The Role of cluster ecosystems and intellectual capital in achieving high growth entrepreneurship: evidence from Germany

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Abstract

Purpose – This paper examines the role played by business cluster ecosystems and intellectual capital in achieving high growth firm (HGF) status.

Design/methodology/approach – We draw our insights from the knowledge-based perspective and economic geography as theoretical lens, which combined offers a more unifying understanding of how business cluster ecosystems and intellectual capital foster high growth entrepreneurship.

Findings – Drawing on a sample of 11,360 German incorporated firms across 80 clusters over the period 2010-2013, we find that cluster ecosystems play a significant role in supporting firms to become high-growth firms. More specifically, being located in business clusters increases the likelihood of becoming high growth firms (HGFs) by 2.2 percent - 4.49 percent. We also find that clusters with more productive firms in the ecosystems provide favourable conditions for member firms to achieve HGF status, while the impact of other cluster-specific conditions (High-tech cluster membership and MNE share in clusters) are less clear. Additional insights suggest that firm intellectual capital (investments in intangible assets) enables firms to achieve high growth status.

Research limitations/implications – The findings of this paper hold theoretical and managerial relevance and shed more light on the impact of cluster-specific factors in the ecosystems and firm intellectual capital in achieving high growth entrepreneurship.

Originality/value – This paper is among the first of its kind to bring together three distinct literatures (HGFs, business clusters and intellectual capital) and utilize insights from each to derive a conceptual framework that links them in explaining high growth entrepreneurship.

Keywords - Business Cluster; Ecosystems; Intellectual capital, High growth firms; Germany

Paper type Research paper

1. Introduction

The topic of High growth firms (HGFs) has attracted increasing attention from academic researchers and policymakers due to their significance for economic development (Beekman and Robinson, 2004; Tomczyk *et al.*, 2012). HGF refers to a firm with a significant growth rate in terms of the number of employees and turnover growth rates over a 3-year period (Du and Temouri, 2015). In comparison with firms that are not considered high-growth, HGFs disproportionately contribute to technological progress, job creation, high levels of innovation and internationalization, and above-average levels of productivity (Henrekson and Johansson 2010; Coad *et al.*, 2014; Hölzl, 2014; López *et al.*, 2018). Since the latest economic downturn caused by COVID-19 in 2020, HGFs remain leaders in their field to foster economic recovery and industrial resilience, even though the pandemic negatively affects the whole economy (Greene *et al.*, 2020).

Parallel to that, the increasing role of business clusters is at the forefront of the public debate and the international policy agenda (Masyuk *et al.*, 2019; Pöyhönen and Smedlund, 2014). In this paper, we take the view by Peltoniemi (2004) that a cluster can be represented as an ecosystem because the literature has indicated similarities between the two concepts of "entrepreneurship ecosystems" (EE) (Moore, 1993, p. 76) and "business clusters" (Porter, 2000, p. 254). In particular, the entrepreneurship ecosystem acts as an economic community to support the co-operative and competitive interaction between organizations and individuals, leading to the diffusion of innovations (Peltoniemi, 2004; Hannah *et al.*, 2019). Similarly, one of the key characteristics of a cluster is the tension between collaboration and competition, because firms simultaneously benefit from working together, whilst competing for customers and market share (Porter, 2000). Empirical evidence has shown that intra-cluster cooperation in business clusters results in learning and demonstration effects (Amdam *et al.*, 2020). Firms within the same region

and industry can learn from better performing organizations (Raspe and Van Oort, 2007). In addition, firms in clusters are often confronted with tougher competition, forcing them to continuously enhance their performance (Temouri *et al.*, 2020).

In this cutting-edge economy with the growth of technologically advanced and knowledge-based companies, intellectual capital (IC) is considered reliable resource for firm's value creation process and firm strategic advantage (Clarke *et al.*, 2011; Mariano, 2024; Martín de Castro and López Sáez Sardo, 2008; Rehman *et al.*, 2022; Sardo and Serrasqueiro, 2018; Temouri *et al.*; 2020; Xu *et al*., 2023). IC that is non-monetary and intangible in nature immensely enhances firm performance to lead a firm to economic growth and technological development (Salehi and Zimon, 2021; Sardo and Serrasqueiro, 2018). Previous research on intellectual capital has focused mainly on topics related to the definition, measurement and classification of IC (Choong, 2008; Dumay, 2009; Petty and Guthrie, 2000). Recently, some studies have examined the relationship between IC assets and business performance (Pena, 2002; Rehman *et al.,* 2022; Sardo and Serrasqueiro, 2018; Smriti and Das, 2018). A notable exception of a study by Temouri *et al.* (2020) reveals a significantly positive impact of investments in intangible assets and generating patents from research and development (R&D) efforts on the proclivity to become HGFs.

Several research gaps have been identified in literature. First, the understanding of the drivers, which support the likelihood of high-growth episodes, remains limited, given the important role of HGFs in the economy (Haltiwanger *et al.*, 2013; Hölzl, 2014; Lawless, 2014; Sardo and Serrasqueiro, 2018; Temouri *et al.*, 2021). Second, the evidence suggests the competition-led efficiency improvement among non-high-growth firms when they are close to fast-productivity-growth firms (Du and Vanino, 2020). Thus, it is reasonable to hypothesize that business cluster ecosystems are conducive to allowing firms to become high-growth not only due

to the proximity to other high-growth entities, but also due to the high level of competition, that may increase the standard to which firms need to succeed in order to stay in business cluster ecosystems. Nevertheless, there has been as yet little systematic analysis on how cluster ecosystems affect the likelihood of achieving high-growth status. Third, despite the recognition of the importance of IC for firm growth (Bontis, 2003; Choong, 2008; Dunmay, 2009; Mariano, 2024; Martín de Castro and López Sáez Sardo, 2008; Rehman *et al.,* 2022; Xu *et al.,* 2023, research on IC in the innovation environment in the EU is largely ignored (Veugelers *et al.*, 2015). Porter and Miranda (2009) highlight that business clusters enhance the dissemination of knowledge and the dispersion of innovation among cluster members. Whilst the link between firm intellectual capital and the likelihood of high-growth episodes in the context of cluster ecosystems remains underdeveloped.

