

**FROM KNOWLEDGE TO ENTREPRENEURSHIP: SOURCES, PRODUCTION,
AND CONDITIONS**

by

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Statement of Originality, Authorship, and Contributions

This thesis is being submitted to Universidad del Desarrollo, Chile.

To the best of my knowledge and belief, it contains no material previously published or written by another person except where due reference is made in the thesis itself.

This dissertation is based on the following original works developed during my candidature. Each author's contribution is outlined as follows. The introduction and conclusion chapters are written entirely by the thesis's sole author.

1. *“Knowledge Sources and Entrepreneurship across Development Contexts: A Systematic Review of the KSTE”*
 - Sebastián Cid (conception, data collection, analysis, writing).
 - Vesna Mandakovic (analysis, writing).
 - José Ernesto Amorós (analysis).
2. *“When Knowledge Spillovers Are Uneven: University Outputs and High-Impact Entrepreneurship”*
 - Sebastián Cid (conception, data collection, analysis, main writing).
 - Vesna Mandakovic (analysis, writing).
 - José Ernesto Amorós (analysis).
3. *“Knowledge Absorption in Entrepreneurial Ecosystems: Understanding Entrepreneurial Ecosystem Configurations”*
 - Sebastián Cid (conception, data collection, analysis, writing).
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 - José Ernesto Amorós (analysis).

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Abstract

Entrepreneurship is widely understood as a mechanism through which knowledge contributes to economic development. However, the relationship between knowledge and entrepreneurial activity is neither automatic nor homogeneous. While existing research has focused on knowledge generation and its aggregate effects, less attention has been paid to the conditions under which knowledge is effectively mobilized into entrepreneurial activity, a limitation that is particularly relevant in the context of knowledge-based policies.

This thesis addresses this gap by examining how different dimensions of knowledge, its sources, its production, and the contextual conditions in which it is embedded, jointly shape entrepreneurial activity through three complementary studies.

The first study develops a systematic literature review to classify knowledge sources in entrepreneurship research, revealing a bias toward codified and institutionalized forms, while experiential and context-specific sources remain underexplored. The second study analyzes how knowledge production, particularly university-related outputs, influences individuals' likelihood of engaging in high-impact entrepreneurship. Using a multilevel design, the results show heterogeneous effects, with scientific knowledge positively associated with high-impact entrepreneurship, while the expansion of formal education exhibits weaker or even negative relationships, varying by individuals' educational background. The third study adopts a configurational approach to examine how ecosystem conditions shape the effective mobilization of knowledge, with preliminary analyses suggesting multiple combinations of factors under which individuals can translate knowledge into entrepreneurial activity.

Overall, the thesis demonstrates that the transformation of knowledge into entrepreneurship depends on the interplay between knowledge sources, production mechanisms, and contextual conditions, highlighting the conditional and context-dependent nature of this process and offering theoretical, empirical, and policy-relevant contributions.

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Introduction

A scientist develops a new process inside a university laboratory, yet the invention remains unused for years. Elsewhere, an entrepreneur recognizes its commercial value, recombines existing knowledge, and transforms it into a new venture. This contrast illustrates a central challenge in entrepreneurship research: the existence of knowledge does not guarantee its entrepreneurial relevance (Sarasvathy, 2001; Shane, 2000).

Knowledge has long occupied a central place in philosophical and economic thought, evolving from a foundational concern with the nature of human understanding to a key resource in modern economic systems. Classical philosophy conceptualized knowledge as the basis of rational action and justified belief, distinguishing it from mere opinion and emphasizing its role in practical reasoning and human action (Plato, 1997; Aristotle, 2000). Early modern philosophers further refined this perspective by examining the origins and limits of knowledge, highlighting its rational foundations while emphasizing experience as a primary source (Descartes, 1996; Locke, 1975).

Building on these foundations, later contributions shifted attention toward the tacit and experiential dimensions of knowledge, recognizing that much of what individuals know cannot be fully articulated or easily transferred (Polanyi, 1966). This insight became particularly influential in economic thought, where knowledge was conceptualized as inherently dispersed across individuals and embedded in localized contexts (Hayek, 1945).

Subsequent developments in economic theory emphasized the productive and dynamic properties of knowledge, particularly its role in innovation and economic growth (Arrow, 1962; Romer, 1990). In parallel, organizational research conceptualized knowledge as a strategic resource, highlighting its contribution to firm performance and competitive advantage (Grant, 1996). Despite these advances, knowledge remains an abstract and multifaceted concept across disciplines, reflecting its complex and context-dependent nature (Geiger & Schreyögg, 2009; Bratianu, 2015).

Unlike traditional factors of production, knowledge exhibits non-rivalry and partial non-excludability, limiting the ability of actors to fully appropriate its returns (Arrow, 1962). These characteristics generate inherent inefficiencies, as private incentives to invest in knowledge creation diverge from its broader social value, leading to positive externalities (Griliches, 1992). As a result, knowledge tends to diffuse beyond its original context, giving

rise to knowledge spillovers, which refer to ideas and capabilities that remain underutilized within incumbent organizations despite their potential value (Audretsch & Keilbach, 2007; Acs et al., 2009).

However, the existence of knowledge does not necessarily translate into its effective economic use. The transformation of knowledge into economically relevant outcomes is shaped by cognitive, organizational, and institutional barriers that limit individuals' ability to recognize and exploit opportunities (Shane & Venkataraman, 2000; Zahra et al., 2014; Audretsch et al., 2026). Consequently, a persistent gap emerges between knowledge creation and its practical application, raising a fundamental question: how is knowledge transformed into entrepreneurially relevant outcomes across heterogeneous contexts?

Entrepreneurship provides a key mechanism through which this gap can be bridged. By identifying and exploiting opportunities embedded in existing knowledge, entrepreneurial activity transforms ideas into new ventures and innovations, linking knowledge to innovation processes and economic growth (Acs et al., 2009; Audretsch & Lehmann, 2005a). Yet, this process is neither automatic nor uniform. Opportunities are not equally perceived by all individuals but depend on prior knowledge and cognitive capabilities (Shane, 2000; Shane & Venkataraman, 2000; Gruber et al., 2013). As a result, individuals exposed to similar knowledge environments may differ substantially in their ability to recognize and mobilize knowledge, implying that the entrepreneurial potential of knowledge is unevenly distributed (Cohen & Levinthal, 1990; Zahra & George, 2002; Qian & Acs, 2013).

This heterogeneity challenges the assumption that knowledge spillovers operate as broadly accessible externalities. Instead, the translation of knowledge into entrepreneurship depends on who can access and exploit it. At the individual level, this process may be understood through mechanisms of knowledge absorption, whereby actors recognize, interpret, and mobilize acquired knowledge for entrepreneurial purposes.

In this regard, context plays a critical role. The entrepreneurial ecosystem perspective conceptualizes entrepreneurship as embedded within a system of interconnected institutions, resources, and actors that shape the opportunities available to individuals (Autio et al., 2014; Stam, 2013; Spigel, 2017). This is particularly relevant in contexts characterized by institutional fragility, uneven resource access, and structural volatility, where entrepreneurial

outcomes may challenge assumptions derived from more stable economic environments (Aguinis et al., 2020). These conditions shape both access to resources and individuals' ability to interpret and act upon knowledge (Shane, 2000). From a microfoundational perspective, this implies that entrepreneurial outcomes depend on how individuals interpret and respond to these conditions.

Moreover, ecosystem conditions rarely operate independently; rather, their influence emerges through interdependence and interaction. Different configurations of ecosystem conditions may enable similar entrepreneurial outcomes, suggesting that knowledge mobilization is inherently configurational (Stam & Van de Ven, 2021; Muñoz et al., 2022; Xie et al., 2021). This implies that understanding how knowledge is transformed into entrepreneurial activity requires moving beyond isolated factors and examining how multiple conditions jointly shape this process (Felin et al., 2012; Barney & Felin, 2013).

Despite extensive research on knowledge and entrepreneurship, a coherent understanding of how knowledge is effectively mobilized remains elusive. Existing studies have largely examined knowledge sources, knowledge production, or contextual factors in isolation, often treating the relationship between knowledge and entrepreneurship as linear, fragmented, and insufficiently sensitive to multi-level interactions (Acs et al., 2009; Audretsch & Keilbach, 2007). However, as argued above, this relationship is contingent upon the interaction between different dimensions of knowledge and the conditions under which it is mobilized.

To address this gap, the thesis adopts a sequential and multi-level approach, where each study examines a distinct yet complementary dimension of the relationship between knowledge and entrepreneurship. Specifically, the thesis conceptualizes this relationship as a multi-dimensional process shaped by the interaction between sources of knowledge, knowledge production, and ecosystem conditions.

The first study examines the nature of knowledge by developing a systematic literature review that identifies and classifies the different sources of knowledge in entrepreneurship research. In doing so, it reveals systematic biases in how knowledge has been conceptualized and operationalized across empirical studies, particularly the predominance of formal and codified sources over more experiential and context-specific forms.

Building on this classification, the second study shifts from knowledge sources to knowledge production and empirically analyzes how different forms of knowledge output influence individuals' likelihood of engaging in high-impact entrepreneurship. The findings highlight that not all forms of knowledge production contribute equally to entrepreneurial outcomes, revealing heterogeneous and, in some cases, contrasting effects depending on how knowledge is accessed and utilized.

Finally, the third study examines when and how knowledge can be effectively mobilized at the individual level. Adopting a configurational approach, it explores how combinations of entrepreneurial ecosystem conditions shape knowledge absorption as an individual-level process underlying entrepreneurial action. Initial analyses indicate that knowledge can be effectively translated into entrepreneurial outcomes only when individual capabilities align with supportive contextual conditions, and that multiple configurations may lead to similar entrepreneurial outcomes.

Overall, these studies provide a more comprehensive understanding of how knowledge is translated into entrepreneurial activity by jointly considering its sources, its production, and the contextual conditions that shape its mobilization. In doing so, the thesis moves beyond linear assumptions and highlights the inherently conditional, multi-level, and context-dependent nature of this process.

Chapter 1

Knowledge Sources and Entrepreneurship across Development Contexts: A Systematic Review of the KSTE

This study examines how knowledge sources are conceptualized and operationalized in empirical applications of the Knowledge Spillover Theory of Entrepreneurship (KSTE), and how their use varies across development contexts. Based on a systematic literature review of 133 empirical studies, it identifies six categories of knowledge sources: scientific, technological, firm-based, formal knowledge networks, human capital and experience, and cultural knowledge. The findings reveal marked asymmetries across countries, with codified and institutionalized sources predominantly studied in high-HDI contexts, while experiential and cultural forms are more common in medium- and low-HDI settings. These results suggest that the empirical foundations of the KSTE are shaped by both theoretical choices and contextual constraints, highlighting the need for a more context-sensitive understanding of how knowledge is mobilized in entrepreneurship.

Keywords: Entrepreneurship, Knowledge sources, Knowledge spillovers, Entrepreneurial activity, Small business, Development context, Human Development Index, Systematic literature review.

1.1 Introduction

Entrepreneurs rely on knowledge to identify opportunities, make decisions, and develop new ventures. Accessing and mobilizing knowledge from different sources is therefore a central process in entrepreneurship, shaping how entrepreneurs recognize opportunities, evaluate risks, and organize new ventures (Aparicio et al., 2023a; Audretsch, 2018). In most cases, the knowledge required for these activities is not generated internally. Instead, entrepreneurs draw on multiple external sources, including universities, firms, professional networks, and prior experience (Acs et al., 2009; Acs & Audretsch, 2010; Siegel et al., 2003; Hayter, 2016). These knowledge sources influence which opportunities are identified and

how entrepreneurial activity unfolds across different contexts (Acs et al., 2013; Qian & Acs, 2013; Lattacher et al., 2021).

The role of knowledge in entrepreneurial activity has been widely studied through the Knowledge Spillover Theory of Entrepreneurship (KSTE) (Acs et al., 2009, 2013). This theory argues that unexploited knowledge generated within firms and institutions can be commercialized through entrepreneurial action, positioning entrepreneurship as the mechanism that transforms unused knowledge into economic value (Ghio et al., 2015). From this perspective, organizations such as firms, universities, and research institutions become key sources of knowledge for entrepreneurial activity and new venture creation. Despite the growing influence of the KSTE (Audretsch & Belitski, 2024; Ferreira et al., 2024), its empirical foundations remain heavily concentrated in advanced economies. Studies are disproportionately drawn from these contexts (Acs et al., 2009; Kirschning & Mrożewski, 2023a; Plummer & Acs, 2014), limiting the diversity of settings in which spillover processes have been empirically examined. Only a limited number of studies analyse emerging economies (Iftikhar et al., 2020a; Mahn & Poblete, 2023), raising questions about whether existing evidence adequately captures the developmental conditions under which knowledge spillovers operate.

Empirical research shows that knowledge spillovers operate unevenly across countries, as their intensity and effectiveness depend on institutional quality, scientific infrastructure, and governance conditions (Audretsch & Belitski, 2024; Audretsch et al., 2025a; Fotopoulos, 2023). These contextual factors influence both the availability of knowledge and the channels through which it is transformed into entrepreneurial activity.

Recent literature reviews have advanced the understanding of the KSTE. Early contributions traced its intellectual origins and conceptual evolution (Ghio et al., 2015), while more recent studies have organized three decades of research around dominant thematic streams such as open innovation, economic geography, academia, and international business (Audretsch et al., 2025b). Although these reviews provide valuable syntheses, they largely treat context as a background condition rather than as an organizing principle for interpreting empirical evidence. Consequently, we still lack a systematic understanding of how contextual and developmental conditions shape both the conceptualization and empirical operationalization of knowledge within the KSTE literature. Recent contributions

continue to emphasize that knowledge spillovers remain a central mechanism linking knowledge creation and entrepreneurial activity across heterogeneous institutional contexts (Audretsch et al., 2026), reinforcing the need for a more systematic understanding of the diverse knowledge sources mobilized by entrepreneurs.

This limitation is particularly evident in the concept of knowledge sources. These sources remain central to the spillover mechanism, yet KSTE research lacks a unified definition of what constitutes a knowledge source. Empirical studies rely on heterogeneous proxies, including patents, publications, R&D, cultural traits, individual experience, and social networks, without a conceptual framework clarifying their boundaries, differences, or functional roles (Audretsch & Belitski, 2023; Shu et al., 2022). This ambiguity limits theoretical accumulation and complicates cross-contextual comparison. Clarifying this distinction is central for improving conceptual precision and for better understanding how different knowledge sources influence entrepreneurial behavior across contexts.

Despite several reviews of the KSTE literature (Anselin et al., 2000; Audretsch et al., 2025a; Cerver-Romero et al., 2020; Morris et al., 2023; Qian, 2018), none has systematically classified these sources or examined how their use varies across contexts.

Access to and use of knowledge sources also vary across countries due to differences in scientific infrastructure, governance, and institutional capacity (Audretsch et al., 2021; Ferreira et al., 2024). Codified indicators such as patents, publications, and R&D are predominantly produced in highly developed economies, biasing the empirical development of the KSTE toward contexts rich in formal knowledge systems. Yet this development-based asymmetry has not been systematically examined, even though it shapes which knowledge sources become observable, measurable, and theorized.

This concern aligns with broader calls in entrepreneurship research to examine the geographical concentration of empirical evidence critically. As Shepherd et al. (2025) argue, much of what we know about entrepreneurship is derived from WEIRD (Western, Educated, Industrialized, Rich, Democratic) contexts, raising questions about the generalizability of established theories. Applied to the KSTE, its empirical foundations may be more context-bound than commonly assumed. This limitation constrains our understanding of how different types of knowledge shape entrepreneurial activity, including opportunity identification, venture creation, and growth, across heterogeneous contexts.

To address this gap, this study examines how knowledge sources are conceptualized and operationalized in empirical research and how their use shapes entrepreneurial activity across development contexts. Moving beyond existing thematic syntheses, the review develops a context-sensitive framework for classifying knowledge sources in KSTE research. Through a systematic literature review (SLR) of empirical research grounded in the KSTE (Fisch & Block, 2018; Tranfield et al., 2003), coding of 133 empirical articles, the analysis identifies six categories of knowledge sources: scientific, technological, firm-based, formal knowledge networks, human capital and experience, and cultural knowledge. It further examines how their empirical use varies across national contexts using Human Development Index (HDI) data. By systematically mapping these sources across development levels, the study reveals structural biases in the empirical foundations of the KSTE. It provides a more coherent basis for theorizing knowledge spillovers across diverse socioeconomic contexts.

Three research questions guide the review. First, *how have knowledge sources been operationalized in empirical applications of the KSTE?* Second, *how does the use of knowledge sources vary across countries with different levels of human development?* Third, *what do these patterns imply for future research on the contextual and developmental biases embedded in the current empirical foundations of the KSTE?* Together, these questions allow us to revisit the empirical foundations of the theory from a contextually grounded perspective.

This study makes three main contributions. First, it enhances conceptual clarity within the KSTE by systematically classifying the diverse knowledge sources used in empirical research. By doing so, it provides a clearer basis for understanding how different types of knowledge shape entrepreneurial activity, particularly how entrepreneurs identify opportunities and mobilize resources under varying contextual conditions. Second, it positions context as a central organizing principle for interpreting the empirical literature, revealing systematic developmental asymmetries in how knowledge sources are operationalized across countries. These findings have important implications for understanding heterogeneous entrepreneurial dynamics and for assessing the contextual scope and generalizability of the KSTE. Third, the study develops a future research agenda that identifies key conceptual and empirical priorities for advancing KSTE research across heterogeneous development contexts, providing a roadmap for future studies on how

different knowledge sources shape entrepreneurial activity under diverse institutional conditions.

The remainder of this paper is structured as follows. Section 2 reviews the theoretical foundations of the KSTE and discusses the role of knowledge sources in entrepreneurial spillover processes. Section 3 describes the systematic literature review methodology and the procedures used to identify and code empirical studies. Section 4 presents the results, including the proposed classification of knowledge sources and their distribution across different development contexts. Finally, Section 5 discusses the implications of these findings for the empirical foundations of the theory and for entrepreneurship research more broadly and outlines a future research agenda.

1.2 Theoretical framework

1.2.1 The knowledge spillover theory of entrepreneurship

The KSTE builds on the idea that knowledge, as a non-rival and partially excludable resource, generates externalities that entrepreneurs can commercialize (Acs & Audretsch, 2010; Arrow, 1962). Within this framework, entrepreneurship functions as the mechanism linking knowledge production to economic value creation by transforming unexploited or underutilized knowledge into new ventures and economic growth (Howitt, 2010; Romer, 1990).

Early formulations of the KSTE conceptualize knowledge as an aggregate stock that enters the entrepreneurial process through spillover mechanisms. Drawing on endogenous growth models (Romer, 1990), the theory does not explicitly differentiate among types of knowledge inputs, leaving their specification open in empirical applications (Acs et al., 2009; Audretsch et al., 2024). As a result, empirical research grounded in the KSTE has operationalized knowledge using a wide range of proxies reflecting both theoretical orientations and differences in data availability across contexts.

Empirical applications of the KSTE commonly employ indicators such as patents, scientific publications, R&D expenditures, and university–industry collaborations to capture codified knowledge stocks (Audretsch et al., 2021; Ferreira et al., 2024). Other studies adopt broader conceptualizations that include experiential knowledge, organizational routines, human capital, and relational or cultural forms of knowledge embedded in firms, individuals,

and networks (Boberg-Faziić & Sharp, 2024; Crossan & Apaydin, 2010; Lattacher et al., 2021).

The KSTE also emphasizes enabling conditions for knowledge spillovers, including the availability of knowledge stocks, the absorptive capacity of actors, and the institutional and regulatory environments in which spillovers occur (Cohen & Levinthal, 1990; Gallouj, 2017). This broad conceptualization allows empirical studies to operationalize knowledge in different ways depending on research focus and data availability.

1.2.2 Knowledge spillovers and the role of context

The relationship between knowledge and entrepreneurship is inherently contextual, as entrepreneurial activity unfolds within specific spatial, institutional, social, and temporal configurations (Welter, 2011; Welter & Gartner, 2016; Zahra et al., 2014). In context-based entrepreneurship research, context constitutes an integral analytical lens through which opportunity structures, actors' choices, and entrepreneurial mechanisms are shaped (Davies et al., 2021; Welter & Gartner, 2016). From this perspective, similar knowledge inputs may generate different entrepreneurial outcomes depending on the environments in which they are embedded, highlighting that knowledge spillovers are not context-neutral processes.

Prior research conceptualizes context as a multidimensional construct operating through interrelated spatial, institutional, and temporal dimensions, each conditioning the channels through which knowledge spillovers unfold. Spatially, access to knowledge infrastructures such as universities, research institutes, incubators, and technology parks is unevenly distributed across countries and regions. Organizational forms associated with knowledge diffusion, such as university spin-offs (Öberg, 2025), business incubators (Voisey et al., 2006), and R&D centers (Lind et al., 2013), tend to concentrate in high-income economies with well-developed innovation ecosystems (Nonnis et al., 2022). Even within countries, regional disparities shape how knowledge is produced, diffused, and absorbed (Anselin et al., 2000; Fotopoulos, 2023). Proximity and spatial concentration facilitate repeated interaction, trust-building, and knowledge recombination, thereby influencing the intensity, direction, and accessibility of entrepreneurial knowledge spillovers.

Institutional context further mediates how knowledge is transformed into entrepreneurial activity. Formal institutions, such as intellectual property regimes, public funding schemes,

and regulatory frameworks, affect incentives for knowledge disclosure, collaboration, and commercialization. Informal institutions, including trust, social norms, and cultural attitudes toward risk and entrepreneurship, shape how actors perceive, interpret, and mobilize available knowledge (Welter, 2011; Morris et al., 2023). In settings where institutional arrangements differ in scope, coherence, or enforcement, spillover processes may rely on distinct channels, ranging from formal intermediaries to experiential and relational mechanisms. Consequently, the same type of knowledge may follow different spillover pathways depending on the institutional environment in which it operates.

Temporal dimensions also shape spillover dynamics. Entrepreneurial ecosystems evolve through path-dependent trajectories influenced by industrial legacies, policy reforms, technological transitions, and external shocks (Zahra et al., 2014). Changes in institutional arrangements or innovation strategies can alter which forms of knowledge become salient, how they circulate, and how entrepreneurial actors access them. Knowledge spillovers should therefore be understood as dynamic processes whose mechanisms and outcomes may shift as contextual conditions evolve.

Within the KSTE literature, empirical studies have emphasized different contextual dimensions and have operationalized knowledge through indicators that are more readily observable in some environments than in others, particularly those associated with formal knowledge institutions and codified outputs (Cristo-Andrade & Ferreira, 2020; Morris et al., 2023). This diversity reflects the embedded nature of knowledge spillovers and underscores the importance of context when comparing empirical applications across countries and regions. Rather than assuming uniform spillover mechanisms, a context-based perspective highlights that knowledge sources, transmission channels, and entrepreneurial outcomes are shaped by the configurations in which they are situated.

Importantly, these contextual dimensions shape how knowledge spillovers unfold and condition which forms of knowledge become empirically observable and analytically tractable across development settings. Given this multidimensional understanding of context, this review adopts the Human Development Index (HDI) as a proxy for countries' broader developmental conditions (Anand & Sen, 1994; Qian et al., 2013). While HDI cannot capture all institutional or territorial nuances, it provides a consistent and comparative measure of socioeconomic development that is systematically available across countries. As such, it

offers a useful lens for examining whether the empirical observability and utilization of different knowledge sources are systematically associated with specific development profiles.

1.2.3 Context, development, and empirical observability of knowledge

Empirical research on knowledge spillovers shows that the observability of knowledge is closely linked to countries' levels of development and institutional capacity (Audretsch & Belitski, 2024; Fotopoulos, 2023). The types of knowledge that can be measured and incorporated into empirical analyses depend on theoretical choices and the availability of data infrastructures, innovation systems, and reporting practices that vary across contexts.

In high-development settings, knowledge production is largely embedded in formal scientific and technological systems, where patents, scientific publications, and R&D expenditures are systematically generated and recorded. These conditions facilitate the use of codified knowledge indicators and support cross-country empirical comparisons (Audretsch et al., 2024; Kirschning & Mrożewski, 2023a). By contrast, in medium- and lower-development contexts, knowledge spillovers often rely more strongly on experiential, organizational, and relational mechanisms, such as human capital accumulation, labor mobility, and informal networks, which are less visible in conventional innovation statistics (Fotopoulos, 2023; Morris et al., 2023).

Empirical studies indicate that the measured strength and form of knowledge spillovers vary with development level, partly reflecting differences in institutional capacity and data availability rather than differences in entrepreneurial dynamics alone (Yang et al., 2022; Audretsch & Belitski, 2024). Recent empirical work further shows that development conditions influence which knowledge flows are captured by standard indicators, as spillover mechanisms operating through relational or experiential channels may remain empirically less visible in lower-capacity contexts (Fotopoulos, 2023; Du et al., 2025). From this perspective, development conditions shape how knowledge sources are operationalized and measured in empirical research. This process influences which sources become empirically observable and analytically salient across contexts.

1.3 Methodology

SLRs enable the systematic examination of existing research, helping synthesize dispersed findings and identify patterns and gaps within a field (Fisch & Block, 2018; Tranfield et al., 2003). In addition, they help ensure conceptual coherence by systematizing dispersed findings and safeguarding theoretical clarity in contexts increasingly affected by information saturation and technological acceleration (Block et al., 2025). This approach is widely applied across disciplines such as social sciences (Sauer & Seuring, 2023), management (Kraus et al., 2024), and entrepreneurship (Moritz et al., 2023), valued for its transparency, replicability, and methodological rigor (Kraus et al., 2022). These strengths stem from its structured research design and the creation of dynamic, updatable databases (Pickering & Byrne, 2014).

Following the protocol of Tranfield et al. (2003), Fisch and Block (2018), and the PRISMA 2020 Statement (Page et al., 2021) the review followed a structured process comprising four sequential stages: identification, screening, eligibility assessment, and inclusion of studies. To ensure consistent results and minimize challenges related to data homogenization, we relied on a single source: the Web of Science (WoS), specifically the Social Science Citation Index (SSCI), which is recognized for its scholarly rigor (Lin et al., 2023). The search was conducted using the phrase “knowledge spillover entrepreneurship” across titles, abstracts, and keywords, covering all articles available online up to April 23, 2025.

The search strategy deliberately relied on a single, highly specific string because the objective of this review is not to capture the broad universe of studies examining knowledge spillovers or entrepreneurship separately, but to systematically map empirical research that explicitly adopts the KSTE as its theoretical foundation (Tranfield et al., 2003). Using broader Boolean combinations would substantially expand the corpus to include studies that discuss knowledge spillovers or the entrepreneurship conceptually but do not engage with the KSTE as a distinct theoretical framework (Fisch & Block, 2018). Such expansion would dilute the analytical focus of this review and undermine its central contribution: classifying how knowledge sources are operationalized within KSTE-based research.

The initial search yielded 319 articles. After limiting results to the categories “Management,” “Business,” and “Economics,” 285 papers remained. We then applied three

inclusion criteria: peer-reviewed status, publication in international journals, and English language. This step reduced the sample to 263 papers. Excluding non-article formats (e.g., monographs, book chapters, conference proceedings), bibliometric papers, reviews, and commentary articles reduced the sample to 231.

