

Entrepreneurship and the  
Geography of Innovation

*Essays on the Role of Related Variety*

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## Abstract

The traditional view that large industrial corporations are the primary engines of innovation and economic progress has gradually been replaced by the notion that *place* is the key organizing platform for innovative activity in the modern knowledge economy. The geography of innovation has shown that innovative activities tend to cluster in space, due to the advantages of certain cities and regions. Recent literature suggests that a regional diversity of economic activities that are *related* in a cognitive or technological sense is advantageous, as it facilitates knowledge spillovers that foster positive economic outcomes. This re-specifies the traditional dichotomy between economic specialization and diversity and opens up new lines of inquiry. This thesis aims to contribute to the literature on the geography of innovation and related variety with studies that treat the relationships between related industry variety, innovation and entrepreneurship in explicit fashions, thus addressing important research gaps. The overall purpose of the thesis is therefore to examine and explain the relationship between regional related variety and regional economic change, in terms of: (a) entrepreneurship, and; (b) innovation.

The thesis consists of an introductory text and five appended papers. Paper 1 provides a bibliometric study of the literature on related variety, while papers 2 to 5 provide empirical analyses that address the implications of related variety for regional economic outcomes in terms of growth, entrepreneurship and innovation. The main findings of the thesis work suggest that related variety facilitates knowledge spillovers that unlock entrepreneurial opportunities, and that knowledge spillover entrepreneurship underpins the external economies of scope that arise from related variety. In addition, the thesis finds that entrepreneurship is an important driver of economic diversification in related activities. Furthermore, findings presented in the thesis align with previous literature that has reported a positive influence of related variety on regional innovation, which indicates the presence of positive knowledge externalities that foster innovation. It is however argued that the thesis work extends on previous findings by emphasizing the function of entrepreneurship in realizing the knowledge spillover effects of related variety. The importance of entrepreneurship is further reinforced by the finding that *unrelated* variety in particular is associated with firm-level entrepreneurial innovation. Drawing on the notion of Knightian uncertainty, the thesis work concludes that the process of innovation may require business decisions under ‘true’ uncertainty about expected returns, particularly when combinations of unrelated knowledge are attempted as they are new and unprecedented, and such pursuits can be understood as acts of entrepreneurial innovation.



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*Thomas Ejdemo  
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## Appended papers

- Paper I.** Örtqvist, D., & Ejdemo, T. Related variety: A bibliometric review and analysis. *(Submitted to peer-reviewed academic journal)*
- Paper II.** Ejdemo, T., & Örtqvist, D. (2021). Exploring a leading and lagging regions dichotomy: Does entrepreneurship and diversity explain it? *Journal of Innovation and Entrepreneurship*, 10 (6).
- Paper III.** Örtqvist, D., & Ejdemo, T. Cross-lagged Associations of Related Variety, Regional Entrepreneurship and Regional Innovation: A test of Regional Branching in Swedish Functional Analysis Regions. *(Submitted to peer-reviewed academic journal)*
- Paper IV.** Ejdemo, T., & Örtqvist, D. (2020). Related variety as a driver of regional innovation and entrepreneurship: A moderated and mediated model with non-linear effects. *Research Policy*, 49 (7).
- Paper V.** Ejdemo, T. & Örtqvist, D. Entrepreneurial innovation, multilevel knowledge flows and regional industry variety: A longitudinal study of Swedish firms. *(Submitted to peer-reviewed academic journal)*



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# 1. Introduction

This section provides a brief background which situates the research that is presented in this thesis in relation to relevant literature. The section provides the main motivations for undertaking this research with respect to the research gaps that the thesis attempts to address, and the section concludes by formulating an overarching research question and purpose.

## 1.1 Background

Increasing rates of urbanization and agglomeration of human activity are prominent features of modern societies. The UN (2019) estimates that more than two thirds of the world's population will live in urban areas by 2050. At the same time, many cities and regions face demographic and economic decline, for example due to deindustrialization (De Groot et al., 2016). Schumpeter (1934) famously argued that the introduction of *new combinations* bring about the competitive elimination of the old, and in similar reasoning, the source of a region's prosperity in one period may be eroded in the next by competing new combinations that are introduced in other places. Cities and regions therefore depend on innovation and the ability to deploy their productive resources in new and competitive ways, or they may eventually face economic and social decline.