Based on the observed research gaps, the question we put forward in this paper is how business cluster ecosystems and firm intellectual capital affect the likelihood of cluster firms relative to non-cluster firms to achieve the status of high growth entrepreneurship. The paper utilizes the knowledge-based perspective (Hoskisson *et al.*, 1999; Maskell, 2001; Lazzeretti and Cinti, 2006) and insights from economic geography (Krugman, 1991) as theoretical lens. The cognitive distance is small within clusters (Krugman, 1991) and the interdependent development among cluster members promotes the ability to create knowledge by variation and a deepened division of labour (Hoskisson *et al.,* 1999; Maskell, 2001). Inside business cluster ecosystems, inter-firm cooperation continuously enhances clusters' knowledge base (Lazzeretti and Cinti, 2006), thereby forming a knowledge environment to transfer information and create new knowledge quickly and freely among members (Spigel and Harrison, 2018). Whilst companies outside clusters are less likely to have such a supportive setting.

The findings from our analysis suggest that the impact from business cluster locations is statistically significantly different from non-cluster locations in Germany in achieving HGF status. In addition, firms who possess a higher level of intellectual capital (higher ratios of intangible assets to total assets) are benefiting in terms of high-growth entrepreneurship. The empirical results also lend support to the moderating effects from a cluster-specific conditions (high-tech cluster membership; and more productive firms in business clusters); and from firm intellectual capital (investments in intangible assets) on the relationship between business clusters and the likelihood of becoming a high growth firm.

This paper contributes new evidence to the literature in several dimensions. First, to the best of our knowledge, this paper will be among the first of its kind to bring together three distinct literatures (HGFs, business clusters, and intellectual capital) and utilize insights from each to derive a conceptual framework that links them in explaining high growth entrepreneurship. Second, we advance the methodology for identifying cluster firms and non-cluster firms in our exhaustive and large-scale sample of firms by drawing on the pre-existing published list and map of business clusters from the website of Federal Ministry for Economic Affairs and Energy of Germany. Furthermore, we rely on two dimensions (geographical proximity and industry specialization) of a business cluster suggested by Porter (2000) for the classification. This quantitative method enables us to capture the presence of firms who are part of a business clusters and firms who are not part of a business clusters. Whilst the large literature on cluster research is mostly qualitative and case study based (see Pereira *et al.*, 2020).

The remainder of this paper is set out as follows. In the next section, we will discuss literature, conceptual framework, and hypotheses. In Section 3, information on data, variables,

empirical models and descriptive statistics will be described. The empirical results are presented in Section 4. Finally, the last section provides the discussion and implications of our research.

2. Literature, Conceptual Framework and Hypotheses

The knowledge-based theory (Hoskisson et al., 1999; Maskell, 2001; Lazzeretti & Cinti, 2006) considers knowledge as the most crucial strategic resource to ensure sustainable differentiation and competitive advantages of organizations. According to Porter and Miranda (2009), knowledge environment is the nature of a business cluster and is one of the cluster-specific factors. We utilise the knowledge-based theory and extend it to derive our hypotheses related to business clusters and high-growth firms. In this research, we follow the argument that business clusters can be presented as an ecosystem as they have a set of common characteristics, including cooperation, competition, knowledge spillover and innovation (Peltoniemi, 2004). Autio (2016, p. 20) describes the ecosystems as "interaction systems comprised of loosely connected, hierarchically independent, yet mutually co-dependent stakeholders". Moreover, cluster ecosystems base their achievement on both cooperation and competition among interconnected actors and factors within a focal territory (Szerb *et al.*, 2017; Horváth and Rabetino, 2019). Some studies highlight the benefits of diversity in EEs as both a risk spreading strategy to manage disruptions (Roundy *et al.*, 2017) and an opportunity for disruptive technologies to evolve (Sussan and Acs, 2017). Having many firms from the same sector and supply chain working within a region helps attract and train new skilled workers (Content *et al.*, 2019). This clustering of firms in close proximity facilitates knowledge processing and creation, a key feature of success in modern economies (Szerb *et al.*, 2017).

From the knowledge-based perspective, knowledge dynamics are at the core of the development and application of innovation capabilities, especially in the innovation at the regional

or local level (Schiuma *et al.*, 2008; Schiuma and Lerre, 2008). According to the knowledge-based perspective of a cluster, a regional knowledge-based capital represents the added value generated by the member entities operating in the region and form knowledge assets that significantly drive innovation dynamics and regional growth (Maskell, 2001; Mariano, 2024; Schiuma and Lerro, 2008). The intra-cluster cooperation in cluster ecosystems brings favourable conditions for cluster entities to promote knowledge spillovers (Du and Vanino, 2020; Spigel, 2017). Jankowska *et al.* (2017, p. 187) highlight that there are two critical dimensions of a cluster ecosystem, including "spatial proximity" and "relational proximity". The spatial dimension favours contacts and fosters cluster entities to interact in both formal and informal settings (Isaksson *et al.*, 2016; Nam, Manchanda and Chintagunta, 2007). The relational dimension allows co-located firms to exchange information, especially uncodified knowledge (Du and Vanino, 2020). These two dimensions foster social capital in the ecosystems, and then reinforce agglomeration externalities.

