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Nizam Aliyev, Najmin Khalafli

Strengths and Weaknesses of Estonia's Entrepreneurial Ecosystem

Master thesis

Supervisor: Piia Vettik- Leemet

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We have written this Master's thesis independently. Any ideas or data taken from other authors or other sources have been fully referenced.

Abstract

This thesis examines the strengths and weaknesses of Estonia's entrepreneurial ecosystem by analysing the institutional, financial, infrastructural, and human capital conditions associated with entrepreneurial activity across ten European economies over the period 2015–2022. The theoretical framework draws on the ecosystem models of Stam (2015, 2018), Isenberg (2011), Mason and Brown (2014), and the OECD (2014). Entrepreneurial activity is measured through new business density, with five ecosystem indicators as explanatory variables. The methodology combines pooled OLS regression, fixed-effects estimation, and cluster analysis. The results indicate that venture capital availability and institutional quality are the conditions most consistently associated with higher rates of business creation. Estonia's ecosystem emerges as institutionally strong but constrained in systemic dimensions, particularly early-stage financing and talent depth. The findings are relevant for policymakers in Estonia and comparable small European economies seeking to strengthen ecosystem conditions.

Keywords

Entrepreneurial ecosystem; entrepreneurship; innovation policy; venture capital; Estonia.

CERCS codes: S180, S181, S189

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Introduction

Estonia's entrepreneurial ecosystem has attracted considerable international attention over the past two decades. The country's early investment in digital governance, its streamlined business registration procedures, and the unexpected emergence of globally scaled technology companies from a population of just 1.3 million have made it a compelling case for understanding how small economies build conditions for entrepreneurial activity, and where structural limitations continue to hold them back. The aim of this thesis is to examine the strengths and weaknesses of Estonia's entrepreneurial ecosystem by analysing the institutional, financial, infrastructural, and human capital conditions associated with entrepreneurial activity, and by situating Estonia's performance within a broader comparative European context.

In small and open economies like Estonia, the conditions that support entrepreneurial activity matter particularly because the domestic market is too limited to sustain firm growth on its own (Stam, 2015; Audretsch & Belitski, 2021). Estonia has built a strong international reputation for its digital infrastructure and relatively transparent regulatory environment, both of which have contributed to high rates of new business creation by regional standards. At the same time, the ecosystem faces persistent structural challenges: limited early-stage capital, a constrained talent pool, and the pressure on new ventures to internationalise before they are fully resourced to do so. Understanding which ecosystem conditions are genuinely functional and which remain underdeveloped is the central concern of this study.

The study approaches Estonia's ecosystem through established frameworks in entrepreneurship research, primarily Stam (2015, 2018), Isenberg (2011), Mason and Brown (2014), and the OECD (2014). These frameworks allow for a structured analysis of the conditions that either support or constrain entrepreneurial activity across institutional, financial, infrastructural, and social dimensions. Applying them to Estonian data, alongside a comparative group of European economies, makes it possible to assess whether Estonia's strong formal conditions translate into consistently stronger entrepreneurial outcomes, and to examine where the ecosystem remains relatively less developed.

The main research question of this thesis is: which institutional, financial, and infrastructural conditions are most strongly associated with entrepreneurial activity, and how does Estonia's

entrepreneurial ecosystem compare with a selected group of European economies in terms of these conditions and their outcomes?

Three sub-questions guide the analysis:

(1) What are the key ecosystem conditions, including institutional quality, access to finance, digital infrastructure, human capital, and innovation, that are associated with differences in entrepreneurial activity across European countries?

(2) How do ecosystem actors in Estonia, including government institutions, investors, and universities, shape the strengths and weaknesses of the country's entrepreneurial ecosystem, based on the theoretical and comparative evidence?

(3) What do Estonia's ecosystem strengths and weaknesses suggest about the conditions needed to sustain entrepreneurial activity and support the broader development of the startup ecosystem over time?

The empirical analysis draws on data from the World Bank, OECD, and related international sources covering the period 2015 to 2022. Entrepreneurial activity is measured using new business density, defined as the number of newly registered limited liability firms per 1,000 working-age people. This indicator captures the rate of business creation and reflects the combined effect of ecosystem conditions on entrepreneurial entry; it does not, however, capture what happens to firms after they are established, such as whether they scale, internationalize, or survive beyond the early stages. The broader trajectory of firms is discussed in the theoretical framework and in the conclusions as a dimension of ecosystem quality, but the empirical focus remains on the conditions associated with business creation. The study is primarily concerned with innovation-oriented entrepreneurial activity, meaning ventures founded by deliberate choice in response to market opportunities, which is the most relevant category for Estonia's technology-intensive startup ecosystem. The empirical scope encompasses ten European economies selected for their structural comparability, with Estonia as the primary case.

The thesis is structured as follows. The first chapter provides theoretical foundation, defining key concepts and reviewing the main ecosystem frameworks. The second chapter presents the methodology and data. The third chapter delivers empirical analysis, including descriptive statistics, regression results, and cluster analysis, examining how ecosystem conditions relate to

entrepreneurial activity across the sample. The concluding chapter discusses the main findings, their implications for Estonia's ecosystem, the study's limitations, and directions for future research.

Keywords

Entrepreneurial ecosystem; entrepreneurship; innovation policy; venture capital; Estonia.

CERCS codes: S180, S181, S189

1. Entrepreneurship and entrepreneurial ecosystem

1.1 Entrepreneurship and Venture Creation

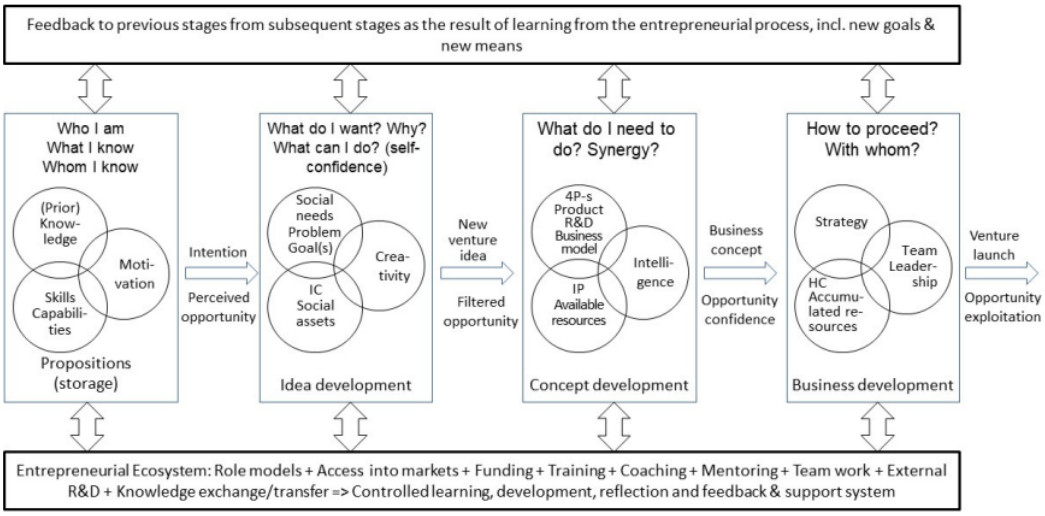
Entrepreneurship has long been a central concept in economics and management, though its definition has shifted over time. Schumpeter (1934) described it as a process of creative destruction, in which innovation displaces existing products and firms, and this idea still shapes much of how economists think about entrepreneurial agency. More recent scholarship has moved away from the individual entrepreneur as the unit of analysis toward the broader contexts that make entrepreneurship possible. Shane and Venkataraman (2000) argue that the field is fundamentally about how opportunities for value creation are discovered and exploited, while Autio et al. (2018) place this process within evolving technological and institutional ecosystems. What these perspectives share is a recognition that entrepreneurship is not simply a personal trait or a spontaneous act; it is a process that unfolds within, and is shaped by, the surrounding environment.

An important distinction in the entrepreneurship literature is between ventures founded out of economic necessity and those founded by deliberate choice in response to a perceived market opportunity (Acs et al., 2017). The former category tends to be associated with self-employment in low-growth sectors, while the latter is more closely linked to innovation, scalability, and

knowledge-intensive activity. This thesis is concerned primarily with innovation-oriented entrepreneurial activity: ventures created by founders who choose to pursue a commercial or technological opportunity rather than being pushed into self-employment by a lack of alternatives. The distinction matters for Estonia, where most technology startups are founded by individuals with existing labour market options who are motivated by specific technological or market opportunities rather than by necessity.

The entrepreneurial process is better understood as a nonlinear and iterative journey than as a fixed sequence of stages. Aldrich and Ruef (2018) describe how new ventures evolve through repeated cycles of opportunity recognition, experimentation, and adjustment, responding to environmental feedback and resource constraints at each step. Mets et al. (2019) elaborate on this by introducing the idea of a feedback loop, whereby entrepreneurs regularly revisit earlier decisions considering new information, such as returning to the product concept after receiving customer feedback on a prototype. As shown in T 1, this process begins with initial propositions and moves through idea development, concept development, and business development, with connections running backwards as well as forwards. The key implication is that entrepreneurial viability often only becomes clear in practice, through action rather than planning (Mets et al., 2019). This has direct consequences for how ecosystems should be evaluated: an environment that supports experimentation and tolerates early failure is more conducive to venture creation than one that expects entrepreneurs to arrive with a fully formed and fundable business plan.

Figure 1. Process chart of a new venture creation and entrepreneurial learning



Source: Mets et al. (2019)

Not all entrepreneurship follows the same logic. Traditional small-scale ventures in retail, construction, or hospitality tend to be locally oriented, grow incrementally, and prioritise stability over rapid expansion (Mets et al., 2019). Technology-intensive startups, by contrast, are designed from the outset for scalability: they enter markets with novel technologies or disruptive business models and rely heavily on external financing such as venture capital or angel investment to fund growth before reaching profitability (Nambisan, 2017). This distinction is relevant to the Estonian context, where the startup ecosystem is predominantly technology intensive. It is also worth noting that the category is not limited to software firms; advanced manufacturing and deep-tech ventures share the same logic of external financing and rapid market expansion, even if they are less visible in the public narrative around Estonia's startup scene (Audretsch & Link, 2019).

A closely related concept that deserves attention in the Estonian context is serial entrepreneurship: the practice whereby founders who have built, scaled, or exited one venture go on to establish or invest in subsequent ones. Serial entrepreneurs bring accumulated knowledge of fundraising, team building, and market navigation; they typically command stronger investor networks; and they often serve as mentors or angel investors for younger ventures (Ucbasaran et al., 2008; Mason & Brown, 2014). In small ecosystems like Estonia's, this matters considerably because serial entrepreneurs recycle financial capital, social capital, and experiential knowledge back into the system, a dynamic that Mason and Brown (2014) identify as essential for ecosystem self-renewal.

Estonia's unicorn cohort, including Skype, TransferWise (now Wise), and Bolt, has produced a generation of experienced entrepreneurs and investors whose continued involvement in the local ecosystem represents one of its most significant long-term assets.

The entrepreneurial process does not happen in isolation. Mentorship, peer networks, and institutional support provide external feedback that helps entrepreneurs adjust their strategies and avoid predictable mistakes. Mason and Brown (2014) note that these ecosystem interactions are essential for sustainable venture growth, because they connect what individual entrepreneurs learn from experience to the broader dynamics of the system. This is particularly relevant for early-stage ventures, which often lack the internal resources to diagnose problems and experiment at the pace that market conditions demand.

