knowledge (Academic)	⬡
	Support	⬢	Support	⬢	Support	⊗	Support	⬢	Support	⊗	Support	⬢

⬢ Robust Conditions ⬡ Non-robust conditions ⊗ Non-significant conditions

agglomerations in developing countries (Glaeser and Xiong, 2017). Last, the distance to the main economic hub variable includes cities' road distance to São Paulo. As prior literature indicates, propinquity to urban agglomerations is associated to connections to larger markets and business networks, functioning as a 'center of gravity' for entrepreneurial activity (Fischer et al., 2018; Crescenzi and Rodríguez-Pose, 2012).

Table 1 presents the full set of analytical variables and their respective sources. Descriptive statistics can be found in Appendix I. Details on the sample profile concerning entrepreneurial activity in the analyzed region are provided in Appendix II.

3.2. Estimation strategy and robustness checks

We apply Generalized Estimating Equations (population average models) for panel data with count outcomes. Negative binomial models were used due to overdispersion in the distribution of dependent variables. Valid samples for city-level analysis comprise 7491 observations (city/period). Z-scores were calculated for continuous variables with the goal of harmonizing coefficients with distinct scales. The structure of the dataset took into account that causal mechanisms between ecosystem features and KISE events take place with a temporal lag. In this regard, we follow a similar approach to that of Qian et al. (2013), using a 1-period lag.[2] A multiplicative interaction term was created for Research Universities and U–I interactions. This was done to capture the extent to which academic connectedness to industrial partners (i.e., the notion of entrepreneurial university) impacts entrepreneurial endeavors (Schaeffer et al., 2021). All procedures are also applied to the case of KIE companies excluding KISE cases, allowing to comparatively address the dynamics of EE from these different perspectives.

A total of six models were estimated, one for each dependent variable (KIE, KISE, KISE Cities, KISE Health, KISE Education and KISE Green). As a first robustness check, we ran the models with a sub-sample of cities that are geographically located within the Brazilian Megalopolis, a massive conurbation that comprehends over forty million people and responds for over a third of the Brazilian GDP. This was done because large urban agglomerations in developing countries suffer from endemic social and environmental distress (Chauvin et al., 2016; Glaeser, 2014; Henderson, 2002). In turn, by estimating these alternative specifications, we can address the consistency of our findings in a group of municipalities embedded in this specific urban setting.

4. Empirical findings

Results from econometric estimations for the total sample of municipalities are reported in Table 2. This includes models for our different specifications of KISE and the benchmark of KIE (excluding KISE cases). Table 3 provides the robustness tests for the alternative sample involving only municipalities located in the Brazilian Megalopolis area. For clarity, we divide our analytical approach following the Stam's (2015) ecosystem dimensions, namely Framework and Systemic Conditions.

4.1. Framework conditions

First, for the case of local-level HDI, our measure of *Institutions*, positive associations could be perceived for both KIE and KISE events. This relationship is actually increased for KISE, but effects are heavily concentrated in KISE Health and KISE Green. In terms of *Culture*, our representation of the dependent variable in t-1 (lead of entrepreneurial events) presents marked homogeneity between KIE and KISE models. Again, however, associations are heterogeneous when considering different scopes of KISE. Effects are particularly noteworthy for KISE Health and KISE Green, but significant effects (at 10%) are also present for KISE Education.

In turn, both variables associated with *Infrastructure* (public investments and energy consumption) are not significant across estimations, thus not representing an influential vector in the sample. While this is contrast with typical EE models, it comes as no surprise considering the infrastructural deficits observed in developing countries such as Brazil (Chauvin et al., 2016; Venables, 2005). For the *Demand* dimension, as indicated, we have three indicators. GDP per capita refers to local demand capacity, and it is positively associated with both KIE and KISE, although it shows no significant effects on KISE Green. In turn, internationalization activity measured through exports/imports have significant effects only for KIE (at 10%) and KISE Cities (at 1%). FDI presence is not significant across models. This comes as no surprise, considering the existing barriers and lack of international orientation in knowledge-intensive entrepreneurs in Brazil (Cahen et al., 2016), a feature that can also be perceived at the ecosystem-level (Alves et al., 2021).

When we address our robustness tests based on cities embedded in the Brazilian Megalopolis, some of these associations could be not be confirmed, thus deserving cautious appropriation (Table 3). In the case of the *Institutional* dimension, outcomes for KISE Health differed from original estimations, generating non-significant impacts associated with the corresponding variable. For the *Culture* vector, the persistence of KIE was not consistent for models involving KIE, KISE Health and KISE Education. The lack of significance of *Infrastructure* indicators remained equal. For *Demand*, the results for Export-Import activity related to KISE Cities was not supported in robustness tests. Table 4 sums up these main findings and their robustness levels based on a simple configurational visualization of econometric estimations. From this exercise we can perceived different trends across estimations.