Firm growth research is an integral part of entrepreneurship research since the 1980s (Audretsch, 2012; Azoulay *et al*. 2020; Birch, 1987) and much attention is focused on HGFs. The entrepreneur is seen to work not in isolation, but in an ecosystem that supports the social context in which entrepreneurship takes place (Audretsch, 2012; Audretsch *et al.*, 2007). Pereira *et al.* (2020) highlight that firms located within business clusters have a competitive advantage, as they are better able to draw from a pool of high-skilled workers, and indeed that many engineers, IT professionals, and those working in R&D may base their career decisions on their ability to move into a relevant industry cluster. Firms in cluster ecosystems have a relative advantage in that they have an enhanced ability to work both strategically with other firms and organizations outside their own organizations (Shin *et al.*, 2012). Such deliberate attempts to collaborate with business constituents benefit organizations and contribute to success both on the individual and collective

levels (Pereira *et al.*, 2020). Empirical evidence on the resilience of cluster-located firms (Helper *et al.*, 2000; Kranton and Minehart, 2000; Spigel and Harrison, 2018) uncover three success factors of cluster ecosystems, including (1) availability of a superior labour pool of high-skill workers (Malmberg and Power, 2005), (2) increased innovation within cluster-located firms (Baptista and Swann, 1998), and (3) access to collaborative linkages, including financiers (Lee *et al.*, 2020). This hints at an important, yet under-researched role of business cluster on entrepreneurial success (Temouri *et al.*, 2020; Du and Vanino, 2020). The above literature leads us to the first hypothesis as followed:

Hypothesis 1: Firms located in '*business cluster ecosystems'* have a higher likelihood of becoming HGFs.

Within cluster ecosystem, HGFs are valued for the positive spillover effects they produce (Weinblat, 2018). Since HGFs possess more advanced knowledge than other firms in the ecosystem, the spillovers can occur due to labour mobility, when workers leave HGFs or when non-HGFs start imitating (De Nicola *et al.*, 2021). These knowledge spillovers increase firms' overall cooperation, productivity, and competition in cluster ecosystems (Agostini *et al.*, 2020; Weinblat, 2018). Moreover, the knowledge spillovers in cluster ecosystems results in the development of cutting-edge technologies that entrepreneurs can access (Cao and Shi, 2021). There is a broad consensus that cluster ecosystems can help stimulate entrepreneurship, innovation, and technological development (Carayannis *et al.*, 2018; Kranton and Minehart, 2000; Ferreira *et al.*, 2018; Stam, 2015). Moore (1993, p. 76) highlights that firms in such communities as EEs "work co-operatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations". In addition, the visible and invisible

modes of governance and structure systems in cluster ecosystems set the processes for the clusters to follow (Cho *et al*., 2022; De Brito and Leitão, 2021; Peltoniemi, 2004; Spigel and Harrison, 2018; Usai *et al.*, 2018) and appropriate structural frameworks that support innovation (Scuotto *et al.*, 2020; Spigel and Harrison, 2018). If implemented successfully, these systems can enable ecosystems distinguish themselves from others, help attract external investment into the ecosystem (Bravo-Biosca, 2010), facilitate open innovation culture and sharing of knowledge and resources (Horváth and Rabetino, 2019; Masyuk *et al.*, 2019), and protect intellectual property rights (Fernandes and Ferreira, 2022; Martín de Castro and López Sáez Sardo, 2008). Furthermore, there is evidence showing that in creative business clusters, firms are inclined to invest heavily in internal research and development (R&D) and a large number of their staff devote to technology-intensive activities, driving innovation, digitalization and valuable knowledge spillovers (Florida, 2004; Flew, 2010). Some studies suggest that cluster ecosystems should be viewed as a digital economy phenomenon due to their emphasis on cutting-edge technology that facilitates entrepreneurial opportunities through radical business model innovation (Audretsch *et al.*, 2019; Autio *et al.*, 2018; Nicotra *et al.*, 2018). As such, we propose the second hypothesis as followed:

Hypothesis 2: Firms located in '*more technological and knowledge intensive'* business cluster ecosystems have a higher likelihood of becoming HGFs.

Due to the specialist knowledge they create, clusters are highly attractive locations for multinational enterprises (MNEs) and, in turn, MNEs may be important catalysts and disseminators of the knowledge creation process within the clusters (Tallman and Chacar, 2011). MNEs, recognized as core firms, occupy key positions in the hierarchical order of clusters (Bucheli

et al., 2018). It is highlighted that knowledge generation and absorption play a very important role in cluster growth and functioning (Porter and Miranda, 2009). Some recent empirical works have unveiled that MNEs are not only knowledge generators but also a knowledge seeker (Rugman and Verbeke, 2003). MNEs increasingly pursuit the augment of its knowledge base through obtaining access to foreign pools of knowledge. Hence, MNEs play a leadership role in cluster upgrading and sustaining through innovation and knowledge.

There is an increase of knowledge seeking via foreign direct investment (FDI) by MNEs (Bucheli *et al.*, 2018). MNEs are prone to enlarge their knowledge base by performing R&D investments in foreign locations with a strong technological activity (Rugman and Verbeke, 2003). In addition, R&D and innovation activities are conducive to the absorptions and generation of new knowledge (Hölzl, 2014). As a result, there is a co-evolution of both foreign subsidiaries and domestic firms via the strengthening of indigenous R&D activities in the host countries. After that, MNEs will replicate best practices and local embeddedness of know-how from foreign locations where their affiliates operate, thereby forming the intra-firm specialization in knowledge creating activities (Caloghirou *et al.*, 2020). In the context of business clusters, valuable knowledge transfer and subsequent knowledge diffusion are between different participants such as parents MNEs coincided with other cluster actors in home countries, and foreign subsidiaries along with indigenous firms in host countries (Rugman and Verbeke, 2003). The international sharing and international linkages form virtuous cycles of co-evolution that significantly contributes to the strengthening of knowledge base for MNEs and to the dynamic of clusters.

In addition, some attempts have been made to date to highlight that assimilation and transfer of knowledge is of vital importance for the support of firm growth (Hölzl, 2014). Macpherson and Holt (2007) argue that firm growth mainly relies on the processes through which

knowledge is utilized and acquired. A firm's knowledge enables firms promote its resource base and then generate new opportunities for firms to obtain superior performance and fast growth. Moreover, firms adopting a geographical diversification strategy increase the HGF incidence (Hölzl, 2014). Similarly, MNEs with a network of its foreign subsidiaries that act as satellites of the parent firms are more likely to scale up. Therefore, the MNEs' heritage of international intra-firm diffusion of knowledge are likely to significantly increases the likelihood of becoming HGFs. Hence, the aforementioned discussion derives our third hypothesis:

Hypothesis 3: Firms located in business cluster ecosystems '*with a higher share of MNEs'*, have a higher likelihood of becoming HGFs.