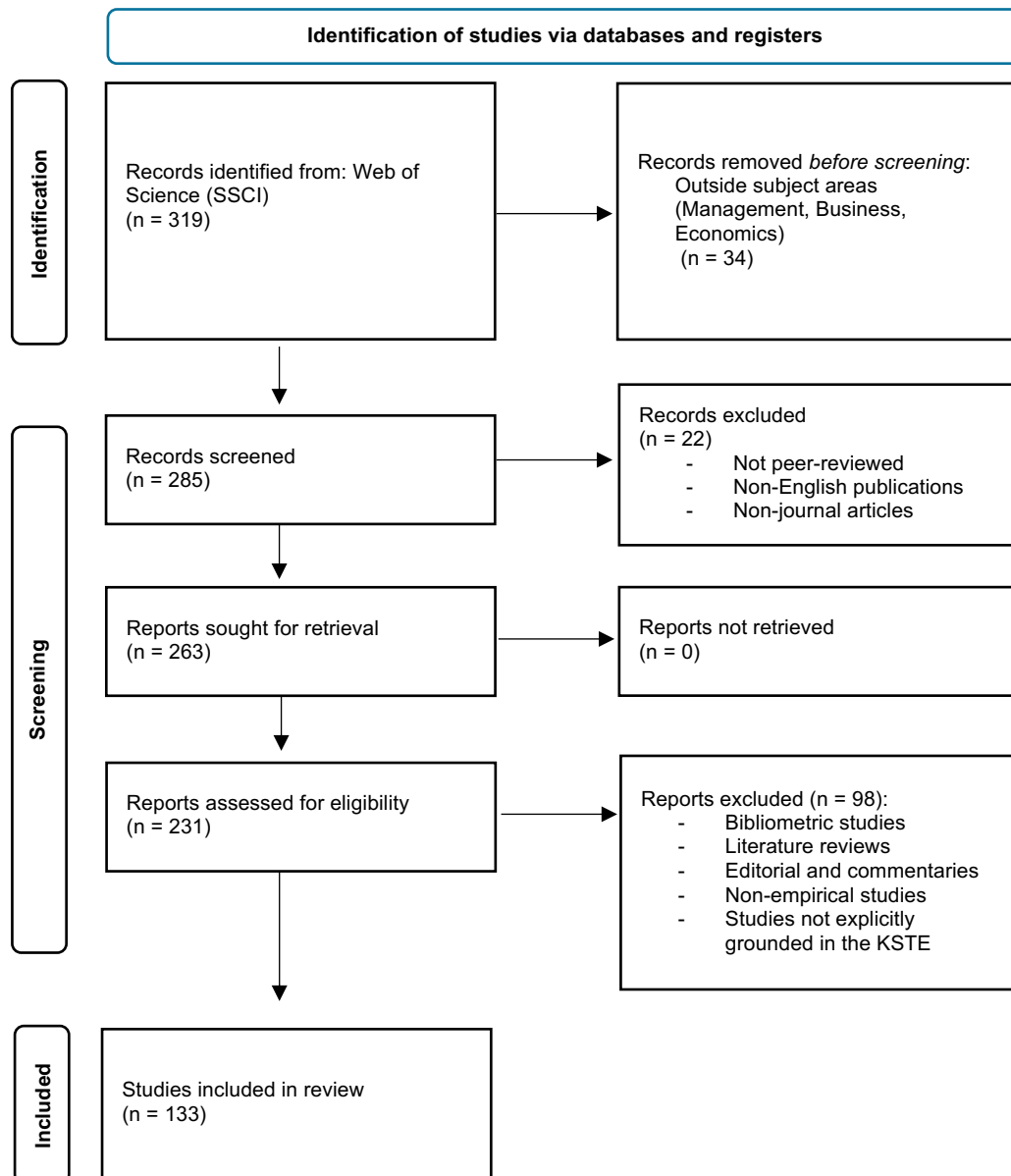
No additional journal quality filters were applied. Because the KSTE has been applied across a heterogeneous set of outlets not exclusively concentrated in top-tier journals, imposing quality filters would risk excluding theoretically relevant contributions and biasing the sample toward Western contexts, which are already overrepresented in the literature (Audretsch et al., 2025b; Ghio et al., 2015; Morris et al., 2023). Moreover, limiting the sample to top-tier journals would systematically exclude research from emerging economies, which are often published in regional or specialized outlets. As Shepherd et al. (2025) note, such exclusions would reinforce the very geographical asymmetries this study aims to uncover.

The identification of knowledge-source categories followed an iterative, primarily inductive procedure. First, all variables and indicators used to operationalize knowledge in the 133 empirical studies (104 quantitative, 22 qualitative, and 7 mixed) were extracted and grouped into preliminary clusters based on their substantive content (e.g., patents, university expenditure, labor mobility, cultural diversity). These clusters were then refined into six main categories and one residual group (“Others”), through successive rounds of coding and comparison (Figure 1.1). Ambiguous or borderline cases were discussed and assigned based on their dominant conceptual meaning rather than their statistical form. Although a single researcher performed coding, category definitions were iteratively refined in consultation with senior scholars, and detailed examples are provided in Appendix 1A to enhance transparency and replicability.

As with any SLR, this design entails limitations. Relying on a single database (WoS–SSCI) and a highly specific search string may leave out relevant studies that discuss knowledge spillovers without explicitly invoking the KSTE. However, this trade-off is deliberate: the aim is not to capture the full universe of knowledge-related entrepreneurship research, but to systematically map the subset of studies that self-identify as KSTE-based. Future reviews could extend this work by triangulating with other databases or broader search terms and by assessing the robustness of the patterns identified here.

Following the United Nations Development Programme (UNDP)¹, countries were grouped according to HDI levels using thresholds of 0.55, 0.70, and 0.80 to distinguish low-, medium-, and high-development contexts, respectively. The complete list of countries and their corresponding HDI classifications is provided in Appendix 1B.

Figure 1.1: PRISMA 2020 flow diagram of the study selection process



¹ <https://hdr.undp.org/data-center/human-development-index#/indicies/HDI>

1.4 Results

This section presents the empirical patterns that emerge from the 133 studies analyzed. The results are organized into two parts: Section 4.1 addresses how knowledge sources have been operationalized in KSTE-based studies (RQ1). In contrast, Section 4.2 examines how these sources are distributed across countries with different levels of human development (RQ2). A detailed breakdown of knowledge sources across studies is available in Appendix 1A.

1.4.1 Classification of knowledge sources in empirical KSTE applications

The 133 selected articles were published in 74 journals between 2004 and 2025, with a marked increase in output after 2020 (Figure 1.2), reflecting growing scholarly interest in KSTE applications. Publications are concentrated in entrepreneurship and innovation outlets such as *Small Business Economics* (22.6%), *Journal of Technology Transfer* (9.0%), and *Entrepreneurship and Regional Development* (8.3%) (Table I). Foundational contributions by scholars such as Acs and Audretsch shaped the conceptual evolution of the KSTE and established the empirical foundations on which subsequent studies build (Acs & Armington, 2004; Acs & Audretsch, 2010). Their work underpins much of the research included in this review and helps contextualize the diversification of empirical applications observed across countries and development levels.

Figure 1.2: Temporal distribution of publications

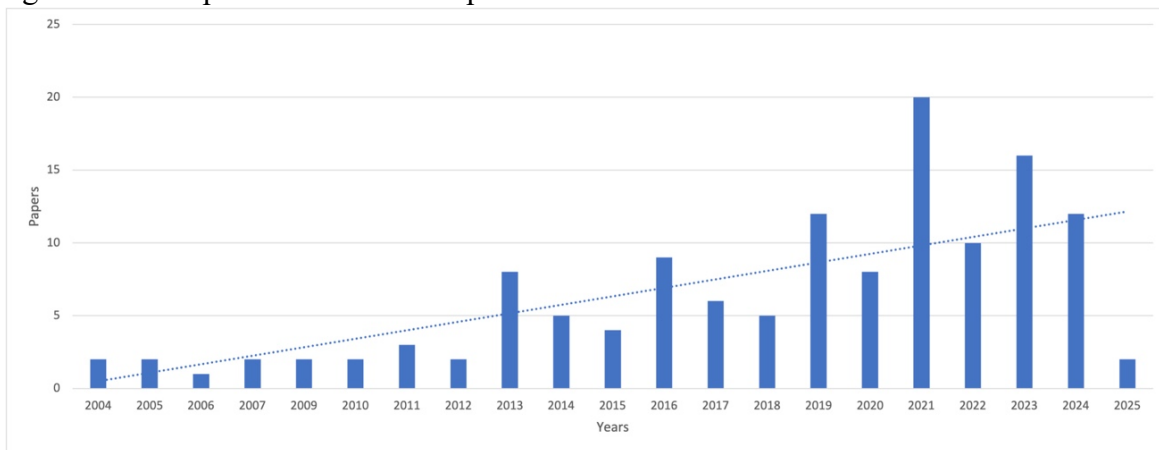


Table 1.1: Journals included in the sample

Journal	Number of contributions	Percentage
Small business economics	30	22.6
Journal of technology transfer	12	9.0
Entrepreneurship & regional development	11	8.3
Research policy	8	6.0
International entrepreneurship and management journal	7	5.3
Knowledge management research & practice	6	4.5
Others	51	38.3
Total	133	100.0

Beyond the concentration of publications in specific journals and the influence of foundational scholars, empirical applications of the KSTE have increasingly diversified across economic and institutional contexts. Studies have examined how spillovers unfold in both advanced and emerging economies (Belitski & Desai, 2016), with particular attention to micro-level mechanisms through which individual entrepreneurs and small firms access and transform external knowledge (Gu et al., 2024; Shu et al., 2014). Other contributions highlight how regional institutions, policy frameworks, and governance structures condition the extent and direction of spillover effects (Braunerhjelm et al., 2016; Guerrero & Urbano, 2014; Proeger, 2020). This growing body of work illustrates the heterogeneity of empirical approaches and highlights the need for a systematic classification of the knowledge sources mobilized in KSTE research.

The reviewed articles reveal six main categories of knowledge sources: *Scientific Knowledge, Formal Knowledge Networks, Firm, Technological, Human Capital and Experience, and Culture* (Table 1.2). This classification is necessary because the KSTE does not specify which types of knowledge should be considered, leading to heterogeneous empirical proxies across studies (Audretsch et al., 2025a; Qian, 2018).

Prior research has emphasized that knowledge is multidimensional, embedded in individuals, routines, technologies, and institutions, and therefore requires analytical grouping to avoid conceptual fragmentation and improve comparability (Crossan & Apaydin, 2010; Grant, 1996). By synthesizing recurring operationalizations, the six categories impose structure on an otherwise diffuse set of indicators (Paul & Criado, 2020), enabling a clearer assessment of how different types of knowledge relate to contextual conditions.

Together, these categories account for 95.49% of the studies analyzed, while the remaining 4.51% fall under an *Other* category. Table 1.2 summarizes this distribution, and the subcomponents of Scientific Knowledge: *Patent and Trademarks* (12.8%), *R&D* (8.3%), *Academic Infrastructures* (6.0%), *Mixed indicators* (5.3%), and *Scientific Articles* (3.8%), highlight the internal diversity even within formal sources. This classification goes beyond a purely descriptive exercise, providing an empirically grounded lens derived from recurrent operationalizations in the literature. Without such grouping, it would be difficult to discern how the empirical foundations of the KSTE are skewed toward certain forms of knowledge that are more easily observable in specific contexts, particularly high-HDI countries, and to assess the resulting developmental biases.

Scientific Knowledge encompasses codified research outputs and infrastructures that enable knowledge creation and diffusion. Patents and trademarks, widely used proxies of codified knowledge, signal the availability of scientific and technological assets that entrepreneurs can potentially commercialize, particularly in advanced economies with consolidated intellectual property systems (Lafuente et al., 2016; Mahn & Poblete, 2023; Qian & Acs, 2013). R&D expenditures are also frequently employed, reflecting the intensity of scientific effort and its role in accelerating the conversion of knowledge into entrepreneurial activity (Audretsch & Keilbach, 2004b; Knoblen et al., 2011). Academic infrastructures further shape entrepreneurial outcomes: universities, laboratories, and research institutes provide organizational and territorial foundations for knowledge generation (Del Monte & Pennacchio, 2020; Kim, 2013). Some studies combine multiple indicators, such as patents, publications, and R&D, to capture regional knowledge capacity more holistically (Kim et al., 2023; Radko et al., 2023). Finally, scientific publications serve as a direct measure of publicly available knowledge (Audretsch & Lehmann, 2005a; Yoon

et al., 2018). Overall, this category is predominantly used in high HDI contexts, where scientific systems are well institutionalized, and indicators are systematically produced.

Formal Knowledge Networks are structured, institutionalized relationships among universities, firms, public agencies, and intermediaries that facilitate systematic knowledge exchange. Academic–industry collaborations and network structures shape the flow of both tacit and codified knowledge (Hayter, 2016; van Stijn et al., 2018). Public innovation programs also function as knowledge gateways, reducing information asymmetries and supporting entrepreneurial discovery (Proeger & Runst, 2020). Networked entrepreneurial ecosystems enhance knowledge diffusion through repeated interactions and governance structures that institutionalize collaboration (Bendickson et al., 2021; Pickernell et al., 2019). This category appears more frequently in middle- and high-HDI economies, where institutional capacity and formal coordination mechanisms tend to be stronger.

The *Firm* category captures knowledge generated within incumbent firms and diffused through market interactions, labor mobility, alliances, or industry clustering. Studies stress the role of proximity and agglomeration, showing how dense firm environments stimulate entrepreneurial learning and resource recombination (Gast et al., 2017; Gómez-Antonio & Sweeney, 2021). Knowledge underutilized by firms can spill over via employee mobility or strategic relationships (Gu et al., 2024; Shu et al., 2014), while multinational presence contributes to capability transfer and local entrepreneurial upgrading (Pathak et al., 2015). Founders' prior experience and organizational legacy also serve as channels of business-relevant knowledge (Hunt et al., 2019). This category is common in middle-HDI countries, where firm-generated knowledge often substitutes for weaker formal research systems.

The *Technological* category includes indicators of technological development, diffusion, and sectoral dynamism. Studies examine sectoral technological regimes, emphasizing that spillovers depend on innovation intensity and recombination opportunities (Delmar et al., 2011). Regional technological variety has been linked to entrepreneurial activity through expanded recombination possibilities (Content et al., 2019). Technological clusters such as technology hubs facilitate knowledge flow by concentrating specialized firms and enabling frequent interactions (Chung, Yang, et al., 2022; Garcia-Vicente et al., 2017). Patent data and employment in knowledge-intensive sectors capture broader technological capacity (Colombelli & Quatraro, 2018; Tsvetkova & Partridge, 2021), while digital technologies and

smart city infrastructures expand entrepreneurial opportunities in urban contexts (Barba-Sánchez et al., 2019). This category spans all HDI levels, but indicators are more consistently available in developed economies.

The *Human Capital and Experience* category emphasizes knowledge embedded in individuals and transmitted through experience, education, and mobility. Worker mobility diffuses both tacit and explicit knowledge across firms and sectors (Braunerhjelm et al., 2016). Educational attainment and skill specialization shape regional entrepreneurial potential by aligning human capital with technological and market demands (Li et al., 2016). Interinstitutional knowledge flows from universities to students and industry reinforce entrepreneurial activity (Cristo-Andrade et al., 2023; Siegel et al., 2003). Entrepreneurial experience functions as experiential capital, shaping opportunity recognition and resilience (Guerrero & Peña-Legazkue, 2019). This category is more prevalent in middle- and low-HDI contexts, where experiential knowledge compensates for limited scientific infrastructure.

The *Cultural* category includes values, norms, diversity, and creativity, and shapes how individuals interpret opportunities and mobilize resources. Cultural diversity fosters idea recombination and innovation-oriented entrepreneurship (Audretsch, Belitski, & Korosteleva, 2021; Dheer, 2023). Migration contributes external knowledge and entrepreneurial capabilities (Li et al., 2018; Wellalage et al., 2023). Creative environments foster nontraditional knowledge flows that support entrepreneurial ecosystems (Audretsch & Belitski, 2013; Belitski & Desai, 2016). At the organizational level, cultural norms influence opportunity identification and intrapreneurial behavior (Gu et al., 2023; Ratten, 2021). This category is especially common in low- and middle-HDI contexts, reflecting reliance on informal and symbolic knowledge structures.

The *Others* category includes psychological, institutional, and infrastructural sources not captured by the main classifications. Unlike the previous categories, which represent distinct assets of knowledge (e.g., technical, scientific, or cultural), the items in this group function primarily as 'enabling conditions' or 'facilitators' of knowledge flow rather than as knowledge stocks per se. For instance, territorial psychological traits shape entrepreneurial propensity (Tavassoli et al., 2021), while physical infrastructure enhances connectivity and interaction frequency (Zuo & Chen, 2024). Makerspaces facilitate tacit knowledge exchange through hands-on experimentation and peer learning (Bao, 2025). Institutional frameworks such as

intellectual property rights and regional development policies shape knowledge access and diffusion (Ortega-Argilés, 2022; Samaniego, 2013). Their classification as 'knowledge sources' in empirical studies reflects a conceptual stretching in the literature, where the conditions for spillovers are often conflated with the source of the spillover itself.

Table 1.2: Classification of Knowledge Sources

Knowledge Source Category	Subcategory	Number of articles	%
Scientific Knowledge (Total)		48	36.1
	Patent and Trademarks	17	12.8
	R&D	11	8.3
	Academic Infrastructures	8	6.0
	Mixed Indicators	7	5.3
	Scientific Articles	5	3.8
Formal Knowledge Networks	–	23	17.3
Firm	–	16	12.0
Technological	–	15	11.3
Human Capital and Experience	–	14	10.5
Culture	–	11	8.3
Others	–	6	4.5

Across all categories, universities emerge as a transversal knowledge actor. Universities are increasingly redefining their roles as intermediaries between science, the market, and society (Audretsch & Lehmann, 2005a; González-Pernía & Peña-Legazkue, 2015; Guerini & Rossi-Lamastra, 2014), reinforcing their potential as catalysts of knowledge spillovers. Thirty-five studies explicitly conceptualize universities as knowledge infrastructures, producers of academic output, partners in networks, commercialization, or recipients of R&D investment (Table 1.3). Their diverse roles reflect the hybrid nature of universities as

producers, brokers, and translators of knowledge (Radko et al., 2023; van Stijn et al., 2018). The distribution across categories highlights the adaptive role of universities across different contexts (Civera et al., 2019; Del Monte & Pennacchio, 2020; Guerrero & Urbano, 2014). This diversity reinforces the university's centrality in the KSTE but also highlights contextual variation in how their contributions materialize, especially between high HDI systems with strong scientific infrastructures and lower HDI contexts where relational and experiential knowledge flows dominate.

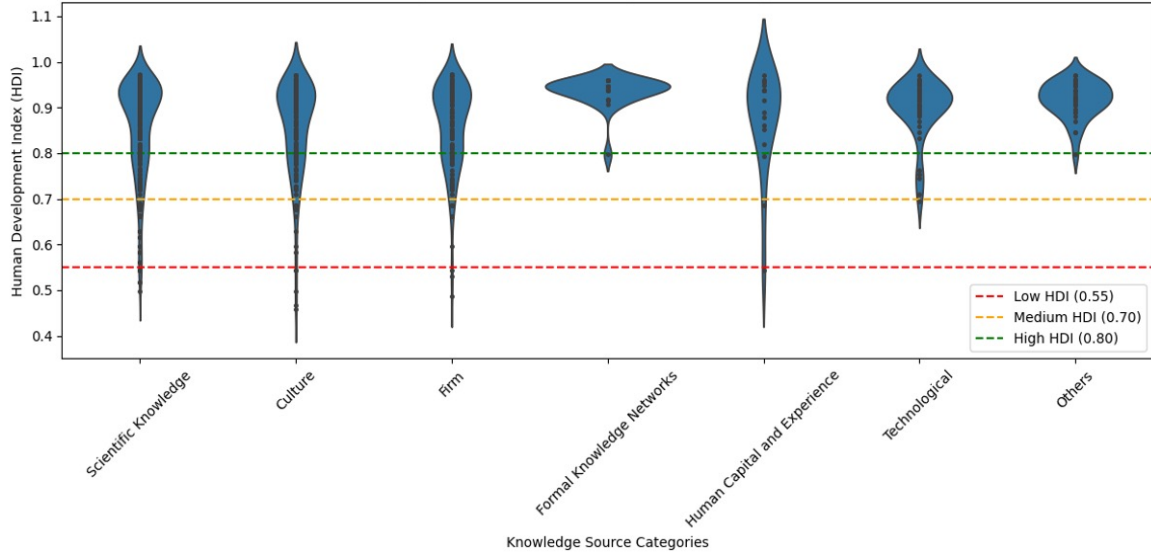
Table 1.3: University as a Source of Knowledge

Subcategory	Number of Articles	Percentage
Academic Knowledge Infrastructure	8	22.86
Academic Output	7	20.00
Relationship with other actors	6	17.13
Knowledge Commercialization	5	14.29
Academic R&D Investment	2	5.71
Other	7	20.00
Total	35	100.00

1.4.2 Knowledge sources and context

To examine how empirical studies on KSTE relate knowledge sources to countries' development levels, Figure 1.3 presents a violin plot of the HDI associated with each category. This visualization shows both the central tendencies and dispersion of HDI values, allowing us to identify which forms of knowledge are predominantly studied in high, medium, or low development contexts. Horizontal reference lines mark the thresholds for low (0.55), medium (0.70), and high (0.80) HDI.

Figure 1.3: Source of Knowledge Classification by Human Development Index



High HDI countries dominate the empirical landscape, particularly in studies that operationalize *Scientific Knowledge*, *Technological*, *Formal Knowledge Networks*, and *Human Capital and Experience*. *Scientific Knowledge* is overwhelmingly concentrated in these settings: over 80% of observations lie above the 0.80 threshold. Indicators including patents, R&D expenditures, scientific publications, and academic infrastructures are systematically produced in countries with mature scientific systems, making them easier to operationalize. The *Technological* category shows an even stronger pattern: nearly all observations fall above 0.85, reflecting that measures of technological variety, innovation intensity, digital platforms, and smart infrastructures are largely available only in advanced economies. *Formal Knowledge Networks* also cluster in high HDI contexts, where institutional capacity enables structured collaboration through innovation consortia, public–private partnerships, academic internationalization, and regional governance arrangements. Finally, *Human Capital and Experience* is skewed toward high HDI countries, as indicators such as tertiary education, specialized skills, and mobility from high productivity firms presuppose robust labor market and educational infrastructures. These patterns indicate that formal, codified, and institutionally embedded sources of knowledge are primarily studied in advanced economies, reflecting both theoretical tendencies and structural advantages in data availability.

Medium HDI countries appear most frequently in the *Firm* and *Culture* categories, while also contributing to observations in *Human Capital, Experience*, and the *Formal Knowledge*

Network. *Firm* knowledge exhibits one of the broadest distributions, with a median around 0.78 and substantial representation in medium HDI contexts. In these countries, firms, rather than universities or public research organizations, often function as the primary generators and diffusers of knowledge. Indicators such as employer productivity, labor mobility, inter-firm alliances, private R&D, and spillovers from foreign multinationals capture these dynamics. *Culture* also features prominently, as indicators like ethnic diversity, migration flows, creative industry employment, and community norms are observable independently of formal scientific infrastructures. Medium HDI contexts thus represent a hybrid space in which business dynamics and cultural heterogeneity compensate for underdeveloped scientific and technological infrastructures.

Low HDI countries appear primarily in *Culture*, *Firm*, and select cases of *Human Capital and Experience*. *Culture* displays the widest HDI dispersion, extending clearly into low HDI contexts. Measures such as cultural diversity, organizational norms, creative practices, and migration-based knowledge are accessible across diverse institutional environments, making culture the most universally observable source of entrepreneurial knowledge. *Firm*-related studies also emerge in low HDI countries, typically emphasizing small firm clusters, informal networks, and labor mobility rather than formal R&D systems. *Human Capital and Experience* measures in these settings often rely on experiential indicators, such as prior entrepreneurial activity or informal skill acquisition. The near absence of *Scientific Knowledge*, *Technological*, and *Formal Knowledge Network* indicators in low HDI contexts reflects both measurement constraints and global inequalities in scientific and institutional capacity.

Across development levels, the analysis reveals a clear pattern. *Scientific Knowledge*, *Technological*, and *Formal Knowledge Networks* are overwhelmingly concentrated in high HDI countries. *Firm* appears across all HDI levels but is particularly prominent in medium HDI contexts. *Culture* is the most evenly distributed, showing meaningful presence in high, medium, and low HDI settings. *Human Capital and Experience* is predominantly studied in high HDI contexts, with only limited representation elsewhere. Collectively, these patterns demonstrate that the type of knowledge source strongly shapes the developmental profile of the countries in which it is empirically examined. Codified and institutionally embedded forms of knowledge align with advanced research environments. By contrast, experiential

and cultural knowledge travel more easily across diverse contexts. The predominance of high HDI countries in the empirical sample likely reflects structural factors such as data availability, research funding, and the geographic concentration of major academic institutions, rather than theoretical necessity. This structural concentration raises questions about the generalizability of current KSTE evidence and underscores the need for broader empirical engagement with low and medium-HDI regions, where knowledge often circulates through mechanisms not captured by traditional scientific indicators.

1.5 Discussion and future research agenda

1.5.1 Revisiting the KSTE through plural knowledge sources

This review uncovers a broader and more nuanced conceptualization of knowledge within the KSTE and its role in shaping entrepreneurial activity than what is typically reflected in mainstream empirical work. Although the theory acknowledges that knowledge can take multiple forms, its operationalization has predominantly centred on codified scientific indicators, such as patents, publications, and R&D expenditures (Audretsch & Lehmann, 2005b; Qian & Acs, 2013). Our classification, however, demonstrates that entrepreneurial spillovers emerge from a far more diverse configuration of knowledge sources, many of which are informal, tacit, relational, cultural, or institutionally embedded. Recognizing this multidimensionality is important for understanding both the heterogeneity of spillover mechanisms and the varied conditions under which knowledge becomes entrepreneurial. More importantly, it helps explain how entrepreneurs identify opportunities, make strategic decisions, and mobilize resources differently depending on the types of knowledge available and the contexts in which they operate.

By structuring this heterogeneity into six categories, the review highlights that spillovers are not merely channels of transmission but processes of interpretation, adaptation, and recombination. Knowledge changes in meaning and usability depending on actors' absorptive capacities, institutional density, and relational architectures. For example, technical knowledge transforms into entrepreneurial opportunity only when mediated by enabling social structures such as collaborative networks, intermediary organizations, or supportive organizational cultures (Civera et al., 2019; Wellalage et al., 2023). These findings suggest that the empirical development of the KSTE has been anchored in a partial

conceptualization of knowledge, privileging codified scientific outputs disproportionately available in high-HDI settings while underrepresenting experiential, cultural, and relational forms of knowledge that play a critical role in shaping entrepreneurial activity in less-developed contexts. These insights have direct implications for entrepreneurship, as they suggest that the types of knowledge available in each context shape opportunity recognition and the feasibility and scalability of new ventures. In this sense, entrepreneurs and small firms operate under structurally different knowledge conditions, which influence how opportunities are identified, evaluated, and transformed into viable entrepreneurial outcomes.

1.5.2 Developmental and contextual asymmetries

These insights challenge the persistent assumption that increasing the supply of codified knowledge is sufficient to stimulate entrepreneurship. Instead, our findings underscore that spillover potential depends on the availability of knowledge, its type, accessibility, and alignment with entrepreneurs' capabilities to recognize and exploit opportunities across different contexts (Lafuente et al., 2016; Mahn & Poblete, 2023).

A central implication of these results is the need to strengthen the contextual grounding of the KSTE. The marked concentration of scientific, technological, and formal network indicators in high-HDI contexts suggests that much of the empirical basis of the theory is anchored in settings with advanced institutional infrastructures. In contrast, experiential, cultural, and firm-based knowledge, more prevalent in medium and low HDI contexts, operate through mechanisms that have received far less theoretical attention. By comparison, in high-HDI environments, entrepreneurial activity is more likely to draw on formalized and institutionally mediated knowledge inputs. This uneven empirical landscape does not invalidate the KSTE; rather, it suggests that existing empirical evidence may offer a partial and context-bound understanding of how knowledge contributes to entrepreneurial activity. Recent empirical evidence also continues to document the heterogeneous ways in which knowledge spillovers operate across different entrepreneurial and institutional environments (Barboza & Braga, 2026), further supporting the contextual perspective advanced in this review. Advancing the theory, therefore, requires greater conceptual and empirical attention

to how different knowledge sources shape entrepreneurial behavior across diverse development contexts.

1.5.3 Future research agenda

Building on the findings of this review, three main avenues emerge for advancing entrepreneurship research on how entrepreneurs and small firms access, combine, and mobilize different types of knowledge under varying contextual conditions: First, the classification reveals that knowledge sources are neither homogeneous nor equivalent in their spillover effects, and that their functioning is conditioned by contextual environments. Yet few studies compare the relative effectiveness of different knowledge types or examine how they interact to produce synergistic or contradictory outcomes across territories (Dheer, 2023; Qian & Acs, 2013). Advancing the field will require more integrative frameworks that explicitly incorporate contextual moderators and explore how combinations of scientific, experiential, cultural, and organizational knowledge operate differently in high-, medium-, and low-development settings.

At the same time, greater conceptual precision is needed regarding what constitutes a knowledge source in the KSTE, whether it refers to an institution, a transmission channel, a type of content, or a functional process. This ambiguity limits theoretical accumulation and complicates cross-contextual comparison. Clarifying this distinction is central for improving theoretical accumulation and for better understanding how different knowledge sources influence entrepreneurial behavior across contexts.

Second, the role of universities as knowledge sources shows strong empirical presence but exhibits significant contextual variation that remains understudied. While existing research emphasizes academic output (Guerrero & Urbano, 2014; Yoon et al., 2018), far less attention is given to how internal governance structures, incentive systems, resource constraints, or territorial disparities shape the university's contribution to entrepreneurial ecosystems (Radko et al., 2023). Our findings suggest that the functions universities perform differ markedly across development contexts: from generators of codified knowledge in high-HDI settings, to brokers and connectors in medium-HDI regions, to relational anchors in resource-constrained environments. Understanding these differentiated roles is critical for

explaining how universities contribute to entrepreneurial activity under diverse institutional conditions.

Third, the literature still underestimates the contextual contingency of spillover processes and their implications for heterogeneous entrepreneurial outcomes (Content et al., 2019). Most empirical studies still implicitly assume that knowledge sources exert similar effects across territorial conditions. Our findings challenge this assumption by showing systematic differences in how knowledge sources are studied and mobilized across HDI levels. Future research should incorporate comparative and longitudinal approaches to examine how institutional configurations, regulatory frameworks, cultural norms, and innovation capacities shape the availability, accessibility, and usability of knowledge across territories. Recent evidence also underscores the importance of exploring behavioral and knowledge spillovers arising from academic entrepreneurship and university-based programs (Opoku et al., 2026). Such work is critical for refining the KSTE and for assessing its generalizability and explanatory power across heterogeneous entrepreneurial contexts.

Table 1.4 synthesizes the main research gaps identified and offers a set of questions to guide future theoretical and empirical efforts.