Although the conditions for KIE and KISE models indicate similar EE patterns in terms of Framework conditions, when we look into different specifications of KISE we notice substantial differences. This is particularly valid for KISE Cities (i.e. entrepreneurial ventures proposing solutions to urban issues). In this case, only a feeble association (non-robust) exists for Demand. These are interesting insights into the both the 'nested' nature of EE dynamics (Spigel, 2022) and the relative lack of maturity in entrepreneurial ecosystems' domains within the

[2] We have also tested 2-period lags to check for consistency of estimations. Results remained unaltered. This alternative specification is not reported for brevity's sake, but they are available from the authors upon request.

socioeconomic environment of developing countries (Fischer et al., 2018).

This allows the examination of our first set of hypotheses (H1a and H1b). H1a is supported for KISE as a whole. In turn – and somewhat surprisingly – we could not identify that KIE drivers are more well-established than KISE in general. But the validity of these conclusions is challenged when we look into different specifications of sustainable entrepreneurship. This is an interesting insight into the idea that EE do not necessarily function as structures that can equally nurture all kinds of entrepreneurship in a similar fashion. In Section 5 we engage in further discussions on these matters.

4.2. Systemic conditions

First, we look into the *Network* aspects of our models. Intensity of Technology Transfer agreements does not demonstrate significant effects in the case of KIE events, but has positive effects in the case of overall KISE – even though other specifications indicate such conditions are restricted to the case of KIE Health. In turn, for University-Industry Interactions, the association is positive and significant across models with varying levels of statistical significance. Second, our measure of the local *Talent* pool indicates a consistent relevance of educational levels for all cases of KIE events. Interestingly, coefficients indicate larger effects in specifications of KISE events than for KIE in general.

Next, assessing the *Knowledge* dimension, special weight can be attached to the presence of leading Research Universities in driving both KIE and KISE (and the different specifications of the latter). In turn, the role played by Technological Activity (Patents per capita) demonstrates more marginal impacts and these of similar magnitude for KIE and KISE events. Again, the strength of these associations is changed when we look into different orientations of KISE and the predictor loses significance for the case of green technologies (KISE Green). Last, concerning the importance of Support *Services*, local availability of incubators and/or science parks has a pivotal influence in most cases, but it shows no significant association with the emergence of KISE Cities and KISE Education.

Taken together, results from our models indicate slight differences between KIE and KISE events. Remarkable distinction, however, appear when analyzing within-KISE cases. The universities should also be highlighted. Not only for their direct impacts related to the Research Universities variable, but also to their effects through human capital formation and establishment of ties through university-industry linkages. Yet another ‘hidden’ feature here takes place through patenting activity and technology transfer dynamics. In Brazil, leading universities dominate the intellectual property scene.

Following these trends, these academic institutions are also extremely important in setting the foundations for entrepreneurial ecosystems to emerge and thrive (Schaeffer et al., 2018). While this is obviously valid for EE worldwide, more incipient ecosystems have a disproportional importance attributed to these institutions due to the relative lack of knowledge capabilities embedded in incumbent firms (Schaeffer et al., 2021).

Robustness tests confirm the rather complete configurations for both KIE and KISE events in terms of Systemic Conditions. This provides support for H2a, but it does not indicate that there is a lack of EE readiness towards sustainable entrepreneurship in our sample. Hence, *prima facie*, H2b can be rejected. But, once again, when we look into distinct orientations of KISE activity, a much more nuanced picture emerges (Table 4). For instance, while we perceive a consistent and complete configuration in terms of Systemic Conditions for KISE Health, the picture for KISE dealing with Education and Green Technologies is much more fragmented. Accordingly, our rejection of H2b (and this is also valid for H1b) raises the issue of understanding what goes on within entrepreneurial ecosystems when it comes to specific orientations of sustainable entrepreneurship. We now turn our attention to discussing such findings and their respective implications.