In terms of the relationship between productivity and high growth firms, much focus has been devoted to describing productivity and firm scalability (Bravo-Biosca, 2010, 2011; Du and Temouri, 2015). Scalability refers to the ability of a company to grow rapidly, whilst productivity is associated with the efficiency in the use of a given set of inputs to obtain the amount of output in production of a company. To be productive in any industry, firms are required to use advanced technology, employ sophisticated methods, and offer unique products and services (Dal Borgo *et al.*, 2013; Du and Temouri, 2015; Greene et al., 2020). A virtuous cycle between productivity and high growth has been highlighted in the scant literature (Du and Temouri, 2015; Greene et al., 2020). Du and Temouri (2015) reveal firms with total factor productivity (TFP) growth have a higher likelihood of growing fast and becoming HGFs. Bravo-Biosca (2011) highlight there is a positive relationship between the productivity growth and the dynamism of firms' growth rates.

In the context of cluster ecosystem, productive firms have a high visibility in a cluster and coincidently, clusters play a vital role in a company's ongoing ability achieve innovation and productivity growth (Porter and Miranda, 2009). Porter and Porter (1998) argue that the level of productivity and productivity growth is highest with the presence of a cluster, instead of isolated firms or industries. Purdy and Chang (2014) emphasise that the quality of the business environment strongly affect the sophistication of how member firms compete in a location. At the same time, productivity rests on how firms compete and that clusters expose the collective responsibility and mutual dependence of all these entities for generating the conditions for productive competition (Porter, 2000). Furthermore, cluster actors are subject to intensive competition from not only cluster members but also outsiders, due to the fact that business clusters grow into international markets, that provide greater incentives for achieving high productivity (Porter and Miranda, 2009; Porter and Porter, 1998). Intense rivalry is viewed as the key to sustained innovation and upgrading that drive a cluster (Coad *et al.*, 2014), and innovation is often associated with increases in productivity (Audretsch *et al.*, 2014; Hintringer *et al.*, 2021; Riley and Robinson, 2011). Furthermore, firms need to improve factor inputs in operational efficiency, quality, capital investment, innovation, and ultimately specialization to be able to increase productivity. Simultaneously, clusters provide firms with access to specialized inputs and information and promote complementarities among cluster participants. More importantly, geographic concentration also typically delivers better access to institutions, public goods and infrastructure (Delgado *et al.*, 2010; Porter, 2000; Porter and Porter, 1998). The presence of productive firms in the networks often amplifies many of the productivity and innovation benefits and hence enhances the productivity of all other firms, and vice versa Porter and Porter (1998). Due to high level of productivity and intensity of competition inside business clusters, firms with lower level of

productivity find it much more difficult to operate in a cluster network compared to productive establishments.

For these reasons, we propose that productivity plays a significant role in the association between business cluster ecosystems and the likelihood of becoming HGFs. As such, we propose hypothesis 4 as follows:

Hypothesis 4: **'***More productive firms'* located in business cluster ecosystems have a higher likelihood of becoming HGFs.

We next extend the analysis of cluster conditions and HGF status to the analysis of the link between intellectual capital and HGF episode. Firm growth and value creation are achievable only by those firms understanding the value of applicable resources such as information, creativity, innovation, and more importantly, intellectual capital (IC), as the fundamental source of others (Clarke *et al.*, 2011; Salehi and Zimon, 2021; Smriti and Das, 2018). Sveiby (1997) classified IC into three major components, including (1) structural capital (SC) such as databases and intellectual assets such as patents, copyrights and trademarks; (2) human capital (HC) such as the kind of knowledge that is generated by the cooperation of employees or divisions; (3) and relational capital (RC) that contains the value and knowledge from corporate networks among customers, suppliers, distributors, competitors and all other related parties.

In the competitive and uncertain environment of contemporary business, it is imperative for firms to make most effective use of their available resources, both tangible and intangible (Barney, 2001). There is a growing interest in understanding intangible assets and the potential role in driving firm growth. For example, there have been attempts to link intangible assets to

productivity growth in the UK (Dal Borgo *et al.*, 2013; Riley and Robinson, 2011), and they find that intangible assets have a significant, positive association with productivity, and that firms with a higher proportion of intangible assets are more likely to be highly productive. The various elements of intangible assets are also found to be crucial attribute of successful HGFs (Riley and Robinson, 2011; Spigel, 2017; Stam, 2015). When knowledge is framed as an intangible asset, it is recognized as a property or possession of the organization, typically consisting of intellectual property rights, investments or human, structural and customer capital (Dove, 1999; Hannah et al., 2019; Ferreira *et al.,* 2018; Macpherson and Holt, 2007; Sveiby, 1997). Thus, intangible assets present another measurement unit to complement our understanding of the sources of firm growth together with tangible factors of production. Besides, some empirical evidence suggests that access to intellectual property is associated with facilitating firm growth. In particular, the BERR study (2008) finds that HGFs have a greater propensity to hold intellectual property, including patents and trademarks, than do lower growth firms. Thus, HGFs seem to be able to better identify opportunities and exploit the advantages offered by a stronger provision of capital and knowledge resources compared to slower-growing firms.