Entrepreneurs face a wide range of practical obstacles when establishing and growing ventures. Resource scarcity is often the most immediate: new firms typically lack financial reserves, established networks, and the ability to attract talent. Startups, which require significant upfront investment before generating revenue, depend heavily on venture capital, and this is not always available in sufficient volume or at the right stage. Menshikov et al. (2024) document that limited early-stage capital is a significant barrier in Estonia specifically, with many investors concentrating on later-stage ventures with demonstrated traction rather than pre-revenue companies. Regulatory compliance adds further costs: while Estonia's e-governance infrastructure has reduced many administrative burdens, sector-specific licensing requirements in fintech, health technology, and biotech can still delay market entry considerably (OECD, 2019). There is also evidence that management quality matters independently of funding. Bloom et al. (2013), in a field experiment across Indian manufacturing firms, show that introducing structured management practices generates substantial and lasting productivity gains, suggesting that some of the variation in startup outcomes may reflect internal organisational capability rather than external ecosystem conditions alone. A further structural pressure specific to small open economies is the limited size of the domestic market, which creates an early imperative to internationalise. For Estonian startups, this often means expanding internationally before the firm has fully consolidated its operational model, which can introduce risks of strategic overextension and increased failure rates (Mets et al., 2019; Vissak, 2010). These pressures underscore the importance of understanding which ecosystem

conditions support sustainable business creation, since it is at the entry stage that most of the measurable variation across countries occurs.

Below, Table 1 summarizes the key barriers identified in the global entrepreneurial environment, highlighting the structural, financial, and institutional factors that influence venture creation.

Table 1. Main Barriers to Venture Creation

Category	Barrier	Description
Financial	Limited early-stage financing	Access to seed and pre-seed capital remains limited; most investors prefer later-stage ventures with proven traction.
Human Capital	Talent shortage	Growing demand for skilled labour in ICT, analytics, and design exceeds supply, increasing hiring costs and forcing firms to recruit internationally.
Knowledge & Innovation	Weak university–industry collaboration	Limited commercialisation of research and low engagement between universities and startups reduce innovation transfer.
Category	**Barrier**	**Description**
Regulatory	Sector-specific regulations	Compliance requirements in finance, health tech, and biotech delay new market entry and increase costs.
Administrative	Taxation and reporting burden	Although simplified by e-governance, compliance procedures still create a disproportionate load for micro and small enterprises.
Structural	Dependence on foreign capital and markets	Small domestic market forces early expansion, increasing exposure to currency, regulatory, and competitive risks.
Growth	Early scaling difficulties	Premature expansion and overextension during the cross-border growth lead to liquidity issues and high failure rates.
Geographical	Infrastructure gaps outside Tallinn	Entrepreneurial activity and venture support are concentrated in the capital; regional ecosystems remain underdeveloped.
Technological	Uneven digital adoption among SMEs	Despite strong national infrastructure, digital transformation among smaller firms remains slow, reducing competitiveness.

Source: Audretsch and Link (2018), Lerner (2010), Mason & Brown (2014), ***The Global Competitiveness Report 2020.***

This study primarily focuses on barriers to venture creation, referring to the challenges entrepreneurs face when establishing new businesses. Recent research shows that early-stage ventures commonly encounter constraints such as limited access to finance, shortages of skilled labour, and institutional barriers that restrict business formation (Stam, 2015; Brown & Mason,

2017). However, existing literature also indicates that many of these constraints are not limited to the initial stages but continue to influence firm growth and scaling over time (Autio et al., 2018; Audretsch & Belitski, 2021). Therefore, while the emphasis of this study is placed on venture creation barriers, it also acknowledges that such barriers are often embedded within broader entrepreneurial ecosystem dynamics (Stam, 2015).

Another key opportunity comes from growing global connectivity. Entrepreneurs today operate in an increasingly borderless world where access to international partners, investors, and customers has never been easier. Global value chains, venture accelerators, and digital collaboration platforms allow entrepreneurs to design scalable business models aimed at global markets from the outset (Mason & Brown, 2014). This interconnectedness strengthens knowledge transfer, fosters innovation, and creates a more diverse environment for new ventures (Spigel, 2017). Moreover, the availability of global venture capital networks and crowdfunding platforms provides entrepreneurs with broader funding options beyond their local markets (Gompers & Lerner, 2001). As a result, international orientation has become a core element of modern entrepreneurship.

1.2 Theoretical Foundations of the Entrepreneurial Ecosystem Concept

Entrepreneurship research has gradually shifted from analysing individual or firm characteristics to studying the wider systems that shape entrepreneurial behaviour. Earlier studies emphasised the personal traits of entrepreneurs such as creativity, innovation, and risk-taking. Later research criticised this narrow view for overlooking the institutional, cultural, and social contexts that influence entrepreneurship. Over time, new approaches such as industrial clusters (Porter, 1990), national innovation systems (Lundvall, 1992), and the triple helix model of collaboration between universities, industry, and government (Etzkowitz & Leydesdorff, 2000) were introduced. These frameworks helped explain innovation and competitiveness, but mainly focused on established firms and technology development rather than on the creation and growth of new ventures.

The entrepreneurial ecosystem perspective emerged to address these limitations. It draws attention to the interconnected networks and institutional environments that support

entrepreneurship (Stam, 2015). Instead of treating entrepreneurship as an isolated activity, this approach highlights the interactions among policies, finance, human capital, markets, and culture. It recognizes that entrepreneurship depends on both tangible resources, such as capital and infrastructure, and on less visible factors like trust, collaboration, and social capital. This framework is particularly relevant for small, innovation-oriented economies such as Estonia, where tight networks often compensate for limited domestic markets. In such contexts, the ecosystem concept helps explain how governments, universities, investors, and entrepreneurs cooperate to encourage innovation, while also revealing why scaling up beyond early stages remains difficult (Mason & Brown, 2014; Isenberg, 2011).

Recent research highlights that earlier theoretical approaches did not fully capture the systemic and dynamic nature of entrepreneurship. Contemporary studies emphasise that entrepreneurial activity is shaped by the interaction of institutional structures, networks, and social conditions rather than by isolated factors. In this context, the entrepreneurial ecosystem perspective has emerged as a dominant framework, integrating formal elements such as policy and infrastructure with informal components such as culture, trust, and knowledge exchange (Spigel, 2017; Brown & Mason, 2017).

The conceptualization of entrepreneurial ecosystems has evolved through several models that aim to explain their internal structure and dynamics. James Moore (1993) first described firms as interdependent actors co-evolving within a shared environment, an idea that later inspired broader ecosystem thinking. Among the frameworks developed, four models stand out for their complementary perspectives and analytical value: Isenberg (2011), OECD (2014), Mason and Brown (2014), and Stam (2015, 2018). This thesis draws on four that are complementary rather than redundant. Isenberg's model outlines the main domains—culture, policy, finance, human capital, markets, and institutional support that form the basic structure of entrepreneurial ecosystems. The OECD framework adds a policy dimension by distinguishing between transactional and relational mechanisms, helping to explain how both formal interventions and informal interactions sustain entrepreneurship. Transactional mechanisms are direct, tangible policy interventions such as grant programmes, tax incentives, and government-backed loan guarantees. Relational mechanisms refer to the informal, trust-based interactions through which ecosystem actors build collaboration over time: mentoring, peer learning, and the diffusion of

practical knowledge between experienced and novice entrepreneurs. Mason and Brown emphasise the social and network-based aspects of ecosystems, focusing on connectivity, role models, and the role of serial entrepreneurship, which are especially important for understanding how smaller ecosystems evolve over time.

Table 2. Key Frameworks of Entrepreneurial Ecosystems

Framework	Key focus	Strengths	Limitations
Isenberg (2011)	Highlights six interdependent domains—policy, finance, culture, human capital, markets, and institutional support—that jointly shape entrepreneurship.	Offers a practical, holistic approach connecting formal and informal factors; adaptable across different economies	Lacks clear operational indicators for cross-country comparison.
OECD (2014)	Distinguishes between transactional mechanisms (e.g., finance, policy) and relational mechanisms (e.g., trust, networks) within entrepreneurial ecosystems.	Useful for evaluating public policy impacts and institutional design; links entrepreneurship with governance quality.	Descriptive framework; limited attention to cultural and behavioural aspects of entrepreneurship.
Mason & Brown (2014)	Emphasises dynamic networks, local culture, and the role of intermediaries or "deal-makers" in connecting ecosystem actors.	Captures social and informal dimensions of entrepreneurship; strong regional relevance for innovation clusters.	Empirically difficult to apply due to reliance on qualitative indicators; limited global comparability.
Stam (2015; 2018)	Proposes a structured system linking framework conditions and systemic conditions to measurable outputs (entrepreneurial activity) and outcomes (value creation).	Provides an empirically testable and comprehensive model; applicable for both advanced and small open economies.	Can oversimplify complex interdependencies; assumes linear flow between inputs and outcomes.

Source: Compiled by the author based on Isenberg (2011), OECD (2014), Mason and Brown (2014), and Stam (2015, 2018).

The entrepreneurial ecosystem framework has become one of the most influential approaches in contemporary entrepreneurship research. It provides an analytical tool to compare how entrepreneurship develops in different institutional and regional contexts and explains why economies with similar economic structures often experience distinct entrepreneurial outcomes (Stam, 2015; OECD, 2014). By differentiating between framework conditions, which include the institutional and infrastructural foundations of entrepreneurship, and systemic conditions, which

relate to leadership, talent, finance, and knowledge networks, the framework allows for a deeper understanding of how local environments influence entrepreneurial behaviour and scaling potential (Stam, 2018). Furthermore, the interaction between transactional mechanisms such as grants, tax incentives, or investment programmes, and relational mechanisms such as mentoring, trust, and knowledge-sharing, determines the long-term strength of these ecosystems (Isenberg, 2011; OECD, 2014). This dual perspective reveals that while institutions can create opportunities for entrepreneurship, only strong social and knowledge-based linkages transform these opportunities into sustainable innovation (Spigel, 2017).

Table 3: The Main Elements of the Entrepreneurial Ecosystem Framework

Component	What It Means	Examples
Framework Conditions	These are the basic foundations that make entrepreneurship possible, institutions, infrastructure, and education systems.	Good governance, quality education, and strong infrastructure (Stam, 2015; OECD, 2014).
Systemic Conditions	These focus on people and networks — how leadership, finance, and knowledge help businesses grow and succeed.	Business leadership, access to funding, innovation culture (Stam, 2018).
Transactional Mechanisms	These are direct government actions or financial tools that encourage entrepreneurship.	Grants, tax benefits, investment programmes (Isenberg, 2011; OECD, 2014).
Relational Mechanisms	These are the social and knowledge connections that build trust and long-term collaboration among entrepreneurs.	Mentorship, trust networks, knowledge sharing (Spigel, 2017).

Source: Compiled by the author based on Stam (2015, 2018), OECD (2014), Isenberg (2011), and Spigel (2017).

Entrepreneurial ecosystems are shaped not only by structural conditions but also by the interaction of key actors, including governments, investors, universities, and entrepreneurs themselves. These actors play complementary roles in supporting venture creation and growth. Governments establish regulatory frameworks, provide financial incentives, and invest in infrastructure that lowers entry barriers for new firms. Investors contribute by supplying capital and supporting high-growth ventures, while universities facilitate knowledge creation, research commercialisation, and talent development. The interaction among these actors creates a dynamic environment in which entrepreneurial opportunities can emerge and develop (Isenberg, 2011; Stam, 2015).

The effectiveness of entrepreneurial ecosystems depends on the coordination and alignment of these actors. Strong collaboration between universities and industry enhances knowledge transfer and innovation, while active investor networks improve access to finance and mentoring for early-stage ventures. Government policies that encourage cooperation and reduce institutional barriers further strengthen these relationships. When these actors operate in a coordinated manner, they create positive feedback loops that support venture creation, scaling, and long-term ecosystem sustainability (Spigel, 2017; Autio et al., 2018).