5. Discussions

A growing number of authors focus on discussing how technology is relevant to empowering sustainable entrepreneurship (Gerli et al., 2021; Ghazinoory et al., 2020; Desa and Basu, 2013). This background suggests a need for advanced ways to combine knowledge and innovation to foment new combinations and disruptive technologies for grand societal challenges. While Knowledge-Intensive Sustainable Entrepreneurship is not the only mechanism to tackle social and environmental issues, it is certainly an important piece of the puzzle towards sustainable transitions. In this respect, although the dynamics of entrepreneurial ecosystems have emerged as a topic of growing interest worldwide due to its potential of generating economic growth and development for cities and regions, discussions are still strongly oriented towards business models that often fail to tackle pressing issues related to social and environmental impacts (Jütting, 2020; Ghazinoory et al., 2020; Surie, 2017; Sarpong and Amankwah-Amoah, 2015; Sarpong and Davies, 2014).

Accordingly, to generate the necessary shifts towards more responsible entrepreneurship, adaptive and supportive entrepreneurial ecosystems that can actively promote these hybrid organizations becomes necessary (Thompson et al., 2018; Del Giudice et al., 2019; Hoogendoorn et al., 2019). In this article we have delved into these aspects in order to shed additional light on the extent to which EE are ready to offer the necessary contextual inputs for sustainable new ventures. With this in mind, we have explored the dynamics of KISE in the State of São Paulo, Brazil. Unraveling the mechanisms that promote KISE activity in a developing country can be key to deriving policy insights for nurturing the sort of entrepreneurship that can generate pervasive social and environmental gains. Transitions towards innovation-driven entrepreneurship that address these needs are likely a way to mitigate fundamental problems of traditional technology management (Sarpong and Davies, 2014; Cohen, 2006).

Our findings indicate a high level of similarity between the configuration of typical entrepreneurial ecosystems and those observed for KISE, in line with prior literature (McMullen, 2018; Thompson et al., 2018; Villegas-Mateos and Vázquez-Maguirre, 2020; Cohen, 2006). This can be interpreted as a fortunate situation, since transitions towards more sustainable entrepreneurial ecosystems does not seem to be far-fetched. Of course, entrepreneurial ecosystems are organic, bottom-up structures and entrepreneurial agency should not be confronted by top-down guidelines – a typical mistake of mission-oriented policies (Audretsch and Fiedler, 2022). But this does not mean that addressing the sustainable development issues should be left to market forces alone. KIE and KISE can and should co-exist, and, from our data, this diversity can come from highly similar configurations. Hence, policies aiming at further legitimizing KISE activity can help overcome the existing barriers to sustainable transitions in cities.

However, our assessment has revealed some striking differences when we look into more specific details in terms of orientations of KISE ventures. This brings some novel elements to the debate on the association between entrepreneurial ecosystems and sustainable entrepreneurship – features that are actually in line with the 'nested ecosystem' argument laid out by Spigel (2022). In his work, the author identifies that EE in the United Kingdom do not function as cohesive wholes, rather being represented by sub-communities that actively coalesce according to their characteristics, goals, norms and behaviors. This creates a notion of 'coherence' that promotes interconnectedness in the ecosystem (Roundy et al., 2017).

When we disaggregate KISE into four domains (Cities, Health, Education and Green Technologies), the strength of EE Framework and Systemic conditions reveals a highly heterogeneous pattern. In this case, the 'ecosystem readiness' towards sustainable transitions varies from more mature (as in the case of HealthTechs with an inclusive orientation) to very incipient configurations (Cities and EdTechs). This brings important implications for policy in understanding (i) what are the primary social and/or environmental goals to be addressed; and (ii) how well ecosystems (or a given specific ecosystem) are equipped to help shaping the conditions for new ventures that are aligned with these challenges to emerge. Alternatively, from a less interventionist perspective, it allows policymakers and practitioners to better comprehend what are the ecosystem strengths and foster specialization in sustainable goals in which the ecosystem has comparative advantages.

In spite of particularities and strong indications of 'nested ecosystems' when it comes to KISE activity, we ought to pinpoint the pervasive positive effects associated directly and indirectly with high-quality Research Universities. These institutions by themselves generate positive and robust impacts in most of our estimations. More than that, they represent pivotal actors in terms of generating and diffusing technological activity in entrepreneurial ecosystems, thus acting simultaneously as knowledge sources and brokers. This is not entirely unexpected, considering that universities often function as 'anchors' of EE in less mature socioeconomic environments (Schaeffer et al., 2021; Alves et al., 2021; Fischer et al., 2018). Yet, when it comes to understanding the dynamics of KISE events, it highlights the importance of academic institutions in sowing the seeds for ecosystem-level sustainable transitions. Nonetheless, it is worth noting that the connection between sustainable ventures and Universities is still considered unclear (Cinar, 2019; Thomsen et al., 2018). Therefore, this relationship must be improved with well-defined strategies for promoting impact interactions such as university-industry collaboration resulting in resources and solutions to positively impact the community life (García-González and Ramírez-Montoya, 2020; Roslan et al., 2020). A better comprehension of the mechanisms, enablers and barriers of this phenomenon is a promising field for further examination.