Most of the research on intellectual capital has focused on individual companies rather than on more macro-level units such as regions or nations (Bontis, 2003; Pöyhönen and Smedlund, 2004). Recently, there is a meager literature on intellectual capital in regional clusters, highlighting the significance of intellectual capital creation on regional competitiveness (Schiuma and Lerro, 2008; Pöyhönen and Smedlund, 2004). Business clusters are the hub of the inter-organizational collaboration among cluster entities within the same geographical area and industry and such intra-cluster cooperation is attributable to the creation of knowledge-based value within the networks (Masyuk *et al.,* 2019; Peltoniemi, 2004; Pereira *et al.,* 2020; Porter and Miranda,

2009). From the insights of economic geography, the success of a region depends essentially on the ability of actors in the networks to employ, circulate and generate knowledge (Flew, 2010). Intellectual capital in regional clusters is created by three main knowledge creation activities among cluster members, including production networks, development networks and innovation networks (Martín de Castro and López Sáez, 2008; Pöyhönen and Smedlund, 2004; Rehman et al., 2022; Sardo and Serrasqueiro, 2018). Each of them is apt for a particular knowledge-based activity: a production network for implementing knowledge into practice efficiently, a development network for the dissemination of knowledge and best practices, and an innovation network is needed for the creation of new knowledge. Hence, Pöyhönen and Smedlund (2004) propose that the intellectual capital creation of regional clusters encompasses the whole spectrum of knowledge-based activities from the implementation and replication of the existing knowledge to innovations. Parallel to that, there has been an increase in empirical and theoretical work that addresses the role of knowledge spillovers and innovation as one of the main sources of firm growth (Temouri *et al.,* 2021; Weinblat, 2018). Thanks to knowledge-based activities, firm are able to engage in the process of creative production and development where firms have a capacity to introduce innovative products and processes to the market. Hence, firm-level innovation can be expected to lower the amount of labour required for the production of goods and services and have a positive influence on sales growth or productivity growth (Audretsch *et al*., 2014; Hannah *et al.,* 2019). With this set of thinking, the capacity of the regional cluster to create intellectual capital can be maximized and its ability for continuous self-renewal secured.

Based on the above literature, we test these ideas through the following hypotheses 5, 6 and 7:

Hypothesis 5: Firms who possess a higher level of intellectual capital (*investments in intangible assets* and *patents)* are more likely to become HGFs.

Hypothesis 6: The impact of '*investments in intangible assets'* on firms becoming HGFs is greater for firms in advanced business cluster ecosystems compared with firms located in less advanced business cluster ecosystems.

Hypothesis 7: The impact of '*patents'* on firms becoming HGFs is greater for firms in advanced business cluster ecosystems compared with firms located less advanced business cluster ecosystems.

We encapsulate the previous discussion of the literature and derivation of hypotheses in **Figure 1**, which represents our conceptual framework.

3. Methodology

3.1. Data and measurement

The empirical analysis in this paper draws on firm-level data from ORBIS provided by Bureau van Dijk. ORBIS is the world leading electronic publisher of annual accounts information for firms across the world. The ORBIS database includes a wide set of data on company profiles, employment, ownership, industry affiliation, total factor productivity (TFP), number of patents, financial data, and location. One of the key advantages of using ORBIS is that it provides an employment variable for each company annually, which we used to construct our dependent variable (i.e., HGF versus non-HGF status). In addition, ORBIS allows us to identify and track the location of every firm. The dataset also provides data on industrial classification for each firm on annual basis. Thanks to the detailed and comprehensive data, we can identify firms who are part

of business clusters and their non-cluster counterparts across Germany. All monetary values in the dataset are in thousands of US dollars. Hence, we use United States GDP Deflator (Trading Economics, 2021) to deflate monetary values.

In total, we have 11,360 firms over the time-period 2010 to 2013, which results in an unbalanced panel dataset of 36,296 firm-year observations. The dataset covers businesses in different industries and sectors in Germany and our choice of focusing on the period 2010-2013, rather than a more recent 3-year period, was driven by data availability that maximized our observations for firms that had enough information for key variables to measure the firm HGF status and productivity as well being observed for the entire 3-year period. We checked for any more recent 3-year periods and the trade-off between more recent data versus fewer observations (for both measuring HGF status and productivity) would have been detrimental for our subsequent analysis. We return to this aspect again in the conclusion section, where we highlight the scope for further research using different datasets. However, in general, we do not think that focusing on the 2010-2013 creates significant problems in terms of the main results, especially since they are based on a larger set of firms that covers more business cluster and non-cluster regions of Germany.

It is important to note that the classification of business clusters has been painstakingly derived from on the pre-existing published list and map of German business clusters published on the government website and the literature on business clusters. We also complement the cluster distinction with more general regional level indicators and policies, which are designed to support entrepreneurial and growth aspirations of firms in different regions of Germany (cluster as well as non-cluster regions). The analysis utilises Probit model regressions on the likelihood of becoming a HGF focusing on different conditions in the business cluster ecosystems (Cluster ecosystem membership; High-tech cluster membership; MNE share in clusters; and Productivity in clusters);

intellectual capital; and the moderating effect of intellectual capital as well as including a host of control variables, such as firm size, firm age, tangible assets, foreign firm, ROA, and level of competition in the region.

3.1.1. High-growth firms

In this paper, we adopt the definition of firm employment growth to describe high-growth incidence. In particular, for firms with 10 employees and more, we adopt the compounding annual growth calculation consistent with the Eurostat-OECD definition (2007, cited in Du and Temouri, 2015), that classify a business as a HGF if the company employs at least 10 employees at the start of the growth period, and experience an annual average growth in employment of 20% or more over a 3-year period. For companies with fewer than 10 employees, we rely on the small HGFs definition suggested by Clayton *et al.* (2013, cited in Du and Temouri, 2015), which captures firms with fewer than 10 employees and grow by more than eight new employees over a three-year period.

3.1.2. Business clusters

The empirical studies in this strand of literature are plagued by a lack of prior knowledge and information on location and industry of recognized clusters in specific countries (Martin & Sunley, 2003). To address this issue, we consider the definition of industry clusters with two main dimensions, including geographical proximity and industry specialization to identify firms who are part of a business cluster (Porter, 2000; Delgado et al., 2014; Hannan and Freeman; 1977; Kelchtermans et al., 2019). We establish a three-stage procedure to identify business cluster firms. First, we detect reference municipalities for recognized business clusters in Germany, based on

business cluster map and list from Federal Ministry for Economic Affairs and Energy of Germany (see **Appendix 1**). Second, we rely on NACE industrial codes (industrial activity classification as defined by Eurostat) for industry specialization of each business cluster. Third, we match reference municipalities with the corresponding NACE codes to identify cluster-located firms. After that, we are able to detect non-cluster firms in the dataset. This way is compatible with quantitative econometric analysis developed therein.