Among these models, Stam's (2015, 2018) framework is chosen as the main theoretical foundation for this thesis. It integrates many of the strengths of the previous models while offering a clearer structure for empirical application. By separating framework conditions (such as infrastructure, institutions, and demand) from systemic conditions (such as leadership, talent, finance, and networks), Stam's model provides a logical and measurable link between inputs and entrepreneurial outcomes. This dual structure makes it suitable for analysing small, digitally advanced economies like Estonia, where high institutional quality coexists with limited market size. The framework also aligns with internationally recognised indices such as the Global Entrepreneurship Index (GEI) and the European Index of Digital Entrepreneurship Systems (EIDES), allowing for comparative and data-based analysis across the Baltic region. For these reasons, Stam's model serves as the central analytical lens in this study, while the other models contribute supporting perspectives that enrich the overall understanding of entrepreneurial ecosystems.

Stam's framework also aligns with empirical tools such as the European Index of Digital Entrepreneurship Systems (EIDES), which measures digital and systemic conditions across countries (Autio et al., 2018). This connection allows the model to bridge theory with data and supports later analysis of how digitalisation, human capital, and social interaction affect entrepreneurship in small markets.

Public policy frameworks have also become increasingly supportive of entrepreneurship. Many governments recognise that new ventures are vital for innovation, employment, and long-term competitiveness. Policies such as simplified registration procedures, tax incentives, and innovation grants help reduce administrative burdens and encourage risk-taking (Lerner, 2010). Recent studies highlight, that countries with efficient institutions and strong rule of law tend to

have higher levels of entrepreneurial activity (Fuentelsaz et al., 2019). Countries that effectively combine regulatory efficiency with access to financing tend to have stronger and more resilient entrepreneurial ecosystems (OECD, 2019; Malecki, 2018).

Education, research, and knowledge exchange also show the important global opportunities for entrepreneurship. Collaboration between universities, research institutions, and industry, often described through the "triple helix" model (Etzkowitz & Leydesdorff, 2000; Ranga & Etzkowitz, 2016), helps transform academic discoveries into commercial innovations. When such collaborations are well developed, they increase innovation capacity and help entrepreneurs commercialise new technologies (Audretsch & Link, 2019). Knowledge spillovers and partnerships between academia and business are particularly important in technology-intensive sectors, where access to expertise can significantly accelerate growth (Mason & Brown, 2014).

Cultural and social conditions play an important role in shaping entrepreneurial activity. Positive attitudes towards entrepreneurship and supportive institutional environments encourage individuals to engage in entrepreneurial behaviour (Stam, 2015; Brown & Mason, 2017).

Overall, the global landscape shows how technology, institutional quality, and international integration jointly create favourable conditions for entrepreneurship. When digital transformation is combined with supportive policies and active knowledge exchange, new ventures are more likely to succeed and scale internationally (Nambisan, 2017; Autio et al., 2018). These systemic opportunities demonstrate that entrepreneurship thrives not only on individual creativity but also on strong ecosystems that nurture innovation and adaptability (Mason & Brown, 2014; Lerner, 2010; OECD, 2021). As the world becomes more connected and technology continues to advance, the foundations for entrepreneurial success are likely to strengthen even further.

Across the world, small and open economies serve as natural laboratories for understanding how innovation emerges despite limited size of domestic markets. Countries like Singapore, Israel, and South Korea illustrate how policy coordination and social capital can compensate for scale disadvantages (World Bank, 2020; OECD, 2023). Singapore has established one of the most structured and technology-driven entrepreneurial ecosystems globally. Through national initiatives such as *Startup SG* and *Enterprise Singapore*, the government has developed an ecosystem where universities, investors, and technology firms are closely connected to promote early-stage ventures (OECD, 2023). This integration aligns with Stam's (2018) systemic

conditions, demonstrating how leadership, finance, and knowledge diffusion combine to foster growth. Moreover, the Singaporean government's investment in human capital and international collaboration supports continuous learning and adaptability, which Isenberg (2011) identifies as critical cultural foundations of strong ecosystems. The country's success also resonates with Mason and Brown's (2014) concept of "deal-makers," where intermediaries bridge public and private actors to accelerate entrepreneurial scaling.

Table 4: Global Case Studies: How Countries Build Entrepreneurial Ecosystems

Country	Main Strategy / Focus	Key Policies or Programs	What Makes Their Ecosystem Strong
Singapore	Builds entrepreneurship through strong policy coordination and public–private partnerships.	*Startup SG* and *Enterprise Singapore* connect universities, investors, and tech firms to support new ventures.	Government leadership, access to finance, and knowledge-sharing networks help start-ups scale globally.
Israel	Focuses on R&D and technology-driven entrepreneurship, turning defence innovation into private sector success.	The *Yozma Programme* created one of the world's first venture capital systems, attracting major foreign investors.	A culture that embraces risk and failure, combined with strong academic–industry links and investor networks.
South Korea	Broadens from export manufacturing toward technology-driven entrepreneurship through long-term government support.	*Creative Economy Initiative* and *K-Startup Grand Challenge* promote collaboration between universities and global investors.	Strong leadership, digital infrastructure, and networks linking government, business, and academia.
Chile	Uses openness to international talent to spark local innovation.	*Start-Up Chile* offers funding and visas for global entrepreneurs to grow ideas locally.	Diversity, learning from global entrepreneurs, and cross-cultural collaboration.
Colombia	Promotes decentralised, region-based innovation rather than centralised national planning.	Regional innovation hubs and partnerships between cities, universities, and start-ups.	Local trust networks and community-driven cooperation strengthen regional entrepreneurship.
Finland	Builds resilience through education, inclusiveness, and collaboration.	University incubators, mentorship schemes, and strong public-private cooperation.	High levels of social trust and long-term investment in human capital sustain innovation even during crises.

Source: Compiled by the author based on OECD (2023), World Bank (2020), Stam (2018), Isenberg (2011), Mason and Brown (2014), and Spigel (2017).

Israel offers another compelling example of a small economy that transformed systemic constraints into strengths. Often referred to as the *Start-Up Nation*, Israel's entrepreneurial dynamism is rooted in decades of investment in research and defence technology, which later became a foundation for private innovation (Senor and Singer, 2009). The Yozma Programme, launched in 1993, created one of the first large-scale government venture capital programmes and attracted significant foreign investment. This example embodies Isenberg's (2011) view that effective ecosystems rely on the interaction between finance, policy, and culture rather than on isolated measures. Israeli entrepreneurs benefit from strong relational mechanisms that connect academia, investors, and the start-up community (Autio et al., 2018). Furthermore, high tolerance for risk and failure, combined with extensive international networks, has allowed Israel to sustain innovation across successive generations of entrepreneurs (Spigel and Harrison, 2018; OECD, 2023).

South Korea represents a case where industrial transformation and innovation policy have evolved together. The country's broadening focus from traditional export manufacturing toward technology-intensive entrepreneurship illustrates how government-led strategies can reshape ecosystems over time. It is worth noting that this shift in emphasis does not mean South Korea's manufacturing sectors are not technologically advanced; rather, the policy focus has expanded to include new venture creation alongside continued industrial upgrading (OECD, 2023). South Korea's policies emphasise education, digital infrastructure, and collaboration between universities and technology parks, reflecting OECD's (2023) argument that human capital and digitalisation are central to modern ecosystems. The Creative Economy Initiative and K-Startup Grand Challenge have contributed to a diversified start-up scene where local entrepreneurs collaborate with global investors. These efforts align closely with Stam's (2018) systemic framework, which highlights that networks and leadership are the bridge between institutions and entrepreneurial outcomes. In addition, South Korea's growing emphasis on cultural change and entrepreneurial role models supports Isenberg's (2011) focus on building social legitimacy for entrepreneurship, meaning the degree to which a society views founding a business as a respectable and valued career path rather than an unreliable or low-status occupation.

Emerging economies such as Chile, Colombia, and India provide additional insights into how entrepreneurial ecosystems develop under different institutional constraints. Chile's Start-Up Chile initiative, launched in 2010, stands as one of the earliest government-funded accelerators

designed to attract international entrepreneurs (World Bank, 2020). It demonstrates that openness to global talent can stimulate local ecosystems by increasing diversity and entrepreneurial learning (Acs et al., 2018). The Chilean model supports the OECD's (2014) observation that transactional incentives are most effective when combined with relational learning, that is, the informal trust-building, peer interaction, and knowledge exchange among founders, mentors, and other ecosystem actors that develop through sustained collaboration rather than through formal policy channels. Colombia, meanwhile, has focused on decentralised innovation hubs that empower regional ecosystems beyond its capital city. This aligns with Spigel's (2017) view that successful ecosystems emerge from localised trust networks rather than national-level planning. Building trust in ecosystems where it is initially low requires deliberate investment in relational infrastructure. Practical approaches documented in the literature include creating shared physical spaces such as co-working hubs and startup campuses where repeated informal interaction can develop, establishing structured mentoring programmes that connect experienced and novice entrepreneurs, and supporting communities of practice in which founders from different ventures exchange operational knowledge without direct competitive pressure (Spigel, 2017; Mason & Brown, 2014).

India has become another important example, particularly in digital entrepreneurship. The country's rapid development of digital infrastructure through initiatives such as *Digital India* has enabled the creation of a large and inclusive start-up ecosystem (OECD, 2023). However, despite progress, systemic weaknesses such as unequal access to finance and talent concentration in major cities remain challenges (World Bank, 2020). These examples highlight that ecosystem policies must adapt to local contexts rather than follow uniform global templates.

In advanced economies, ecosystem strength often depends more on social trust and cooperation than on financial incentives. Canada illustrates this through its emphasis on community-based entrepreneurship, mentorship programmes, and university-linked incubators (Spigel and Harrison, 2018). The Canadian model supports Stam's (2018) argument that systemic conditions, especially leadership and knowledge networks, play a greater role in sustaining ecosystems than traditional policy frameworks. Similarly, Finland and Sweden have developed ecosystems rooted in education, inclusiveness, and collaboration between public and private sectors. These countries demonstrate how high social trust and an open innovation culture can maintain ecosystem resilience even during economic fluctuations (Autio et al., 2018; OECD, 2023).

The United States provides another useful comparison. Although it is a large economy, regional ecosystems differ significantly in performance. For example, Silicon Valley's success results from its dense networks of investors, entrepreneurs, and research institutions that continuously share knowledge and reinvest experience (Mason and Brown, 2014; Malecki, 2018). In contrast, other U.S. regions with similar infrastructure but weaker social connectivity do not achieve the same innovation outcomes (Audretsch and Belitski, 2021).

Global evidence confirms that similar institutional frameworks do not guarantee similar entrepreneurial results. Culture, trust, and access to networks determine how effectively resources are used (Isenberg, 2011; Brown and Mason, 2017). Economies such as Singapore, South Korea, and Finland show that a combination of sound institutional design and social cohesion produces balanced and self-sustaining ecosystems. Conversely, some developing countries in Southeast Asia and Africa, despite improving their policy environments, still face limits in scaling due to low levels of trust and weak knowledge-sharing structures (World Bank, 2020; OECD, 2023). There is also evidence that management quality matters independently of ecosystem conditions. Bloom et al. (2013), in a field experiment across Indian manufacturing firms, demonstrate that introducing structured management practices generates substantial and lasting productivity gains, suggesting that some of the variation in firm outcomes may reflect internal organisational capability rather than external factors alone. These observations align with Stam's (2015) and the OECD's (2014) conclusion that entrepreneurship is a systemic process that depends on coordination among multiple actors rather than isolated interventions. Sustainable ecosystems, therefore, rely not only on financial and infrastructural resources but on the social fabric that connects entrepreneurs, investors, and institutions.

From a theoretical perspective, the Stam (2018) model remains one of the most comprehensive frameworks for analysing how entrepreneurship emerges and evolves in small and open economies. The model divides ecosystems into framework and systemic conditions, offering both analytical clarity and empirical applicability. It enables comparison across contexts by identifying measurable elements such as infrastructure, human capital, leadership, and access to finance. More importantly, Stam's model captures the dynamic interaction between structure and agency—between formal institutions and informal networks—that determines ecosystem resilience (Stam, 2015; Audretsch and Link, 2019). The model's flexibility also makes it suitable

for studying economies where entrepreneurship depends on adaptability and international integration rather than domestic scale.