6. Concluding remarks

From our analysis, a substantial overlap emerges between the configurations of entrepreneurial ecosystems in promoting 'traditional' and 'sustainable' knowledge-intensive entrepreneurship (in line with observations from the seminal contribution of Cohen, 2006). Considering these similarities, there seems to be room for initiatives that look for both knowledge-intensive and sustainable orientation in their entrepreneurial activities, aligning social and environmental positive impact with innovation towards economic development. Although entrepreneurship is based on bottom-up activities, we are facing, as a society, an unprecedented historical moment that requires orchestrated transition processes to an *impact-oriented entrepreneurship*. Our analyses indicate that EE features do not need to be reconfigured to promote the emergence of sustainable entrepreneurial practices. Rather, a reorientation towards the inclusion of KISE firms in the agenda can offer a guide for the allocation of resources that facilitate the process of transition to a more inclusive and sustainable economy (Eiselein et al., 2017; Pandey et al., 2017; Roundy, 2017; Thomsen et al., 2018; Cohen, 2006).

Our empirical results also underscore the different levels of 'ecosystem readiness' towards sustainability when it comes to different areas of concentration in the activity of entrepreneurial firms. In this respect, we found relatively mature EE in driving HealthTechs with an inclusive orientation, but the configurations leading to KISE ventures dedicated to address urban and educational challenges (KISE Cities and Education) still seem to be at embryonic stages. This is a contribution that resonates with Spigel's (20022) call to view EE as 'nested communities' rather than 'cohesive wholes'.

Overall, such elements provide relevant guidelines for public policies, regulations for sustainable enterprises and expand impact investing (Bozhikin et al., 2019; Guerrero et al., 2021; Gali et al., 2020; Cheah et al., 2019; Islam, 2020). The main global challenges cannot be solved by one actor alone (Jütting, 2020), thus highlighting that collaboration among different actors such as enterprises, society, government, scientists, and industry can help establish the conditions for a new and more sustainable innovation trajectory in entrepreneurial ecosystems. In this vein, 'steering' EE towards more socially and environmentally sustainable goals is likely to generate valuable gains for human society.

Finally, our findings are not without limitations. First, by focusing solely in one region of Brazil, our conclusions do not necessarily apply to other contexts. In this regard, analyses provide a restricted representation of: (i) the relevant dimensions to involved in ecosystem dynamics, and (ii) the interactions and flows of resources and knowledge that occur in the locations studied. In addition, there is a sample bias since we used only funded projects which means they passed our institutional evaluation filter. Hence, we encourage new research topics to address these issues. Promising avenues for future research include deeper approaches on the interplay between technological capabilities and sustainable orientation of entrepreneurial firms, and the role of universities in sustainable technology development. Further, it would be valuable to understand the development process of new kinds of ventures using the KISE concept in other emerging countries. This will offer us a better understanding of the organizations, institutions, patterns, pathways, and management lessons that can be followed to foster sustainable innovation within the context of entrepreneurial ecosystems.

Data availability

Data will be made available on request.

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Appendix I. Summary statistics