3.1.3. Business cluster conditions

In this paper, a number of business cluster conditions are investigated. First, we classify high-tech business clusters by relying our analysis on the industry specialization of a business clusters. Second, MNE share is included to distinguish the effect of a higher share of MNEs in a business cluster on the relationship of business cluster ecosystems and HGFs incidence. Third, Total Factor Productivity (TFP), which is calculated as a residual of a production function for each 2-digit industry, captures business clusters with more productive firms.

3.1.4. Intellectual capital

We base our analysis on the definition of intellectual capital that intellectual capital is a vital intangible asset to a business (Sveiby, 1997). Accordingly, we utilize the ratio of intangible assets to total assets (IATA) as a proxy variable for the investment in intangible assets as suggested by Jones and Temouri (2017). Besides, we also use the variable number of patents as another indicator for firm intellectual capital as suggested by Salehi and Zimon (2021) that structural capital is one of three major components of IC that includes intellectual assets such as patents, copyrights and trade and service marks. Thanks to these two different measures as proxies for the variable intellectual capital, we are able to ensure the robustness in our empirical analysis.

3.1.5. Explanatory variables

We use a set of explanatory variables, including firm age (the age of a firm calculated since the year the company was incorporated), firm size (measured by annual turnover as suggested by Jones and Temouri (2016), tangible assets, Herfindahl index (known as an indicator of the amount of competition among firms in the same industry), foreign firms, and Return on Assets (ROA). Those variables are discussed in the work by Evans (1987), Dritsakis *et al.* (2006), Mazzucato and Parris (2015), Monteiro (2019), Eklund (2020) as determinants of firm growth.

Table 2 demonstrates the correlations matrix with the values ranging from -0.11 to 0.33. That shows a very week correlation between our variables. Therefore, multicollinearity is not a problem.

(Insert Table 2 here)

3.2 Empirical model and specifications

We employed probit regressions on a dichotomous variable (HGF vs. non-HGF), with results reported as marginal effects. Equation (1) depicts the empirical model for the first hypothesis about the relationship between business cluster ecosystems and the likelihood of becoming HGFs.

$$HGF_{i,t} = \beta_0 + \beta_1 ClusterEcosystem_i + \Sigma\, ß_2 Firm_{i,t} + \Sigma\, ß_3 Industry_{i,t} + time_t + \varepsilon_{i,t} \quad (1)$$

where i denotes firm, t denotes time (i.e., year) and ε indicates the random error term representing all unobserved influences. In equation (1), the dependent variable HGF represents the employment growth of a firm i at time t, that offers a proxy for entrepreneurship in the context of this paper. $ß_1$ is the coefficient of primary interest as it quantifies the impact of being located in

business clusters on achieving high growth entrepreneurship. The vector $Firm_{i,t}$ captures a number of firm characteristics such as firm age, firm size, tangible assets, Herfindahl index, foreign firms and returns on assets (ROA). The vector $Industry_{i,t}$ includes industry dummy variables at two-digit NACE level as proposed by Eurostat definition. The time dummy variable covers a research period from the year 2010 to the year 2013.

Hypotheses 2, 3, and 4 test a set of cluster-specific conditions (high-tech business clusters, high-share MNE cluster, and business clusters with more productive firms).

Hypothesis 2 about cluster type (High-tech cluster vs. non-high-tech cluster) and HGF incidence is tested, using an equation in the following form:

$$HGF_{i,t} = \beta_0 + \beta_1 ClusterType_i + \Sigma\, ß_2 Firm_{i,t} + ß_3\, \Sigma Industry_{i,t} + time_t + \varepsilon_{i,t} \quad (2)$$

The variable $ClusterType_{i,t}$ in the equation is a dummy variable, equals 1 if the business cluster is a high-tech cluster (based on industry specification) and 0 otherwise. Accordingly, $ß_1$ quantifies the impact of high-tech business clusters on the likelihood of becoming HGFs.

Hypothesis 3 about the share of domestic and foreign MNEs in business clusters and the likelihood of becoming HGFs is tested by using the following equation.

$$HGF_{i,t} = \beta_0 + \beta_1 Cluster_i + \beta_2 MNE_{i,t} + \beta_3 Cluster_i * MNE_{i,t} + \Sigma\, ß_4 Firm_{i,t} + \Sigma\, ß_5 Industry_{i,t} + time_t + \varepsilon_{i,t} \quad (3)$$

In specification (3), an interaction term between business cluster and MNE share is included to verify the moderating effect of the MNE share in a cluster on the correlation.

We then include the interaction term of TFP into specification (4) to verify the moderating effect of productivity on the correlation between business cluster ecosystem and the likelihood of becoming HGFs. The model is as followed:

$$HGF_{i,t} = \beta_0 + \beta_1 Cluster_i + \beta_2 Productivity_{i,t} + \beta_3 Cluster_i * Productivity_{i,t} + \Sigma\beta_4 Firm_{i,t} + \Sigma\beta_5 Industry_{i,t} + time_t + \varepsilon_{i,t} \quad (4)$$

Hence, the impact of firm intellectual capital on HGF status is tested in hypothesis 5 and then we extend to test the link in the context of cluster ecosystem for hypotheses 6 and 7. Hypothesis 6 about the impact of intangible assets on the HGF incidence is tested by using the following equation:

$$HGF_{i,t} = \beta_0 + \beta_1 Advanced\ Cluster_i + \beta_2 Intangiblei_{,t} + \beta_3 Advanced\ Cluster_i * Intangible_{i,t} + \Sigma\beta_4 Firm_{i,t} + \Sigma\beta_5 Industry_{i,t} + time_t + \varepsilon_{i,t} \quad (5)$$

The variable Advanced $Cluster_i$ is a dummy variable to denote those clusters that are known to be in high-technology industries and sectors.