Complementary models enrich this perspective. Isenberg's (2011) framework highlights cultural and behavioural aspects, suggesting that entrepreneurship depends on the alignment between formal rules and social attitudes. The OECD (2014) model further distinguishes between transactional and relational mechanisms, warning that grants and subsidies alone cannot build sustainable ecosystems without community engagement. Mason and Brown (2014) draw attention to the importance of intermediaries or "deal-makers" who bridge information and resource gaps between different actors. Finally, Spigel (2017) provides a relational interpretation, explaining how trust-based interactions and local identity shape the uniqueness of each ecosystem. Together, these models complement each other and provide a multidimensional foundation for understanding entrepreneurship as a process shaped by both structure and interaction.

Overall, the global evidence suggests that entrepreneurial ecosystems thrive when policy coordination, institutional reliability, and social connectivity reinforce one another. The sustainability of these systems depends not only on policy quantity but also on the quality of cooperation and learning among their participants. Framework conditions such as policy design and infrastructure are essential, yet they become productive only when supported by systemic conditions such as leadership, finance, and collaborative culture (Stam, 2018; OECD, 2023). Countries that have achieved this balance, such as Singapore, Finland, and Canada, demonstrate that ecosystems can continuously generate innovation and adapt to global changes. The entrepreneurial ecosystem perspective therefore provides not only an analytical framework for comparing economies but also practical guidance for policymakers seeking to build more resilient, innovation-driven societies (Stam, 2015; OECD, 2023; World Bank, 2020).

2. Methodology

2.1 Research design

This research adopts a quantitative approach based on secondary data to examine the relationship between entrepreneurial ecosystem conditions and entrepreneurial activity across countries. The main objective is to analyse how key ecosystem factors, including institutions, infrastructure, finance, human capital, and innovation, are related to differences in entrepreneurial activity, measured by new business density. The analysis is grounded in the entrepreneurial ecosystem framework developed by Erik Stam (2015), which views entrepreneurship as the outcome of interacting systemic conditions rather than the result of a single factor.

Although the primary focus of the study is on Estonia, the analysis is extended to a broader group of European countries, including Latvia, Lithuania, Poland, the Czech Republic, Slovenia, Hungary, Croatia, and Austria. These countries were selected to provide a meaningful comparative context, as they share relatively similar economic and institutional backgrounds while still displaying variation in entrepreneurial performance. (Stam 2015) This broader sample allows for a more balanced assessment of whether Estonia represents a distinct case or reflects wider regional patterns.

The research follows a deductive approach, where theoretical expectations derived from the entrepreneurial ecosystem literature are examined using empirical data. The selected variables are intended to capture several core dimensions of the entrepreneurial ecosystem identified in the literature. Rule of Law reflects the institutional environment and the quality of governance, which influence business stability and market confidence. Internet usage represents digital infrastructure and technological accessibility, which are increasingly important for entrepreneurial activity. Education is included as a proxy for human capital and workforce quality, while R&D expenditure captures the level of innovation investment within the economy. Venture capital is used to represent access to entrepreneurial finance and funding opportunities for new firms. Together, these indicators provide a multidimensional view of the conditions that may support or constrain entrepreneurial activity across countries. The empirical analysis is structured in several steps. First, descriptive statistics are calculated for all variables, including mean, standard deviation, minimum, and maximum values. This provides an overview of the distribution and variation of entrepreneurial activity and ecosystem conditions across countries and over time. In addition, a correlation matrix is constructed to explore the strength and direction of relationships between new business density and the selected ecosystem indicators.

To complement this, a few scatter plots are used to visually illustrate the relationship between entrepreneurial activity and key explanatory variables. These plots provide an intuitive representation of patterns observed in the data and support the interpretation of statistical results.

Second, regression analysis is employed to examine the relationship between entrepreneurial ecosystem factors and entrepreneurial activity in a more structured manner. Entrepreneurial activity is measured using new business density, defined as the number of newly registered limited liability firms per 1,000 working-age people aged 15–64. The ecosystem factors are represented by Rule of Law, measured using the World Governance Indicators percentile rank; Internet usage, measured as the percentage of individuals using the internet; Education, measured as the percentage of the population aged 25–64 with tertiary education; R&D expenditure, measured as gross domestic expenditure on research and development as a percentage of GDP; and Venture Capital, measured as venture capital investment as a percentage of GDP. The baseline model is estimated using pooled ordinary least squares.The model is specified as:

$$NBD_{it} = \beta_0 + \beta_1 RuleOfLaw_{it} + \beta_2 Internet_{it} + \beta_3 Education_{it} + \beta_4 RD_{it} + \beta_5 VC_{it} + \epsilon_{it}$$

To account for unobserved differences across countries and over time, an additional specification including country and time fixed effects is also estimated. This allows the analysis to distinguish between cross-country differences and within-country changes. Given the relatively limited number of observations, the results of the fixed effects model are interpreted with caution and are used primarily as a robustness check rather than as the main specification.

This approach groups countries into clusters that reflect similarities in institutional quality, infrastructure, human capital, innovation, and access to finance. These dimensions are widely emphasized in entrepreneurial ecosystem research as key conditions supporting entrepreneurial activity and ecosystem development (Isenberg, 2011; Stam & van de Ven, 2021).

Overall, this combination of descriptive statistics, correlation analysis, regression modelling, and clustering techniques allows for a comprehensive and structured examination of entrepreneurial ecosystems. While regression analysis focuses on relationships between variables, cluster analysis provides insight into two distinct groups of countries based on their entrepreneurial

ecosystem characteristics. Together, these methods offer a more complete understanding of how ecosystem conditions are associated with entrepreneurial activity.

All data used in the analysis are secondary and obtained from recognized international sources. The World Bank provides data on new business density, institutional quality, and internet usage. The OECD supplies data on venture capital investment, research and development expenditure and education. The time period covered in the analysis is 2015 to 2023, depending on data availability, ensuring that the findings reflect relatively recent developments. The selected variables correspond to the main dimensions of Stam's (2015) framework, with new business density serving as the outcome variable representing entrepreneurial activity.

Table 5. Dependent and explanatory variables.

Ecosystem dimension (Stam, 2015)	Indicator	Description	Source
Institutions	Institutional Quality, measured by the Rule of Law	Measures confidence in the legal system, contract enforcement, and institutional reliability (Percentile Rank, Upper Bound of 90% Confidence Interval)	World Bank, Worldwide governance indicators
Infrastructure	Individuals using the Internet	Share of people with Internet access, representing digital readiness and infrastructure quality (% of population)	World Bank
Finance	Venture capital investments	Indicates the availability of financial support for new ventures (market statistics, % of GDP)	OECD
Human capital	Share of tertiary-educated adults	Measured as the percentage of the population aged 25–64 with tertiary education (% of population).	OECD
Innovation	R&D expenditure	Reflects the level of investment in research	OECD

		and innovation (% of GDP)	
Entrepreneurial output	New business density	New business registrations per 1000 people aged 15-64	World Bank, Worldwide governance indicators

Source: Composed by Authors

The results are interpreted within the framework of the entrepreneurial ecosystem approach, which emphasises the interaction between different systemic conditions. Rather than focusing on single causal effects, the analysis aims to identify patterns and associations that help explain how combinations of factors are linked to entrepreneurial performance.

The empirical analysis focuses on Estonia while including Latvia, Lithuania, Poland, Czech, Slovakia, Slovenia, Austria, Hungary and Croatia. as reference cases. At the same time, their entrepreneurial outcomes are not identical despite these similarities. This creates an opportunity to examine whether differences in ecosystem conditions are associated with variations in entrepreneurial activity rather than structural characteristics such as geography or development level. The purpose of the comparison is therefore not to rank countries, but to place Estonia's performance in context and to determine whether its ecosystem reflects a distinctive national pattern or a broader regional trend.

2.2 Descriptive statistics.

In this part of the analysis, I focus on entrepreneurial activity using new business density as the main indicator. This measure shows how many new firms are being created, so it reflects the level of business creation in each country. At the same time, it does not capture what happens to these firms after they are established, such as whether they grow, scale, or expand internationally. Because of this, the results should be interpreted as evidence of entrepreneurial activity and ecosystem conditions, rather than direct evidence of firm growth or cross-border expansion.

As an outcome indicator, it reflects the combined effect of institutional, financial, and knowledge-related conditions discussed in the theoretical framework. Before analysing individual ecosystem dimensions, it is necessary to first observe how entrepreneurial activity itself has evolved in these countries.

Table 6. New business registrations per 1000 people aged 15-64.

Country	2015	2016	2017	2018
Estonia	17.52	19.48	21.81	23.6
Latvia	9.81	8.2	7.56	8.09
Lithuania	3.22	3.36	3.55	3.33
Croatia	4.51	4.91	5.52	5.86
Poland	1.55	1.69	1.52	1.45
Czechia	3.71	4	4.5	4.4
Slovenia	3.95	3.08	3.3	3.02
Slovakia	3.26	4.76	5.26	5.28
Hungary	3.2	3.42	3.51	3.77
Austria	1.08	1.01	1.02	0.99
2019	2020	2021	2022	2023
24.74	24.14	29.42	24.32	N/A
7.95	6.91	7.21	6.73	N/A
3.26	2.94	3.27	2.95	N/A
5.57	4.44	5.53	6.25	N/A
1.6	1.68	2.17	2.16	N/A
4.19	3.81	4.31	4.06	N/A
2.88	2.62	2.65	2.76	N/A
5.55	5.16	5.28	5.48	N/A
3.97	4.04	4.88	4.32	N/A
1	0.86	0.95	N/A	N/A

Source: World Bank

Table 6 presents new business registrations per 1,000 people aged 15–64 across the selected countries over the period 2015–2022. This indicator reflects the level of entrepreneurial activity and the rate of new firm creation within each economy. A clear pattern emerges, with Estonia consistently recording the highest levels of business creation throughout the entire period. The indicator shows a strong upward trend, rising from approximately 17.5 in 2015 to a peak above 29 in 2021, before slightly declining in 2022. This indicates a highly dynamic entrepreneurial environment compared to other countries in the sample.

A second group of countries, including Latvia, Slovakia, Hungary, and Croatia, demonstrates moderate levels of entrepreneurial activity. These countries generally maintain values between 4 and 8, with some fluctuations over time but no strong upward trend comparable to Estonia. Slovakia and Hungary show slight increases in later years, suggesting gradual improvement.

Lower levels of business creation are observed in countries such as Lithuania, Slovenia, and the Czech Republic, where values remain relatively stable and typically range between 2.5 and 4.5.

These patterns indicate more limited entrepreneurial activity despite relatively developed economic conditions. At the lower end, Poland and Austria consistently record the smallest number of new business registrations. Their values remain below 2 throughout the period, suggesting a comparatively lower rate of new firm entry.

Taken together, the table highlights substantial differences in entrepreneurial activity across countries. Estonia clearly stands out as the strongest performer, while most other countries exhibit either moderate or low levels of business creation, with relatively limited convergence over time.