The characteristics that underpin an economy's ability to achieve innovation and growth are important to shed light on, not least to inform policy design. With respect to this, Schumpeter (1942) argued that large-scale industrial establishments had become the primary engines of economic progress. Landström (2008) notes that this view persisted for several decades, but as globalization and technological advances gave rise to the modern knowledge economy, scholars and policymakers have recognized the increasing importance of small and medium-sized knowledge-based enterprises as key drivers of innovation and growth. This emphasizes the importance of entrepreneurship for cities and regions that seek to maintain and enhance prosperity. According to Florida et al. (2017), the industrial corporation has been replaced by *place* as the key organizing unit for innovation in the knowledge economy, as cities and regions provide platforms for organizing "the firms, individuals, talent, and other institutions and services" that innovation depends on.

Economic geographers and scholars in related fields have studied why some places become successful hubs of innovative activity and economic growth while others stagnate or decline. The composition of regional economies has been of particular interest (e.g. Kemeny & Storper,

2015), as industry structure has implications for the possibilities of knowledge to transfer between economic actors (e.g. Feldman & Kogler, 2010). An important topic in this literature is the presence of positive knowledge externalities due to spillovers, and to what extent important externalities arise either from geographic concentration of industries or from a diversity of economic activities. This line of inquiry was initiated by Glaeser et al. (1992) and has become known as ‘MAR versus Jacobs’, with reference to theories that favor either specialization (Marshall, 1890; Arrow, 1962; Romer, 1986) or diversity (Jacobs, 1969). As documented by De Groot et al. (2016), the seminal contribution by Glaeser et al. (1992) was followed by a substantial literature that has aimed to determine whether specialization (i.e. the geographic concentration of an industry) or diversity affords greater external economies, but no conclusive empirical evidence has emerged from these efforts.

Frenken et al. (2007) proposed an alternative way to think about diversity in terms of *related* and *unrelated variety*. In this view, related variety refers to industry compositions that consist of economic activities with low cognitive distance (e.g. Boschma, 2005), which facilitates spillovers between activities that have complementary knowledge and is thus thought to foster innovation (Frenken et al., 2007). As shown in a review by Content and Frenken (2016), a promising empirical literature has emerged which supports the overall hypothesis that related variety is positively associated with regional economic growth, which implies a positive influence on innovation. Following its introduction in 2007, the notion of related variety was quickly established in European regional policy discourse and is cited as the key to successful economic diversification (e.g. Foray et al., 2012).

## **1.2 Research problem and purpose**

Although the emerging empirical literature on regional related variety supports that it is associated with positive knowledge externalities, the review by Content and Frenken (2016) identified several research gaps that have since only been partially addressed. First, only a modest number of studies have considered the relationship between related variety and explicit measures of innovation (e.g. Tavassoli & Carbonara, 2014; Castaldi et al., 2015; Miguelez & Moreno, 2018; Barbieri et al., 2020). This means that the ‘mechanism’ through which related variety fosters for example employment growth has remained rather implicit in the extant literature, and consequently the need for more explicit treatments of innovation is a gap that this thesis attempts to address.

Second, the relationship between regional related variety and innovation has mainly been investigated using patent-based measures of innovation. There is a need to consider alternative and more direct measures of innovation to improve the knowledge on mechanisms that explain ‘how’ related variety fosters positive economic outcomes. An example of such a measure is found in Aarstad et al. (2016) who used an explicit firm-level measure of product innovation based on survey responses.

Third, the study by Aarstad et al. (*ibid*) is a rare example of empirical work on the relationship between regional industry variety and firm-level innovation outcomes. Current knowledge about the relationship between related variety and innovation thus lacks empirical evidence obtained at the firm-level of analysis, which is the third relevant gap this thesis aims to address. Efforts to fill this gap may enable policy-relevant insights on how firm-level characteristics affect the implications of regional industry variety.