Hypothesis 7 about the impact of patent on HGFs for firms in advanced business cluster ecosystems compared with less advanced business cluster ecosystems is tested by using the equation as followed:

$$HGF_{i,t} = \beta_0 + \beta_1 AdvanceCluster_i + \beta_2 Patent_{i,t} + \beta_3 Advanced\ Cluster_i * Patent_{i,t} + \Sigma\ ß_4 Firm_{i,t} + \Sigma ß_5 Industry_{i,t} + time_t + \varepsilon_{i,t} \quad (6)$$

4. Results

The findings address our research question "How business cluster ecosystems and firm intellectual capital affect the likelihood of cluster firms relative to non-cluster firms to achieve the status of high growth entrepreneurship?" and empirical results support the theoretical hypotheses. Table 3 reports the results of marginal effects for equations (1)-(6). Column (1) exhibits the results for the baseline model regarding cluster ecosystem membership and the HGF incidence; Column (2) corresponds to the relationship between high-tech cluster membership; Column (3) presents the results related to MNE share in clusters; Column (4) indicates the results of productivity in clusters; Column (5) shows the results of intangible assets to total assets (IATA); and Column (6) presents the results related to patents in the context of the likelihood of becoming HGFs in clusters. For each variable, two rows of numbers are displayed. The first row presents the coefficient, and the second shows the standard error.

(Insert Table 3 here)

First, the results indicate a significantly important role of cluster ecosystem on firm to become a high-growth entity. With respect to Cluster ecosystem membership, the coefficients of the business cluster variable in specifications (1)-(5) are positive and significant at 1 percent level. The coefficients ranging from 0.022 to 0.0449 imply that being located in business clusters increase the likelihood of becoming HGFs by 2.2 percent - 4.49 percent. That is consistent with our hypothesis 1 that firms who are part of business cluster ecosystem have a higher likelihood of becoming HGFs.

Second, the findings, to some extent, highlight the role of some particular cluster-specific conditions on the achievement of HGF status for member firms. To investigate the impact of high-tech cluster membership, the variable high-tech and the corresponding interaction term are included in regressions. While the coefficient of high-tech variable is not significant in model (2),

it is positive and significant at 1 percent level in model (6). So, we find a piece of evidence to support the positive relationship between high-tech firms and their likelihood of becoming HGFs. Interestingly, the coefficient of the interaction term between high-tech and cluster is negative and significant at 1 percent level, confirming the moderating effect of cluster in the relationship between high-tech firms and HGF status. However, the negative and precisely determined coefficient of the interaction term between the high-tech variable and the cluster dummy indicate that the effect of high-tech firms outside business clusters is stronger than that inside business clusters. Our explanation for this result is that clusters are the ecosystems of technology and innovation where member firms benefit from such favorable conditions. Firms in business clusters may possess a certain level of technology to be able to survive and thrive in the ecosystems. While, high-tech firms outsides business clusters do not need to encounter the fierce rivalry from other firms, which allows them to focus more on achieving high-growth status.

In terms of MNE share, the results show negative and significant coefficients at 1 percent level. The finding suggests that the more international a firm is, the less likelihood of becoming HGFs the firm will experience. This is an intriguing finding and might be explained due to the fact that multinational firms normally reach a high level of growth already.

With regards to productivity, the coefficient of the productivity variable is negative and significant at 10 per cent level, implying that productivity exerts negative and significant effect of HGF incidence. Intriguingly, the coefficient of the interaction term between cluster and productivity becomes positive and strongly significant at 1 per cent level. The result supports our argument for hypothesis 4 that business cluster ecosystems with more productive firms bring favorable conditions for firms to achieve HGF status.

We now turn the results for the role played by intellectual capital in achieving HGF episode. To explore the impact of investments in intangible to total assets on HGFs and the moderating effect of business cluster, the IATA (intangible assets by total assets) variable, and the interaction term between cluster, high-tech and IATA are included. While the coefficient of IATA is positive and significant at 1 per cent level, the coefficient for the interaction term is not. That offers support to the fact that firm intellectual capital is very significant to the HGF incidence of a firm. The result confirms past study by Denicolai *et al.* (2014) that the extent of the HGF incidence of a firm is positively dependent on the value of its intangible assets.

Regarding the number of patents, our empirical result shows a negative and significant coefficient at 10 per cent level. The coefficient of the variable patent implies that number of patents is merely a contributor to achieve HGF episode. The results neither confirm the impact of patents on HG episode nor the moderating effect of cluster on the correlation between the impact of patents and HGFs incidence.

Turning to explanatory variables, all control variables are lagged for one-year period. Coefficients for such variables as firm age, firm size, tangible assets, Herfindahl index, and foreign ownership are statistically significant at 1 percent level. The coefficients of firm age and firm size are negative, indicating that small and young firms are more likely to become HGFs compared to large and old firms. This is consistent with the literature suggesting that entrepreneurial ventures will thrive when they are provided with a dynamic environment and given the freedom to disrupt the status quo and implement unique and innovative business processes and practices (Block *et al.*, 2017).

The coefficients for tangible assets are positive, highlighting that firms with higher level of tangible assets are more likely to have higher HGF incidence. The positive coefficients of

Herfindahl index reveal that the higher amount of competition among firms in the same industry contribute to the higher likelihood of becoming HGFs. The positive coefficients of the variable Foreign Ownership show that firms with the share of foreign ownership of at least 50% in the emerging market are more likely to become HGFs. The results are in line with discussion on determinants of firm growth in the work by Evans (1987), Dritsakis *et al.* (2006), Mazzucato and Parris (2015), Monteiro (2019), Eklund (2020).

5. Discussion and conclusion

In this study, we set out to examine the role of business cluster ecosystems and intellectual capital in helping firms become high growth entrepreneurship entities. Our findings confirm that cluster ecosystems that are represented as an EE, facilitate the development of HGFs. In addition, our finding, that high-tech firms have a higher incidence of becoming HGFs, supports the argument by Autio *et al.* (2018) that EEs should be viewed as a digital economy phenomenon that emphasizes cutting-edge technologies. Furthermore, we reveal that firms from cluster ecosystems with more productive firms benefit from the ecosystems to achieve HGF episode. Accordingly, productivity acts as a success factor in cluster ecosystems for firms to become a HGF.