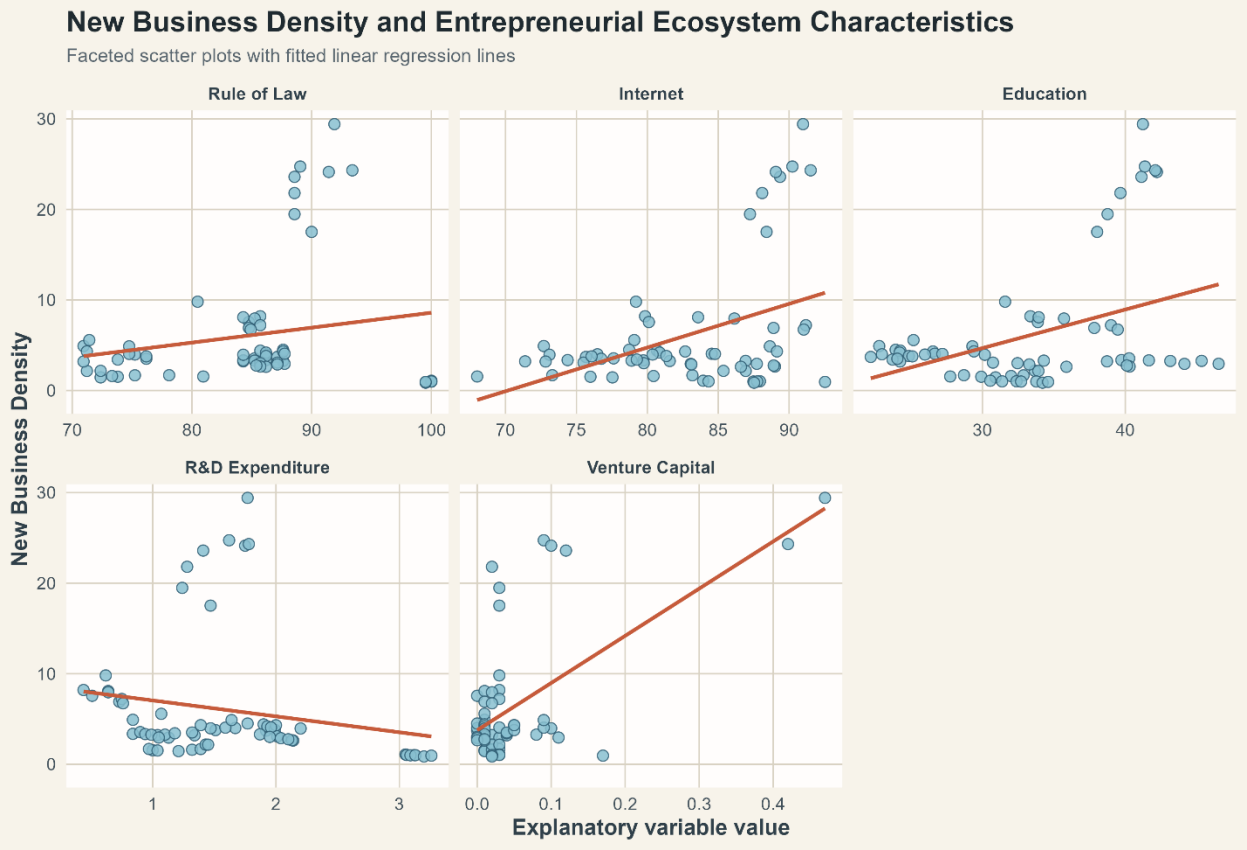


Figure 2. Relationship Between New Business Density and Entrepreneurial Ecosystem Indicators Source: Created by authors based on World Bank and OECD data The scatterplots provide an initial visual overview of the relationships between new business density and the selected entrepreneurial ecosystem indicators. Overall, several variables show a positive association with entrepreneurial activity. In particular, venture capital exhibits the strongest positive relationship, with higher levels of investment clearly corresponding to higher levels of new business creation. A similar, although more moderate, positive pattern can be observed for

internet usage and education, suggesting that digital infrastructure and human capital are important supporting factors for entrepreneurial activity.

The relationship with the rule of law also appears positive, but less pronounced, indicating that institutional quality may play a supportive role, although its effect is not as strong as financial or technological factors in this descriptive view. In contrast, R&D expenditure shows a weak negative relationship with new business density. This suggests that higher levels of R&D investment do not necessarily translate into higher rates of firm entry, possibly because such investments are more closely linked to innovation within existing firms rather than the creation of new ones. It is important to note that these relationships are purely descriptive and do not imply causality. However, they provide useful preliminary insights that are further examined in the regression analysis.

Table 7 presents the descriptive statistics for the main variables used in the analysis. The table reports the mean, standard deviation, and the range of values across all countries and years included in the dataset.

Table 7. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
NBD	5.890	6.923	0.861	29.422
Rule of Law	82.922	10.326	64.553	99.881
Internet	83.211	7.752	67.228	95.241
Education	33.514	6.321	21.816	42.441
R&D	1.486	0.786	0.443	3.264
VC	0.038	0.046	0.001	0.160

Source: Created by authors based on World Bank and OECD data

The descriptive statistics reveal substantial variation across both entrepreneurial activity and ecosystem conditions. The wide range of values suggests that while some observations reflect low levels of entrepreneurial activity, others exhibit significantly higher rates.

Institutional quality, measured by the rule of law, is relatively high on average across the sample, although there is still meaningful variation between countries. A similar pattern is observed for internet usage, where most countries demonstrate high levels of digital connectivity, but

differences remain at the lower end of the distribution. Education levels are more moderately distributed, with less extreme variation compared to other indicators.

In contrast, R&D expenditure and venture capital investment display more uneven distributions. In particular, venture capital shows a relatively low mean combined with a high standard deviation, indicating that access to finance is concentrated in a limited number of country-year observations. This suggests that financial resources are not evenly distributed across the sample and may play a differentiating role in entrepreneurial activity.

3. Empirical results and discussions.

The correlation matrix provides an initial indication of the strength and direction of relationships between entrepreneurial activity and ecosystem factors. The full correlation matrix is presented in Appendix. Venture capital exhibits the strongest positive correlation with new business density, suggesting that greater availability of financial resources is associated with higher levels of business creation. Internet usage and education also display moderate positive relationships with entrepreneurial activity, indicating that digital infrastructure and human capital may play supportive roles.

In contrast, R&D expenditure shows a weak negative correlation with new business density. This result may reflect structural differences between innovation intensity and the number of newly established firms, as higher R&D investment does not necessarily correspond to a greater quantity of new business entries. Institutional quality demonstrates a relatively weak positive relationship with entrepreneurial activity, suggesting that its effect may be more complex or indirect.

Overall, the correlations suggest that financial conditions and digital infrastructure are more closely aligned with entrepreneurial activity, while other variables exhibit weaker or less direct associations. To complement the statistical results, scatter plots are used to visually examine the relationship between new business density and selected ecosystem variables.

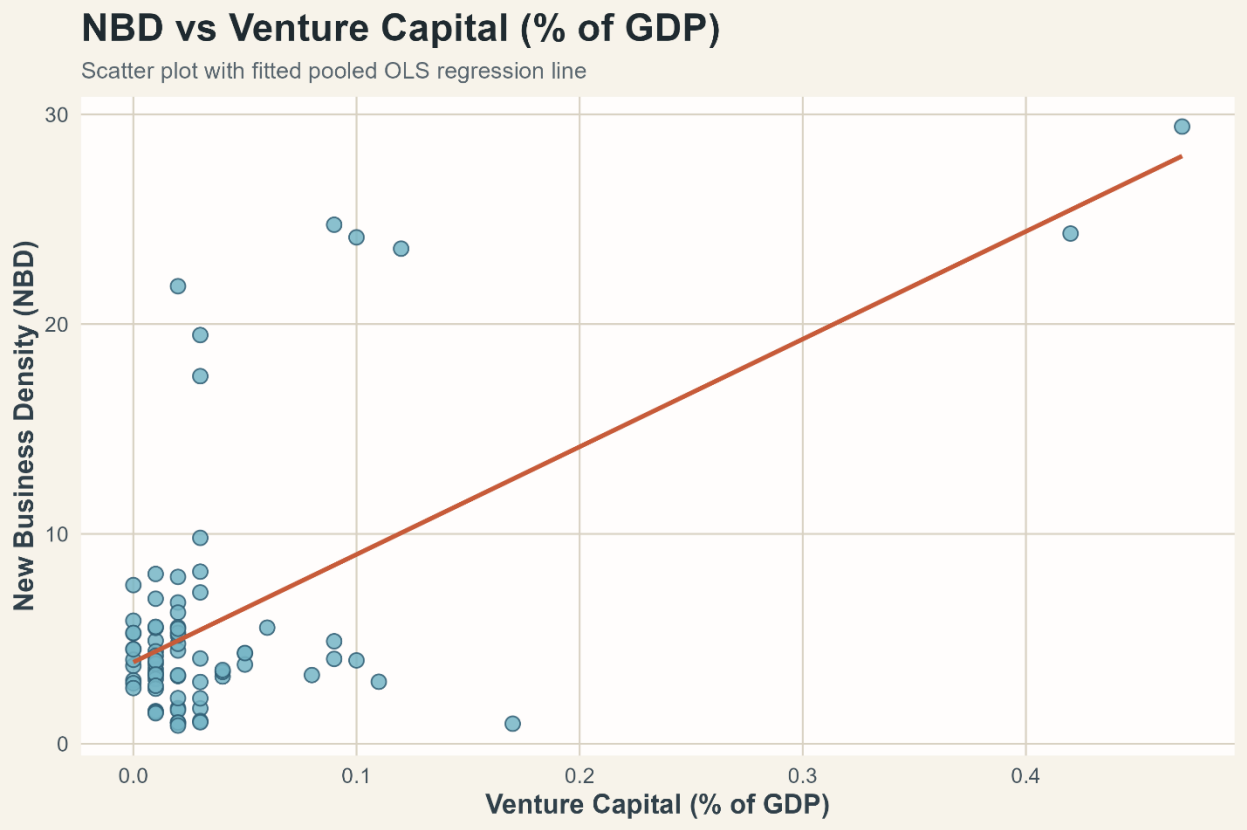


Figure 3. NBD vs Venture Capital (% of GDP) Source:-Composed by authors, based on World Bank and OECD

The relationship between new business density and venture capital is particularly pronounced. The scatter plot shows a clear upward trend, indicating that higher levels of venture capital investment are associated with increased entrepreneurial activity. However, the distribution of observations suggests that this relationship is influenced by a limited number of high-investment cases, reflecting the uneven distribution of venture capital across countries.

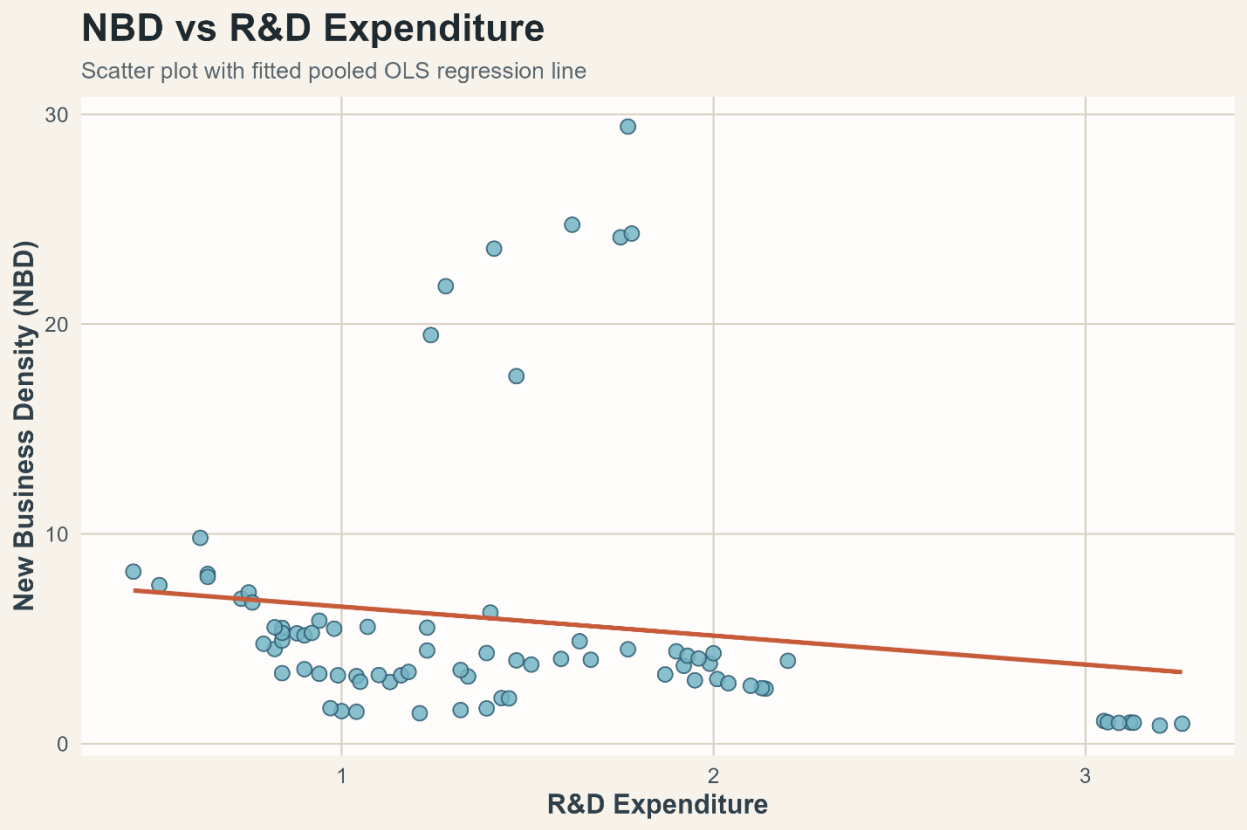


Figure 4. NBD and R&D Expenditure Source: Authors based on World Bank and OECD data