	N		Min.		Max.		Mean		Median		St. Dev. (within)		St. Dev. (between)	
Variable	Total	Megalopolis	Total	Megalopolis	Total	Megalopolis	Total	Megalopolis	Total	Megalopolis	Total	Megalopolis	Total	Megalopolis
KIE (excluding KISE) t-1	7740	2124	0	0	19	19	0.054651	0.1426554	0	0	0.3994359	0.7001054	0.480081	0.8139387
KISE total	7740	2124	0	0	35	35	0.05801	0.1356932	0	0	0.5284651	0.9083257	0.593684	0.9195667
KISE Cities	7740	2124	0	0	10	10	0.007364	0.0221239	0	0	0.1444976	0.2649282	0.084325	0.1469853
KISE Health	7740	2124	0	0	14	14	0.028165	0.0589971	0	0	0.2409883	0.3763261	0.347568	0.5355189
KISE Education	7740	2124	0	0	6	6	0.003876	0.0113078	0	0	0.0761885	0.1435564	0.067558	0.1117894
KISE Green	7740	2124	0	0	15	15	0.025323	0.0599803	0	0	0.2217897	0.3831653	0.273257	0.390089
FDI	7644	2076	0	0	1	1	0.02551	0.0811209	0	0	0.0791529	0.1353893	0.16225	0.2771485
Research University	7644	2076	0	0	1	1	0.057954	0.0963618	0	0	0.1251984	0.1563359	0.234802	0.2964419
U–I Interactions	7644	2076	0	0	515	515	1.896128	4.52409	0	0	11.56513	20.30553	20.13938	35.06199
Incubators & Tech Parks	7644	2076	0	0	1	1	0.031528	0.0619469	0	0	0.0901921	0.1223847	0.178118	0.2427476
HDI	7680	2113	0.3407	0.340681	0.935799	0.935799	0.749508	0.7687492	0.7547654	.778654	0.0425095	0.0426881	0.077786	0.0792807
Export-Import activity	7740	2124	0	0	0.1843575	0.1843575	0.013085	0.0294005	0.0054945	.0216016	0.0114303	0.016123	0.021067	0.0306773
Distance to main economic hub	7740	2124	0	0	758	314	343.6605	134.7689	352	134	98.6858	38.9464	183.6867	73.26186
Tertiary enrollment	7644	2076	0	0	0.2483603	0.2483603	0.0086	0.0143577	0	0	0.0115903	0.0148663	0.02144	0.0270562
Technological Activity	7644	2076	0	0	0.0015861	0.0007505	1.34E-05	0.0000205	0	0	0.0000223	0.000027	5.18E-05	0.0000386
Technology Transfer	7644	2076	0	0	0.000361	0.0003333	2.29E-06	0.00000584	0	0	7.92E-06	0.00000988	1.25E-05	0.0000165
GDP per capita	7644	2076	3182.9	3182.94	401304	376459.1	21230.16	27104.31	16180.78	19035.32	10920	15186.99	20382.33	28962.92
Population density	7644	2076	3.73	7.13	13159.64	13159.64	305.6153	971.937	38.29	162.10	628.4368	1132.611	1224.887	2197.447
Population	7644	2076	803	2287	11600000.00	11600000.00	64576.33	171941.2	12638	42254	10679.98	20083.04	457814.7	866467.2
Energy Comsumption	7644	2076	0.3937	0.662759	367.629	32.68278	2.831709	3.171698	1.764488	2.461377	5.800727	1.586499	12.85488	2.896743
Public Investments	7644	2093	0	0	6490.826	6490.826	303.3039	312.9657	222.734	227.8965	0	0	407.1924	434.0928

Appendix II. Sample profile

A. Temporal Evolution of KISE in the State of São Paulo, Brazil

Year	KIE (exclud. KISE)	KISE Total	KISE Cities	KISE Health	KISE Education	KISE Green	KISE Total %
2005	4	2	0	1	0	1	33%
2006	17	16	3	4	1	8	48%
2007	17	11	2	5	0	5	39%
2008	9	8	1	6	0	2	47%
2009	30	28	3	16	2	9	48%
2010	20	29	1	13	0	16	59%
2011	33	33	2	19	2	14	50%
2012	29	24	0	17	0	8	45%
2013	63	59	4	32	5	26	48%
2014	48	56	9	26	4	23	54%
2015	60	68	10	31	4	30	53%
2016	93	115	22	48	12	54	55%
Overall	423	449	57	218	30	196	51%

B. Leading Cities Ordered by Total KIE Activity (KISE & Non-KISE)

City	Total	KIE (exclud. KISE)	KISE Total	KISE Cities	KISE Health	KISE Education	KISE Green
São Paulo	24.2%	20.1%	28.1%	36.8%	30.3%	43.3%	21.9%
São Carlos	15.9%	14.7%	17.1%	12.3%	17.9%	10.0%	18.9%
Campinas	15.5%	19.9%	11.4%	15.8%	7.8%	10.0%	13.8%
São José dos Campos	8.3%	12.3%	4.5%	8.8%	3.7%	6.7%	4.6%
Ribeirão Preto	6.4%	4.3%	8.5%	0.0%	14.2%	3.3%	3.6%
Piracicaba	2.9%	2.6%	3.1%	1.8%	0.5%	0.0%	6.6%
Sorocaba	2.4%	2.4%	2.4%	0.0%	2.8%	3.3%	3.1%
Botucatu	1.7%	0.9%	2.4%	1.8%	1.8%	0.0%	3.6%
São José do Rio Preto	1.4%	0.9%	1.8%	0.0%	2.8%	0.0%	1.0%
Mogi das Cruzes	1.3%	1.2%	1.3%	0.0%	1.4%	0.0%	1.5%
Rest of cities	20.1%	20.8%	19.4%	22.8%	17.0%	23.3%	21.4%

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