Fourth, as raised by Content and Frenken (2016), the relationship between regional related variety and entrepreneurship is underexplored. A modest number of previous studies have examined this relationship (e.g. Bishop, 2012; Colombelli, 2016; Guo et al., 2016; Tavassoli & Jienwatcharamongkhol, 2016; Basile et al., 2017; Fritsch & Kublina, 2018; Content et al., 2019), but there is a lack of studies that explicitly consider the role of the innovating entrepreneur as the agent of change that Schumpeter (1934) describes. Acs et al. (2009; 2013) emphasized that entrepreneurs are conduits for spillovers of knowledge and the ensuing innovative activity, which implies that the interplay between entrepreneurship and innovation performance should be investigated jointly with the influence of regional related variety, in order to advance theoretical as well as empirical insights.

Fifth, there is a scope for examining some assumptions that implicitly underline the extant literature regarding the relationship between related variety and relevant regional economic outcomes. While the published empirical work generally finds evidence of a positive relationship, there is a lack of studies that consider if the ‘returns’ to related variety are linear in nature or not. In addition, there is a scope for paying increased attention to causality in the observed relationships between related variety, entrepreneurship and innovation. An associated literature deals with the notion of ‘regional branching’ (e.g. Frenken & Boschma, 2007; Boschma & Frenken, 2011a) and suggests that regions tend to diversify in related rather than unrelated technologies. An implication is that innovation and entrepreneurship may enhance

related variety over time in a region, but there is a lack of studies that examine directional causality in this sense using explicit measures of related variety.

Based on the above, the overarching research question of the thesis work can be formulated as:

*RQ: What is the relationship between regional related variety and: (a) entrepreneurship; (b) innovation?*

The overall purpose of this thesis is thus *to examine and explain the relationship between regional related variety and regional economic change, in terms of: (a) entrepreneurship, and; (b) innovation.*

## **2. Theoretical frames of reference**

This section introduces the main theoretical frames of reference that underpin this thesis. First, a general discussion of knowledge spillovers as a source of innovation is provided and the role of entrepreneur's is briefly addressed. Second, the section situates knowledge spillovers as central to the external economies of scale and scope that are thought to explain why some regions become successful hubs of innovation and growth, while others stagnate or decline. This leads to a conceptual introduction of the notions of related and unrelated variety and their implications. The section concludes with a review of the extant literature on related and unrelated variety. The review outlines the research gaps that this thesis attempts to address. The papers that are appended to this thesis are largely ignored in the review, as they are described in detail in later sections.

### **2.1 Knowledge spillovers and innovation**

The endogenous growth theory emphasizes that ideas are nonrival and therefore, investments in the creation of new knowledge are associated with increasing returns to society (e.g. Romer, 1990). It is well-known that the pursuit of innovation through R&D creates knowledge that can spill over to other entities without a priced transaction (e.g. Hall & Rosenberg, 2010). Therefore, it has been argued that private incentives to invest in R&D are reduced which may lead to underinvestment relative to the socially desirable level (Spence, 1984). This makes the case for appropriability regimes such as patents that enable firms to profit from their inventions (Teece, 2010).

While the ability to patent technical knowledge provides important incentives for R&D, it has also been argued that patents may involve social costs by for example creating barriers to entry and by reducing spillovers that are beneficial for society at large (Spence, 1984; Cohen, 2005). Romer (1990) clarified that new knowledge embodied in patents is only partially excludable, which suggests that private incentives to invest in knowledge creation co-exists with a scope for positive externalities. Patented technologies cannot be copied and sold without compensation to the inventor, but other inventors cannot be excluded from studying and learning from the knowledge that is embodied in the patent.

The relationships between knowledge creation, innovation and appropriability regimes are thus far from straightforward for several reasons, including ones beyond those briefly addressed here (see for example Dosi & Nelson, 2010), and other means of knowledge appropriation are frequently employed by firms (see Hall et al., 2014, for a review). What is clear is that whether

knowledge is generated at the firm's own expense or accessed through external knowledge flows, new knowledge is an input that innovative firms depend on (Roper & Hewitt-Dundas, 2015).