In contrast, the relationship between new business density and R&D expenditure displays a downward trend. This negative association is consistent with the correlation results and suggests that higher levels of innovation investment may be linked to fewer, but potentially more advanced, firms. One possible explanation is that R&D activity is often concentrated in larger, established firms rather than new ventures, meaning that innovation does not necessarily translate into higher rates of firm entry. In addition, economies with higher R&D intensity may be characterised by greater technological complexity and higher entry barriers, which can limit the number of new firms. This highlights the distinction between the quantity of business creation and the intensity of innovation within an economy.

The relationship between new business density and internet usage is provided in the Appendix. positive but more dispersed. While countries with higher levels of digital connectivity tend to exhibit higher entrepreneurial activity, the variation across observations indicates that internet access alone is not sufficient to explain differences in business creation.

Taken together, the scatter plots reinforce the findings from the correlation analysis and provide additional insight into the nature of the relationships between ecosystem conditions and entrepreneurial activity.

3.1 Regression analysis

Before presenting the regression results, the relationship between entrepreneurial ecosystem conditions and entrepreneurial activity is examined using panel regression analysis. The dependent variable is new business density, measured as the number of newly registered limited liability firms per 1,000 working-age people. The explanatory variables represent key dimensions of the entrepreneurial ecosystem identified in the theoretical framework, including institutional quality, internet infrastructure, education, research and development expenditure, and venture capital availability.

To evaluate the robustness of the results, three different model specifications are estimated. Model 1 applies pooled ordinary least squares (OLS) regression with robust standard errors. Model 2 extends the baseline specification by including year fixed effects in order to control for common time-specific shocks affecting all countries. Model 3 applies country fixed effects to account for unobserved country-specific characteristics that remain constant over time. Comparing these models makes it possible to examine whether the observed relationships remain consistent across different estimation approaches.

Table 8. Pooled OLS Regression Results (Robust Standard Errors)

Variable	Model 1 Pooled OLS	Model 2 Year FE	Model 3 Country FE
Rule of Law	0.304***	0.026	-0.160.
	(0.061)	(0.103)	(0.093)
Internet	0.307**	0.825***	-0.124
	(0.114)	(0.172)	(0.103)
Education	-0.106	-0.014	0.126
	(0.106)	(0.114)	(0.204)
R&D expenditure	-5.249***	-3.971***	1.305
	(1.014)	(0.989)	(1.333)
Venture capital	43.988***	52.332***	14.337**
	(5.209)	(4.836)	(5.202)
Observations	65	65	65
R-squared	0.550	0.703	0.984
Adjusted R-squared	0.512	0.634	0.980
Year fixed effects	No	Yes	No
Country fixed effects	No	No	Yes
Robust standard errors	Yes	Yes	Yes

Model 1: Pooled OLS | Model 2: Pooled OLS + Year Fixed Effects | Model 3: Country Fixed Effects

Standard errors in parentheses. Significance: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, . $p < 0.10$

Source: Authors

The regression results provide insight into the relationship between entrepreneurial ecosystem characteristics and new business density across three model specifications.

In Model 1 (pooled OLS), several variables are statistically significant. Venture capital shows the strongest positive relationship, with a coefficient of 43.988 ($p < 0.01$), indicating that even small increases in venture capital as a share of GDP are associated with substantial increases in new business density. Internet usage also has a positive and significant coefficient of 0.307 ($p < 0.01$), suggesting that higher levels of digital access are linked to greater firm creation. Similarly, the rule of law is positively associated with new business density, with a coefficient of 0.304 ($p < 0.01$).

In contrast, R&D expenditure has a negative and statistically significant coefficient of -5.249 ($p < 0.01$). This result appears somewhat counterintuitive, particularly since the scatterplot does not

show a clear negative relationship between R&D and new business density. One possible explanation is that the regression captures the effect of R&D after controlling for other variables. In more advanced economies, higher R&D spending may be concentrated in large, established firms rather than in new ventures, which could explain why higher R&D intensity is associated with lower levels of firm entry.

In Model 2, which includes time fixed effects, the main patterns remain broadly consistent. Venture capital continues to have a strong positive effect (52.332, $p < 0.01$), while internet usage becomes even more pronounced, with a coefficient of 0.825 ($p < 0.01$). R&D expenditure remains negative and significant (-3.971, $p < 0.01$), confirming that this relationship is not driven by time-specific factors.

Model 3 incorporates country fixed effects, which control for unobserved, time-invariant differences between countries. In this specification, most variables lose statistical significance. For example, the coefficient for internet decreases from 0.825 in Model 2 to -0.124 and becomes insignificant, while rule of law, education, and R&D expenditure also lose significance. Venture capital remains the only variable that is statistically significant, with a coefficient of 14.337 ($p < 0.05$).

This shift suggests that the relationships observed in the previous models are largely driven by differences between countries rather than changes within countries over time. In other words, countries that consistently have higher levels of venture capital, stronger institutions, or better digital infrastructure tend to exhibit higher levels of entrepreneurial activity, but changes within a given country over time do not produce similarly strong effects.

The very high R^2 value of 0.984 reflects the inclusion of a large number of country dummy variables, which capture a substantial portion of the variation in the dependent variable. Given the relatively small sample size of 65 observations and the inclusion of many parameters, this specification may overfit the data. As a result, the model's explanatory power is largely driven by fixed effects rather than the explanatory variables themselves, and the estimated coefficients should be interpreted with caution. In this sense, the country fixed effects model is less reliable for drawing strong conclusions about the relationships between ecosystem variables and entrepreneurial activity.

Overall, the results highlight the particularly strong role of venture capital in supporting business creation, while also showing that many relationships are primarily driven by structural differences across countries rather than short-term changes within them.

The variance inflation factors (VIF) provide an indication of multicollinearity among the explanatory variables. As shown in Appendix, all VIF values are relatively low, ranging from 1.21 for venture capital to 2.56 for R&D expenditure. These values are well below commonly used thresholds such as 5, suggesting that multicollinearity is not a major concern in the model. However, given the relatively small sample size and the conceptual relatedness of variables such as institutional quality, education, and innovation, the low VIF values are somewhat unexpected. This may reflect the fact that, although these variables are theoretically connected, they capture different dimensions of the entrepreneurial ecosystem and do not exhibit strong linear relationships within this particular dataset.

The highest VIF values are observed for R&D (2.56) and Rule of Law (2.53), indicating some degree of correlation with other variables. Nevertheless, these values remain sufficiently low to suggest that multicollinearity is unlikely to distort the estimated coefficients.

To further assess the robustness of the results, a two-way fixed effects model including both country and time effects was estimated (see Appendix). The results differ notably from the baseline models. Most explanatory variables lose statistical significance, and several coefficients change sign. For example, both Rule of Law and Internet become negative and are only weakly significant under conventional standard errors, while they lose significance entirely when robust standard errors are applied.

These changes indicate that the estimated relationships are sensitive to model specification. While several variables appear statistically significant in the pooled models, their effects weaken or disappear once both country-specific and time-specific factors are taken into account. This suggests that the observed relationships are largely driven by cross-country differences rather than consistent within-country variation over time.

Venture capital remains the only variable that retains a consistent positive and statistically significant effect. In the robust specification, its coefficient is 14.158 and remains significant at the 5 percent level. This highlights the importance of access to finance as the most stable factor associated with entrepreneurial activity across different model specifications.

Overall, the two-way fixed effects results suggest that the relationships between ecosystem characteristics and new business density are not fully robust. Given the relatively small sample size and the large number of estimated parameters, these findings should be interpreted with caution.

3.2 Cluster analysis

To complement the regression analysis, a cluster analysis was conducted to examine how countries group together based on their entrepreneurial ecosystem characteristics. The clustering is based on five key indicators: Rule of Law, Internet usage, Education, R&D expenditure, and Venture Capital. In order to focus on structural differences between countries rather than short-term fluctuations, the variables were averaged at the country level over the period 2015–2023. All variables were standardised prior to clustering to ensure comparability across different scales. The number of clusters was determined using the elbow method, which indicated that a two-cluster solution provides the most appropriate balance between simplicity and explanatory power.

The results reveal two distinct groups of countries based on their ecosystem characteristics. The first cluster is characterised by relatively stronger institutional quality, higher levels of digitalisation, and greater availability of venture capital. These countries can be interpreted as having more developed entrepreneurial ecosystem conditions. The second cluster includes countries with comparatively lower values across these indicators, reflecting less developed ecosystem structures.

It is important to emphasise that these clusters do not represent a strict ranking of countries, but rather different configurations of ecosystem characteristics. The analysis is descriptive and does not imply causal relationships. Instead, it highlights how countries differ in terms of the underlying conditions that support entrepreneurial activity.

In the case of Estonia, the results show that it is grouped with countries that share similar ecosystem characteristics. This suggests that Estonia’s entrepreneurial environment is shaped by a specific combination of institutional, technological, and financial factors. When considered alongside the regression results, the cluster analysis supports the idea that differences in entrepreneurial activity across countries are largely associated with broader structural conditions rather than short-term changes within countries.

Table 9. Cluster profiles (Standart means) Source: Authors

Cluster	Rule of Law	Internet	Education	R&D	VC
1	0.820	0.898	0.813	0.464	0.390
2	-0.533	-0.584	-0.528	-0.301	-0.253

The cluster analysis identifies two distinct groups of countries based on their entrepreneurial ecosystem characteristics. Cluster 1 is characterised by above-average values across all variables, with standardised scores of 0.820 for institutional quality, 0.898 for internet usage, and 0.813 for education. R&D and venture capital also display positive values of 0.464 and 0.390, respectively. This indicates that countries in this cluster tend to have relatively stronger ecosystem conditions across multiple dimensions.

In contrast, Cluster 2 is defined by below-average values for all indicators. Institutional quality, internet usage, and education have standardised values of -0.533, -0.584, and -0.528, respectively, while R&D and venture capital also remain negative. This suggests that countries in this group share a common pattern of comparatively lower ecosystem indicators relative to the sample average.

At first glance, this grouping may appear counterintuitive, particularly given that Estonia and Austria are assigned to the same cluster despite differences in their overall economic development. However, it is important to note that the clustering is based on the relative configuration of variables rather than absolute economic performance. The results therefore indicate that these countries share a similar profile in terms of how their ecosystem characteristics are structured within the sample.