Table 1.4: Future Research Directions on Knowledge Sources and Contextual Conditions

Research Gap	Conceptual Opportunity	Future Research Question
Limited understanding of how different types of knowledge interact and how these interactions vary across contexts	Develop integrative frameworks examining complementarities, tensions, and contextual contingencies of diverse knowledge flows	How do scientific, experiential, cultural, and organizational knowledge interact to shape entrepreneurial outcomes in different development contexts? Under what institutional or developmental conditions do certain combinations of knowledge sources enhance or inhibit spillover effects? How can resource-constrained ecosystems amplify the spillover potential of informal or non-codified knowledge?
Universities' intermediary roles remain underexplored, particularly across heterogeneous institutional and territorial environments	Reframe universities as context-dependent mediators whose contributions vary according to governance structures, institutional maturity, and territorial capacities.	What organizational structures and incentive systems enable universities to effectively mediate between knowledge sources? How do governance models and academic cultures shape universities' spillover roles across different innovation environments? How do universities adapt their mediation functions in low and medium HDI contexts where scientific infrastructures are weaker?
Contextual factors shaping knowledge spillovers are understudied; most research assumes uniform effects across territories	Incorporate institutional, territorial, and comparative perspectives to identify how context conditions the availability, accessibility, and usability of knowledge	How do institutional and territorial configurations mediate the effects of specific knowledge sources on entrepreneurial activity? What contextual combinations (e.g., regulatory quality, scientific infrastructure, cultural norms) facilitate or constrain spillover processes? How do spillover dynamics evolve over time as countries experience institutional reforms, economic shocks, or technological transitions?

1.6 Appendix 1A: Articles Analyzed

Number	Year	Authors	Article Title	Journal	Approach	Sources of Knowledge Classification	Sub classification	University as an Actor	University Subcategory	Countries studied
1	2004	Acs & Armington	The impact of geographic differences in human capital on service firm formation rates	Journal of urban economics	Quantitative	Human Capital and Experience				United States
2	2007	Acs et al.	The determinants of new-firm survival across regional economies: The role of human capital stock and knowledge spillover	Papers in regional science	Quantitative	Scientific Knowledge	Mixed			United States
3	2012	Acs et al.	Growth and entrepreneurship	Small business economics	Quantitative	Scientific Knowledge	R&D			Global, not specified
4	2009	Acs et al.	The knowledge spillover theory of entrepreneurship	Small business economics	Quantitative	Scientific Knowledge	R&D			Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, United Kingdom, United States
5	2005	Ács & Varga	Entrepreneurship, agglomeration and technological change	Small business economics	Quantitative	Scientific Knowledge	Scientific Articles			Belgium, France, Germany, Hungary, Ireland, Italy, Poland, Spain, United Kingdom

6	2024	Akcigit et al.	Fencing off Silicon Valley: Cross-border venture capital and technology spillovers	Journal of monetary economics	Quantitative	Scientific Knowledge	Patents / Trademarks				United States
7	2021	Anokhin et al.	Flagship enterprises, entrepreneurial clusters, and business entry rates: insights from the knowledge spillover theory of entrepreneurship	Entrepreneurship and regional development	Quantitative	Firm					United States
8	2019	Anokhin et al.	Industrial clusters, flagship enterprises and regional innovation	Entrepreneurship and regional development	Quantitative	Scientific Knowledge	Patents / Trademarks	Yes	Knowledge Commercialization		United States
9	2020	Antonietti & Gambarotto	The role of industry variety in the creation of innovative start-ups in Italy	Small business economics	Quantitative	Formal Knowledge Networks		Yes	Relationship with other		Italy
10	2024	Araki et al.	Regional innovation networks & high-growth entrepreneurship	Research policy	Quantitative	Formal Knowledge Networks					United States
11	2010	Audretsch et al.	Cultural diversity and entrepreneurship: a regional analysis for Germany	Annals of regional science	Quantitative	Formal Knowledge Networks	Mixed	Yes	Other		Germany
12	2021	Audretsch & Belitski	Frank Knight, uncertainty and knowledge spillover entrepreneurship	Journal of institutional economics	Quantitative	Formal Knowledge Networks					United Kingdom
13	2013	Audretsch & Belitski	The missing pillar: the creativity theory of knowledge spillover entrepreneurship	Small business economics	Quantitative	Culture					Not specified
14	2021	Audretsch, Belitski, & Caiazza	Start-ups, Innovation and Knowledge Spillovers	Journal of technology transfer	Quantitative	Formal Knowledge Networks					United Kingdom
15	2022	Audretsch et al.	The dynamic contribution of innovation ecosystems to 40 Schumpeterian firms: A multi-level analysis	Journal of business research	Quantitative	Formal Knowledge Networks		Yes	Relationship with other		United Kingdom

16	2021	Audretsch, Belitski, & Korosteleva	Cultural diversity and knowledge in explaining entrepreneurship in European cities	Small business economics	Quantitative	Culture					Czech Republic, Denmark, Spain, Hungary, Italy, Poland, Romania, Slovakia, Germany
17	2007	Audretsch & Keilbach	The theory of knowledge spillover entrepreneurship	Journal of Management Studies	Quantitative	Scientific Knowledge					
18	2004	Audretsch & Keilbach	Entrepreneurship and regional growth: an evolutionary interpretation	Journal of evolutionary economics	Quantitative	Scientific Knowledge	R&D				Germany
19	2005	Audretsch & Lehmann	Does the knowledge spillover theory of entrepreneurship hold for regions?	Research policy	Quantitative	Scientific Knowledge	Scientific Articles	Yes	Academic Output		Germany
20	2025	Bao	Do makerspaces affect entrepreneurship? If so, who, how, and when?	Strategic management journal	Quantitative	Others					United States
21	2019	Barba-Sánchez et al.	Smart cities as a source for entrepreneurial opportunities: Evidence for Spain	Technological forecasting and social change	Quantitative	Technological					Spain
22	2024	Barboza	Missing links of knowledge spillover effects on firm intensity and regional development	Small business economics	Quantitative	Human Capital and Experience					United States
23	2024	Barboza & Pedre	Weak vs Strong Knowledge Spillover Effects. Evidence from Geographic Distribution of Innovative Startup in Italy	Review of regional studies	Quantitative	Firm					Italy

24	2022	Belderbos et al.	Trademarks, patents and the appropriation strategies of incumbents: the scope of new firm formation in European regions	Regional studies	Quantitative	Scientific Knowledge	Patents / Trademarks	Austria, Belgium, Germany, Denmark, Spain, France, United Kingdom, Hungary, Italy, Lithuania, Netherlands, Portugal
25	2016	Belitski & Desai	Creativity, entrepreneurship and economic development: city-level evidence on creativity spillover of entrepreneurship	Journal of technology transfer	Quantitative	Culture		Belgium, Bulgaria, Cyprus, Germany, Estonia, Spain, Finland, France, Hungary, Lithuania, Italy, Latvia, Netherlands, Sweden, Slovenia, Slovakia
26	2021	Bendickson et al.	Entrepreneurial ecosystem knowledge spillover in the face of institutional voids: groups, issues, and actions	Knowledge management research & practice	Qualitative	Formal Knowledge Networks		United States
27	2013	Block et al.	What turns knowledge into innovative products? The role of entrepreneurship and knowledge spillovers	Journal of evolutionary economics	Quantitative	Scientific Knowledge	Patents / Trademarks	Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal,

Slovakia,
Spain, Sweden,
United
Kingdom

Sweden

Australia,
Austria,
Belgium,
Canada,
Croatia, Czech
Republic,
Denmark,
France,
Georgia,
Germany,
Iceland,
Ireland, Italy,
Japan,
Luxembourg,
North
Macedonia,
Netherlands,
New Zealand,
Norway,
Russia,
Slovenia,
Sweden,
Switzerland,
United
Kingdom,
United States,
Algeria,
Argentina,
Armenia,
Bolivia,
Botswana,
Chile, Costa
Rica, Estonia,
Finland,
Greece,
Guatemala,
Hong Kong,

China,
Hungary,
India, Jordan,
Kazakhstan,
Latvia,
Lithuania,
Madagascar,
Mexico,
Morocco,
Pakistan, Peru,
Philippines,
Poland,
Portugal,
Romania,
Senegal,
Slovakia,
South Africa,
Spain, Sri
Lanka,
Tunisia,
Turkey,
Ukraine,
Zambia
China

30	2023	Chen & Zeng	Highways, railways and entrepreneurship in peripheral cities: evidence from China	Economic research- ekonomska istrazivanja	Quantitative	Scientific Knowledge	Patents / Trademarks			
31	2023	Chen et al.	Transferring Scientific Knowledge to Academic Startups: the Moderating Effect of the Dual Identity of Academic Entrepreneurs on Forming Knowledge Depth and Knowledge Breadth	Journal of the knowledge economy	Quantitative	Scientific Knowledge	Academic Infrastructure	Yes	Academic Knowledge Infrastructure	China

32	2022	Chung, Jung, et al.	Investigating the relationship of high-tech entrepreneurship and innovation efficacy: The moderating role of absorptive capacity	Technovation	Quantitative	Technological		Global, not specified
33	2022	Chung, Yang, et al.	Investigating the Relationship between Technological Entrepreneurship and National Innovativeness: Moderating Effects of Intellectual Property Protection and R&D Transfer Environment	Entrepreneurship research journal	Quantitative	Scientific Knowledge	R&D	Bosnia and Herzegovina, Botswana, Brazil, Canada, Chile, China, Colombia, Costa Rica, Croatia, Czech Republic, Denmark, Ecuador, El Salvador, Estonia, Ethiopia, Finland, France, Georgia, Germany, Ghana, Greece, Guatemala, Hungary, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Algeria, Angola, Argentina, Australia, Austria, Bangladesh, Barbados, Belgium, Bolivia, Kazakhstan, Republic of Korea,

Kosovo,
Latvia, Libya,
Lithuania,
Luxembourg,
North
Macedonia,
Malawi,
Malaysia,
Mexico,
Netherlands,
Nigeria,
Norway,
Pakistan,
Panama, Peru,
Philippines,
Poland,
Portugal,
Qatar,
Romania,
Russia,
Singapore,
Slovakia,
Slovenia,
South Africa,
Spain,
Suriname,
Sweden,
Switzerland,
Thailand,
Trinidad and
Tobago,
Tunisia,
Turkey,
Uganda,
United
Kingdom,
Uruguay,
United States,
Vietnam
Italy

34	2019	Civera et al.	Do academic spinoffs internationalize?	Journal of technology transfer	Quantitative	Formal Knowledge Networks		Yes	Academic Output
35	2016	Colombelli	The impact of local knowledge bases on the creation of innovative start-ups in Italy	Small business economics	Mixed	Scientific Knowledge	Patents / Trademarks		Italy

36	2023	Colombelli et al.	When computer science is not enough: universities knowledge specializations behind artificial intelligence startups in Italy	Journal of technology transfer	Quantitative	Scientific Knowledge	Academic Infrastructure	Yes	Academic Knowledge Infrastructure	Italy
37	2024	Colombelli et al.	The creation of digital innovative start-ups: the role of digital knowledge spillovers and digital skill endowment	Small business economics	Quantitative	Technological				Italy
38	2019	Colombelli & Quatraro	Green start-ups and local knowledge spillovers from clean and dirty technologies	Small business economics	Quantitative	Technological				Italy
39	2018	Colombelli & Quatraro	New firm formation and regional knowledge production modes: Italian evidence	Research policy	Quantitative	Technological				Italy
40	2019	Content et al.	Does related variety foster regional entrepreneurship? Evidence from European regions	Regional studies	Quantitative	Technological				Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Slovakia, Spain, Sweden, France, United Kingdom

41	2019	Corradini	Location determinants of green technological entry: evidence from European regions	Small business economics	Quantitative	Scientific Knowledge	Patents / Trademarks			Austria, Belgium, Denmark, Germany, Spain, Finland, France, Greece, Italy, Ireland, Luxembourg, Netherlands, Portugal, Sweden, United Kingdom
42	2024	Cristo-Andrade et al.	Knowledge spillovers in business intelligence organizations: a strategic entrepreneurship perspective	International entrepreneurship and management journal	Qualitative	Human Capital and Experience				Not specified
43	2023	Cuvero et al.	Start-ups' use of knowledge spillovers for product innovation: the influence of entrepreneurial ecosystems and virtual platforms	R & D management	Qualitative	Formal Knowledge Networks		Yes	Relationship with other	United Kingdom
44	2022	Cuvero et al.	The Effects of Knowledge Spillovers and Accelerator Programs on the Product Innovation of High-Tech Start-Ups: A Multiple Case Study	IEEE transactions on engineering management	Mixed	Formal Knowledge Networks		Yes	Knowledge Commercialization	United Kingdom
45	2016	Dada et al.	University-Business Engagement Franchising and Geographic Distance: A Case Study of a Business Leadership Programme	Regional studies	Qualitative	Formal Knowledge Networks		Yes	Academic Output	United Kingdom
46	2021	Davies et al.	University knowledge spillover from an open innovation technology transfer context	Knowledge management research & practice	Quantitative	Scientific Knowledge	Academic Infrastructure	Yes	Academic Knowledge Infrastructure	United Kingdom
47	2020	Del Monte & Pennacchio	Historical roots of regional entrepreneurship: the role of knowledge and creativity	Small business economics	Quantitative	Scientific Knowledge	Academic Infrastructure	Yes	Academic Knowledge Infrastructure	Italy

48	2011	Delmar et al.	Endogenous growth through knowledge spillovers in entrepreneurship: an empirical test	Strategic entrepreneurship journal	Quantitative	Technological					Sweden
49	2023	Dheer	Cultural diversity: an impetus to economic growth - under what conditions?	Entrepreneurship and regional development	Quantitative	Culture					United States
50	2024	Duran	The geography of entrepreneurship from a developing country perspective. The role of large spatial differences	Entrepreneurship and regional development	Quantitative	Human Capital and Experience		Yes	Academic Output		Turkey
51	2020	Ejdemo & Örtqvist	Related variety as a driver of regional innovation and entrepreneurship: A moderated and mediated model with non-linear effects	Research policy	Quantitative	Scientific Knowledge	Mixed				Sweden
52	2024	Ertugrul et al.	Knowledge spillover and entrepreneurship: Evidence from BITNET	Research policy	Quantitative	Scientific Knowledge	Academic Infrastructure	Yes	Academic Knowledge Infrastructure		United States
53	2021	Fazlagić et al.	City policies to promote entrepreneurship: A cross-country comparison of Poland and Germany	Journal of entrepreneurship management and innovation	Qualitative	Formal Knowledge Networks		Yes	Other		Poland, Germany
54	2017	Feser & Proeger	Asymmetric information as a barrier to knowledge spillovers in expert markets	International entrepreneurship and management journal	Qualitative	Formal Knowledge Networks					Germany
55	2023	Fotopoulos	Knowledge Spillovers, Entrepreneurial Ecosystems and the Geography of High Growth Firms	Entrepreneurship theory and practice	Quantitative	Scientific Knowledge	R&D	Yes	Academic R&D Investment		United Kingdom
56	2019	Fuster et al.	The emerging role of university spin-off companies in developing regional entrepreneurial university ecosystems: The case of Andalusia	Technological forecasting and social change	Mixed	Formal Knowledge Networks		Yes	Knowledge Commercialization		Spain
57	2017	García-Cabrera et al.	Macro-level spillovers and micro-level capabilities as antecedents of young SMEs' propensity to export and to become a born global	International entrepreneurship and management journal	Quantitative	Technological					Spain

58	2017	Garcia-Vicente et al.	Information technology clusters and regional growth in America, 1970-1980	Small business economics	Quantitative	Technological					United States
59	2017	Gast et al.	Antecedents of the small firm effect: the role of knowledge spillover and blocked mobility for employee entrepreneurial intentions	International entrepreneurship and management journal	Quantitative	Firm					Germany
60	2016	Ghio et al.	University knowledge and the creation of innovative start-ups: an analysis of the Italian case	Small business economics	Quantitative	Scientific Knowledge	Academic Infrastructure	Yes	Academic Knowledge Infrastructure		Italy
61	2021	Gómez-Antonio & Sweeney	Testing the role of intra-metropolitan local factors on knowledge-intensive industries' location choices	Annals of regional science	Quantitative	Firm		Yes	Other		Spain
62	2015	González-Pernía & Peña-Legazkue	Export-oriented entrepreneurship and regional economic growth	Small business economics	Quantitative	Scientific Knowledge	Scientific Articles	Yes	Academic Output		Netherlands

63	2015	González-Pernía et al.	Innovation-driven entrepreneurship in developing economies	Entrepreneurship and regional development	Quantitative	Scientific Knowledge	R&D	Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Jamaica, Mexico, Panama, Peru, Trinidad and Tobago, Uruguay, Ghana, Nigeria, South Africa, Uganda, Zambia, Algeria, Egypt, Iran, Jordan, Morocco, Saudi Arabia, Tunisia, Bosnia and Herzegovina, Croatia, Hungary, Kazakhstan, Lithuania, North Macedonia, Montenegro, Poland, Romania, Russia, Serbia, Turkey, China, India, Indonesia, Malaysia, Pakistan, Philippines, Thailand
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64	2012	Grimm & Jaenicke	What drives patenting and commercialization activity at East German universities? The role of new public policy, institutional environment and individual prior knowledge	Journal of technology transfer	Quantitative	Scientific Knowledge	Patents / Trademarks	Germany
65	2023	Gu et al.	Knowledge Filters and Employee Venturing Behaviors: A Cross-Institutional Study of the US and Indian Firms	IEEE transactions on engineering management	Quantitative	Culture		United States, India
66	2024	Gu et al.	Knowledge creation and knowledge exploitation influencing employee venturing behaviors at the national level: the moderating role of national entrepreneurial values	Entrepreneurship and regional development	Quantitative	Firm		Argentina, Brazil, Chile, China, Colombia, Croatia, Germany, Greece, Iran, Ireland, Malaysia, Mexico, Netherlands, Panama, Peru, Poland, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, United Kingdom, United States, Uruguay, Ecuador, Estonia, Finland, France, Guatemala, Hungary, India, Italy, Latvia, Portugal, South Korea, Australia,

										Barbados, Belgium, Bosnia and Herzegovina, Canada, Indonesia, Israel, Jamaica, Japan, Luxembourg, Norway, Puerto Rico, Romania, Russia Italy
67	2014	Guerini & Rossi- Lamastra	How university and industry knowledge interact to determine local entrepreneurship	Applied economics letters	Quantitative	Scientific Knowledge	Scientific Articles	Yes	Academic Output	
68	2019	Guerrero & Peña-Legazkue	Renascence after post- mortem: the choice of accelerated repeat entrepreneurship	Small business economics	Quantitative	Human Capital and Experience				Netherlands, Norway, Latvia, Chile, Peru, Uruguay
69	2014	Guerrero & Urbano	Academics' start-up intentions and knowledge filters: an individual perspective of the knowledge spillover theory of entrepreneurship	Small business economics	Quantitative	Culture		Yes	Other	Spain
70	2021	Hahn et al.	Founding or succeeding? Exploring how family embeddedness shapes the entrepreneurial intentions of the next generation	Technological forecasting and social change	Quantitative	Culture		Yes	Other	Albania, Algeria, Argentina, Australia, Austria, Belarus, Brazil, Chile, China, Colombia, Costa Rica, Czech Republic, Ecuador, El Salvador, England, Estonia, Finland, France, Germany,

Greece,
Hungary,
Indonesia,
Ireland, Italy,
Japan, Jordan,
Kazakhstan,
Kosovo,
Lebanon,
Liechtenstein,
Lithuania,
Mexico, New
Zealand,
Norway,
Pakistan,
Panama, Peru,
Poland,
Portugal,
Republic of
Korea, North
Macedonia,
Russia, Saudi
Arabia, Sierra
Leone,
Slovakia,
Slovenia,
South Africa,
Spain,
Switzerland,
Turkey,
Ukraine,
United Arab
Emirates,
Uruguay,
United States
Germany

71	2022	Hartmann & Philipp	Lost in space? Refugee Entrepreneurship and Cultural Diversity in Spatial Contexts	ZFW-advances in economic geography	Quantitative	Scientific Knowledge	Patents / Trademarks
72	2016	Hayter	Constraining entrepreneurial development: A knowledge-based view of social networks among academic entrepreneurs	Research policy	Mixed	Formal Knowledge Networks	

United States

73	2017	Hervas-Oliver et al.	The dynamics of cluster entrepreneurship: Knowledge legacy from parents or agglomeration effects? The case of the Castellon ceramic tile district	Research policy	Qualitative	Firm		Spain
74	2006	Honig et al.	Social capital and the linkages of high-tech companies to the military defense system: Is there a signaling mechanism?	Small business economics	Quantitative	Technological		Israel
75	2019	Hunt et al.	Parental endowments versus business acumen: Assessing the fate of low-tech, service-sector spinouts	Strategic entrepreneurship journal	Quantitative	Firm		United States
76	2020	Ifrikhar et al.	The knowledge spillover theory of entrepreneurship: the developing country context	International entrepreneurship and management journal	Quantitative	Human Capital and Experience		Pakistan
77	2022	Ifrikhar et al.	The knowledge spillover theory of entrepreneurship: an Asian perspective	Small business economics	Quantitative	Scientific Knowledge	R&D	Azerbaijan, Bangladesh, China, Georgia, Hong Kong, India, Indonesia, Israel, Japan, Jordan, Kazakhstan, Kyrgyzstan, Malaysia, Pakistan, Philippines, Republic of Korea, Sri Lanka, Tajikistan, Thailand, Turkey

78	2023	Jamaludin et al.	Knowledge Distribution in Immigrant Entrepreneurship: A Qualitative Study of Immigrant Entrepreneurs in Malaysia	Journal of distribution science	Qualitative	Human Capital and Experience					Malaysia, Bangladesh
79	2019	Jarchow & Röhm	Patent-based investment funds: from invention to innovation	Journal of technology transfer	Qualitative	Human Capital and Experience					Not specified
80	2023	Kim et al.	Green-tech firm creation in Germany: the role of regional knowledge	International entrepreneurship and management journal	Quantitative	Scientific Knowledge	Mixed				Germany
81	2013	Kim	The ivory tower approach to entrepreneurial linkage: productivity changes in university technology transfer	Journal of technology transfer	Quantitative	Scientific Knowledge	Academic Infrastructure	Yes		Academic Knowledge Infrastructure	United States
82	2023	Kirschning & Mrożewski	Revisiting the knowledge spillover paradox: the impact of infrastructure	Small business economics	Quantitative	Formal Knowledge Networks					Global, not specified
83	2023	Kirschning & Mrożewski	The role of entrepreneurial absorptive capacity for knowledge spillover entrepreneurship	Small business economics	Quantitative	Scientific Knowledge	R&D				Global, not specified
84	2011	Knoben et al.	Employment from new firm formation in the Netherlands: Agglomeration economies and the Knowledge Spillover Theory of Entrepreneurship	Entrepreneurship and regional development	Quantitative	Scientific Knowledge	R&D	Yes		Academic R&D Investment	Netherlands

85	2010	Kotha	Spillovers, spill-ins, and strategic entrepreneurship: America's first commercial jet airplane and Boeing's ascendancy in commercial aviation	Strategic entrepreneurship journal	Qualitative	Technological		United States
86	2016	Lafuente et al.	Country level efficiency and national systems of entrepreneurship: a data envelopment analysis approach	Journal of technology transfer	Quantitative	Scientific Knowledge	Patents / Trademarks	Austria, Belgium, Bosnia and Herzegovina, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Latvia, Lithuania, North Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, Argentina, Barbados,

Brazil, Chile,
Colombia,
Costa Rica,
Ecuador, El
Salvador,
Mexico,
Panama, Peru,
Trinidad and
Tobago,
United States,
Uruguay,
China, Iran,
Japan,
Republic of
Korea,
Malaysia,
Pakistan,
Singapore,
Thailand,
Algeria,
Angola,
Botswana,
Ghana,
Malawi,
Namibia,
Nigeria, South
Africa,
Tunisia,
Uganda,
Zambia
United States

87	2021	Lange & Wagner	The influence of exploratory versus exploitative acquisitions on innovation output in the biotechnology industry	Small business economics	Mixed	Scientific Knowledge	Patents / Trademarks			
88	2021	Lattacher et al.	Knowledge spillover in entrepreneurial emergence: A learning perspective	Technological forecasting and social change	Qualitative	Others				Not specified
89	2016	Lehmann & Menter	University-industry collaboration and regional wealth	Journal of technology transfer	Quantitative	Scientific Knowledge	Academic Infrastructure	Yes	Academic Knowledge Infrastructure	Germany

90	2018	Li et al.	The More the Merrier? Immigrant Share and Entrepreneurial Activities	Entrepreneurship theory and practice	Quantitative	Culture	Australia, Austria, Brazil, Canada, China, Croatia, Denmark, Dominican Republic, Finland, France, Germany, Hungary, India, Ireland, Israel, Japan, North Macedonia, Netherlands, Norway, Peru, Philippines, Portugal, Romania, South Africa, Republic of Korea, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States, Uruguay United States
91	2016	Li et al.	Location determinants of high-growth firms	Entrepreneurship and regional development	Quantitative	Human Capital and Experience	
92	2009	Xibao & Ronald	The Pace and Stability of Small Enterprise Innovation in Highly Dynamic Economies: A China-Based Template	Journal of small business management	Quantitative	Firm	China
93	2022	Liu & Shao	Innovation and new business formation: the role of innovative large firms	Small business economics	Quantitative	Firm	United States

94	2023	Mahn & Poblete	Contextualizing the knowledge spillover theory of entrepreneurship: the Chilean paradox	Entrepreneurship and regional development	Quantitative	Scientific Knowledge	Patents / Trademarks			Chile
95	2019	Maliranta & Nurmi	Business owners, employees, and firm performance	Small business economics	Quantitative	Human Capital and Experience				Finland
96	2021	Martínez-Climent et al.	The knowledge spillover effect of crowdfunding	Knowledge management research & practice	Mixed	Technological				Spain
97	2021	Minola et al.	The relationship between origin and performance of innovative start-ups: the role of technological knowledge at founding	Small business economics	Quantitative	Firm		Yes	Other	Italy
98	2022	Ortega-Argilés	The evolution of regional entrepreneurship policies: no one size fits all	Annals of regional science	Mixed	Others				Not specified
99	2021	Padilla-Meléndez et al.	Knowledge spillovers, knowledge filters and entrepreneurial university ecosystems. Emerging role of University-focused venture capital firms	Knowledge management research & practice	Qualitative	Formal Knowledge Networks		Yes	Relationship with other	United Kingdom
100	2023	Park & Vonortas	Translational research: from basic research to regional biomedical entrepreneurship	Small business economics	Quantitative	Scientific Knowledge	Patents / Trademarks			United States

101	2015	Pathak et al.	Inbound foreign direct investment and domestic entrepreneurial activity	Entrepreneurship and regional development	Qualitative	Firm	Argentina, Australia, Brazil, Chile, China, Colombia, Croatia, Czech Republic, Denmark, Ecuador, Egypt, Hungary, Iceland, India, Indonesia, Iran, Israel, Japan, Kazakhstan, Latvia, North Macedonia, Malaysia, Mexico, New Zealand, Norway, Peru, Philippines, Romania, Russia, Slovenia, Republic of Korea, Sweden, Switzerland, Thailand, Turkey, United Kingdom, Uruguay, United States, United Kingdom
102	2019	Pickernell et al.	Innovation performance and the role of clustering at the local enterprise level: a fuzzy-set qualitative comparative analysis approach	Entrepreneurship and regional development	Quantitative	Formal Knowledge Networks	

103	2014	Pijnenburg & Kholodilin	Do Regions with Entrepreneurial Neighbors Perform Better? A Spatial Econometric Approach for German Regions	Regional studies	Quantitative	Human Capital and Experience					Germany
104	2014	Plummer & Acs	Localized competition in the knowledge spillover theory of entrepreneurship	Journal of business venturing	Quantitative	Scientific Knowledge	Patents / Trademarks	Yes	Knowledge Commercialization		United States
105	2020	Proeger	Knowledge Spillovers and Absorptive Capacity- Institutional Evidence from the German Mittelstand	Journal of the knowledge economy	Qualitative	Formal Knowledge Networks					Germany
106	2020	Proeger & Runst	Digitization and Knowledge Spillover Effectiveness- Evidence from the German Mittelstand	Journal of the knowledge economy	Quantitative	Formal Knowledge Networks					Germany
107	2025	Qalati et al.	How Knowledge Spillover Entrepreneurship Influences the Adoption of Social Media and Customer Relationship Management	Knowledge and process management	Quantitative	Culture					China
108	2013	Qian & Acs	An absorptive capacity theory of knowledge spillover entrepreneurship	Small business economics	Quantitative	Scientific Knowledge	Patents / Trademarks				United States
109	2013	Qian et al.	Regional systems of entrepreneurship: the nexus of human capital, knowledge and new firm formation	Journal of economic geography	Quantitative	Scientific Knowledge	Patents / Trademarks				United States
110	2023	Radko et al.	Conceptualizing the entrepreneurial university: the stakeholder approach	Journal of technology transfer	Qualitative	Scientific Knowledge	Mixed	Yes	Other		Germany
111	2020	Ramesh	Entrepreneurship in China and India	Journal of the knowledge economy	Qualitative	Scientific Knowledge	R&D				China, India
112	2021	Ratten	Sport entrepreneurial ecosystems and knowledge spillovers	Knowledge management research & practice	Qualitative	Culture					Australia