We also find firms with high intellectual capital (represented by the intangible assets) are likely to have HGF incidence. This result is in line with the contention by Dove (1999) that high productivity and related rapid firm growth can be generated via investment in-, development of-, and effective use of intangible assets. Our findings suggest that both tacit and explicit knowledge is critical for firms to achieve high growth. However, one cannot judge the knowledge and its worth merely by patent registration as our findings suggest that firms with large number of patent registrations are less likely to become HGFs. The results therefore challenge the notion of linking

patents as a measure of high growth, prompting the need for more appropriate measures to capture the growth.

The paper contributes to the literature by developing the interrelationship of business cluster location, intellectual capital and high growth entrepreneurship. The critical role of knowledge in cluster ecosystems and the growth of firms is identified in this study. Business cluster ecosystems allow companies to use open innovation by combining knowledge flows to accelerate firm growth (De Brito and Leitão, 2021; Usai *et al.*, 2018). Furthermore, two critical dimensions (spatial proximity and relational proximity) of a business cluster form a basis for the effective creation of new knowledge among cluster entities. Thus, the process of knowledge creation emerges from the effective exchange and sharing of knowledge resources among members (Jabbour and Mucchielli, 2007; Li and Bathelt, 2018).

Empirically, this paper utilizes a very detailed dataset with a wealth of rich information, not been exploited in its entirety before. In addition, this is among the first of its kind that uses all this information combined in order to shed light on the above-mentioned research objective. Furthermore, one can utilize the results emanating from this study to outline a number of important avenues for future investigation. These would include findings at the intersections of entrepreneurial ecosystems such as business clusters and intellectual capital measures. Besides, our results throw light on the influence at firm-level growth trajectories.

5.1 Theoretical implications

Theoretically, our study makes a vital contribution to the knowledge-based perspective and economic geography literature, and hence extend the literature strands on cluster ecosystems, IC and HGFs. The results show that cluster ecosystem provide firms with greater incentives for achieving high growth status by allowing firms to raise the efficiency in their production,

development and innovation. Our study also portrays how learning possibilities for a firm are not homogeneous across supply chain partners (Isaksson *et al.,* 2016). We argue that when there is exchange of such asymmetrical knowledge within business clusters, there is facilitation of the process of sharing ideas and knowledge in the networks. Firms are prompted to learn from other actors, leading to the creation of new knowledge over time. A truly operating cluster continuously enhances its knowledge base, thereby enabling cluster members to possess higher strategic flexibility and faster response to market changes compared to outsiders (Du and Vanino, 2020).

Furthermore, we extend the cluster literature and the HGF literature by examining cluster-specific conditions that facilitate firms to achieve high-growth status. We find that the cluster-specific condition (more productive firms in business clusters) provides favourable conditions for member firms to achieve HGF status. In particular, clusters expose the mutual dependence and collective responsibility of all these entities for generating the conditions for productive competition (Porter, 2000). A strong cluster environment promotes growth at the region-industry level by raising the returns to business expansion, capital investment and innovation and facilitating operational efficiency, thereby bring favourable conditions to member firms to enhance their growth. In addition, the study fills a gap in the literature by highlighting the significance of intellectual capital for firms to achieve high growth status. This is in line with the findings in the extensive literature that IC represents the knowledge-based activities and processes that contribute to firms' innovation, value creation, competitive advantages, and hence drive firms to explore new areas and pursue continuous growth (Rehman *et al*., 2022; Xu *et al*., 2023).

5.2 Managerial and policy implications

Not all regional cluster ecosystems are the same. While extant literature does not explain why some EEs are more successful, we highlight certain drivers that can help managers choose which

ecosystem they become part of. Our findings also have implications for policymakers regarding the support they provide to firms in the regional EEs, and the speed at which they provide regulatory responses to changes in the dynamic business environment. The transition towards a global digital economy and industry 5.0 is occurring at a rapid pace. Policymakers and managers can use this information to identify potential HGFs and provide them with relevant support through investments. The findings can also help with designing business clusters with relevant governance models and structures that pose low bureaucratic costs and barriers, allow sharing of knowledge, and provide open innovation opportunities for high technology HGFs to take advantage of and sustain their growth.

5.3 Limitations and future research

There are some limitations to our study. First, we only investigated clusters in Germany, representing an advanced economy, that may limit the generalizability of our findings to other contexts. Future studies could compare regional clusters across developed and emerging economies and investigate how varying economic conditions affect the interrelation between cluster ecosystems, intellectual capital and high-growth entrepreneurship to improve the external validity of our findings.

Second, we based our classification of firms as ‘cluster’ and ‘non-cluster’ on pre-existing recognized business cluster maps and lists sourced from government websites. In the modern economy, firms operate as part of complex supply chains and value networks that extend beyond cluster boundaries. Hence, the impact of firms’ intellectual capital on their HGF status may not only be limited to clusters, but instead involve whole supply chains. This possibility certainly merits future research.

The third set of issues that we did not consider is how knowledge spillover occurs in the cluster ecosystem? How is tacit knowledge transformed into explicit knowledge? How is the knowledge held by firms protected and how can this be measured if patents are not an accurate measure of it? It would be fascinating to see future studies that could investigate such research questions in the context of different types of clusters and entrepreneurial ecosystems. Insights into such research questions would potentially require more qualitative research methods, such as case studies, interviews and survey techniques, which would complement the evidence provided by quantitative studies.

Last but not least, our measure for intellectual capital that mainly focuses on the type of structural capital could be improved upon. Future research could consider other types of intellectual capital such as human capital or relational capital. Scholars could then compare and contrast the impact of different types of intellectual capital on HGF episode. This may lead to an exciting future research agenda aimed at exploring intellectual capital in greater detail in the context of cluster ecosystems and HGF. Given the important role of business cluster ecosystems, this paper opens up a new line of enquiry in terms of research that bring together three distinct literatures (HGFs, intellectual capital and firm productivity).

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