Overall, the clustering results highlight a clear distinction between two different ecosystem profiles, suggesting that these factors tend to move together rather than independently. At the same time, the findings should be interpreted cautiously, as the clusters reflect relative differences within the sample rather than a strict ranking of countries.

Table 10. Country-level cluster classification

Country	Rule of Law	Internet	Education	R&D	VC	Cluster
Austria	99.88	88.14	33.15	3.14	0.044	2
Estonia	90.19	89.36	40.56	1.54	0.160	2
Croatia	71.19	75.89	23.98	0.96	0.010	1
Czechia	86.80	80.12	24.45	1.89	0.014	1
Hungary	74.14	80.98	26.12	1.43	0.063	1
Latvia	84.48	85.00	35.60	0.64	0.019	1
Lithuania	85.85	80.30	42.44	1.00	0.035	1
Poland	74.68	78.85	31.22	1.23	0.019	1
Slovenia	85.85	81.86	34.66	2.06	0.006	1

Source: Created by Authors based on World Bank and OECD data

The clustering results reveal an interesting pattern, where Estonia and Austria form a separate cluster from the remaining countries. At first glance, this may appear counterintuitive, as these countries differ in terms of overall economic development. However, the clustering is based on the relative configuration of ecosystem variables rather than absolute performance levels.

A closer look at the underlying data suggests that Estonia and Austria share similar patterns across the selected indicators, particularly in terms of comparatively lower values in certain variables relative to the sample average. This indicates that the clustering captures structural similarities in the composition of their entrepreneurial ecosystems, rather than differences in economic size or overall development.

This result highlights that countries can exhibit similar ecosystem profiles even if they differ in broader economic terms. Therefore, Estonia's position in the same cluster as Austria reflects a distinct combination of institutional, technological, and financial characteristics that set it apart from the other countries in the sample.

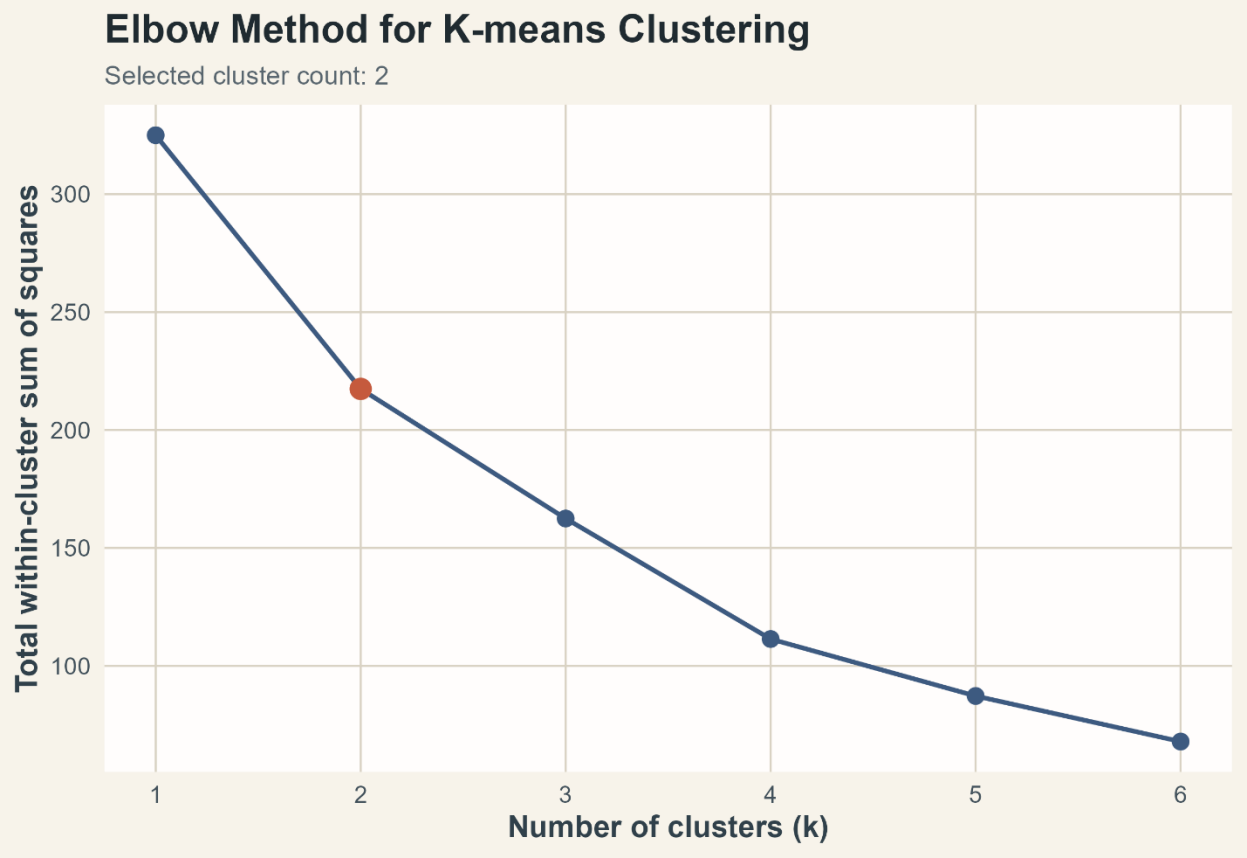


Figure 4. Elbow method for K-means Clustering Source: Composed by Authors

The elbow method is used to determine the appropriate number of clusters by examining how the total within-cluster sum of squares changes as the number of clusters increases. As shown in Figure 5, the total within-cluster variation decreases sharply when moving from one to two clusters, indicating a substantial improvement in the model's ability to group similar observations. However, after two clusters, the reduction in variation becomes more gradual, suggesting diminishing returns from adding additional clusters.

This point of inflection, often referred to as the "elbow," is observed at **k = 2**, which indicates that a two-cluster solution provides a reasonable balance between model simplicity and explanatory power. Therefore, two clusters were selected for the subsequent analysis.

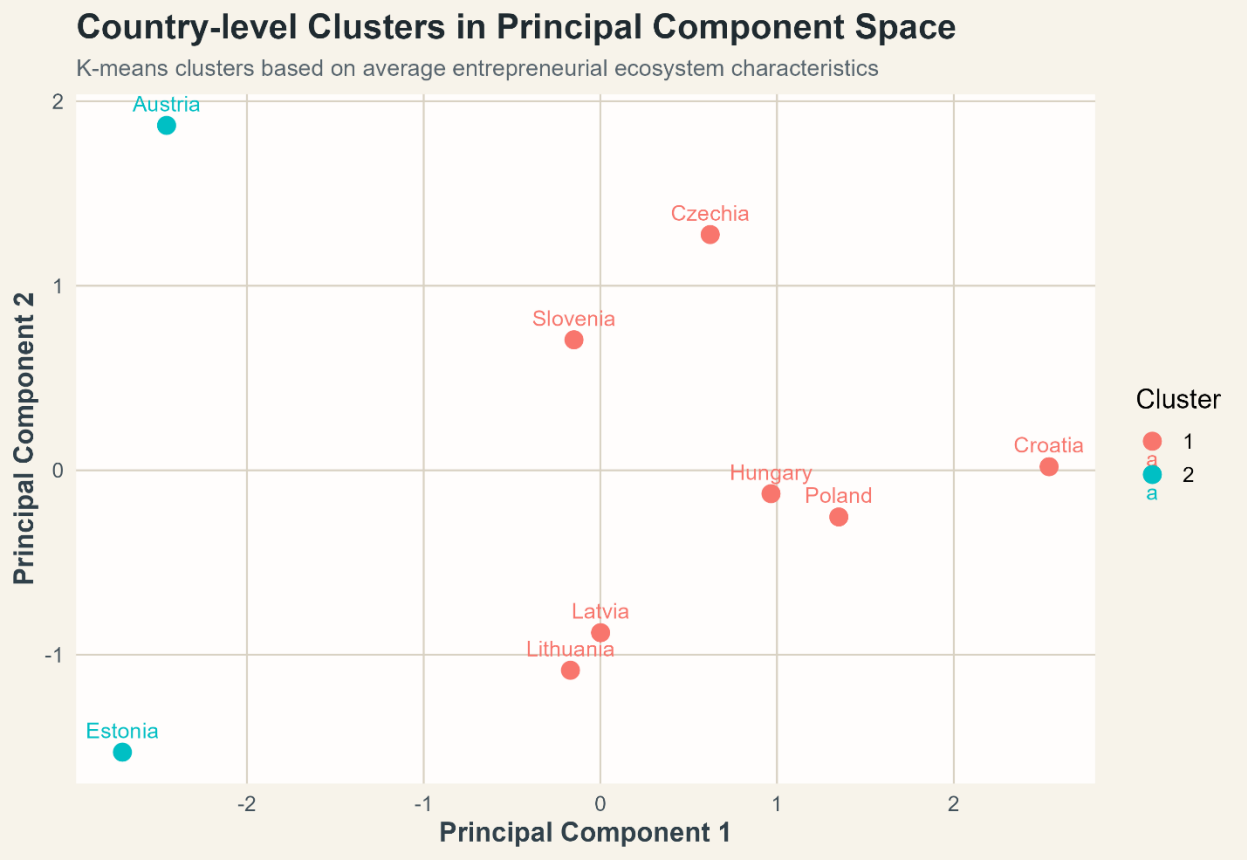


Figure . Country-level Clusters in Principal Component Space Source: Composed by Authors

The cluster structure is further illustrated using principal component analysis The principal component analysis provides a simplified representation of the variation in ecosystem characteristics across countries. The first principal component (PC1) captures the overall level of entrepreneurial ecosystem development, with higher values associated with stronger institutional quality, digital infrastructure, education, and access to finance. Countries positioned on the right-hand side of the plot therefore tend to exhibit more developed ecosystem conditions, while those on the left-hand side show comparatively lower values across these indicators.

The second principal component (PC2) reflects differences in the composition of ecosystem characteristics rather than their overall level. This can be observed in the positioning of Austria and Estonia, which are located on opposite ends of the vertical axis despite belonging to the same cluster. This suggests that, while these countries share a similar overall profile relative to the sample, the underlying structure of their ecosystem characteristics differs.

Overall, the PCA results support the clustering findings by showing that countries group together based on similar configurations of ecosystem indicators, while also highlighting important differences within clusters.

4. Conclusion and suggestions about Estonia's entrepreneurial ecosystem

The empirical results provide a clear perspective on the strengths and weaknesses of Estonia's entrepreneurial ecosystem when compared to a group of similar European countries. By combining descriptive statistics, regression analysis, and cluster analysis, the study identifies both the areas where Estonia performs relatively strongly and the dimensions where potential limitations remain.

One of the most evident strengths of Estonia lies in its high level of new business density, which consistently exceeds that of most countries in the sample. This indicates a dynamic entrepreneurial environment with a strong level of business creation. The descriptive and comparative evidence suggests that this performance is associated with favourable ecosystem conditions, particularly in terms of institutional quality and digital infrastructure. Estonia demonstrates high values in rule of law and internet usage, reflecting a stable institutional environment and advanced digitalization, both of which may reduce barriers to entry and support entrepreneurial activity.

The regression analysis broadly supports these observations. Institutional quality and internet usage show positive relationships with new business density in the baseline models, highlighting the importance of effective public institutions and digital infrastructure within entrepreneurial ecosystems. These findings are consistent with entrepreneurial ecosystem literature, particularly Stam (2015), which emphasises the role of systemic conditions in supporting entrepreneurial activity. In addition, venture capital emerges as the most robust and statistically significant factor across different model specifications. This suggests that investors and access to finance represent important components of Estonia's entrepreneurial ecosystem and may play a key role in supporting entrepreneurial activity and new firm creation. Compared to several other countries in the sample, Estonia demonstrates relatively favourable venture capital conditions, although a gap remains when compared to the strongest-performing entrepreneurial ecosystems.