Hall and Rosenberg (2010) note that the ways in which knowledge may be transferred through spillovers are diffuse, but it is at least conceptually possible to disentangle spillovers from other forms of knowledge flows. For clarity, the term 'externalities' in the following discussion refers to gains caused by successful appropriation of spillovers of external knowledge, broadly known as 'knowledge externalities'. Drawing on Andersson and Karlsson (2007), one can think of knowledge flows that are embodied in formal transactions between firms such as R&D collaboration, as distinct from knowledge spillovers that may occur in two different forms. First, a firm may receive external knowledge as a side-effect of market transactions, causing positive pecuniary externalities. Second, spillovers may occur due to non-market actions such as observing others, causing 'pure' or 'technological' externalities when the new knowledge is appropriated. Since these mechanisms are indeed diffuse, not least to operationalize empirically, the treatment of knowledge spillovers in this thesis may be understood as potentially encompassing both pecuniary and technological externalities.

Empirical studies of firms' innovation output have often utilized the knowledge production function approach, which was originally formalized by Griliches (1979). This approach has been described by Acs and Audretsch (2010) as the most prevalent theory about innovation and technological change. Foray and Lissoni (2010) note that this literature particularly emphasizes the externalities that arise due to spillovers of external knowledge, in addition to firms internal innovation efforts.

### *2.1.1 Knowledge spillover theory of entrepreneurship*

It appears clear that knowledge spillovers are a relevant source of input to innovation processes, but the entrepreneur is so far absent from this theory. Acs et al. (2009) noted that the role of entrepreneurial activity was neglected in endogenous growth models that emphasize investment in knowledge creation (e.g. Romer, 1990), despite the technological opportunities that arise from spillovers. In response, Acs et al. (2009) developed the knowledge spillover theory of entrepreneurship (KSTE), which suggests a strong relationship between spillovers from the stock of knowledge and entrepreneurial activity, as opportunities are identified and exploited by entrepreneurs. One implication of this model is thus that entrepreneurship is an

important conduit for the spillover of knowledge. Empirical tests that have supported the KSTE include for instance Qian and Acs (2013), Plummer and Acs (2014), and Colombelli (2016).

## **2.2 The geography of innovation**

According to the geography of innovation (Feldman, 1994), proximity and location have important implications for innovative activity. Feldman and Kogler (2010) summarize a series of stylized and commonly accepted facts that have been clarified by this literature. These include for instance that: innovation is spatially concentrated; geography provides a platform to organize economic activity; knowledge spillovers are localized, and; places have uneven endowments in terms of urbanization, localization, and diversity. These uneven endowments are sources of external economies of scale and scope, or *agglomeration economies*, which are of core interest to this thesis and will therefore be given some attention below.

Urbanization economies refer to advantages that are associated with the size and density of a geography, such as access to different amenities (Florida et al., 2008). According to Florida et al. (2017), cities provide “the enabling infrastructure where connections take place, networks are built and innovative combinations are consummated”. In contrast to size, the external economies that arise from localization and diversity are more particular to the composition of a regional economy. Localization economies arise due to spatial concentration of an industry, thus creating specialized clusters and economies of scale, whilst diversity economies arise from the cross-fertilization of ideas between different industries (Feldman & Kogler, 2010).

As noted by Feldman and Kogler (*ibid*), research on these external economies has tended to focus on specialization and diversity, often situating them within a dichotomous framework. The prevalence of knowledge externalities due to spillovers has been a core interest in this literature. A study by Glaeser et al. (1992) is typically pointed to as initiating a line of inquiry which tries to determine whether specialization or diversity is more favorable.

Two main theoretical perspectives on specialization and diversity can be distinguished. First, the Marshall-Arrow-Romer (MAR)-perspective (drawing on the work of Marshall, 1890; Arrow, 1962; Romer, 1986), which emphasizes geographical concentration of same-industry firms, as this is thought to foster knowledge spillovers that diffuse technical information in addition to fostering development of local specialized suppliers and pools of workers (Feldman & Kogler, 2010). Second, and in contrast to the theory on MAR-externalities, Jacobs (1969) had argued that important knowledge spillovers occur *between* rather than *within* industries,

and the theory on Jacobs-externalities thus emphasize that cross-fertilization of ideas from different sectors are conducive to innovation (Feldman & Kogler, 2010).