113	2018	Rodríguez-Gulías et al.	The role of knowledge spillovers on the university spin-offs innovation	Science and public policy	Quantitative	Scientific Knowledge	R&D	Spain, Italy
114	2013	Samaniego	Knowledge spillovers and intellectual property rights	International journal of industrial organization	Quantitative	Others		Belgium, Bulgaria, Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden, United Kingdom, Norway, Switzerland Portugal
115	2017	Sarkar	Uncorking knowledge-purposeful spillovers as a strategic tool for capability enhancement in the cork industry	International entrepreneurship and management journal	Qualitative	Firm		
116	2021	Secundo et al.	Knowledge spillover creation in university-based entrepreneurial ecosystem: the role of the Italian Contamination Labs	Knowledge management research & practice	Qualitative	Human Capital and Experience		Italy

117	2022	Shu et al.	The Role of the Government in the Knowledge Spillover Theory of Entrepreneurship: A Firm-Level Analysis	IEEE transactions on engineering management	Quantitative	Firm					Spain, Italy
118	2014	Shu et al.	The Knowledge Spillover Theory of Entrepreneurship in Alliances	Entrepreneurship theory and practice	Quantitative	Firm					China
119	2013	Stam	Knowledge and entrepreneurial employees: a country-level analysis	Small business economics	Quantitative	Scientific Knowledge	Mixed				Australia, Belgium, Chile, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Japan, Republic of Korea, Mexico, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States
120	2013	Stephens et al.	Innovation, entrepreneurship and economic growth in lagging regions	Journal of regional science	Quantitative	Human Capital and Experience				Integrated Academic Knowledge Channels	United States
121	2023	Szulczewska-Remi & Nowak-Mizgalska	Who really acts as an entrepreneur in the science commercialisation process: the role of knowledge transfer intermediary organisations	Journal of entrepreneurship in emerging economies	Qualitative	Scientific Knowledge	Mixed	Yes		Knowledge Commercialization	Poland, Czech Republic
122	2024	Tarek & Albaqami	Foreign Direct Investment and Entrepreneurship in MENA Region: Does Country's Absorptive Capacity Matter?	Montenegrin journal of economics	Quantitative	Technological					Algeria, Bahrain, Iraq, Jordan, Malta, Morocco, Oman, Qatar, Saudi Arabia,

123	2021	Tavassoli et al.	Entrepreneurship in Cities	Research policy	Quantitative	Others				Tunisia, United Arab Emirates United States
124	2024	Tekic et al.	Analyzing and predicting a country's entrepreneurial activity using insights from entrepreneurs' digital footprint	Journal of entrepreneurship in emerging economies	Quantitative	Technological				Russia
125	2015	Tsvetkova	Innovation, Entrepreneurship, and Metropolitan Economic Performance: Empirical Test of Recent Theoretical Propositions	Economic development quarterly	Quantitative	Scientific Knowledge	Patents / Trademarks			United States
126	2021	Tsvetkova & Partridge	Knowledge-based service economy and firm entry: an alternative to the knowledge spillover theory of entrepreneurship	Small business economics	Quantitative	Technological				United States
127	2018	van Stijn et al.	Exploring the motives and practices of university-start-up interaction: evidence from Route 128	Journal of technology transfer	Qualitative	Formal Knowledge Networks		Yes	Relationship with other	United States
128	2021	Wagner et al.	University-linked programmes for sustainable entrepreneurship and regional development: how and with what impact?	Small business economics	Quantitative	Formal Knowledge Networks		Yes	Relationship with other	Germany
129	2020	Wang	Will Entrepreneurship Promote Productivity Growth in China?	China & world economy	Quantitative	Firm				China

130	2023	Wellalage et al.	Immigration and entrepreneurship: Is there a uniform relationship across countries?	International review of economics & finance	Qualitative	Culture	Australia, Austria, Belgium, Canada, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Republic of Korea, Luxembourg, Netherlands, Norway, Poland, Portugal, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States, Trinidad and Tobago, Algeria, Argentina, Bosnia and Herzegovina, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Ecuador, Egypt, El Salvador, Ghana, Guatemala, India, Indonesia,
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Iran, Jamaica,
Malaysia,
Mexico,
Morocco,
North
Macedonia,
Pakistan,
Panama, Peru,
Philippines,
Romania,
South Africa,
Suriname,
Thailand,
Tunisia,
Turkey,
Uruguay,
Vietnam,
Zambia,
Burkina Faso,
Ethiopia,
Uganda

131	2021	Yi et al.	Knowledge spillover, knowledge management capabilities, and innovation among returnee entrepreneurial firms in emerging markets: Does entrepreneurial ecosystem matter?	Journal of business research	Quantitative	Formal Knowledge Networks				China
132	2018	Yoon et al.	A cross-national study of knowledge, government intervention, and innovative nascent entrepreneurship	Journal of business research	Quantitative	Scientific Knowledge	Scientific Articles	Yes	Academic Output	Argentina, Brazil, Canada, Chile, Colombia, Ecuador, Guatemala, Mexico, Peru, United States, Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Netherlands, Poland, Portugal, Romania, Russia, Slovakia, Spain, Sweden, Switzerland, Turkey, United Kingdom, Australia, China, India, Japan, Republic of Korea, Malaysia, Pakistan, Philippines, Singapore, Thailand, Egypt, Iran,

Israel, Jordan,
South Africa,
Tunisia
China

133	2024	Zuo & Chen	Airport construction and entrepreneurship: Evidence from the newly registered company	Structural change and economic dynamics	Quantitative	Others
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1.7 Appendix 1B: Countries and HDI classification

Number	Country	HDI	HDI Classification
1	Albania	0.81	High
2	Algeria	0.76	High
3	Angola	0.62	Medium
4	Argentina	0.87	High
5	Armenia	0.81	High
6	Australia	0.96	High
7	Austria	0.93	High
8	Azerbaijan	0.79	High
9	Bahrain	0.90	High
10	Bangladesh	0.69	Medium
11	Barbados	0.81	High
12	Belarus	0.82	High
13	Belgium	0.95	High
14	Bolivia	0.73	High
15	Bosnia and Herzegovina	0.80	High
16	Botswana	0.73	High
17	Brazil	0.79	High
18	Bulgaria	0.85	High
19	Burkina Faso	0.46	Low
20	Canada	0.94	High
21	Chile	0.88	High
22	China	0.80	High
23	Colombia	0.79	High
24	Costa Rica	0.83	High
25	Croatia	0.89	High
26	Cyprus	0.91	High
27	Czech Republic	0.92	High
28	Denmark	0.96	High
29	Dominican Republic	0.78	High
30	Ecuador	0.78	High
31	Egypt	0.75	High
32	El Salvador	0.68	Medium
33	Estonia	0.91	High
34	Ethiopia	0.50	Low
35	Finland	0.95	High
36	France	0.92	High
37	Georgia	0.84	High

38	Germany	0.96	High
39	Ghana	0.63	Medium
40	Greece	0.91	High
41	Guatemala	0.66	Medium
42	Hong Kong	0.96	High
43	Hungary	0.87	High
44	Iceland	0.97	High
45	India	0.69	Medium
46	Indonesia	0.73	High
47	Iran	0.80	High
48	Iraq	0.70	High
49	Ireland	0.95	High
50	Israel	0.92	High
51	Italy	0.92	High
52	Jamaica	0.72	High
53	Japan	0.93	High
54	Jordan	0.75	High
55	Kazakhstan	0.84	High
56	Kyrgyzstan	0.72	High
57	Latvia	0.89	High
58	Lebanon	0.75	High
59	Libya	0.72	High
60	Liechtenstein	0.94	High
61	Lithuania	0.90	High
62	Luxembourg	0.92	High
63	Madagascar	0.49	Low
64	Malawi	0.52	Low
65	Malaysia	0.82	High
66	Malta	0.92	High
67	Mexico	0.79	High
68	Montenegro	0.86	High
69	Morocco	0.71	High
70	Namibia	0.67	Medium
71	Netherlands	0.96	High
72	New Zealand	0.94	High
73	Nigeria	0.56	Medium
74	North Macedonia	0.82	High
75	Norway	0.97	High
76	Oman	0.86	High
77	Pakistan	0.54	Low

78	Panama	0.84	High
79	Peru	0.79	High
80	Philippines	0.72	High
81	Poland	0.91	High
82	Portugal	0.89	High
83	Qatar	0.89	High
84	Republic of Korea	0.94	High
85	Romania	0.85	High
86	Russia	0.83	High
87	Saudi Arabia	0.90	High
88	Senegal	0.53	Low
89	Serbia	0.83	High
90	Sierra Leone	0.47	Low
91	Singapore	0.95	High
92	Slovakia	0.88	High
93	Slovenia	0.93	High
94	South Africa	0.74	High
95	Spain	0.92	High
96	Sri Lanka	0.78	High
97	Suriname	0.72	High
98	Sweden	0.96	High
99	Switzerland	0.97	High
100	Tajikistan	0.69	Medium
101	Thailand	0.80	High
102	Trinidad and Tobago	0.81	High
103	Tunisia	0.75	High
104	Turkey	0.85	High
105	Uganda	0.58	Medium
106	Ukraine	0.78	High
107	United Arab Emirates	0.94	High
108	United Kingdom	0.95	High
109	United States	0.94	High
110	Uruguay	0.86	High
111	Vietnam	0.77	High
112	Zambia	0.60	Medium

Chapter 2

When Knowledge Spills Unevenly: University Outcomes and High Impact Entrepreneurship

High-impact entrepreneurship (HIE) is widely recognized as a driver of innovation, economic transformation, and long-term competitiveness. Drawing on the Knowledge Spillover Theory of Entrepreneurship (KSTE), this study examines how different university outcomes are associated individuals' engagement in HIE across 37 countries. Specifically, we distinguish among three university outcomes: graduate formation, scientific research production, and university–industry collaboration. Using a multilevel logistic regression framework, we combine individual-level data from the Global Entrepreneurship Monitor (GEM) with country-level indicators from UNESCO, Scimago, the World Bank, and the Global Innovation Index.

The results reveal heterogeneity in the associations between university outcomes and high-impact entrepreneurship. Scientific research production is positively associated with individuals' engagement in HIE, whereas higher university graduation rates are associated with a lower average likelihood of engaging in HIE. These associations also vary according to individuals' educational attainment. Specifically, the negative association between graduation rates and HIE is weaker among individuals with tertiary education, while the positive association between scientific research production and HIE is stronger among those without tertiary education. In contrast, no statistically significant differences are observed in the association between university–industry collaboration and HIE across educational groups.

These findings suggest that university outcomes should not be treated as a homogeneous source of entrepreneurial opportunities. Instead, different university outcomes are associated with distinct spillover dynamics that reach potential entrepreneurs through different channels. The study contributes to the KSTE literature by showing that the entrepreneurial value of university outcomes depends both on the type of university outcome and on the characteristics of the individuals exposed to it. The findings also offer policy implications for designing university systems that promote more inclusive and innovation-driven forms of entrepreneurship.

Keywords: Knowledge spillovers, High-impact entrepreneurship, University outcomes, Multilevel Analysis.

2.1 Introduction

High-impact entrepreneurship (HIE), ventures marked by rapid growth, bold innovation, and international reach, has become a defining force in economic transformation and societal progress (Acs, 2008; Covin & Wales, 2019). As economies grow ever more knowledge-intensive, understanding what allows these types of ventures to emerge and thrive is particularly relevant (Carayannis et al., 2015; Moid et al., 2023). At the core of relevant conditions lies knowledge itself: its creation and diffusion shape the entrepreneurial ecosystems in which innovation-driven ventures emerge (Aparicio et al., 2023; Audretsch, 2018).

Building on these insights, the Knowledge Spillover Theory of Entrepreneurship (KSTE) provides a framework for understanding how knowledge generated within organizations can be transformed into entrepreneurial opportunities (Acs et al., 2009). Recent contributions emphasize that the entrepreneurial exploitation of knowledge depends on interactions among knowledge-producing institutions, entrepreneurial actors, and the broader context in which spillovers occur (Audretsch et al., 2025a, 2025b, 2026). Despite the prominence of this perspective, the mechanisms through which university outcomes reach potential entrepreneurs remain insufficiently understood, particularly in comparative settings.

Among the key institutions responsible for generating, concentrating, and disseminating knowledge in modern economies, universities stand out as central actors (Bessette, 2003; Majidpour et al., 2025; Padilla-Meléndez et al., 2021). Through their core functions of teaching, research, and collaboration (Guerrero et al., 2015), they generate a range of outcomes that are associated with entrepreneurial activity through different channels (Goddard & Vallance, 2013). These include the formation of highly skilled graduates (Hahn et al., 2017), the production of scientific publications and technological innovations (Bonaccorsi et al., 2023; Fritsch & Aamoucke, 2013), and collaborative efforts with industry and other stakeholders (Bloedon & Sokes, 1994; Siegel et al., 2003). While these contributions have been widely acknowledged at the ecosystem level (Alkaabi et al., 2023;

Spigel, 2020), their role in shaping entrepreneurial behavior at the individual level remains less clear.

Despite growing evidence on the role of universities in entrepreneurial ecosystems, limited research has examined how specific university outcomes are associated with individuals' engagement in HIE across different institutional contexts (Welter, 2011; Welter & Gartner, 2016). Addressing this issue is necessary for linking the macro-level production of knowledge with the micro-level processes through which entrepreneurial opportunities are recognized and exploited. While prior studies have established the importance of higher education and academic institutions for entrepreneurship (Rothaermel & Thursby, 2005; Shane, 2004), most have examined universities through aggregate indicators such as university presence, entrepreneurial university activities, or ecosystem-level effects (Guerrero et al., 2015; Lehmann et al., 2020). As a result, limited evidence exists regarding how specific university outcomes are associated with individuals' engagement in HIE. Moreover, little attention has been paid to whether these associations vary according to entrepreneurs' educational attainment.

Motivated by these gaps, we first examine how various university outcomes are associated with individuals' decisions to engage in HIE across different countries. Second, we explore whether these associations differ between those who have attended university and those who have not. To investigate this, we develop a multilevel model using harmonized data from 37 countries. We integrate Global Entrepreneurship Monitor (GEM) microdata with national indicators from the World Bank (WB), United Nations Educational, Scientific, and Cultural Organization (UNESCO), Scimago, and the Global Innovation Index (GII), reported by The World Intellectual Property Organization (WIPO), all data for 2021 and 2022.

The study is guided by the following research question: *How are university outcomes associated with individuals' engagement in high-impact entrepreneurship?*

This study contributes to the literature on entrepreneurship and knowledge diffusion by integrating individual- and country-level perspectives within a multilevel framework. By combining microdata from entrepreneurs with national indicators of university outcomes, it identifies both direct and cross-level associations while accounting for institutional heterogeneity across countries. In addition, the study extends KSTE by incorporating

individual educational attainment as a boundary condition shaping the entrepreneurial value of university outcomes. The study challenges the implicit assumption in KSTE that university outcomes constitute a homogeneous source of entrepreneurial opportunities. By distinguishing among educational, scientific, and collaborative university outcomes, the findings reveal that different forms of university outcomes are associated with distinct entrepreneurial spillover dynamics and vary in their accessibility and entrepreneurial value. While prior research has largely focused on the aggregate relationship between knowledge production and entrepreneurial activity (Hayter, 2013; Qian, 2018; Tsvetkova & Partridge, 2021), this study highlights the importance of multi-level heterogeneity in shaping individuals' ability to access and leverage knowledge spillovers.

2.2 Theoretical background and hypotheses

2.2.1 Knowledge spillover theory of entrepreneurship

The KSTE explains how knowledge generated within organizations can be transformed into entrepreneurial opportunities beyond their boundaries (Acs et al., 2005; Audretsch & Lehmann, 2005b). While KSTE focuses on the entrepreneurial exploitation of knowledge spillovers, it is conceptually anchored in complementary theoretical perspectives. Human Capital Theory highlights how differences in individuals' knowledge, skills, and educational backgrounds shape their ability to recognize and act upon entrepreneurial opportunities, whereas Institutional Theory emphasizes the role of contextual conditions, norms, and supporting structures that facilitate or constrain the mobilization of knowledge (Becker, 1964; North, 1990; Scott, 2013). Recent developments further emphasize the importance of ecosystem conditions and knowledge mobilization processes in shaping the entrepreneurial outcomes of knowledge spillovers (Audretsch et al., 2025b; Cuvero et al., 2025).

Within the KSTE framework, entrepreneurial opportunities emerge when individuals can identify, access, and exploit knowledge generated outside their organizations (Zahra et al., 2014). The effectiveness of this process depends on the availability of knowledge, potential entrepreneurs' ability to recognize, interpret, and apply knowledge, and the institutional conditions that facilitate knowledge diffusion (Leyden & Link, 2017). Universities are particularly relevant in this regard because they generate multiple forms of knowledge and create channels through which that knowledge can reach external actors. Graduate training,

publications, and collaborative relationships with industry constitute outcomes through which academic knowledge becomes accessible beyond university boundaries (Fischer et al., 2021).

University education provides individuals with cognitive skills, technical knowledge, and exposure to academic environments, which enhance their ability to interpret and mobilize complex knowledge (Schlegel et al., 2022; Sreenivasan & Suresh, 2023). Conversely, those lacking such education may struggle to directly benefit from these resources, instead relying on indirect impacts mediated by other actors or institutions (Lehmann et al., 2020).

To understand the entrepreneurial potential of university outcomes, it is central to go beyond aggregate indicators such as research and development (R&D) spending or the number of patents (Gertner et al., 2011; Halberstadt et al., 2019). These outcomes differ in their levels of codification, accessibility, and relevance depending on the recipient's background and institutional context. For example, scientific publications might be more accessible to highly educated individuals who can decipher technical language, while collaborative R&D might benefit companies or entrepreneurs with access to university-industry networks.

From a KSTE perspective, these university outcomes can be understood as distinct channels through which knowledge becomes available to potential entrepreneurs. Although graduate formation, scientific production, and university-industry collaboration differ in their dissemination mechanisms, they share a common function: increasing the availability of knowledge that can be recognized and exploited through entrepreneurial action. The extent to which these channels translate into entrepreneurial activity depends not only on the volume of knowledge generated but also on individuals' capacity to access, interpret, and apply that knowledge. Consequently, educational attainment is expected to condition the entrepreneurial value of university outcomes.

2.2.2 High-impact entrepreneurship and the role of universities

The HIE refers to ventures that scale rapidly, continuously innovate, and expand into international markets (Acs, 2008; Covin & Wales, 2019). These ventures are characterized by three key dimensions: the novelty of their products or services, the adoption of advanced technologies or processes, and their global reach (Agarwal & Shah, 2014; Dutta et al., 2020).

As such, HIE drives firm-level success and contributes to national competitiveness and long-term economic growth.

Universities act as catalysts for HIE by equipping individuals with advanced capabilities, generating cutting-edge research, and fostering interaction with external stakeholders (Guerrero et al., 2015; Lehmann et al., 2020). Their outcomes facilitate knowledge flows essential for opportunity recognition and the execution of entrepreneurial initiatives.

Three outcomes stand out for their relevance to the entrepreneurial value of university outcomes: first, the training of individuals capable of identifying and exploiting business opportunities (Acs et al., 2007; Qian et al., 2013); second, the generation of scientific knowledge with commercial or social applicability (Bonaccorsi et al., 2023); and third, collaboration with industry, which facilitates the exchange and co-creation of knowledge across organizational boundaries (Aamoucke, 2016). These outcomes represent distinct channels through which universities shape the capabilities, resources, and networks available to potential entrepreneurs. The following hypotheses examine how these university outcomes are associated with individuals' likelihood of engaging in HIE.

2.2.3 Hypotheses development

Although universities play a vital role in cultivating human capital (Halbinger, 2020; Lehmann et al., 2020), a higher national university graduation rate does not necessarily foster greater engagement with HIE. In fact, as university systems expand and graduation becomes more accessible, the quality and entrepreneurial relevance of education may become diluted. This phenomenon implies that a growing number of graduates may hold degrees that are weakly aligned with the skills and mindsets required to create and scale innovative ventures (Hemsley-Brown & Oplatka, 2015).

From a structural perspective, mass university education systems tend to prioritize academic credentials and standardized curricula over creativity, risk-taking, and opportunity recognition, traits crucial to HIE (Guerrero et al., 2015; Tam, 2001). Moreover, universities in many countries remain disconnected from entrepreneurial ecosystems, with limited engagement in applied research, weak industry linkages, and insufficient training in venture creation (Bonaccorsi et al., 2013; Lehmann et al., 2020). As a result, the expansion of university education may produce a surplus of graduates whose skills and aspirations are better suited to traditional employment paths than to innovation-driven entrepreneurship.

The KSTE highlights that not all knowledge generated within universities translates automatically into entrepreneurial activity. Effective spillovers depend on mechanisms that connect academic knowledge with agents capable of absorbing and leveraging it for venture creation (Acs et al., 2009; Audretsch & Lehmann, 2005b). When university education focuses primarily on academic advancement without fostering entrepreneurial intent or capacity, the potential of these spillovers remains underutilized.

Additionally, in some labor markets, university graduates may face structural and cultural incentives that deter them from pursuing high-risk entrepreneurial paths. While university education equips individuals with advanced capabilities, it also provides access to stable and prestigious career trajectories, particularly in countries where public-sector employment or established corporate roles are highly valued. In these contexts, entrepreneurship may be perceived not as a desirable first option but rather as a fallback or secondary career choice (Thurik et al., 2008). This perception is reinforced by evidence showing that, despite greater autonomy, self-employed individuals often report lower satisfaction with income stability, job security, and social protection than wage employees (Millán et al., 2013). Furthermore, although self-employment can lead to higher long-term life satisfaction, the initial uncertainty and risks may discourage university graduates from pursuing alternative employment options (Litsardopoulos et al., 2021). These dynamics suggest that the mere availability of human capital is not sufficient to foster HIE; rather, the institutional, cultural, and labor market conditions in which graduates are embedded play a crucial moderating role in shaping their entrepreneurial decisions. Accordingly, the following hypothesis is proposed:

Hypothesis 1: Graduation ratio by universities at the country level is negatively related to individuals' likelihood of engaging in high-impact entrepreneurship.

Academic research generated by universities offers a foundation of technical and scientific knowledge that entrepreneurs can adapt for innovation and commercialization (Acs & Audretsch, 2010; Audretsch & Belitski, 2021). However, translating research into entrepreneurship is not automatic; it requires the ability to interpret complex findings and adapt them to evolving market demands (Yew Wong & Aspinwall, 2004). Research outcomes often lead to new technologies, processes, and business models that enable the development of novel products and services. These contributions expand the technological

frontier and provide inputs for ventures aiming to compete in dynamic sectors (Acs & Audretsch, 2010; Bonaccorsi et al., 2023). Fields such as artificial intelligence, biotechnology, and materials science exemplify how academic research can create new market opportunities across different regions (Dutta et al., 2021; Park & Vonortas, 2023).

Additionally, entrepreneurs who are exposed to academic environments or have undergone research-intensive training acquire advanced cognitive and analytical skills. These competencies strengthen their capacity to adapt scientific knowledge to solve real-world problems, manage risk, and design scalable business models (Ratten, 2021; Sreenivasan & Suresh, 2023). The practical relevance of academic research is realized when its results are applied to address specific societal or market challenges. Applied research helps ensure that knowledge does not remain confined within academic circles but instead flows into the broader entrepreneurial environment, contributing to innovation, competitiveness, and social impact (Fagerberg et al., 2012; Rossoni et al., 2023). Thus, it proposes the following hypothesis:

Hypothesis 2: Research production provided by universities at the country level is positively related to individuals' likelihood of engaging in high-impact entrepreneurship.

Collaboration between universities and industry functions as a structured mechanism for translating academic knowledge into entrepreneurial outcomes that address real-world challenges (Bonaccorsi et al., 2013; Guerini & Rossi-Lamastra, 2014; Lehmann & Menter, 2016). These partnerships facilitate knowledge transfer from universities to firms, entrepreneurs, or public institutions who apply it to develop impactful solutions (Acs et al., 2013). Mechanisms such as joint research projects, internships, strategic consulting, and public-private partnerships channel scientific findings into productive activities (Antonietti & Gambarotto, 2020; Hajrizi & Shaqiri, 2024; Sarkar, 2017). These initiatives support entrepreneurs by providing access to resources, specialized expertise, and problem-solving tools, enabling them to develop sustainable and scalable ventures (Stolze, 2021).

In the context of HIE, these collaborations help bridge the gap between technological potential and market application. Entrepreneurs who engage in university-linked initiatives are better positioned to integrate scientific advancements into their business models, increasing their ventures' competitiveness and long-term viability (Fritsch & Aamoucke, 2013, 2017; Guerrero & Urbano, 2019). Countries with university systems promoting

industry collaboration tend to foster an entrepreneurial environment where innovative ventures can thrive. These partnerships also support a culture of applied innovation, expanding the reach and influence of academic knowledge (Audretsch et al., 2020; Fritsch & Aamoucke, 2013, 2017; Guerrero et al., 2016). From the KSTE perspective, these collaborations enable the spillover of technical discoveries, skills, know-how, and organizational capabilities necessary for developing HIE (Audretsch & Keilbach, 2004a). Universities with strong industry connections enhance knowledge diffusion and foster an environment of innovation. Based on this reasoning, the hypothesis is as follows:

Hypothesis 3: University-industry collaboration at the country is positively related to individuals' likelihood of engaging in high-impact entrepreneurship.

The moderating role of educational attainment is not expected to be uniform across university outcomes. Different university outcomes vary in the extent to which they require specialized knowledge for interpretation and use, as well as in the channels through which they are disseminated (Gertner et al., 2011; Halberstadt et al., 2019). Knowledge embodied in university graduates is closely linked to formal educational processes and therefore may be more readily leveraged by individuals with similar educational backgrounds (Schlegel et al., 2022; Sreenivasan & Suresh, 2023). By contrast, research outcomes and university–industry collaborations often diffuse through broader channels that extend beyond universities, including open-access dissemination, intermediary organizations, industry networks, and public engagement activities (Acs & Armington, 2004; Fischer et al., 2021; Fritsch & Aamoucke, 2013). As a result, educational attainment may strengthen or attenuate the associations between university outcomes and HIE.

University outcomes are not equally accessible to all individuals. Their use depends on individuals' ability to recognize, interpret, and apply them in practice (Audretsch & Belitski, 2023; Yi et al., 2021). In this context, individuals' educational backgrounds shape how national levels of university graduates influence decisions to pursue HIE (Howell et al., 2020; Schlegel et al., 2022).

A larger share of graduates in a country signals a greater stock of advanced skills and a broader infrastructure for the circulation of knowledge through universities, professional networks, and innovation systems (Kirby et al., 2011). However, individuals may differ in their ability to benefit from these knowledge externalities. From a KSTE perspective, the

entrepreneurial value of knowledge depends on its availability and the ability of potential entrepreneurs to recognize, interpret, and apply it. Individuals with university education are generally better equipped to recognize, interpret, and apply complex knowledge generated within universities because they possess relevant cognitive skills, technical training, and familiarity with academic environments (Schlegel et al., 2022; Sreenivasan & Suresh, 2023).

By contrast, individuals without university education may also benefit from a more knowledge-rich environment, but their access to and effective use of university outcomes are likely to be more indirect, relying on intermediaries, networks, or spillovers from other actors (Acs & Armington, 2004). Consequently, increases in the national stock of university graduates may create entrepreneurial opportunities for the broader population. However, consistent with KSTE, these opportunities are expected to translate into entrepreneurial action more effectively among individuals with university education, whose educational backgrounds enhance their ability to recognize, interpret, and apply university outcomes.

Although Hypothesis 1 predicts a negative average relationship between national graduation rates and individuals' likelihood of engaging in HIE, this relationship is not expected to be homogeneous across individuals. Consistent with KSTE, educational attainment may attenuate this negative relationship by enabling university-educated individuals to recognize, interpret, and apply knowledge embedded within university education systems more effectively than those without university education. Thus, the following hypothesis is proposed:

Hypothesis 4a: The relationship between the gross graduation ratio of universities at the country level and individuals' likelihood of engaging in high-impact entrepreneurship is moderated by educational attainment: it is weaker among individuals with university education than among those without university education.

University research outcomes are formal channels for disseminating advanced knowledge that supports innovation and entrepreneurship (Kirby, 2006). However, their influence varies depending on individuals' educational backgrounds.

Individuals without university education often access this knowledge through inclusive formats such as open-access platforms, community hubs, or university outreach efforts (Anselin et al., 1997; Fritsch & Aamoucke, 2013). In countries with high research outcomes,

these pathways allow non-graduates to identify and seize entrepreneurial opportunities by leveraging publicly available innovations (Boutaleb, 2023; Chen et al., 2023).

By contrast, graduates may be more likely to be absorbed into academic or organizational career paths in academia or industry, where entrepreneurship is not the primary focus (Agarwal & Shah, 2014; Stam, 2013; Yuan et al., 2020). Their skills are often absorbed into structured systems that prioritize security over risk-taking, thereby limiting direct engagement with entrepreneurial opportunities derived from academic research. This pattern suggests that broad access to university research may benefit non-graduates more directly. With fewer institutional constraints, they may be better positioned to apply scientific knowledge in entrepreneurial ways. This leads to the following hypothesis:

Hypothesis 4b: The relationship between research outcomes at the country level and the likelihood of engaging in high-impact entrepreneurship is moderated by educational attainment: it is stronger for individuals without university education and weaker for those with university education.