At the same time, the analysis also reveals certain limitations within Estonia's ecosystem. The results suggest that research and development expenditure does not contribute positively to new business density in the regression models and, in some specifications, is negatively associated with it. One possible explanation is that R&D investment may be concentrated in larger or more established firms rather than translating directly into new business formation. This interpretation is consistent with literature distinguishing innovation intensity from entrepreneurial entry, where innovation investments may support productivity and firm development without necessarily increasing the number of newly established firms. Similarly, education does not show a statistically significant association, suggesting that the quantity of human capital alone may not be sufficient to explain differences in entrepreneurial activity across countries.

The cluster analysis provides additional insight into Estonia's position within the broader ecosystem landscape. Estonia is grouped separately from most of the other analysed countries, together with Austria, indicating that these countries share a distinct configuration of ecosystem characteristics relative to the sample. Although this result may initially appear counterintuitive given the differences in overall economic development, it highlights that countries can exhibit similar ecosystem profiles despite broader structural differences. In particular, Estonia and Austria display comparatively strong institutional and digital conditions relative to several Central and Eastern European countries included in the sample. This suggests that Estonia possesses a unique combination of institutional, technological, and financial characteristics within the regional context.

The findings of the study provide clear answers to the research questions outlined in the introduction. First, the analysis demonstrates that Estonia's entrepreneurial ecosystem is characterised by several important strengths, particularly in terms of institutional quality, digital infrastructure, and access to venture capital. These factors are consistently associated with higher levels of entrepreneurial activity and distinguish Estonia positively from several other countries included in the sample.

Second, the results indicate that ecosystem actors contribute to entrepreneurial activity in different ways and with varying levels of effectiveness. Government institutions play an important role through regulatory quality and digital governance, investors contribute through venture capital availability, while universities and research institutions influence the ecosystem through education and innovation-related activities. However, the findings also suggest that strong innovation and education indicators do not automatically translate into higher levels of new business creation, highlighting the importance of interaction and coordination between ecosystem actors.

Third, the study demonstrates that entrepreneurial activity cannot be explained by a single ecosystem factor alone. Consistent with the entrepreneurial ecosystem literature, particularly Stam (2015), the results suggest that entrepreneurial outcomes emerge from the interaction of institutional, financial, technological, and human capital conditions. Estonia's ecosystem performs strongly in several of these areas, although certain structural limitations remain, particularly regarding the commercialisation of innovation and the translation of knowledge into entrepreneurial outcomes.

Based on these findings, several practical implications can be drawn. First, maintaining and further strengthening institutional quality and digital infrastructure should remain a priority, as these represent important components of Estonia's entrepreneurial ecosystem. Continued investment in e-governance, regulatory transparency, and digital accessibility may help sustain the country's favourable environment for entrepreneurial activity.

Second, the role of venture capital suggests that policies aimed at improving access to finance should continue to be supported. This may include expanding funding opportunities for early-stage startups, encouraging private investment, and strengthening connections between investors and entrepreneurs. Given the consistently positive relationship between venture capital and new business density, improvements in this area may contribute positively to entrepreneurial activity.

Third, the relatively weak contribution of research and development to entrepreneurial activity indicates a need to strengthen the connection between innovation and entrepreneurship. Although Estonia demonstrates relatively strong innovation-related indicators, the findings suggest that these investments do not automatically translate into higher levels of new business creation. This highlights the importance of universities, research institutions, and public support mechanisms in facilitating knowledge transfer and the commercialisation of research outcomes. Strengthening cooperation between these ecosystem actors may improve the practical impact of innovation within the entrepreneurial ecosystem.

Finally, although education levels are relatively high, the lack of a statistically significant relationship with entrepreneurial activity suggests that greater attention should be given to the quality and practical applicability of skills. Strengthening entrepreneurial education, practical training, and alignment between skills and market needs may improve the effectiveness of human capital within the entrepreneurial ecosystem.

In summary, the study demonstrates that Estonia has developed a comparatively strong entrepreneurial ecosystem within the regional context, particularly through its institutional quality, digital infrastructure, and relatively favourable access to finance. At the same time, the findings indicate that entrepreneurial ecosystems remain complex systems in which strong performance in one dimension does not automatically guarantee entrepreneurial outcomes in another. The thesis contributes to the entrepreneurial ecosystem literature by applying a comparative quantitative approach to Estonia and by demonstrating how different ecosystem conditions and actors interact in shaping entrepreneurial activity within small open economies. These findings may provide useful insights for policymakers seeking to strengthen entrepreneurial ecosystems not only in Estonia, but also in other comparable European economies.

Limitations of the Study

Several limitations should be acknowledged when interpreting the findings of this thesis, relating to the choice of outcome measure, the scope of explanatory variables, and the broader challenges of capturing ecosystem dynamics through macro-level quantitative indicators.

The primary outcome variable, new business density, is a well-established and internationally comparable indicator of business creation, but it has important boundaries. It captures the rate at which new firms are registered relative to the working-age population, not whether those firms

subsequently survive, grow, or expand internationally. The analysis can therefore speak to the conditions associated with firm entry but not to those that support scaling or long-term development. Measuring post-entry dynamics would require firm-level longitudinal data that were not available for the cross-country panel used here.

The explanatory variables, while grounded in the ecosystem literature, cover only a subset of the conditions that theoretical frameworks consider important. Several dimensions that Stam (2015, 2018) and others identify as significant are difficult to quantify consistently across countries: relational mechanisms such as trust, mentorship, and peer learning; entrepreneurial culture and risk tolerance; and the informal circulation of knowledge among founders and investors. The study therefore captures the structural and institutional side of the ecosystem more effectively than the social and relational side, a trade-off that is common in comparative ecosystem research and reflects the practical constraints of cross-country measurement.

The sample of ten European economies was selected for structural comparability, but cross-country comparison at this scale involves simplification. National-level indicators can obscure within-country variation; in Estonia, for instance, entrepreneurial activity is heavily concentrated in Tallinn and Harju County, a pattern that national averages do not reflect. Similarly, aggregate institutional indices do not capture sector-specific regulatory conditions in areas such as fintech or biotechnology. The relatively small number of countries and the limited time dimension of the panel also constrain statistical power. The fixed-effects specification controls for unobserved country-level heterogeneity but absorbs much of the between-country variation that is analytically interesting in a comparative study. The results should therefore be read as indicative of associative patterns rather than as evidence of causal relationships.

Future research could extend this analysis in several directions. Firm-level datasets from startup registries or venture capital databases would make it possible to examine the relationship between ecosystem conditions and post-entry outcomes such as firm growth, survival, and export activity. Mixed-methods or longitudinal case study designs could capture the relational and cultural dimensions that macro-level indicators cannot easily reach. Network analysis tools could help map the informal connections among entrepreneurs, investors, and institutions that theoretical literature identifies as central to ecosystem functioning. These extensions would add depth to the comparative picture that the present cross-country analysis provides.

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Appendices.

Appendix 1. Pooled OLS (Conventional Standard Errors)

Variable	Coefficient	Std. Error	Significance
Rule of Law	0.304	0.118	*
Internet	0.307	0.139	*
Education	-0.106	0.139	
R&D	-5.249	1.343	***
VC	43.988	8.251	***
Constant	-35.239	11.455	**

Source: Composed by Authors based on World Bank and OECD data

Appendix 2. Variance Inflation Factors (VIF)

Variable	VIF
Rule of Law	2.53
Internet	1.90
Education	2.30
R&D	2.56
VC	1.21

Source: Created by Authors based on World Bank and OECD data

Appendix 3. Two-Way Fixed Effects (Conventional SE)

Variable	Coefficient	Std. Error	Significance
Rule of Law	-0.195	0.085	*
Internet	-0.181	0.081	*
Education	0.113	0.171	
R&D	1.743	1.853	
VC	14.158	2.874	***
Constant	25.440	14.550	.

Source: Composed by authors based on World Bank and OECD

Appendix 4. Two-Way Fixed Effects (Robust SE)

Variable	Coefficient	Robust SE	Significance
Rule of Law	-0.195	0.119	
Internet	-0.181	0.119	
Education	0.113	0.167	
R&D	1.743	2.028	
VC	14.158	4.695	**
Constant	25.440	19.884	

Source: Composed by authors based on World Bank and OECD data

Appendix 5. Elbow Method Results

Number of Clusters (K)	WSS
1	325.000
2	217.425
3	162.469
4	111.375
5	87.219
6	67.886

Source: Composed by authors

Appendix 6. Correlation Matrix

	NBD	Rule_of_Law	Internet	Education	RD	VC
NBD	1.000	0.194	0.417	0.407	-0.183	0.608
Rule_of_Law	0.194	1.000	0.474	0.408	0.619	0.312
Internet	0.417	0.474	1.000	0.536	0.402	0.410
Education	0.407	0.408	0.536	1.000	0.289	0.257
RD	-0.183	0.619	0.402	0.289	1.000	0.211
VC	0.608	0.312	0.410	0.257	0.211	1.000

Source: Composed by authors based on World Bank and OECD data

Appendix 7. Model Comparison Summary

Model	R^2	Observations	Notes
Pooled OLS	0.550	65	Baseline
Fixed Effects	0.987	65	Includes country & year dummies

Source: Composed by authors

Kokkuvõte

Käesolev magistritöö analüüsib Eesti ettevõtlusökosüsteemi tugevusi ja nõrkusi, keskendudes institutsionaalsetele, finantsilistele, infrastruktuurilistele ja inimkapitaliga seotud teguritele, mis mõjutavad ettevõtlusaktiivsust kümnes Euroopa riigis ajavahemikul 2015–2022. Teoreetiline raamistik tugineb Stami (2015, 2018), Isenbergi (2011), Masoni ja Browni (2014) ning OECD (2014) ökosüsteemimudelitele. Ettevõtlusaktiivsust mõõdetakse uute ettevõtete registreerimiste arvuna 1000 tööealise elaniku kohta ning selgitavate muutujatena kasutatakse viit ökosüsteemi näitajat. Metoodika hõlmab koondregressiooni, fikseeritud efektidega mudelit ning klasteranalüüsi. Tulemused näitavad, et riskikapitali kättesaadavus ja institutsionaalne kvaliteet on kõige järjepidevamalt seotud kõrgema ettevõtete loomise määraga. Eesti ökosüsteem on institutsionaalselt tugev, kuid süsteemsete mõõtmete, eriti varajase faasi rahastamise ja talendipagasi osas, esineb kitsaskohti. Uurimistöö tulemused on olulised Eesti ja teiste väikeste avatud majanduste ettevõtluspoliitika kujundamisel.

Märksõnad: ettevõtlusökosüsteem; ettevõtlus; innovatsioonipoliitika; riskikapital; digitaalne infrastruktuur; Eesti.

CERCS-koodid: S180, S181, S189

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The generative-AI assistant **Claude** (model Sonnet 4.5) provided by Anthropic was employed solely for language-editing purposes during the preparation of this thesis:

1. **Stylistic refinement** – polishing wording, improving sentence structure, and strengthening academic tone in the theoretical chapter (Sections 1.1–1.2), the abstract, the limitations section, and the Estonian summary (*Kokkuvõte*).
   Typical prompt: "Revise the following paragraph to improve academic flow and reduce repetition while preserving the original argument and citations."
2. **Addressing supervisor feedback** – proposing revisions in response to tracked comments.
   Typical prompt: "The supervisor commented, 'Perhaps both concepts should be explained,these are not self-evident.' Revise the paragraph on transactional and relational mechanisms accordingly."
3. **Getting assistance from Codex for codding purposes** – getting help for codding in R programming language.

All research design, variable selection, data collection, empirical analysis (regression and cluster analysis), interpretation of results, and final conclusions were carried out independently by the authors **Nizam Aliyev** and **Najmin Khalafli**.

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