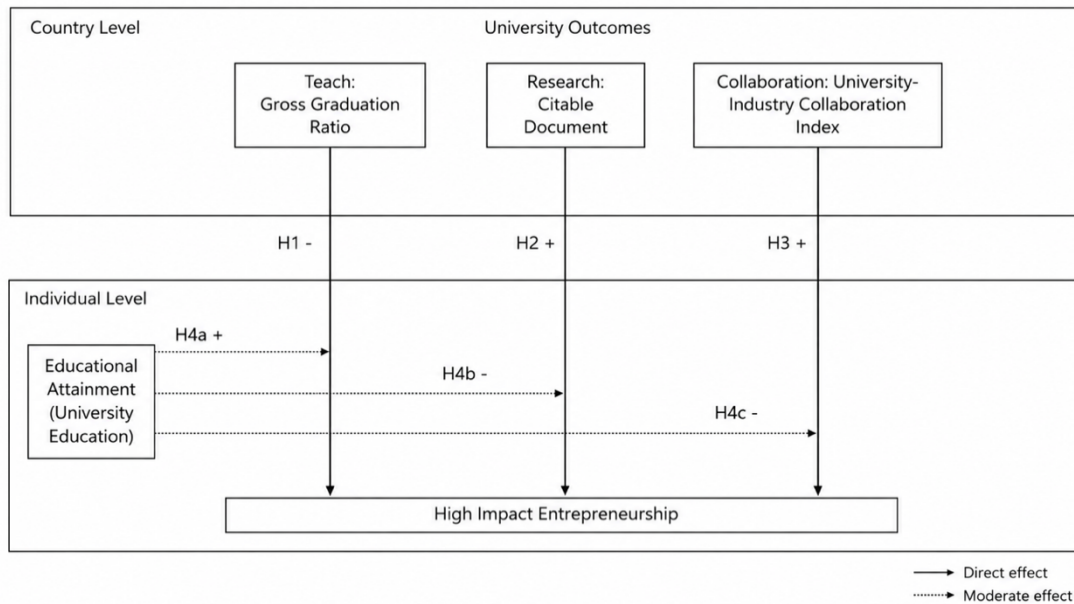
University-industry collaborations transmit academic knowledge to the market through joint research, internships, and partnerships (Guerini & Rossi-Lamastra, 2014; Lehmann & Menter, 2016). Yet, their benefits are not exclusive to individuals with university education. Non-graduates often access innovations via public-facing mechanisms, such as innovation fairs, open seminars, and digital platforms (Hajrizi & Shaqiri, 2024). Informal networks, community events, and local media also facilitate the application of knowledge by entrepreneurs outside academic circles (Araki et al., 2024; Huggins et al., 2014; Hur, 2017). In contrast, graduates frequently use these collaborations as gateways to stable employment. They are more likely to pursue salaried positions at partnering firms rather than to initiate ventures based on shared innovations (Agarwal & Shah, 2014; Othman et al., 2006; Stam, 2013). Thus, while university-industry collaboration increases the availability of entrepreneurial knowledge, its effect may be stronger among individuals without university education, who face fewer institutional constraints and are more inclined to pursue innovation-based ventures. Therefore, the following hypothesis is proposed:

Hypothesis 4c: The relationship between university–industry collaboration at the country level and the likelihood of engaging in high-impact entrepreneurship is moderated

by educational attainment: it is stronger for individuals without university education and weaker for those with university education.

Figure 2.1 summarizes the conceptual model stemmed from the previous hypotheses.

Figure 2.1: Summary of the research model



Source: authors' elaboration

2.3 Methodology

2.3.1 Empirical model

This study employs a multilevel logistic regression model with random intercepts to analyze hierarchical data in which individuals are nested within country-year contexts (Rabe-Hesketh & Skrondal, 2006; Wooldridge, 2016). By accounting for variation at both the individual and contextual levels, this approach improves estimation accuracy and reduces the risk of Type I errors associated with ignoring higher-level structures (Stephan et al., 2015). The model includes a random intercept at the country-year level to capture unobserved heterogeneity in the baseline probability of engaging in HIE across countries and years. Estimation was performed using maximum likelihood with robust standard errors clustered at the country-year level. A likelihood ratio (LR) test comparing the multilevel specification with a standard logistic regression confirmed the appropriateness of the hierarchical

approach by indicating significant between-country-year variance (Wooldridge, 2016). To analyze how an entrepreneur's individual characteristics and the characteristics of countries' university outcomes are associated with the probability of having a HIE, we define two levels, as presented below.

First Level: Individual

The model is represented by equation (1) to analyze:

$$(1) \text{logit} \left(P(Y_{ij} = 1) \right) = \beta_{0j} + \beta_{1j}PEOP_{ij} + r_i$$

Where Y_{ij} is the probability to expect HIE for individual i from a country-year j , β_{0j} is the country-specific intercept j , to capture differences between countries-year, $PEOP_{ij}$ is the vector of all variables at the individual level i , in country-year j , β_{1j} is the effect of individual characteristics, and r_{ij} is the random error at the individual level.

Second Level: Country

The intercept β_{0j} at the country-year level depends on the characteristics of the university outcomes of country-year j W_{0j} . Thus, the model is represented by equation (2) to analyze:

$$(2) \beta_{0j} = \gamma_{00} + \gamma_{1j}UNI_j + \gamma_{2j}COUNTRY_CONTROL_j + u_j$$

Where γ_{00} is the overall average of HIE across all regions. The $\gamma_{1j}UNI_j$ is the effect of university outcomes of country-year j , $COUNTRY_CONTROL_j$ is the j country-years' vector control variables, γ_{1j} is the effect of country control variables, and u_j is the unexplained variation across the country-year.

Mixed model

If we substitute equation (2), level 2, into equation (1), level 1 equation, we obtain equation (3); thus, combining both levels yields equation (4):

$$(3) \text{logit} \left(P(Y_{ij} = 1) \right) = (\gamma_{00} + \gamma_{1j}UNI_j + \gamma_{2j}COUNTRY_CONTROL_j + u_j) + \beta_{1j}PEOP_{ij} + r_i$$

$$(4) \text{logit} \left(P(Y_{ij} = 1) \right) = \gamma_{00} + \beta_{1j}PEOP_{ij} + \gamma_{1j}UNI_j + \gamma_{2j}COUNTRY_CONTROL_j + r_i + u_j$$

This shows that the probability of HIE for an individual depends on: individual factors ($PEOP_{ij}$), university outcomes at the country-year level (UNI_j), country controls ($COUNTRY_CONTROL_j$), random variation between country-years (u_j), and random variation between individuals (r_i).

Interaction model

Model 4 is extended by incorporating cross-level interaction terms between individual educational attainment and country-level university outcomes. This specification allows us to assess whether the association between university outcomes and HIE varies according to individuals' educational backgrounds. Reorganizing is obtaining equation (5):

$$(5) Y_{ij} = \gamma_{00} + \beta_{1j}PEOP_{ij} + \gamma_{1j}UNI_j + \delta_{1ij}UNIEDUC_{ij} * UNI_j \\ + \gamma_{2j}COUNTRY_CONTROL_j + r_i + u_j$$

This shows that the probability of HIE for an individual depends on: Individual factors ($PEOP_{ij}$), university outcomes at the country-year (UNI_j), the interaction between university education of people i and university outcomes at the country ($UNIEDUC_{ij} * UNI_j$), country controls ($COUNTRY_CONTROL_j$), random variations between country-year (u_j), and random variations between individuals (r_i).

We opted for a parsimonious random-intercept model with fixed slopes, meaning that the effects of the covariates are assumed to be constant across countries and years while the baseline probability of engaging in HIE is allowed to vary across country-year contexts. Given the limited number of higher-level units (country-year observations), estimating random slopes would increase model complexity and reduce parameter stability. Several explanatory variables from the GEM dataset, such as perceived entrepreneurial skills and fear of failure, are ordinal. For modeling purposes, these variables were treated as continuous because they contain ordered response categories and prior entrepreneurship research commonly assumes an approximately linear relationship with entrepreneurial outcomes (Leković et al., 2021). This specification enhances interpretability while maintaining model parsimony. Nevertheless, as a robustness check, these variables were alternatively specified as categorical using factor-variable notation, and the direction and statistical significance of the results remained unchanged.

2.3.2 Data and variables

This study uses a unique dataset that combines individual and country-level data from three primary sources. The individual-level data is collected from the GEM 2021 and 2022, specifically the Adult Population Survey (APS), to measure entrepreneurial activities. The APS examines the traits, drives, and goals of people launching a business, as well as their perspectives on entrepreneurship.

Country-level indicators on general conditions and university outcomes were obtained from the WB, UNESCO, Scimago, and the GII. The GII ranks innovation environments across more than 130 economies, using indicators of science investment, technology adoption, and socioeconomic impact (World Intellectual Property Organization, 2021, 2022). The dataset covers 37 countries over two years, 2021 and 2022, enabling a comprehensive, multilevel analysis that integrates macro- and micro-level factors shaping entrepreneurial activity. A list of individual observations by country included in the sample is available in Appendix 2A.

The dependent variable, HIE, captures entrepreneurial activity with the potential to generate significant economic and societal effects, typically through innovation, scalability, and internationalization. HIE is distinguished from other types of entrepreneurs by their ability to introduce novel products or services, leverage new technologies or processes, and expand beyond local markets (Acs, 2008; Koppl & Minniti, 2010; Parker, 2011). In this study, the HIE variable is operationalized as a dichotomous indicator that takes the value 1 if the respondent reports the following characteristics in their entrepreneurial endeavor: (i) offering products or services that are new to some or all customers; (ii) using new technologies or production processes; and (iii) targeting international markets beyond the domestic economy. If these conditions are met, the variable is coded as 1; otherwise, 0. Consistent with prior entrepreneurship research, HIE is conceptualized as entrepreneurial activity with the potential to generate disproportionate economic value through innovation, technological sophistication, and market expansion. Because realized growth outcomes are not observable in GEM cross-sectional data, this study operationalizes HIE through venture characteristics associated with future impact potential rather than realized growth outcomes (Acs, 2008; Agarwal & Shah, 2014; Covin & Wales, 2019; Dutta et al., 2020).

At the individual level, the model includes several predictors drawn from the GEM 2021 and 2022: age (Parker, 2011), age squared, gender (Koellinger et al., 2013; Ruiz et al., 2023), university education (Ruiz et al., 2023), perceived capabilities (Arenius & Minniti, 2005), fear of failure (Boudreaux et al., 2019), if know other entrepreneur (Ramos-Rodríguez et al., 2010), and the technological level of the sector (Chung et al., 2022). These variables account for demographic, cognitive, and contextual factors that are associated with entrepreneurial behavior (Xuan & Yankai, 2025).

At the country level, three variables are employed to capture university outcomes that represent potential channels of knowledge spillovers associated with HIE. First, the gross graduation ratio serves as a proxy for the human capital generated by universities, reflecting the scale at which universities produce graduates who may become entrepreneurs or contribute to entrepreneurial ventures (Guerrero et al., 2015; Guerrero-Cano et al., 2006). Second, the number of citable documents, as reported by Scimago, is used to approximate the volume of scientific knowledge produced by universities. This indicator captures peer-reviewed research outcomes published in international journals, reflecting the academic system's ability to generate original knowledge and to mediate knowledge spillovers through intermediaries, networks, and diffusion mechanisms beyond formal academic participation (Mañana-Rodríguez, 2015). Third, the University-Industry Collaboration index captures the extent to which universities are engaged in collaborative R&D with the productive sector. This indicator is derived from survey responses collected from a panel of national experts in both academia and industry, who assess the degree of interaction, joint research efforts, and knowledge transfer between universities and firms within their country (Akpoviri et al., 2023; Moid et al., 2023; Rossi & Rosli, 2014). This indicator serves as a proxy for the institutionalized channels of knowledge transfer and the strength of linkages between academic and industry actors. Following KSTE research, university outcomes are operationalized through educational, scientific, and collaborative outcomes that represent distinct channels through which knowledge becomes available to potential entrepreneurs. While these indicators do not directly measure knowledge spillovers, they capture observable manifestations of the production and diffusion of university knowledge (Acs et al., 2009; Audretsch & Lehmann, 2005b; Fischer et al., 2021; Gertner et al., 2011).

Additionally, the model controls for GDP growth, population, and the unemployment rate to account for broader country-level conditions (Bendig et al., 2024; Crowley & Barlow, 2022). A detailed description and operationalization of all variables are in Table 2.1. To capture the shocks that occurred between the two years covered by the study, a dummy variable is included that takes the value 1 if the individual observation is from 2022 and 0 if it is from 2021. Table 2.2 shows the descriptive statistics of the variables at the individual and country levels; Table 2.3 shows the correlation matrix between variables at the individual level, and Table 2.4 shows the correlation matrix between variables at the country level. To investigate potential multicollinearity, we calculate variance inflation factors for all variables and find no evidence of multicollinearity (mean: 2.04).

Table 2.1: Description of variables

Variable	Description	Values	Type	Source
Dependent Variable				
High-impact entrepreneurship (HIE)	Entrepreneur reports (i) a novel product/service, (ii) the use of new technology or process and (iii) international market reach	1 = meets all three criteria; 0 = otherwise	Dichotomous	GEM (2021, 2022)
Individual-Level				
Age	The age of the respondent	18 - 80	Continuous	GEM (2021, 2022)
Gender	Gender of the respondent	0 = Male 1 = Female.	Dichotomous	GEM (2021, 2022)
University education	University education of the respondent	0 = Don't have university education 1 = Have university education.	Dichotomous	GEM (2021, 2022)
Suskill	"Do you have the knowledge, skill, and experience to start a business?"	1 = Strongly disagree 2 = Disagree 3 = Neither agree nor disagree 4 = Agree 5 = Agree Strongly	Ordinal (5 levels)	GEM (2021, 2022)
Fearfail	"Would you not start a business for fear it might fail?"	1 = Strongly disagree 2 = Disagree 3 = Neither agree nor disagree 4 = Agree 5 = Agree Strongly	Ordinal (5 levels)	GEM (2021, 2022)
Knowent	"How many people do you know personally who started a business in the last 2 years?"	0 = None 1 = One 2 = 2-4 3 = 5 or more.	Categorical (4 levels)	GEM (2021, 2022)
Teahitec	Classifies entrepreneurial activity	0 = No/low-tech 1 = Medium-tech 2 = High-tech.	Categorical (3 levels)	GEM (2021, 2022)
Country-Level Predictors				
Gross graduation ratio	Number of graduates from first degree university programs (at ISCED level 6 and 7)	A percentage of the population of the theoretical graduation age of the most common first-degree programs.	Percentage (%)	UNESCO (2021, 2022)
Ln citable documents	Citable scientific articles published in SciMago	Natural logarithm of the number of citable scientific articles published	Continuous	Scimago (2021, 2022)
University industry collaboration	Collaboration rank based on expert surveys extent of joint R&D between academia and firms.	Rank	Continuous	GII (2021, 2022)
Country-Level Controls				
GDP growth	GDP growth		Percentage (%)	WB (2021, 2022)
Ln population	Natural logarithm of the total population		Percentage (%)	WB (2021, 2022)
Unemployment rate	Unemployment rate		Percentage (%)	WB (2021, 2022)

Table 2.2: Descriptive statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Individual Level					
High impact entrepreneurship	34,347	0.409	0.492	0	1
Age	307,260	41.791	14.13	18	80
Gender	326,147	0.495	0.5	0	1
University education	320,698	0.509	0.5	0	1
Suskill	319,052	3.164	1.508	1	5
Fearfaill	317,892	3.154	1.511	1	5
Knowent	315,881	0.912	1.047	0	3
Teahitec	37,027	0.076	0.349	0	2
Country Level					
Gross graduation ratio	259,855	39.549	13.535	0	74.081
Ln Citable Documents	324,371	10.396	1.597	0	13.834
University industry collaboration	313,761	48.8	12.571	26.7	79.6
GDP growth	322,143	5.72	3.016	-28.759	63.335
Ln population	324,377	17.111	1.428	9.21	21.078
Unemployment rate	324,316	8.242	5.364	0.13	35.359

Table 2.3: Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) High impact entrepreneurship	1.000							
(2) Age	-0.052	1.000						
(3) Gender	-0.025	-0.010	1.000					
(4) University education	0.060	0.012	-0.023	1.000				
(5) Suskill	0.059	0.051	-0.059	0.020	1.000			
(6) Fearfaill	-0.005	0.027	0.038	-0.014	-0.160	1.000		
(7) Knowent	0.100	-0.079	-0.046	0.049	0.157	-0.065	1.000	
(8) Teahitec	0.038	0.004	-0.076	0.081	-0.004	-0.023	-0.010	1.000

Table 2.4: Matrix of Correlations - Country Level

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) Gross graduation ratio	1.000					
(2) Ln citable documents	0.512	1.000				
(3) University industry collaboration	0.199	0.108	1.000			
(4) GDP growth	-0.016	0.112	-0.301	1.000		
(5) Ln population	0.180	0.842	-0.090	0.152	1.000	
(6) Unemployment ratio	-0.185	0.169	-0.386	0.154	0.212	1.000

2.4 Results

This section presents the empirical findings. Table 2.5 presents the multilevel logistic estimation. The Model 1 shows the results for the individual level. Model 2 presents the results of the multilevel model, which includes the individual and country levels. Models 3 and 4 represent the multilevel models for the subsamples of those with university education and those without, respectively. Finally, Models 5, 6, and 7 detail the models with specific individual and country-level interactions. The Model 8 combines the three interactions of the multilevel model.

Individual Model

The results of the individual-level, Model 1, analysis indicate significant associations between several predictors and the likelihood of engaging in HIE. Age shows a negative and significant effect ($\beta = -0.0462$, $p < 0.01$), while the squared term of age is positive and significant ($\beta = 0.000459$, $p < 0.01$), suggesting a non-linear relationship. Gender is negatively associated with HIE, with women being less likely to participate ($\beta = -0.0635$, $p < 0.1$).

University education is positively and significantly related to HIE engagement ($\beta = 0.238$, $p < 0.01$). Similarly, perceived entrepreneurial capabilities ($\beta = 0.0999$, $p < 0.01$) and fear of failure ($\beta = 0.0175$, $p < 0.05$) are associated with a higher likelihood of engaging in this type of entrepreneurship.

In addition, knowing other entrepreneurs ($\beta = 0.170$, $p < 0.01$) and participating in technology-intensive sectors ($\beta = 0.202$, $p < 0.01$) are both positively associated with HIE.

Multilevel Model

The results of the multilevel model, compared to the individual-level Model 1, show that most individual-level variables retain their direction, magnitude, and statistical significance. However, gender ($\beta = -0.0558$, $p > 0.1$) and fear of failure ($\beta = 0.0126$, $p > 0.1$) no longer reach statistical significance once contextual variables are introduced. Age maintains a negative coefficient ($\beta = -0.0345$, $p < 0.01$) with a positive quadratic term ($\beta = 0.000288$, $p < 0.01$), indicating an inverted U-shaped relationship. University education ($\beta = 0.150$, $p < 0.01$), perceived entrepreneurial skills ($\beta = 0.0775$, $p < 0.01$), knowing other entrepreneurs ($\beta = 0.0155$, $p < 0.01$), and engagement in technology-based entrepreneurship ($\beta = 0.192$, $p < 0.01$) remain positively and significantly associated with HIE.

At the contextual level, the gross graduation ratio ($\beta = -0.0157$, $p < 0.01$) is negatively and significantly associated with HIE, supporting hypothesis 1. In contrast, scientific knowledge production measured as the natural logarithm of citable documents ($\beta = 0.411$, $p < 0.01$), shows a positive and statistically significant relationship, supporting hypothesis 2. University-industry collaboration ($\beta = 0.00255$, $p > 0.1$), GDP growth ($\beta = 0.0144$, $p > 0.1$), and unemployment rate ($\beta = 0.00622$, $p > 0.1$). On the other hand, population size ($\beta = -0.315$, $p < 0.01$) is significantly and negatively associated with HIE. The marginals can be seen in the graphs in Figure 2.2.

Beyond statistical significance, the marginal effects indicate that the association of university outcomes are meaningful. As shown in Figure 2.2, increases in the gross graduation ratio are associated with a noticeable decline in the predicted probability of engaging in HIE, whereas higher levels of scientific research production are associated with an increase in the probability of HIE. These results suggest that university outcomes reach statistical significance and are associated with meaningful differences in entrepreneurial behavior across national contexts.

The estimated country-level intercept variance is 0.228 (SE = 0.0529), and the intraclass correlation coefficient (ICC) is 0.065, suggesting that approximately 6.5% of the total variance in HIE is attributable to between-country differences. This supports the relevance of a multilevel approach and highlights the role of national context in shaping the probability of engaging in HIE activity.

Models 3 and 4 explore potential differences in the determinants of HIE based on individuals' educational attainment. Specifically, separate multilevel models were estimated for two subsamples: individuals with university education (Model 3) and those without university education (Model 4). Both models maintain the same specification as the baseline multilevel model (2), including a random intercept at the country level.

In both subsamples, the age in the subsample with university education ($\beta = -0.0345$, $p > 0.1$) and without university education ($\beta = -0.0597$, $p > 0.1$), has no significance. However, the age-squared in Model 3 ($\beta = -0.0358$, $p < 0.01$) and Model 4 ($\beta = -0.03515$, $p < 0.01$) continue to exhibit a positive and significant relationship observed in previous models. Perceived entrepreneurial skills ($\beta = 0.102$, $p < 0.01$) are significant only among those with university education. Knowing other entrepreneurs in Model 3 ($\beta = 0.171$, $p < 0.01$), in Model 4 ($\beta = 0.130$, $p < 0.01$), and involvement in technological entrepreneurship in Model 3 ($\beta = 0.186$, $p < 0.01$) and Model 4 ($\beta = 0.227$, $p < 0.05$) remain significant and positively associated with HIE in both groups. Notably, while most coefficients remain statistically significant in the university education subsample, several predictors lose significance in the non-university group, potentially due to a smaller sample size and reduced explained variance.

Gross graduation ratio is negatively and significantly associated with HIE in Model 3 ($\beta = -0.0170$, $p < 0.01$) and Model 4 ($\beta = -0.0144$, $p < 0.1$), though the association is smaller

and less significant in Model 4. In contrast, the natural logarithm of citable documents shows a consistently positive and significant association across both groups ($\beta = 0.475$, $p < 0.01$ in Model 3 and $\beta = 0.307$, $p < 0.05$ in Model 4). The marginals can be seen in the graphs in Figure 2.3.

The estimated random intercept variance is higher in Model 3 ($\beta = 0.235$, $p < 0.01$) and Model 4 ($\beta = 0.215$, $p < 0.01$), indicating greater between-country heterogeneity within each educational group. Similarly, the ICC reaches 6.7% in Model 3 and 6.1% in Model 4, suggesting that a substantial proportion of the variance in HIE is explained by country-level differences, particularly among individuals with university education.

Dividing the sample between individuals with university education and those without, as done in models 3 and 4, may initially appear to be a useful strategy to approach the spillover association of university outcomes. However, this approach presents certain methodological limitations. Splitting the sample reduces the effective size of each subgroup, which may affect the precision of the estimates and limit the direct comparability between models. Moreover, this segmentation does not adequately capture potential differences in the marginal effects of university outcomes on HIE depending on an individual's educational attainment. For these reasons, it is more appropriate to model these differences through interaction terms between the contextual knowledge-related variables and a dummy indicating whether the individual holds a university education degree. This approach allows for a direct evaluation of whether the association of these variables differs significantly across groups, while preserving the full sample structure and increasing the robustness of the results.

Interaction

Models 5, 6, 7, and 8 incorporate interactions between university education and country-level variables, allowing for an examination of how this level of education moderates the relationship between certain university system outcomes and HIE. Model 5 considers the interaction between university education and the gross graduation ratio; Model 6 includes the interaction with $\ln$ citable documents; Model 7 includes the interaction with university-industry collaboration; and Model 8 simultaneously includes all three interactions.

In Model 5, although the interaction coefficient between university education and the gross graduation ratio is not statistically significant ($\beta = -0.000311$, $p > 0.1$), its inclusion slightly improves model fit compared to Model 2. In Model 6, the interaction between ln citable documents and university education is significant and negative ($\beta = -0.0750$, $p < 0.05$), suggesting that while an increase in scientific publications is positively associated with HIE, this association is reduced among individuals with university education. In Model 7, the interaction with university-industry collaboration is not significant ($\beta = -0.000474$, $p > 0.1$), indicating no differential effect by education level. The marginals can be seen in the graphs in Figure 2.4.

In Model 8, the interaction between university education and the gross graduation ratio is positive and statistically significant at the 10% level ($\beta = 0.00562$, $p < 0.10$). This provides limited support for Hypothesis 4a. The coefficient is consistent with an attenuation of the negative association on the log-odds scale among individuals with university education; the processes underlying this pattern are not directly observed.

The interaction between university education and research output is negative and statistically significant ($\beta = -0.0994$, $p < 0.01$), supporting Hypothesis 4b. This finding indicates that the positive association of scientific research outcomes on HIE is stronger among individuals without university education. One possible explanation is that research-based knowledge diffuses through publicly accessible channels, such as open-access publications, outreach activities, intermediary organizations, and broader innovation networks, allowing non-graduates to benefit from knowledge spillovers beyond formal academic environments.

The marginal effects presented in Figure 2.4 further illustrate the substantive relevance of these moderating effects. The predicted probabilities reveal that educational attainment is associated with different patterns in the relationship between university outcomes and HIE. In particular, the positive association of scientific research production is stronger among individuals without university education, whereas the negative average association of graduation rates is considerably attenuated among those with university education. These differences are statistically significant and substantively relevant in terms of their impact on the likelihood of engaging in HIE.

In contrast, the interaction between university education and university–industry collaboration remains statistically insignificant ($\beta = -0.00452$, $p > 0.1$). Therefore, Hypothesis 4c is not supported, suggesting that the entrepreneurial association of university–industry collaboration does not differ systematically according to educational attainment.

Table 2.5: Multilevel logistic regression model.

Dependent variable: High-Impact Entrepreneurship. Coefficients in Log-Odds.	1	2	3	4	5	6	7	8
Age	-0.0462*** (0.00570)	-0.0345*** (0.00739)	-0.0358*** (0.00926)	-0.0315*** (0.0106)	-0.0344*** (0.00731)	-0.0346*** (0.00742)	-0.0339*** (0.00720)	-0.0347*** (0.00729)
Age squared	0.000459*** (6.82e-05)	0.000288*** (9.47e-05)	0.000306*** (0.000115)	0.000243* (0.000137)	0.000287*** (9.38e-05)	0.000289*** (9.50e-05)	0.000282*** (9.28e-05)	0.000289*** (9.40e-05)
Gender	-0.0635*** (0.0236)	-0.0558 (0.0714)	-0.0492 (0.0879)	-0.0848 (0.0698)	-0.0556 (0.0709)	-0.0565 (0.0718)	-0.0552 (0.0716)	-0.0596 (0.0712)
University education	0.238*** (0.0238)	0.150*** (0.0443)			0.161 (0.116)	0.931*** (0.323)	0.381** (0.191)	1.215*** (0.279)
Suskill	0.0999*** (0.0116)	0.0775*** (0.0190)	0.102*** (0.0201)	0.0402 (0.0265)	0.0775*** (0.0189)	0.0780*** (0.0189)	0.0777*** (0.0189)	0.0780*** (0.0189)
Fearfail	0.0175** (0.00776)	0.0126 (0.0224)	0.00598 (0.0271)	0.0253 (0.0213)	0.0126 (0.0224)	0.0131 (0.0224)	0.0126 (0.0224)	0.0129 (0.0224)
Knowent	0.170*** (0.0112)	0.155*** (0.0276)	0.171*** (0.0299)	0.130*** (0.0350)	0.155*** (0.0275)	0.155*** (0.0275)	0.156*** (0.0276)	0.156*** (0.0275)
Teahitec	0.202*** (0.0335)	0.192*** (0.0496)	0.186*** (0.0552)	0.227** (0.0938)	0.193*** (0.0494)	0.192*** (0.0497)	0.194*** (0.0496)	0.192*** (0.0495)
Gross graduation ratio		-0.0157*** (0.00588)	-0.0170*** (0.00598)	-0.0144* (0.00752)	-0.0155** (0.00689)	-0.0155*** (0.00594)	-0.0159*** (0.00588)	-0.0195*** (0.00680)
Ln citable documents		0.411*** (0.126)	0.475*** (0.146)	0.307** (0.126)	0.411*** (0.128)	0.450*** (0.123)	0.411*** (0.125)	0.473*** (0.126)
University industry collaboration		0.000255 (0.00558)	-0.00596 (0.00568)	0.00926 (0.00597)	0.000267 (0.00561)	3.67e-05 (0.00556)	0.00341 (0.00621)	0.00276 (0.00617)
GDP growth		0.0114 (0.0325)	0.000343 (0.0311)	0.0315 (0.0382)	0.0114 (0.0325)	0.0104 (0.0323)	0.0119 (0.0325)	0.0108 (0.0324)
Ln population		-0.315*** (0.0946)	-0.389*** (0.108)	-0.224*** (0.0980)	-0.315*** (0.0955)	-0.310*** (0.0950)	-0.317*** (0.0940)	-0.317*** (0.0951)
Unemployment rate		0.00622 (0.00867)	0.00618 (0.00936)	0.00674 (0.00887)	0.00625 (0.00874)	0.00626 (0.00865)	0.00631 (0.00874)	0.00582 (0.00881)
University education#Gross graduation ratio					-0.000311 (0.00289)			0.00562* (0.00316)
University education#Ln citable documents						-0.0750** (0.0305)		-0.0994*** (0.0300)
University education#university industry collaboration							-0.00474 (0.00350)	-0.00452 (0.00374)
Constant	-0.205* (0.122)	1.216 (0.855)	2.314** (0.936)	0.245 (0.955)	1.207 (0.875)	0.739 (0.877)	1.088 (0.864)	0.633 (0.866)
Wald	612.25	326.50	268.80	76.42	339.47	405.77	353.95	421.77
Prob >	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Log Likelihood	-20,913.296	-13,203.361	-8,206.937	-5,015.1375	-13,203.35	-13,199.328	-13,201.941	-13,196.86
Intercept variance (estimate)		0.228***	0.235***	0.215***	0.228***	0.229***	0.228***	0.231***
Residual Variance (SE)		(0.0529)	(0.0524)	(0.0599)	(0.0531)	(0.0519)	(0.0530)	(0.0529)
Interclass Correlation Coefficient (ICC)		0.0648 (0.0122)	0.0667 (0.0136)	0.0613 (0.0135)	0.0648 (0.0122)	0.0650 (0.0122)	0.0647 (0.0122)	0.0656 (0.0123)
LR test vs logistic model		815.28	450.89	280.91	814.47	812.21	808.08	808.83
Observations	31,341	20,853	12,889	7,964	20,853	20,853	20,853	20,853
Number of groups		62	62	61	62	62	62	62

Robust standard errors in parentheses

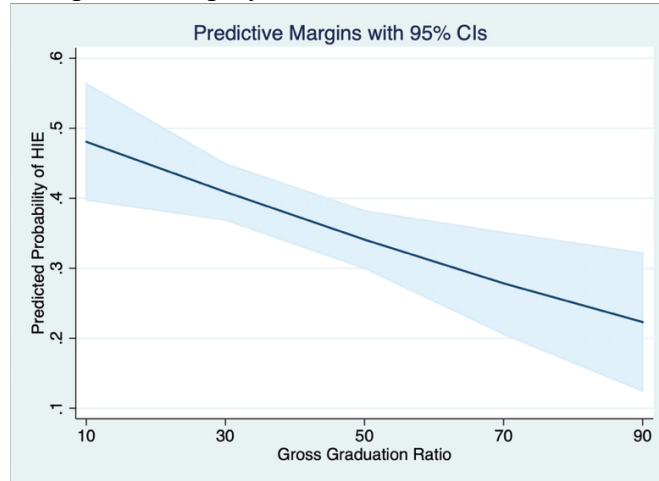
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Note: (1) Individual level, (2) Multilevel, (3) Sub sample with university education, (4) Sub sample without university education, (5) Gross graduation ratio interaction, (6) Ln citable documents interaction, (7) University industry collaboration interaction, (8) All interactions

All models are controlled by year.

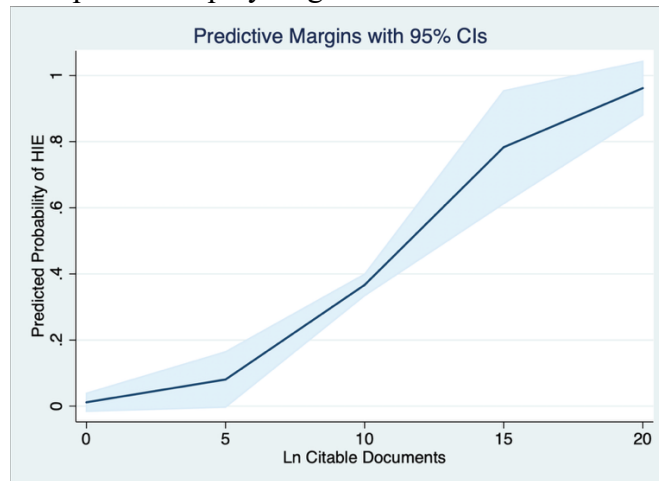
Figure 2.2: Marginal effects – Multilevel Model

Figure 2.2.a: Predicted Probability of High-Impact Entrepreneurship by Gross Graduation Ratio



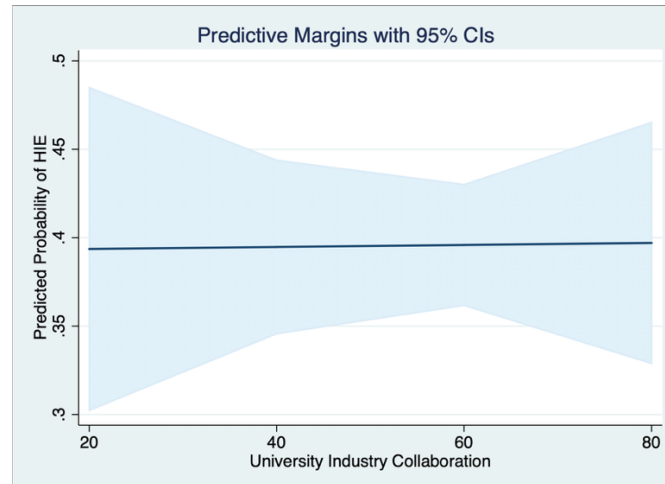
Predicted probabilities estimated. Shaded areas represent 95% confidence intervals.

Figure 2.2.b Predicted Probability of High-Impact Entrepreneurship by Log of Citable Documents



Predicted probabilities estimated. Shaded areas represent 95% confidence intervals.

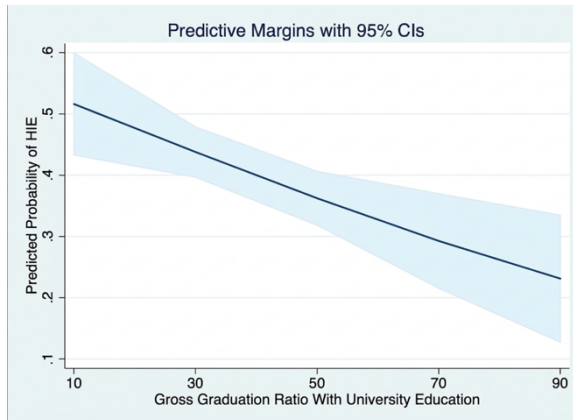
Figure 2.2.c Predicted Probability of High-Impact Entrepreneurship by University-Industry Collaboration



Predicted probabilities estimated. Shaded areas represent 95% confidence intervals.

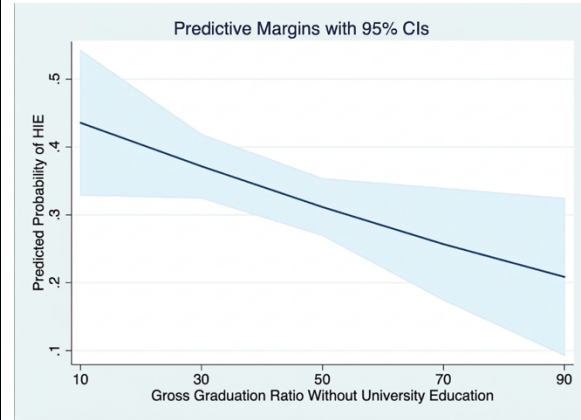
Figure 2.3: Marginal effects – Multilevel Model – Sub samples

Figure 2.3.a.1: Predicted Probability of High-Impact Entrepreneurship by Gross Graduation Ratio in sample with University Education



Predicted probabilities estimated 8. Shaded areas represent 95% confidence intervals.

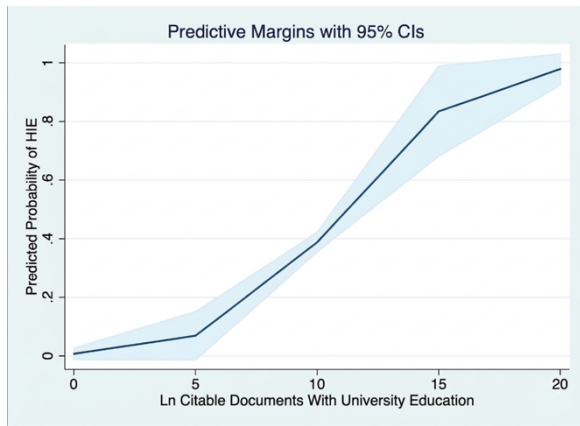
Figure 2.3.a.2: Predicted Probability of High-Impact Entrepreneurship by Gross Graduation Ratio in sample without University Education



Predicted probabilities estimated. Shaded areas represent 95% confidence intervals.

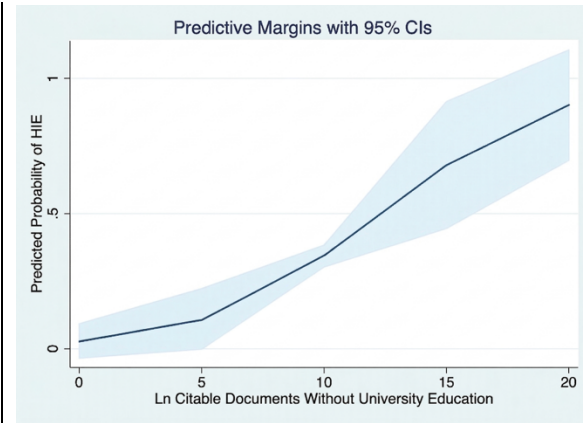
Figure 2.3.b.1 Predicted Probability of High-Impact Entrepreneurship by Log of Citable Documents in sample with University Education

Figure 2.3.b.2 Predicted Probability of High-Impact Entrepreneurship by Log of Citable Documents in sample without University Education



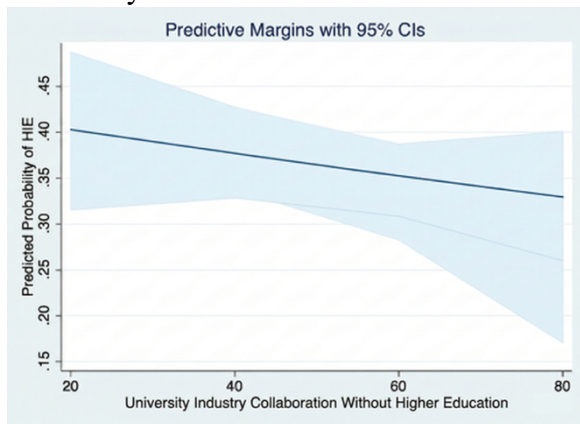
Predicted probabilities estimated. Shaded areas represent 95% confidence intervals.

Figure 2.3.c.1 Predicted Probability of High-Impact Entrepreneurship by University-Industry Collaboration in sample with University Education

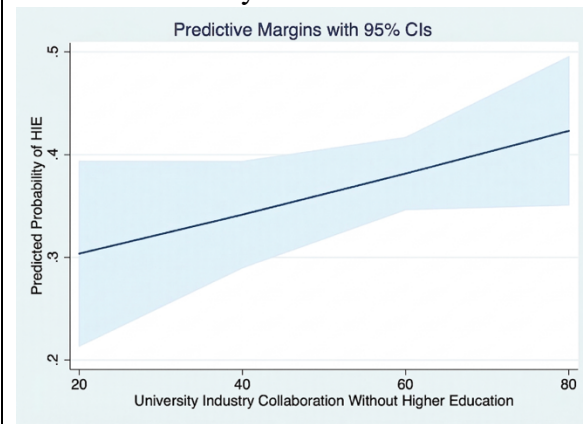


Predicted probabilities estimated. Shaded areas represent 95% confidence intervals.

Figure 2.3.c.2 Predicted Probability of High-Impact Entrepreneurship by University-Industry Collaboration in sample without University Education



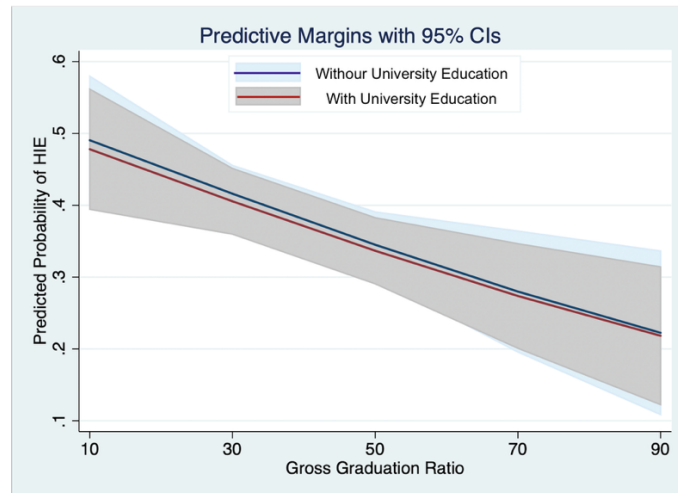
Predicted probabilities estimated. Shaded areas represent 95% confidence intervals.



Predicted probabilities estimated. Shaded areas represent 95% confidence intervals.

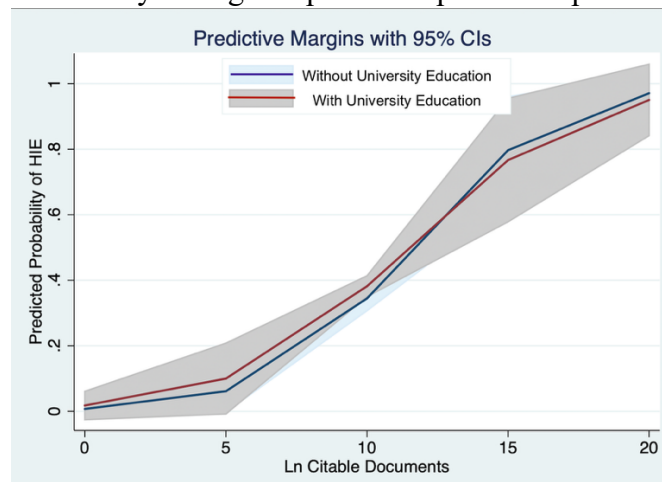
Figure 2.4: Marginal effects – Interaction Model

Figure 2.4.a: Interaction Effect Between University Education and Gross Graduation Ratio on the Probability of High-Impact Entrepreneurship



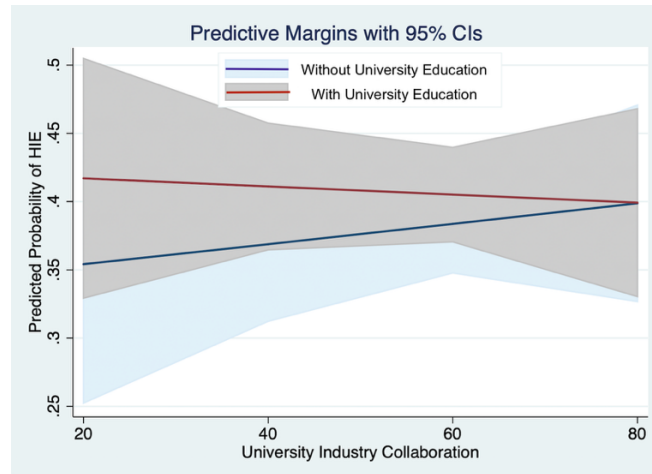
Predicted probabilities estimated. Shaded areas represent 95% confidence intervals.

Figure 2.4.b Interaction Effect Between University Education and Log of Citable Documents on the Probability of High-Impact Entrepreneurship



Predicted probabilities estimated. Shaded areas represent 95% confidence intervals.

Figure 2.4.c Interaction Effect Between University Education and University-Industry Collaboration on the Probability of High-Impact Entrepreneurship



Predicted probabilities estimated. Shaded areas represent 95% confidence intervals.

To further assess the robustness of our findings and reduce concerns regarding potential reverse causality, we re-estimated the principal multilevel models using one-year lagged country-level explanatory variables. Specifically, gross graduation ratios, scientific publication output, university–industry collaboration, and all country-level control variables were replaced by their corresponding one-year lagged values. As reported in Appendix 2B, the principal findings remain substantively unchanged. Gross graduation ratios continue to exhibit a negative association with high-impact entrepreneurship, whereas scientific publication output remains positively associated. Likewise, the moderating effects of educational attainment on graduation rates and scientific publications retain both their direction and statistical significance, while university–industry collaboration remains statistically insignificant. Overall, these results provide additional support for the robustness of the reported associations and suggest that the main findings are not driven solely by contemporaneous relationships between university knowledge outcomes and entrepreneurial activity.

2.5 Discussion, implications, and future research lines

2.5.1 Discussion

This study contributes to the literature on knowledge-based entrepreneurship by providing empirical evidence consistent with KSTE and showing how university outcomes

can be associated with the emergence of HIE. More specifically, it demonstrates that universities function as knowledge producers and facilitators of knowledge flow through teaching, research, and collaborative channels. By disaggregating university outcomes, the study demonstrates that university outcomes represent distinct channels through which knowledge spillovers become available. Educational expansion, scientific production, and university–industry collaboration are associated with distinct entrepreneurial patterns. This finding suggests that university outcomes should not be treated as a homogeneous construct within KSTE, but rather as a set of distinct spillover channels with different levels of accessibility, applicability, and entrepreneurial relevance.

The finding that higher gross graduation ratios are associated with lower probabilities of engaging in HIE challenges conventional assumptions about the benefits of educational expansion (Audretsch & Keilbach, 2007; Qian, 2018; Tam, 2001). While university education is generally expected to foster entrepreneurial capacity by enhancing human capital, this result suggests that broader access to university degrees may dilute graduates' entrepreneurial orientation. In contexts where university education becomes more massified, institutions may prioritize academic credentialing over the cultivation of innovation-oriented and entrepreneurial skills (Lafuente et al., 2016; Tam, 2001). Consequently, graduates may be more inclined toward traditional employment paths, particularly in the public or corporate sectors, rather than pursuing risk-intensive, innovation-driven ventures.

This interpretation aligns with previous research indicating that the quality, orientation, and labor-market relevance of university education is critical to determining its entrepreneurial outcomes (Fotopoulos, 2023; Guerrero & Urbano, 2019). Additionally, in systems where the expansion of university education is not matched by corresponding improvements in entrepreneurial infrastructure or institutional support, the transition from education to entrepreneurial action may be obstructed. Thus, the negative association observed here may reflect structural mismatches between educational expansion and the actual conditions for HIE (Stam & Spigel, 2016).

The positive and significant association of the interaction between university education and gross graduation ratio suggests that the association between graduation rates and HIE differs by educational attainment. In other words, while a higher gross graduation ratio is, on average, associated with a lower likelihood of engaging in HIE, this negative association is

attenuated among those with university education. One possible interpretation is that graduates may be better positioned because they have greater capacity to access institutional networks, advanced resources, and to effectively translate university outcomes into entrepreneurial opportunities. From the perspective of the KSTE, this reinforces the idea that knowledge spillovers are not automatic but are mediated by individual ability to recognize, interpret, and apply knowledge (Leyden & Link, 2017; Yi et al., 2021). Thus, in contexts with a higher proportion of university graduates, those with university education appear better positioned to relate these conditions to HIE engagement, highlighting an unequal distribution in the ability to capitalize on available academic knowledge.

The positive relationship between the number of citable documents and individuals' likelihood of engaging in HIE supports the notion that vibrant research ecosystems are associated with entrepreneurial activity. In line with the KSTE, the production of scientific knowledge enriches the knowledge base available for opportunity recognition and venture creation (Acs et al., 2009; Audretsch & Lehmann, 2005a). Research-intensive environments may provide a fertile ground for entrepreneurial discovery, especially in fields related to technology, science, and digital innovation, where codified knowledge supports the development of new products and services.

However, the significant and negative interaction between research output and educational attainment reveals a more nuanced pattern. While research outcomes are generally beneficial, their association with HIE is stronger among individuals without university education. This counterintuitive finding suggests that those without university training may rely more heavily on broader spillovers of codified knowledge, such as those disseminated through open-access research, media, or industry dissemination channels. Conversely, university-educated individuals may already be embedded in other knowledge systems (e.g., firm-specific, sectoral, or applied), reducing the marginal association of general academic research on their entrepreneurial behavior.

Our findings contribute to a broader stream of research emphasizing that contextual conditions determine both the prevalence of entrepreneurship, as well as its quality and its development potential. (Chowdhury et al., 2018). Consistent with Autio et al. (2014), the results suggest that university outcomes do not translate uniformly into entrepreneurial action. Rather, its entrepreneurial value depends on the interaction between knowledge

production processes, institutional conditions, and the characteristics of potential entrepreneurs.

The results also align with evidence showing that the determinants of innovation-oriented and internationally oriented entrepreneurship vary across national contexts (Aparicio et al., 2021). Our findings extend this argument by demonstrating that heterogeneity operates not only across countries but also across individuals within those contexts. Specifically, educational attainment shapes how individuals recognize, interpret, and leverage university outcomes, influencing the extent to which knowledge spillovers are transformed into entrepreneurial action.

Furthermore, our findings are consistent with recent evidence indicating that contextual conditions are more strongly associated with productive entrepreneurship in developing economies than in advanced ones (Fu et al., 2025), as well as with multilevel research showing that institutional conditions are associated with ambitious entrepreneurship differently across development settings (Bendig et al., 2024). They also resonate with evidence from Latin America suggesting that the entrepreneurial relevance of R&D activities and knowledge-related policies depends on institutional quality and local contextual conditions (Amorós et al., 2019). Taken together, these findings suggest that the entrepreneurial value of university outcomes are shaped simultaneously by the characteristics of knowledge itself, the attributes of potential entrepreneurs, and the broader institutional environments in which knowledge spillovers occur.

2.5.2 Implications

This study refines KSTE by showing that different university outcomes are associated with HIE in different ways. While scientific research production is positively associated with entrepreneurial engagement, graduate formation exhibits a negative average association, university-industry collaboration shows a more complex, sometimes counterintuitive effect, suggesting the need to reassess assumptions about its uniform benefits (Acs & Audretsch, 2010; Bonaccorsi et al., 2013).

For policymakers, the findings highlight the importance of moving beyond knowledge creation toward effective mechanisms of knowledge mobilization. This includes investing in advanced human capital programs that embed entrepreneurial training into university

education, supporting applied research with commercialization potential, and ensuring inclusive access to academic resources, especially for individuals without formal university education. Policies promoting open science may help strengthen university-business trust and reduce regulatory asymmetries, enhancing the reach and inclusivity of academic spillovers (Lehmann & Menter, 2016).

For universities, the study underscores the need to broaden their engagement strategies. Institutions must produce research outputs and ensure that these outputs are accessible and usable by diverse entrepreneurial actors. Enhancing interdisciplinary collaboration, simplifying technology transfer procedures, and expanding community outreach initiatives are crucial steps toward translating academic knowledge into economic and social value.

Entrepreneurs and ecosystem builders, in turn, should focus on developing the capability to recognize, interpret, and apply university-generated knowledge. Programs that combine mentorship, experiential learning, and early-stage partnerships with research institutions can help bridge the gap between recognizing opportunities and creating ventures.

These findings may be particularly relevant for developing and middle-income economies, where institutional constraints often limit direct access to university resources and where knowledge mobilization frequently depends on intermediary organizations, informal networks, and broader ecosystem actors. Under these conditions, university outcomes may reach potential entrepreneurs through channels that differ from those commonly observed in advanced economies.

2.5.3 Limitations and future research

This study presents limitations that should be considered when interpreting the findings. First, the dependent variable captures high-impact entrepreneurial potential rather than realized entrepreneurial impact. Consistent with prior entrepreneurship research, the measure combines innovation, technological sophistication, and international market orientation as characteristics associated with ventures that are more likely to generate economic value (Acs, 2008; Covin & Wales, 2019). However, because the GEM data do not provide longitudinal information on firm growth, employment creation, or long-term performance, the results should not be interpreted as evidence regarding realized entrepreneurial impact.

Second, the indicators used to capture university outcomes represent observable manifestations of the production and diffusion of university knowledge rather than direct measures of knowledge spillovers. Graduation rates, scientific publications, and university–industry collaboration reflect distinct channels through which knowledge may become available to potential entrepreneurs, but they do not fully capture the quality, accessibility, relevance, or actual utilization of university outcomes (Fischer et al., 2021; Gertner et al., 2011). Future studies could complement these measures with more direct indicators of knowledge mobilization, technology transfer, and entrepreneurial engagement.

Third, the empirical design does not allow definitive causal inference. The analysis combines cross-sectional individual-level data with country-year indicators for 2021 and 2022, making it difficult to fully capture the long-term dynamics through which university knowledge outcomes are associated with entrepreneurial behavior. Although the lagged specifications reduce concerns regarding contemporaneous reverse causality, reverse causality and omitted institutional or ecosystem characteristics cannot be completely ruled out. Although the analysis incorporates several macroeconomic controls and accounts for contextual heterogeneity through a multilevel specification, unobserved institutional and ecosystem characteristics may still influence both university knowledge outcomes and entrepreneurial behavior. Consequently, the findings should be interpreted as associations rather than causal effects.

Finally, while the sample includes countries at different stages of development, the mechanisms through which university outcomes reach entrepreneurs may differ across institutional contexts. Future research could examine these relationships separately across developed and developing economies, as well as across different industrial and technological sectors, to better understand how contextual conditions shape the entrepreneurial relevance of university-generated knowledge. Beyond these substantive extensions, future research could strengthen causal identification by combining longer longitudinal datasets with quasi-experimental designs or valid instrumental variable approaches. Such designs would make it possible to examine more directly whether changes in university knowledge outcomes precede changes in entrepreneurial behavior and to better identify the mechanisms through which university-generated knowledge is associated with HIE.

2.6 Appendix 2A: Countries and Individual Observations

Individual Observations				
N	Country	2021	2022	Total
1	Austria		256	256
2	Canada	280	216	496
3	Chile	2473	2431	4,904
4	China		183	183
5	Colombia	311		311
6	Croatia		183	183
7	Cyprus	165	165	330
8	Egypt		157	157
9	Finland	125		125
10	Germany	228	317	545
11	Greece	100	94	194
12	Hungary	187	185	372
13	India	418	190	608
14	Indonesia		165	165
15	Israel	119	153	272
16	Italy	86		86
17	Japan	97	97	194
18	Latvia	85	225	310
19	Lithuania		233	233
20	Morocco	174	132	306
21	Netherlands	264	226	490
22	Norway	50	111	161
23	Poland	151	119	270
24	Qatar	478	289	767
25	Romania	145	142	287
26	Saudi Arabia	772	754	1,526
27	Slovakia	115	172	287
28	Slovenia	99	115	214
29	South Africa	433	200	633
30	South Korea	242	225	467
31	Spain	1433	1824	3,257
32	Sweden	279	266	545
33	Switzerland	140	117	257
34	Tunisia		299	299
35	Turkey	124		124
36	United Kingdom	202		202
37	Uruguay	409	428	837
Total		10,184	10,669	20,853

2.7 Appendix 2B: Robustness Check

Using one-year Lagged Country-level Variables

Dependent variable: High-Impact Entrepreneurship. Coefficients in Log-Odds	Main Model (2)	Lagged Model (2)	Main Model (8)	Lagged Model (8)
Gross graduation ratio	-0.0157*** (0.00588)	-0.0248*** (0.00433)	-0.0195*** (0.00680)	-0.0234*** (0.00776)
Ln citable documents	0.411*** (0.126)	0.465*** (0.145)	0.473*** (0.126)	0.443*** (0.134)
University–industry collaboration	0.000255 (0.00558)	0.00334 (0.00777)	0.00276 (0.00617)	0.00387 (0.00876)
University education × Gross graduation ratio	—	—	0.00562* (0.00316)	0.00765* (0.00455)
University education × Ln citable documents	—	—	-0.0994*** (0.0300)	-0.0899** (0.0456)
University education × University–industry collaboration	—	—	-0.00452 (0.00374)	-0.00322 (0.00811)
Individual-level controls	Yes	Yes	Yes	Yes
Country-level controls	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes

Using one-year Lagged Country-level Variables

Dependent variable: High-Impact Entrepreneurship. Coefficients in Log-Odds	Main Model (2)	Lagged Model (2)	Main Model (8)	Lagged Model (8)
Wald χ^2	326.50	397.75	421.77	443.34
Log likelihood	-13,203.36	-13,266.35	-13,196.86	-13,246.75
Intercept variance	0.228	0.233	0.231	0.264
ICC	0.0648	0.0661	0.0656	0.0743
Observations	20,853	20,853	20,853	20,853
Number of country-year groups	62	62	62	62
Lagged models replace all country-level explanatory variables (gross graduation ratio, scientific publications, university–industry collaboration, GDP growth, population, and unemployment rate) with their one-year lagged values. All specifications retain the same multilevel structure, individual-level controls, country-level controls, and year fixed effects reported in the main analysis. Robust standard errors are reported in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.10.				

Chapter 3

Knowledge Absorption in Entrepreneurial Ecosystems: Understanding Entrepreneurial Ecosystem Configurations²

Knowledge plays a central role in entrepreneurship, yet individuals exposed to similar knowledge differ in their ability to recognize its entrepreneurial usefulness. While entrepreneurial ecosystem research has extensively examined contextual determinants of entrepreneurship, less attention has been devoted to the individual-level mechanisms through which ecosystem conditions influence knowledge absorption. This study examines how configurations of entrepreneurial ecosystem conditions are associated with high levels of knowledge absorption among entrepreneurs. Drawing on absorptive capacity theory, entrepreneurial ecosystem research, and a microfoundational perspective, the study employs fuzzy-set Qualitative Comparative Analysis (fsQCA) using survey data from 662 entrepreneurs in Chile. The findings show that no single ecosystem condition is necessary for high knowledge absorption. Instead, multiple sufficient configurations emerge, highlighting the roles of institutional finance, entrepreneurship training, regulatory clarity, perceived opportunities, and business networks in different combinations. These results underscore the configurational nature of entrepreneurial ecosystems and demonstrate that knowledge absorption is shaped by alternative pathways rather than a single optimal set of conditions. The study contributes to entrepreneurial ecosystem research by identifying knowledge absorption as a micro-level mechanism linking ecosystem conditions with entrepreneurial action and by providing configurational evidence of the causal complexity underlying entrepreneurial knowledge processes.

Keywords: Knowledge absorption; Entrepreneurial ecosystems; Absorptive capacity; Microfoundations; fsQCA; Entrepreneurial knowledge; Configurational analysis.

² This study is an outcome of a research project supported by Templeton World Charity Foundation [TWCF–2023–32650]

3.1 Introduction

Knowledge has long been regarded as a fundamental driver of entrepreneurship and regional development. Universities, higher education, and innovation systems are increasingly viewed as key mechanisms for expanding the knowledge base available to entrepreneurs. Yet the availability of knowledge alone does not generate entrepreneurship. Its economic value depends not only on whether individuals can recognize, assimilate, and apply that knowledge in ways that support entrepreneurial action, but also on the context in which these processes take place (Cohen & Levinthal, 1990; Zahra & George, 2002). Although prior research has highlighted the importance of education and human capital in shaping entrepreneurial activity (Qian & Acs, 2013), individuals exposed to similar knowledge often differ substantially in their ability to recognize its entrepreneurial value and translate it into action.

Absorptive capacity provides a useful theoretical lens for understanding these differences. Originally defined as the ability to recognize the value of new knowledge, assimilate it, and apply it to economic activities (Cohen & Levinthal, 1990), the concept has increasingly been extended to entrepreneurial settings, where knowledge absorption reflects the extent to which individuals recognize the usefulness of acquired knowledge and mobilize it for entrepreneurial purposes (Qian & Acs, 2013). From this perspective, entrepreneurial outcomes depend not only on the knowledge individuals possess but also on the capabilities that allow them to transform that knowledge into entrepreneurial action. This view is consistent with the growing micro foundational perspective in entrepreneurship research, which emphasizes how individual-level capabilities underpin broader entrepreneurial outcomes (Felin et al., 2012; Barney & Felin, 2013; Cosenz et al., 2023; Felin & Foss, 2023; Roundy & Lyons, 2023).

Individual capabilities do not develop or operate in isolation. They are embedded within entrepreneurial ecosystems (EE) that are understood as the constellation of institutions, resources, and contextual arrangements that shape the environment within which entrepreneurial activity takes place (Stam, 2015; Autio et al., 2014). Within this framework, entrepreneurial outcomes emerge from the interaction of multiple ecosystem elements rather than from isolated factors. However, much of the EE literature has focused on aggregated

ecosystem attributes, providing limited insight into the micro mechanisms through which ecosystem conditions shape how individuals mobilize knowledge for entrepreneurship (Shepherd et al., 2021). Ecosystem conditions shape the translation of knowledge into entrepreneurial outcomes, such that knowledge yields result only when there is effective alignment between education, policy frameworks, and environmental attributes (Audretsch et al., 2026). Accordingly, the ability to mobilize knowledge is not determined solely by individual capabilities but is also shaped by ecosystem dimensions such as institutions, resources, and support structures that influence the opportunities and constraints faced by entrepreneurs (Xie et al., 2021).

Empirical research has mainly examined the relationship between universities, regional knowledge stocks, or aggregated human capital and entrepreneurial activity (Qian, 2017). While these studies provide important insights into the structural sources of entrepreneurial opportunities, they offer limited understanding of the micro mechanisms through which individuals recognize, interpret, and apply acquired knowledge in entrepreneurship. This limitation is particularly relevant within the entrepreneurial ecosystem literature, where recent research increasingly calls for greater attention to the micro mechanisms through which ecosystem conditions translate into entrepreneurial action. In particular, the role of individual-level knowledge absorption within entrepreneurial ecosystems has received comparatively limited systematic attention, especially in settings characterized by institutional heterogeneity and structural constraints (Kraus et al., 2011; Muñoz & Kimmitt, 2019).

Addressing this gap requires examining how entrepreneurial ecosystem conditions interact to shape individual-level knowledge absorption. Accordingly, this study addresses the following research question:

Which configurations of entrepreneurial ecosystem conditions enable high levels of knowledge absorption among entrepreneurs?

To address this research question, the study adopts a configurational perspective in which different combinations of ecosystem elements may lead to similar levels of knowledge absorption. In such contexts, the presence of one condition may compensate for the absence of another, reflecting dynamics of equifinality and causal complexity. To examine these patterns, the study employs fuzzy-set Qualitative Comparative Analysis (fsQCA), a set-

theoretic approach that is well suited for analyzing how multiple conditions combine to produce specific outcomes in entrepreneurship research (Ragin, 2008; Schneider & Wagemann, 2012; Muñoz et al., 2022; Nikou et al., 2024).

By examining how ecosystem conditions combine to shape knowledge absorption at the individual level, this study contributes to the literature on entrepreneurial ecosystems and knowledge-based entrepreneurship in several ways. First, this study advances entrepreneurial ecosystem research by identifying knowledge absorption as a micro foundational mechanism through which ecosystem conditions influence entrepreneurial action.

Second, the study contributes by empirically examining knowledge absorption at the individual level. While prior research has largely treated knowledge processes in aggregate or organizational terms, this study operationalizes knowledge absorption as an individual-level phenomenon, thereby connecting microfoundations with ecosystem-level conditions.

Third, by adopting a configurational approach, this study explains how different combinations of ecosystem conditions lead to similar levels of knowledge absorption, highlighting the causal complexity underlying its emergence. This configurational perspective highlights the existence of multiple pathways through which knowledge can be effectively mobilized, advancing the understanding of causal complexity in entrepreneurial ecosystems.

3.2 Theory

3.2.1 Knowledge absorption as a micro mechanism of entrepreneurial action

The concept of absorptive capacity (Cohen & Levinthal, 1990) provides a useful theoretical lens for understanding how knowledge is recognized, assimilated, and applied for economic purposes. Originally defined as the ability to recognize the value of new knowledge, assimilate it, and apply it for commercial ends, absorptive capacity highlights that the economic value of knowledge depends on actors' cognitive and organizational capabilities. Subsequent research has extended this perspective by emphasizing that absorptive capacity operates both at the organizational level and at the level of individuals (Zahra & George, 2002; Lane et al., 2006; Volberda et al., 2010). In entrepreneurial contexts, knowledge absorption can be understood as the individual-level expression of absorptive capacity, referring to the process through which acquired knowledge is interpreted,

evaluated, and mobilized for entrepreneurial purposes (Qian & Acs, 2013; Kirschning & Mrożewski, 2023b). From this perspective, the effective use of knowledge depends on whether individuals possess the cognitive skills and interpretative abilities necessary to understand and mobilize the knowledge they acquire in entrepreneurial contexts (Shane, 2000).

Within entrepreneurship research, these dynamics are particularly relevant because entrepreneurial activity often involves identifying and exploiting opportunities embedded in prior knowledge (Shane & Venkataraman, 2000). Entrepreneurs must evaluate whether the knowledge they possess or acquire can be applied to new economic contexts and whether it can support the development of viable business initiatives (Shane, 2000; Qian, 2018; Gruber et al., 2013). The ability to perform this evaluation depends on the availability of knowledge and the individuals' capacity to interpret information, connect ideas, and assess their potential economic relevance. Prior knowledge therefore shapes how individuals recognize and evaluate entrepreneurial opportunities, as they are more likely to identify opportunities in domains where they possess relevant experience or expertise (Shane, 2000).

From a microfoundational perspective, understanding how knowledge translates into entrepreneurial activity requires focusing on the actions and capabilities of individual actors. Microfoundations scholarship emphasizes that aggregate economic outcomes emerge from the decisions and behaviors of individuals who interpret and act upon available resources and opportunities (Felin et al., 2012; Barney & Felin, 2013). This perspective has increasingly informed entrepreneurship and ecosystem research by highlighting how individual-level capabilities and actions underpin broader entrepreneurial dynamics (Felin & Foss, 2023; Roundy & Lyons, 2023). In this sense, individual knowledge absorption can be understood as a micro mechanism linking knowledge acquisition with entrepreneurial action. Through this mechanism, individuals evaluate the usefulness of their knowledge and determine whether it can support the development of entrepreneurial initiatives (Qian, 2018). Knowledge absorption is therefore conceptualized as a micro-level mechanism through which knowledge can be translated into entrepreneurial action.

3.2.2 Entrepreneurial ecosystems as enabling structures for knowledge mobilization

While individual capabilities are necessary for the mobilization of knowledge, entrepreneurial action is also shaped by the institutional and structural environments in which individuals operate (Autio et al., 2014). From an EE perspective, productive entrepreneurship emerges from the interaction among actors, institutions, and resources that together form an interdependent system at the territorial level (Stam, 2015; Fotopoulos & Qian, 2025). Within this framework, ecosystems function as enabling structures that shape how individuals access, interpret, and apply knowledge in entrepreneurial contexts.

The EE shape the opportunities and constraints faced by entrepreneurs through multiple dimensions, including access to finance, participation in business networks, regulatory conditions, and the availability of public support mechanisms (Isenberg, 2010; Spigel, 2017; Stam & Van de Ven, 2021). These ecosystem attributes influence how individuals perceive opportunities and evaluate whether their knowledge can be mobilized in entrepreneurial initiatives. In this sense, ecosystem conditions shape the resources, incentives, and institutional arrangements that affect the translation of knowledge into entrepreneurial action.

Prior research suggests that knowledge is more likely to translate into entrepreneurial outcomes when individual capabilities interact effectively with supportive environmental conditions (Acs et al., 2017; Audretsch et al., 2026; Tsvetkova & Partridge, 2021). Rather than operating in isolation, the mobilization of knowledge depends on the alignment between the skills and cognitive capacities of individuals and the broader ecosystem structures that provide access to resources, networks, and institutional support (Autio et al., 2014; Stam, 2015).

In this sense, EE influence the extent to which individuals can mobilize knowledge by facilitating access to complementary resources and shaping the institutional conditions under which entrepreneurial action takes place (Qian, 2018). Accordingly, knowledge absorption should be understood as an individual capability and as a process embedded within broader ecosystem structures that enable or constrain the mobilization of knowledge for entrepreneurial activity.

Configurational approaches have been increasingly used to analyze entrepreneurial ecosystems, emphasizing the interdependence of ecosystem elements. This literature shows that multiple combinations of institutional, resource, and contextual conditions can produce similar entrepreneurial outcomes, while also suggesting that factors often assumed to be necessary may play only a peripheral role within specific configurations. While these studies highlight the configurational nature of ecosystems at aggregate levels (Muñoz et al., 2020; Xie et al., 2021), they have largely overlooked individual-level processes. This study extends this line of research by examining how ecosystem configurations shape knowledge absorption as a micro-level mechanism underlying entrepreneurial action

3.2.3 Ecosystem conditions shaping knowledge absorption

Entrepreneurial processes unfold within contexts shaped by multiple ecosystem conditions. Rather than operating independently, these conditions interact in ways that shape the environment in which knowledge can be effectively mobilized. Consequently, the contribution of any single element often depends on the presence of other complementary conditions within the broader ecosystem (Autio et al., 2014; Stam & Van de Ven, 2021).

One important dimension concerns perceived opportunities, which reflect individuals' assessment of whether favorable conditions exist for starting a business in their environment. Opportunity perception captures how signals from the economic and institutional context are interpreted by potential entrepreneurs, including market dynamism, local demand conditions, and broader economic prospects (Stam, 2015; Autio et al., 2014). From a microfoundational perspective, opportunities are not objective features of the environment but are cognitively interpreted and enacted by individuals based on their prior knowledge and experience (Shane, 2000; Felin et al., 2012).

In addition, a relevant condition is access to financial resources, which influences the feasibility of transforming ideas into entrepreneurial initiatives. Financial capital constitutes a core structural element of entrepreneurial ecosystems because it provides the resources necessary to initiate or expand business activities (Isenberg, 2010; Stam & Van de Ven, 2021). In this study, financial support is conceptualized as encompassing both informal and institutional sources. While informal finance reflects resources obtained through personal ties, institutional finance includes funding from formal actors such as banks, venture capital,

and government-backed mechanisms. The availability of these resources may facilitate the application of knowledge in entrepreneurial activity by reducing resource constraints that could otherwise limit opportunity exploitation (Qian, 2018).

Business networks represent the relational infrastructure through which entrepreneurs gain access to information, advice, and contacts. Networks facilitate the circulation of knowledge and resources within entrepreneurial environments and can support opportunity recognition, problem solving, and access to complementary capabilities (Spigel, 2017). Through these relational ties, individuals may obtain information that helps them interpret the potential usefulness of their knowledge in entrepreneurial contexts.

Another important ecosystem element relates to regulatory conditions, which shape the institutional framework within which entrepreneurial activity takes place. Regulatory environments influence how individuals perceive the feasibility of starting and operating a business by structuring the incentives and constraints associated with entrepreneurial activity (Autio et al., 2014). Clear and supportive regulatory frameworks may therefore reduce uncertainty and facilitate the application of knowledge within business initiatives.

Finally, complementary entrepreneurial education may strengthen individuals' capabilities to interpret market signals, evaluate opportunities, and apply knowledge in entrepreneurial settings. Training programs oriented toward entrepreneurship can enhance managerial and cognitive skills that support opportunity recognition and the practical use of knowledge in business creation processes (Qian, 2018; Kirschning & Mrożewski, 2023b). Such initiatives may therefore reinforce the alignment between individual capabilities and the surrounding entrepreneurial environment.

The influence of these ecosystem conditions often depends on how they combine within specific contexts. For example, recognizing promising business opportunities may not lead to entrepreneurial initiatives without access to finance or supportive networks, while financial resources may remain underutilized in the absence of entrepreneurial capabilities or institutional support. As a result, similar levels of knowledge absorption may emerge from different configurations of ecosystem conditions, reflecting the heterogeneous and context-dependent nature of entrepreneurial processes (Huang et al., 2025; Lee, 2025; Tsvetkova & Partridge, 2021).

3.3 Methodology

3.3.1 Research Design

This study adopts a configurational research design using fsQCA. This approach allows the modeling of degrees of set membership, making it particularly suitable for analyzing social phenomena in which conditions and outcomes are not simply dichotomous but may exhibit varying levels of intensity (Ragin, 2008; Fiss, 2011). By allowing partial membership in sets, fsQCA enables the examination of how different conditions combine to produce specific outcomes.

Unlike regression-based approaches, which estimate linear and additive relationships between variables, fsQCA focuses on configurations of conditions that jointly lead to an outcome. The method is particularly suited for analyzing causal complexity characterized by equifinality, causal asymmetry, and conjunctural causation, where multiple combinations of conditions may generate similar outcomes (Ragin, 2008; Muñoz et al., 2022; Nikou et al., 2024). This configurational perspective is especially appropriate for examining how different combinations of entrepreneurial ecosystem conditions are associated with high levels of knowledge absorption.

Necessary condition analysis was conducted to examine whether any single ecosystem condition constitutes a prerequisite for high levels of knowledge absorption. Following established practice in fsQCA, a condition is considered necessary when the outcome is consistently a subset of that condition. Consistency thresholds of 0.90 or above are commonly used to identify necessary conditions, while coverage indicates their empirical relevance (Ragin, 2008; Schneider & Wagemann, 2012). After the analysis of necessity, sufficiency analysis was conducted to identify configurations of ecosystem conditions associated with high levels of knowledge absorption. This step examines how combinations of conditions jointly produce the outcome, in line with the principles of equifinality and conjunctural causation.

3.3.2 Data

The study draws on data from a nationally representative survey administered in Chile in May 2025 to a stratified random sample of 2,885 adults aged 18 years and older

across all regions of the country. The sampling design ensured representativeness by geographic zone, gender, and socioeconomic status, with a margin of error of ± 2.7 percentage points at the 95% confidence level. The survey collected individual-level information on environmental conditions, entrepreneurial trajectories, and perceptions regarding the usefulness of knowledge acquired through formal education for entrepreneurial activity. Sampling weights were applied to correct for unequal probabilities of selection and nonresponse, ensuring nationally representative estimates.

The analysis focuses exclusively on entrepreneurs identified based on their occupational status. Consistent with the entrepreneurship economics literature, which defines entrepreneurs in terms of occupational choice into self-employment or business ownership (Parker, 2009), individuals who report being self-employed or owners of a private business are classified as entrepreneurs. In line with evidence highlighting heterogeneity across different types of entrepreneurial activity (Henrekson & Sanandaji, 2014), this definition encompasses both self-employed individuals and employers, without imposing *ex ante* distinctions in the causal structure underlying knowledge absorption. The Chilean context provides an appropriate setting for examining these relationships because its entrepreneurial ecosystem has undergone rapid institutional development inspired by internationally recognized ecosystem models, while continuing to exhibit substantial heterogeneity in the distribution of entrepreneurial resources and support structures (Barton et al., 2025; Harima et al., 2024; Mahn & Poblete, 2023; Poblete et al., 2026).

From the full sample, 760 respondents were identified as entrepreneurs based on their occupational status, defined as self-employed individuals and private business owners. After excluding observations with missing values in the outcome and causal conditions, the final analytical sample consisted of 662 entrepreneurs, who constitute the unit of analysis in this study.

3.3.3 Outcome

The outcome of interest corresponds to high levels of knowledge absorption, understood as the extent to which individuals can recognize and mobilize knowledge for entrepreneurial purposes. In this study, knowledge absorption is operationalized through individuals' perceived usefulness of knowledge acquired through formal education for

entrepreneurial activity. As a perception-based measure, it captures individuals' subjective evaluation of knowledge applicability rather than its objective use.

While knowledge absorption is conceptually related to absorptive capacity, its empirical measurement at the individual level presents important challenges. The available measure captures individuals' evaluation of whether the knowledge they possess can be applied in entrepreneurial contexts. In this sense, it captures an initial and necessary stage of the knowledge absorption process, namely the recognition of the applicability of knowledge.

Although this operationalization does not capture the full multidimensional nature of absorptive capacity, it provides a meaningful approximation of knowledge absorption at the individual level. Prior research emphasizes that the economic value of knowledge depends on individuals' ability to recognize its usefulness and apply it in productive activities (Cohen & Levinthal, 1990; Qian & Acs, 2013). From this perspective, perceived usefulness can be interpreted as an observable manifestation of individuals' capacity to interpret and mobilize knowledge in entrepreneurial settings.

3.3.4 Conditions

The analysis incorporates six ecosystem conditions, including two distinct forms of financial support (informal and institutional), which capture key dimensions of the entrepreneurial environment that may influence individuals' ability to mobilize knowledge for entrepreneurial purposes. First, perceived opportunities reflect individuals' assessment of whether favorable conditions exist for starting a business in their region, capturing how potential entrepreneurs interpret signals from their surrounding environment, such as market dynamism and local economic prospects (Stam, 2015; Autio et al., 2014). Second, financial support is conceptualized as comprising two distinct forms: informal and institutional finance, each representing different sources of resources available to entrepreneurs that may reduce constraints associated with venture creation and facilitate the translation of knowledge into entrepreneurial initiatives (Isenberg, 2010; Stam & Van de Ven, 2021; Qian, 2018).

Third, government support reflects access to public funding mechanisms aimed at fostering entrepreneurial activity (Isenberg, 2010; Stam & Van de Ven, 2021). In this study, government support is captured as part of institutional finance, encompassing financial

resources provided by the public sector, which may also facilitate entrepreneurial initiatives by easing financial constraints and enabling the application of knowledge in business creation (Audretsch et al., 2026).

Fourth, networks capture the extent to which individuals are connected to business contacts or entrepreneurial networks that provide access to information, advice, or collaboration opportunities, thereby supporting the circulation of knowledge and resources within entrepreneurial environments (Spigel, 2017). Fifth, regulatory conditions refer to individuals' perception of the regulatory environment as favorable or understandable for entrepreneurial activity, shaping the perceived feasibility of starting and operating a business through institutional incentives and constraints (Autio et al., 2014). Finally, complementary entrepreneurial education captures participation in entrepreneurship-related training programs beyond formal education, which may strengthen individuals' managerial and cognitive capabilities and support the practical application of knowledge in entrepreneurial settings (Qian, 2018; Kirschning & Mrożewski, 2023a).

The conditions include both crisp and fuzzy sets. Binary conditions are treated as crisp sets, while regulatory clarity is calibrated as a fuzzy set following the procedures proposed by Ragin (2008).

3.3.4.1 Calibration

The outcome variable was calibrated as a fuzzy set representing membership in the set of high knowledge absorption. The original measure is based on an ordinal three-category scale capturing individuals' perceived usefulness of knowledge acquired through formal education for entrepreneurial activity ("none," "some," and "a lot").

Given the limited number of response categories, a calibration based on ordinal recoding was adopted, following set-theoretic calibration principles (Ragin, 2008). The variable was thus transformed into fuzzy-set scores ranging from 0 to 1. Specifically, "none" was calibrated as full non-membership (0), "some" was assigned a value close to the crossover point (0.49), and "a lot" as full membership (1) in the set of high knowledge absorption.

This calibration preserves the ordinal structure of the original measure while distinguishing clearly between low, intermediate, and high levels of knowledge absorption,

while avoiding the assignment of full ambiguity to the intermediate category. See Table 3.1 and Appendix 3.A for detailed calibration thresholds.

Table 3.1: Calibration

Set	Type	Operationalization	Calibration
Knowledge absorption	Outcome	Perceived usefulness of knowledge acquired through formal education for entrepreneurial activity (proxy for knowledge absorption)	Calibration based on the ordinal structure of the original variable: 0 = Full non-membership ("None") 0.49 = Crossover point ("Some") 1 = Full membership ("A lot")
Perceived opportunities	Condition	Expectation of good business opportunities in the next 6 months	0 = No 1 = Yes
Informal finance	Condition	Financial support from family, friends/neighbors, or colleagues	0 = No 1 = Yes
Institutional finance	Condition	Financial support from banks, venture capital, or government	0 = No 1 = Yes
Business network participation	Condition	Participation in business networks	0 = No 1 = Yes
Regulatory clarity	Condition	Perceived clarity of business regulations (1–10 scale)	Based on the empirical distribution and substantive interpretation of the scale: 3 = Full non-membership 6 = Crossover point 9 = Full membership
Entrepreneurship training	Condition	Participation in entrepreneurship training programs	0 = No 1 = Yes

3.3.5 Descriptive statistics

Descriptive statistics for all calibrated sets are presented in Table 3.2. The outcome variable exhibits a relatively high average level of membership in the set of high knowledge absorption, suggesting that a substantial proportion of individuals perceive formal education as useful for entrepreneurial activity.

Among the causal conditions, perceived opportunities show a relatively high prevalence, while other conditions, such as network participation and informal finance, display lower levels of occurrence. Regulatory clarity, calibrated as a fuzzy set, presents a balanced distribution around the crossover point, indicating substantial heterogeneity in individuals' perceptions of the institutional environment.

Table 3.2: Descriptive statistics of QCA sets

Variable	Min	Mean	Median	Max	SD
Knowledge absorption	0.000	0.788	1.000	1.000	0.306
Perceived opportunities	0.000	0.634	1.000	1.000	0.482
Informal finance	0.000	0.243	0.000	1.000	0.429
Institutional finance	0.000	0.329	0.000	1.000	0.470
Business network participation	0.000	0.180	0.000	1.000	0.384
Regulatory clarity	0.007	0.459	0.500	0.980	0.351
Entrepreneurship training	0.00	0.358	0.000	1.000	0.480

3.4 Results

The analysis unfolds in three steps. It begins with an examination of empirical configurations through the truth table, followed by an assessment of necessary conditions. It then presents the intermediate configurational solutions, complemented by robustness checks.

3.4.1 Truth table and empirical configurations

Table 3.3 presents the reduced truth table for high knowledge absorption, constructed from all logically possible combinations of the selected causal conditions. Following fsQCA procedures, the truth table organizes cases according to their membership in each configuration and reports the empirical consistency and frequency associated with each combination (Ragin, 2008; Schneider & Wagemann, 2012).

To identify empirically relevant configurations, two thresholds were applied. First, a consistency threshold of 0.80 was used to assess the degree to which each configuration can

be considered a sufficient subset of the outcome. In set-theoretic terms, consistency captures the extent to which cases sharing a given configuration also exhibit the outcome. Second, a frequency threshold of five cases was established to ensure that only empirically meaningful and representative configurations were retained in the analysis (Ragin, 2008; Schneider & Wagemann, 2012).

Only configurations meeting both criteria (consistency ≥ 0.80 and frequency ≥ 5) are included in Table 3.3. Each row represents a unique combination of causal conditions, indicating the presence (1) or absence (0) of each condition, along with the number of cases (n), consistency, and proportional reduction in inconsistency (PRI). These configurations constitute the empirical basis for the subsequent minimization and identification of sufficient pathways leading to high knowledge absorption.

The table reveals substantial heterogeneity in the observed configurations, with multiple combinations of conditions exceeding the sufficiency threshold, evidence of configurational diversity and multiple empirically relevant pathways associated with high knowledge absorption.

Table 3.3: Reduced truth table for high knowledge absorption

Configuration	Perceived opportunities	Informal finance	Institutional finance	Business network participation	Regulatory clarity	Entrepreneurship training	n	Consistency	PRI
2	0	0	0	0	0	1	20	0.871	0.851
3	0	0	0	0	1	0	18	0.839	0.774
4	0	0	0	0	1	1	14	0.974	0.971
25	0	1	1	0	0	0	10	0.852	0.814
34	1	0	0	0	0	1	21	0.890	0.853
35	1	0	0	0	1	0	54	0.861	0.810
36	1	0	0	0	1	1	22	0.940	0.925
37	1	0	0	1	0	0	6	0.874	0.837
39	1	0	0	1	1	0	7	0.862	0.821
41	1	0	1	0	0	0	7	0.912	0.908
43	1	0	1	0	1	0	12	0.870	0.860
44	1	0	1	0	1	1	11	0.929	0.919
48	1	0	1	1	1	1	9	1.000	1.000
52	1	1	0	0	1	1	5	0.943	0.935
58	1	1	1	0	0	1	10	0.962	0.958
59	1	1	1	0	1	0	11	0.937	0.928
60	1	1	1	0	1	1	15	0.955	0.951
62	1	1	1	1	0	1	5	0.926	0.892
64	1	1	1	1	1	1	28	0.977	0.974

Note. Configuration numbers correspond to truth table row identifiers. For crisp conditions, 1 = presence and 0 = absence. KABS_FS and REGUL_FS are fuzzy sets. Truth table rows represent empirically observed configurations after fuzzy-set calibration. Only configurations with consistency ≥ 0.80 and $n \geq 5$ are reported. PRI = proportional reduction in inconsistency.

Source: Authors' calculations based on survey data.

3.4.2 Necessary conditions

Table 3.4 reports the results of the necessity analysis for high knowledge absorption. Following established fsQCA conventions, a condition is considered necessary when its consistency exceeds the threshold of 0.90, indicating that the outcome is consistently a subset of that condition (Ragin, 2008; Schneider & Wagemann, 2012).

As shown in Table 3.4, none of the examined conditions, nor their negations, reach the required consistency threshold for necessity. The highest consistency values are observed for the absence of business network participation (0.804) and the absence of informal finance (0.746), yet both remain well below the conventional cutoff. These results indicate that no single ecosystem condition constitutes a necessary prerequisite for high levels of knowledge absorption. In other words, high knowledge absorption can occur under multiple and diverse contextual circumstances, without relying on any individual condition being universally present or absent.

This finding provides support for the presence of causal complexity and reinforces the appropriateness of a configurational approach, where the outcome is expected to emerge from combinations of conditions rather than from any single dominant factor.

Table 3.4. Necessary conditions for high knowledge absorption

Condition	Consistency	Coverage
Perceived opportunities	0.645	0.801
Informal finance	0.254	0.824
Institutional finance	0.354	0.847
Business network participation	0.196	0.859
Regulatory clarity	0.522	0.897
Entrepreneurship training	0.393	0.865
~Perceived opportunities	0.355	0.766
~Informal finance	0.746	0.776
~Institutional finance	0.646	0.759
~Business network participation	0.804	0.772
~Regulatory clarity	0.559	0.813
~Entrepreneurship training	0.607	0.745

Note. A condition is considered necessary when consistency ≥ 0.90 . Both the presence and absence (~) of each condition are evaluated. Coverage indicates empirical relevance.

3.4.3 Configurational solutions for high knowledge absorption

Table 3.5 presents the intermediate configurational solution identifying the combinations of conditions associated with high knowledge absorption. The overall solution exhibits satisfactory consistency (0.876) and coverage (0.572), indicating that the identified configurations provide an empirically relevant account of the outcome.

Consistent with the absence of necessary conditions, the results reveal multiple sufficient pathways associated with high knowledge absorption, supporting the presence of equifinality. These configurations correspond to the intermediate solution derived from the minimization procedure, reflecting combinations of core and peripheral conditions.

To facilitate interpretation, the identified configurations can be grouped into three broad patterns: (1) Institutionally-enabled configurations, (2) resource-constrained configurations, and (3) hybrid configurations.

3.4.3.1 Institutionally-enabled configurations

A first set of configurations (Paths 1–4) is characterized by the presence of institutional finance, regulatory clarity, and entrepreneurship training that create enabling environments for knowledge absorption. Across these configurations, perceived opportunities are also consistently present, suggesting that favorable opportunity perceptions reinforce these institutionally enabled pathways.

Some configurations combine perceived opportunities with institutional finance and favorable regulatory conditions, indicating that formal support structures and institutional clarity are associated with individuals' ability to mobilize knowledge. In other cases, perceived opportunities are combined with entrepreneurial training, suggesting the relevance of complementary skills and learning mechanisms in facilitating the application of knowledge in entrepreneurial contexts.

Importantly, these configurations do not require the simultaneous presence of all ecosystem conditions. Instead, different combinations of institutional support, regulatory clarity, and training appear sufficient when perceived opportunities are present, indicating that multiple enabling environments may support knowledge absorption.

3.4.3.2 Resource-constrained configurations

A second set of configurations (Paths 5–6) reveals that high knowledge absorption can also be associated with contexts characterized by the absence of both informal and institutional finance. These configurations are particularly relevant as they indicate that resource availability is not a necessary condition for the mobilization of knowledge.

In these cases, knowledge absorption is associated with combinations involving regulatory clarity or entrepreneurial training, suggesting that institutional transparency and individual-level capabilities may compensate for limited access to financial resources. The absence of business networks in several of these configurations further indicates that knowledge mobilization may occur even in relatively isolated contexts.

These findings point to alternative pathways to knowledge absorption that do not depend on resource abundance, highlighting the potential role of compensatory mechanisms across ecosystem conditions.

3.4.3.3 Hybrid configurations

A third group of configurations (Paths 7–9) combines elements of both enabling and constraining environments. These mixed pathways include combinations where perceived opportunities coexist with selective forms of financial support, as well as configurations where certain institutional resources are present alongside the absence of other conditions such as networks or training.

These configurations suggest that knowledge absorption does not follow a single dominant logic but instead emerges from context-dependent interactions among ecosystem conditions. In particular, they indicate that the presence of some enabling factors may offset the absence of others, pointing to patterns of substitutability across conditions.

Overall, the configurational results indicate that high knowledge absorption is associated with multiple, context-dependent combinations of conditions rather than any single dominant factor. This underscores the importance of adopting a configurational perspective to capture the complexity and heterogeneity underlying the mobilization of knowledge in entrepreneurial settings.

Table 3.5: Configurational solution for high knowledge absorption

Condition	Knowledge absorption								
	1	2	3	4	5	6	7	8	9
Perceived opportunities	○	○	○	○			○	●	⊗
Informal finance	●				⊗	⊙	⊙	⊗	●
Institutional finance	●	●	●		⊙	⊙	⊙	●	○
Business network participation		⊙		⊗	⊗	⊗	●	⊙	⊙
Regulatory clarity		●	●	○	●				⊙
Entrepreneurship training	●		●	●		●	⊗	⊙	⊙
Configurational pattern	Institutionally-enabled	Institutionally-enabled	Institutionally-enabled	Institutionally-enabled	Resource-constrained	Resource-constrained	Hybrid	Hybrid	Hybrid
Consistency	0.915	0.923	0.966	0.943	0.881	0.860	0.818	0.869	0.852
PRI	0.907	0.915	0.963	0.933	0.843	0.840	0.779	0.863	0.814
Raw coverage	0.116	0.094	0.115	0.100	0.246	0.143	0.022	0.038	0.018
Unique coverage	0.034	0.023	0.015	0.008	0.172	0.069	0.022	0.015	0.018
Solution consistency	0.876								
Solution coverage	0.572								

Note. ● indicates the presence of a core condition; ○ indicates the presence of a peripheral condition; ⊗ indicates the absence of a core condition; ⊙ indicates the absence of a peripheral condition; blank spaces indicate irrelevant conditions. Core and peripheral conditions are identified by comparing the parsimonious and intermediate solutions. Solution consistency = 0.876; solution coverage = 0.572. PRI = proportional reduction in inconsistency.

3.4.3.4 Core and peripheral conditions

To further interpret the configurational results, this section examines the role of core and peripheral conditions across the identified pathways. In fsQCA, core conditions represent those that are consistently central to a configuration, while peripheral conditions play a more contingent or supportive role. To identify systematic patterns, Table 3.6 summarizes the frequency with which each condition appears as a core or peripheral presence and absence across the nine configurations.

Table 3.6: Frequency Condition

Condition	Core presence (●)	Peripheral presence (○)	Core absence (⊗)	Peripheral absence (⊘)
Perceived opportunities	1	5	1	0
Informal finance	2	0	2	2
Institutional finance	4	1	0	3
Business network participation	1	0	3	3
Regulatory clarity	3	1	0	1
Entrepreneurship training	4	0	1	2

Note. Counts reflect the number of configurations (Paths 1–9) in which each condition appears as core or peripheral presence or absence.
Source: Authors' calculations based on survey data.

The results indicate that institutional finance and entrepreneurial training emerge as the most structurally relevant conditions, appearing most frequently as core elements across configurations. Their recurrent presence suggests that both formal access to resources and the development of entrepreneurial capabilities are systematically associated with higher levels of knowledge absorption. These conditions appear to provide a stable foundation that supports individuals' ability to mobilize knowledge across different entrepreneurial environments.

In contrast, perceived opportunities predominantly appear as a peripheral condition, with five occurrences as peripheral presence and only one as a core condition. Although present in several configurations, its role is less structurally central, suggesting that favorable environmental perceptions may enhance knowledge absorption but are not, by themselves, a defining component of the underlying causal structure. This pattern indicates that

opportunities may act more as enabling signals rather than as primary drivers of knowledge mobilization.

The analysis also reveals a marked asymmetry in the role of certain conditions, particularly informal finance and business networks. Both conditions appear with similar frequency as present and absent across configurations, indicating that their influence is highly context-dependent. Rather than exerting a uniform effect, they may either support or be irrelevant to knowledge absorption depending on how they interact with other ecosystem conditions. This asymmetry underscores the importance of conjunctural causation, where the effect of any single condition depends on its combination with others.

A particularly notable pattern concerns regulatory clarity, which appears as a core condition in three configurations, especially in contexts where financial resources are absent or limited. This suggests a potential compensatory mechanism, whereby institutional transparency and predictability may facilitate knowledge mobilization in resource-constrained environments. In such cases, clear regulatory frameworks may reduce uncertainty and enable individuals to apply knowledge even in the absence of strong financial support.

These findings indicate that high knowledge absorption is structured by a combination of foundational conditions and context-dependent mechanisms, rather than by any single dominant factor. Core conditions such as institutional finance and entrepreneurial training provide a stable basis across configurations, while other conditions operate in more flexible and contingent ways. This reinforces the value of a configurational perspective for understanding how different elements of the entrepreneurial ecosystem jointly shape the mobilization of knowledge.

3.4.4 Robustness analysis

To assess the robustness of the configurational results, an additional analysis was conducted using a more stringent consistency threshold. Specifically, the minimum consistency cutoff for sufficiency was increased from 0.80 to 0.85, while maintaining the same frequency threshold ($n \geq 5$). This approach allows evaluating the stability of the identified configurations under stricter inclusion criteria.

The results of this robustness check are reported in Appendix B. Overall, the analysis confirms the stability of the main findings. Most of the configurations identified in the intermediate solution remain present under the higher consistency threshold, indicating that the core empirical patterns are not sensitive to moderate variations in calibration criteria.

At the solution level, both alternative solutions (M1 and M2) exhibit identical consistency (0.881) and coverage (0.515), values that remain close to those reported in the main analysis. This suggests that the explanatory power of the configurational model is largely preserved, despite the more restrictive inclusion threshold.

At the configurational level, most of the pathways identified in the main analysis are replicated with similar levels of consistency and coverage. Minor variations are observed in some configurations, particularly those with lower empirical coverage, which tend to be more sensitive to threshold adjustments. However, these differences do not alter the overall structure of the results.

3.5 Conclusions and Discussion

The purpose of this study was to examine how entrepreneurial ecosystem conditions shape individual-level knowledge absorption through a configurational perspective. Drawing on absorptive capacity theory, entrepreneurial ecosystem research, and micro foundational approaches, we argued that knowledge absorption emerges not only from individual capabilities but also from the ecosystem conditions within which entrepreneurs operate. The findings support this argument by showing that high levels of knowledge absorption arise through multiple configurations of ecosystem conditions rather than through a single optimal combination. This highlights the fundamentally equifinal nature of entrepreneurial ecosystems and suggests that entrepreneurs can translate educational knowledge into entrepreneurial action through different contextual pathways.

3.5.1 Entrepreneurial ecosystems as enabling contexts for knowledge absorption

A first contribution concerns the entrepreneurial ecosystem literature. Previous studies have primarily examined how ecosystem characteristics such as universities, finance, institutions, and regional knowledge stocks are associated with entrepreneurial outcomes

(Autio et al., 2014; Stam, 2015; Stam & Van de Ven, 2021). While this literature has substantially improved our understanding of entrepreneurial ecosystems, less attention has been devoted to the individual-level mechanisms through which ecosystem conditions influence entrepreneurial action. Our findings contribute to this discussion by identifying knowledge absorption as one mechanism linking ecosystem conditions with entrepreneurial behavior. This complements recent microfoundational work emphasizing identity-based mechanisms within entrepreneurial ecosystems by suggesting that ecosystem conditions also influence entrepreneurial action through entrepreneurs' ability to absorb and mobilize knowledge (Poblete et al., 2026).

Rather than viewing ecosystems solely as collections of supportive resources, our results suggest that they shape the entrepreneur's ability to recognize the entrepreneurial usefulness of the knowledge they already possess. In doing so, the study responds to recent calls for stronger micro foundational explanations of entrepreneurial ecosystems (Roundy & Lyons, 2023; Cosenz et al., 2023).

3.5.2 Knowledge absorption as a microfoundational mechanism

The findings also contribute to absorptive capacity research by extending the concept to entrepreneurial ecosystems. Although absorptive capacity has traditionally been examined at the organizational level, entrepreneurship also depends on the ability of individuals to recognize, interpret, and apply knowledge under conditions of uncertainty. Our results suggest that knowledge absorption should not be understood exclusively as an individual cognitive capability but as a process embedded within entrepreneurial ecosystems.

The configurational evidence indicates that ecosystem conditions do not contribute equally to this process. Institutional finance and entrepreneurship training consistently emerge as core conditions across multiple configurations, suggesting that they provide the most stable mechanisms through which entrepreneurs transform educational knowledge into entrepreneurial action. In contrast, perceived opportunities appear predominantly as peripheral conditions. Rather than acting as primary drivers, favorable opportunity perceptions appear to enhance knowledge mobilization only when combined with stronger institutional and capability-building conditions.

This pattern provides a better understanding of the relationship between entrepreneurial ecosystems and individual capabilities. Knowledge mobilization does not depend only on entrepreneurs recognizing opportunities, but on their ability to access ecosystem resources that strengthen their capacity to interpret, validate, and apply knowledge. In this sense, entrepreneurial ecosystems influence knowledge absorption not merely by expanding the availability of resources, but by shaping the institutional conditions under which knowledge becomes economically actionable.

The Chilean context provides a useful lens through which to interpret these findings. Although Chile has developed one of the most mature entrepreneurial support systems in Latin America, entrepreneurs continue to experience substantial heterogeneity in access to institutional finance, entrepreneurial training, and other forms of ecosystem support across territories and entrepreneurial profiles. The prominence of institutional finance and entrepreneurship training as core conditions suggests that knowledge mobilization depends less on entrepreneurial optimism alone than on the entrepreneur's ability to connect with these institutional components of the ecosystem. This may help explain why different configurations, rather than a single dominant pathway, support high levels of knowledge absorption.

3.5.3 Multiple pathways and configurational complexity

A third contribution concerns the configurational nature of entrepreneurial ecosystems. The absence of necessary conditions, together with the identification of multiple sufficient configurations, demonstrates that entrepreneurial ecosystems should not be interpreted through additive or linear logic. Instead, ecosystem conditions operate together, with the contribution of each element depending on the broader configuration in which it is embedded. Institutional finance, entrepreneurial training, regulatory clarity, business networks, and perceived opportunities do not exert uniform effects across all entrepreneurs. Rather, different combinations of these conditions generate similarly high levels of knowledge absorption, illustrating the principles of equifinality and causal complexity that characterize entrepreneurial ecosystems.

Also our findings suggest that some ecosystem conditions may partially compensate for the absence of others. In several configurations, regulatory clarity and entrepreneurial

training appear to offset more limited access to financial resources or business networks, while in other cases institutional finance plays a more central enabling role. These patterns indicate that entrepreneurial ecosystems should be understood as flexible institutional arrangements rather than as systems requiring a single ideal combination of conditions. In conclusion, ecosystem effectiveness depends less on the presence of every favorable attribute than on the existence of coherent combinations capable of supporting entrepreneurs' ability to recognize and apply knowledge.

3.5.4 Implications for research and practice

These findings have several implications for future research. First, they reinforce the value of integrating absorptive capacity theory with entrepreneurial ecosystem research to better understand the mechanisms linking knowledge and entrepreneurship. Second, they encourage researchers to examine entrepreneurial ecosystems from a configurational perspective, recognizing that similar entrepreneurial outcomes may emerge through alternative combinations of ecosystem conditions. Finally, they suggest that future studies should continue exploring micro-level mechanisms that connect ecosystem structures with entrepreneurial behavior, particularly using longitudinal and comparative research designs capable of capturing the dynamic interaction between individuals and their entrepreneurial environments.

From a practitioner's point of view, our findings suggest that policies that aim to strengthen entrepreneurial ecosystems should move beyond universal policy prescriptions. Rather than assuming that all ecosystem elements must be simultaneously strengthened, policymakers should recognize that different regional contexts may require different combinations of institutional support, entrepreneurial education, financial resources, and regulatory frameworks. Designing ecosystem interventions that acknowledge this contextual diversity may increase the effectiveness of policies intended to enhance the entrepreneurial use of knowledge.

3.6 Appendix 3A: Calibration thresholds for all sets

Set	Type	Full non-membership	Crossover	Full membership	Justification
Knowledge absorption	Fuzzy	0 (None)	0.49 (Some)	1 (A lot)	Ordinal recoding of three-category scale
Perceived opportunities	Crisp	0	-	1	Binary condition
Informal finance	Crisp	0	-	1	Binary condition
Institutional finance	Crisp	0	-	1	Binary condition
Business network participation	Crisp	0	-	1	Binary condition
Regulatory clarity	Fuzzy	3	6	9	1–10 scale and substantive interpretation
Entrepreneurship training	Crisp	0	-	1	Binary condition

Note. Fuzzy sets are calibrated using either ordinal recoding (KABS_FS) or the direct method (REGUL_FS) following Ragin (2008). Crisp sets are binary conditions coded as 0 (absence) and 1 (presence).

3.7 Appendix 3B: Robustness check

Table B1. Robustness check using a higher consistency threshold

Solution	Path	Configuration	Consistency	PRI	Raw coverage	Unique coverage
M1	M1_R1	OPPRT*INFORMAL_FIN*INSTITUTIONAL_FIN*TRAIN	0.915	0.907	0.116	0.034
M1	M1_R2	OPPRT*INSTITUTIONAL_FIN*~NETWORK*REGUL_FS	0.923	0.911	0.094	0.023
M1	M1_R3	OPPRT*INSTITUTIONAL_FIN*REGUL_FS*TRAIN	0.966	0.963	0.115	0.015
M1	M1_R4	OPPRT*~NETWORK*REGUL_FS*TRAIN	0.943	0.932	0.100	0.008
M1	M1_R5	~INFORMAL_FIN*~INSTITUTIONAL_FIN*~NETWORK*TRAIN	0.860	0.837	0.143	0.098
M1	M1_R6	OPPRT*~INFORMAL_FIN*~INSTITUTIONAL_FIN*NETWORK*~TRAIN	0.818	0.777	0.022	0.022
M1	M1_R7	OPPRT*~INFORMAL_FIN*INSTITUTIONAL_FIN*~NETWORK*~TRAIN	0.869	0.849	0.038	0.015
M1	M1_R8	~OPPRT*INFORMAL_FIN*INSTITUTIONAL_FIN*~NETWORK*~REGUL_FS*~TRAIN	0.852	0.806	0.018	0.018
M1	M1_R9	OPPRT*~INFORMAL_FIN*~NETWORK*REGUL_FS	0.884	0.843	0.202	0.115
M2	M2_R1	OPPRT*INFORMAL_FIN*INSTITUTIONAL_FIN*TRAIN	0.915	0.907	0.116	0.034
M2	M2_R2	OPPRT*INSTITUTIONAL_FIN*~NETWORK*REGUL_FS	0.923	0.911	0.094	0.023
M2	M2_R3	OPPRT*INSTITUTIONAL_FIN*REGUL_FS*TRAIN	0.966	0.963	0.115	0.015
M2	M2_R4	OPPRT*~NETWORK*REGUL_FS*TRAIN	0.943	0.932	0.100	0.008
M2	M2_R5	~INFORMAL_FIN*~INSTITUTIONAL_FIN*~NETWORK*TRAIN	0.860	0.837	0.143	0.098
M2	M2_R6	OPPRT*~INFORMAL_FIN*~INSTITUTIONAL_FIN*NETWORK*~TRAIN	0.818	0.777	0.022	0.010
M2	M2_R7	OPPRT*~INFORMAL_FIN*INSTITUTIONAL_FIN*~NETWORK*~TRAIN	0.869	0.849	0.038	0.015
M2	M2_R8	~OPPRT*INFORMAL_FIN*INSTITUTIONAL_FIN*~NETWORK*~REGUL_FS*~TRAIN	0.852	0.806	0.018	0.018

Table B1. Robustness check using a higher consistency threshold

Solution	Path	Configuration	Consistency	PRI	Raw coverage	Unique coverage
M2	M2_R9	OPPRT*~INFORMAL_FIN*~INSTITUTIONAL_FIN*REGUL_FS*~TRAIN	0.861	0.796	0.127	0.115

Note. Robustness check based on a stricter consistency threshold of 0.85 and a frequency threshold of 5 cases. * indicates logical AND; ~ indicates the negation of a condition. PRI = proportional reduction in inconsistency.

Table B2. Robustness solution-level metrics

Solution	Consistency	Coverage
M1	0.881	0.515
M2	0.881	0.515

Conclusion

This thesis addresses the question introduced at the beginning of the dissertation: how is knowledge transformed into entrepreneurially relevant outcomes across heterogeneous contexts? The three studies contribute to this question by examining how knowledge sources are operationalized in entrepreneurship research, how university knowledge-related outcomes are associated with high-impact entrepreneurial potential, and how combinations of conditions are associated with entrepreneurs' perceived usefulness of educational knowledge. Taken together, their findings support an interpretation in which the entrepreneurial relevance of knowledge depends on distinctions among knowledge sources and outputs, differences among individuals, and the conditions surrounding potential use. Understanding this relationship therefore requires connecting these dimensions while preserving their conceptual and empirical differences.

The overarching contribution of the thesis is to bring these dimensions together through a knowledge mobilization perspective. Within this perspective, the KSTE provides the central framework for understanding the relationship between knowledge generated within organizations and entrepreneurial activity beyond their boundaries (Acs et al., 2009; Audretsch & Keilbach, 2007). Absorptive capacity directs attention to the processes through which actors recognize, assimilate, and apply knowledge (Cohen & Levinthal, 1990; Zahra & George, 2002), while entrepreneurial ecosystem research emphasizes the resources, relationships, and institutional conditions surrounding entrepreneurial activity (Spigel, 2017; Stam & Van de Ven, 2021). The thesis connects these perspectives through complementary evidence on the specification of knowledge, individual heterogeneity, and contextual combinations. This integration offers an interpretation of how knowledge may acquire entrepreneurial relevance; the studies do not directly trace a common sequence from knowledge production to application and subsequent entrepreneurial outcomes.

A central connection between the studies concerns the distinction between knowledge-producing actors and the indicators used to represent their activities. The systematic review identifies considerable diversity in how empirical KSTE research operationalizes knowledge. Universities appear within this literature through different roles, including research infrastructure, academic outputs, collaborative relationships, and

commercialization activities. The multilevel study develops this distinction by examining educational, scientific, and collaborative indicators separately. Together, these studies show why the institutional origin of knowledge does not provide a sufficient basis for treating its observable manifestations as equivalent. Heterogeneity exists across the sources considered in the literature and within the activities associated with a single institutional actor.

This distinction has substantive consequences for interpreting the relationship between university knowledge-related outcomes and entrepreneurship. In the multilevel analysis, scientific publication output is positively associated with the indicator of high-impact entrepreneurial potential, whereas the national gross graduation ratio is negatively associated with it. University–industry collaboration does not exhibit a statistically significant association in the reported models. These findings indicate that educational, scientific, and collaborative indicators capture different dimensions of the knowledge environment and should not be interpreted as interchangeable measures of entrepreneurial opportunity. The absence of a statistically significant association for collaboration also limits claims about its relationship with the outcome in this study, without establishing that collaboration is irrelevant to entrepreneurship more broadly.

A further connection concerns the distinction between educational expansion, individual educational attainment, and the perceived entrepreneurial usefulness of knowledge. The multilevel study separates national graduation indicators from individuals' university education and finds that the association involving scientific publication output varies by educational attainment. In the reported interaction model, this positive association is weaker among individuals with university education. The configurational study examines another dimension: how entrepreneurs evaluate the usefulness of knowledge acquired through formal education under different combinations of conditions. Bringing these findings together highlights that the scale of educational output, possession of a university education, and recognition of knowledge usefulness represent distinct aspects of the knowledge–entrepreneurship relationship. Their separation makes it possible to ask more precisely when educational knowledge becomes relevant to entrepreneurial activity and for whom.

The configurational findings add to this interpretation by identifying alternative combinations associated with high perceived usefulness of educational knowledge among

entrepreneurs in Chile. None of the examined conditions, or their negations, reaches the specified threshold for necessity. The sufficient configurations include combinations involving institutional support and training, as well as combinations in which perceived usefulness is high despite the absence of reported financial support. These patterns direct attention to the conditions accompanying individuals' evaluations of knowledge and suggest that the relevance of particular resources should be examined within the combinations in which they occur. They also motivate investigation of possible complementarities and compensatory processes, whose operation cannot be established from configurational membership patterns alone.

Context consequently enters the integrated argument in two distinct ways. In the systematic review, the uneven distribution of knowledge operationalizations across development settings raises questions about the contextual scope of the available evidence. The observed prominence of an indicator in particular settings does not establish the relative effectiveness of the corresponding knowledge source in those settings. In the configurational study, context is approached through reported resources, participation, and perceptions at the individual level. Considering these approaches together emphasizes the importance of context both when assessing the reach of existing knowledge claims and when examining the conditions associated with perceived knowledge usefulness. Cross-country development profiles and individual experiences of entrepreneurial conditions remain analytically distinct, even when both inform a contextual interpretation.

The contribution emerging from these connections is a more precise account of what must be distinguished and related when explaining the entrepreneurial relevance of knowledge. The literature review establishes the diversity of empirical representations on which knowledge-based explanations are built. The empirical studies then show why particular knowledge-related indicators, individual characteristics, and combinations of conditions warrant separate examination. Their integration suggests that entrepreneurial relevance cannot be inferred from institutional origin or aggregate availability alone. It must be investigated in relation to particular individuals and the circumstances surrounding potential use. The thesis thus refines the empirical specification and interpretation of relationships central to the KSTE, while connecting them to questions about individual knowledge evaluations and entrepreneurial ecosystem conditions.

The scope of this contribution is bounded by the evidence available across the studies. The review characterizes a selected body of KSTE research rather than directly comparing the effectiveness of all knowledge sources. The multilevel analysis uses observable knowledge-related indicators rather than direct measures of spillovers, and its outcome captures entrepreneurial characteristics associated with impact potential rather than realized economic impact. Its observational design supports conclusions about associations. The configurational study captures perceived usefulness of formal educational knowledge, rather than the full process of knowledge acquisition, assimilation, transformation, and exploitation, and its findings concern the entrepreneurs and conditions examined in Chile. Furthermore, the studies use different samples, measures, and analytical approaches. Their findings therefore provide a basis for theorizing connections across these dimensions without establishing that knowledge absorption mediates the relationship between university outcomes and entrepreneurial performance.

For universities and policymakers, this integrated interpretation suggests broadening the evaluation of knowledge-based entrepreneurship initiatives. Counts of graduates, publications, and collaborative activities describe important aspects of institutional activity, but do not by themselves establish who accesses the resulting knowledge or how it is used. Evaluation could also examine which individuals engage with available knowledge, whether they recognize its entrepreneurial usefulness, and whether they subsequently apply it. The configurational findings further motivate attention to combinations of support conditions and differences among entrepreneurial profiles. These implications offer directions for designing and assessing initiatives whose effectiveness requires direct evaluation.

The relationships that remain unobserved across the studies define a common research agenda. Its central question is how available knowledge becomes accessible, is recognized as useful, is applied in entrepreneurial activity, and contributes to subsequent outcomes under different individual and contextual conditions. Addressing this question requires connecting the dimensions examined separately in the thesis. Four interrelated priorities follow from its findings and limitations.

The first priority is conceptual clarification and measurement. The diversity of operationalizations identified in the review, together with the indirect measures used in the empirical studies, highlights the need to distinguish knowledge-producing actors, knowledge

content, transmission channels, enabling conditions, and entrepreneurial outcomes. Future research should develop and validate measures that separately capture availability, access, perceived usefulness, and actual use. Qualitative interviews could examine how entrepreneurs identify their sources of knowledge and describe their application, informing survey instruments that distinguish these dimensions. Evidence of specific practices, such as the adaptation of research findings or the use of knowledge obtained through professional experience, could then help assess whether perceived usefulness corresponds to observable application. Clearer measurement would strengthen comparisons across individuals, knowledge sources, and contexts.

The second priority is to identify the mechanisms connecting knowledge environments with individual entrepreneurial activity. The heterogeneous associations observed in the multilevel study raise questions about how people with different educational and experiential backgrounds encounter, interpret, and use knowledge. The configurational findings draw attention to training, financial support, networks, and regulatory perceptions as conditions to investigate within these processes. Future studies could follow entrepreneurs with contrasting backgrounds and document their interactions with universities, firms, intermediaries, and support organizations. Such research would help distinguish explanations involving access, interpretation, prior experience, occupational alternatives, or other processes. It would also allow the mechanisms proposed in the theoretical discussion to be assessed through direct evidence.

The third priority is to examine combinations of knowledge and conditions across contexts. The systematic review identifies a broader range of knowledge operationalizations than those examined in the empirical chapters, while the configurational study focuses specifically on perceived usefulness of formal educational knowledge. Future research could investigate how scientific, experiential, and organizational knowledge are combined under different institutional and resource conditions. Comparative designs using equivalent measures across territories and entrepreneurial profiles could assess whether similar combinations recur or whether their relevance changes with the knowledge considered. Configurational analysis could identify recurring patterns, while in-depth case studies could examine how entrepreneurs experience the complementarities or substitutions those patterns

suggest. This would extend the thesis's contextual argument beyond differences in the representation of knowledge toward direct comparison of its use.

The fourth priority is to connect knowledge evaluations and application with entrepreneurial outcomes over time. Longitudinal research should examine whether perceived usefulness precedes actual use and whether such use is associated with innovation, survival, employment creation, or growth. Following individuals and ventures would connect the evaluation examined in the configurational study with the entrepreneurial potential considered in the multilevel analysis and with realized outcomes that neither study observes. Where suitable interventions or institutional changes are available, research designs that strengthen causal identification could evaluate whether changes in access, training, or support contribute to changes in knowledge use and entrepreneurial outcomes. Longitudinal qualitative evidence could complement these analyses by revealing how knowledge is reinterpreted, combined, or abandoned as ventures develop.

These priorities form a cumulative programme of research. Clearer concepts and measures provide the basis for identifying mechanisms; comparative evidence establishes their contextual scope; and longitudinal investigation examines their development and consequences. The programme extends the thesis by making the connections among knowledge, individuals, and conditions themselves the object of empirical analysis. It also creates opportunities to examine feedback, including how entrepreneurial experience changes the knowledge individuals seek and the value they attribute to it.

This thesis contributes to entrepreneurship research by showing why knowledge sources and indicators, individual educational characteristics, and perceived knowledge usefulness must be distinguished when interpreting the entrepreneurial relevance of knowledge. Its integrated perspective connects these distinctions with the conditions surrounding potential use and identifies the relationships that remain to be tested. The resulting contribution is a foundation for explaining more precisely which knowledge becomes relevant, for whom, and under what circumstances, and for investigating how that relevance develops into entrepreneurial action and realized outcomes.

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