After Glaeser et al. (1992) reported findings that supported the ideas of Jacobs (1969), a substantial empirical literature has examined the effects of these externalities (i.e. ‘MAR versus Jacobs’) on regional economic development, to understand their importance and influence. Glaeser (2000) concluded that at the time, the question remained unresolved, as there was evidence in favor of either. More recently, De Groot et al. (2016) conducted a meta-analysis of this literature, which in their sample reflects 73 scientific articles that had reported statistically significant estimates. Their findings reveal mixed evidence: about fifty percent of the empirical literature concludes that diversity rather than specialization encourages employment growth; specialization appears to be more important in ‘low-density’ places such as mid-sized manufacturing centers; specialization appears to have a positive effect in studies that focus on patents or innovations, while externalities due to diversity appear to have a positive impact on urban growth. The overall conclusion is that the conventional lines of inquiry in the literature under scrutiny “have reached strongly diminishing returns” (ibid, p. 776).

### **2.3 The introduction of related variety**

The economic concepts of related and unrelated variety were introduced to the wider research community by Frenken et al. (2007), in what must be considered a seminal paper. They advanced the idea that the diversity of economic activities in a region could be conceptualized as either *related* or *unrelated variety*, and proposed an approach for how to operationalize these notions empirically. The paper has later been described by Content and Frenken (2016) as an attempt to resolve the ‘MAR versus Jacobs’ problem briefly outlined in the previous section, and the empirical literature that followed appears promising in this regard. These research efforts are associated with the emerging framework of Evolutionary Economic Geography (e.g. Frenken & Boschma, 2007; Boschma & Martin, 2010; Boschma & Frenken, 2011b).

Frenken et al. (2007) suggested that their view of variety had two important implications for regional economic development: (i) related variety would enhance the presence of Jacobs-externalities, and; (ii) unrelated variety would enhance a region’s resilience towards external shocks, drawing on portfolio-theory. The notion that Jacobs-externalities arise due to knowledge spillovers between related industries rests on the argument that related industries have similar knowledge about technologies and markets (Content & Frenken, 2016). Therefore, there is low cognitive distance (e.g. Boschma, 2005) between them, which enables spillovers

to be appropriated in new combinations of complementary knowledge, more so than spillovers between unrelated industries. This emphasizes that related variety is distinct from specialization, which implies same-industry spillovers.

A clear implication is that regions would benefit from having a density of related economic activities, as firms that use similar technologies or operate in similar markets could more easily appropriate spillovers of external knowledge and, through innovation, create new products and technologies, which fosters employment growth. High levels of unrelated variety on the other hand implies a regional economy that is diversified in economic activities that have little similarities and are therefore not exposed to the same markets and business cycles, which enhances its resilience.

#### **2.4 An overview of the literature on related variety**

As part of the thesis work, a bibliometric study of the empirical literature on related variety was conducted. This work identified 136 studies that had been published in 55 different journals from the year 2007 until 2020. The body of literature has been growing at an annual rate of approximately 20 percent. Frequently occurring publication outlets include some of the top journals in economic geography and its related fields. This suggests that research efforts on the notions of related and unrelated variety appear to be fruitful and lead to meaningful contributions.

The first study to examine the influence of related variety on regional economic outcomes was naturally Frenken et al., (2007), who analyzed data at the NUTS 3 level from the Netherlands and found that related variety was positively associated with employment growth. Other early studies that reported a positive influence of related variety on regional economic outcomes such as employment- or productivity growth include Boschma and Iammarino (2009), Bishop and Gripiaios (2010), Quatraro (2010), Bosma et al. (2011), Falcioğlu (2011), and Hartog et al. (2012). More recent studies on the influence of related variety on these outcomes include Cortinovis and van Oort (2015), van Oort et al. (2015), Wixe and Andersson (2017), Firgo and Mayerhofer (2018), and Fritsch & Kublina (2018). The influence of unrelated variety appears to be more unclear, with many mixed or statistically insignificant results reported in the extant literature.

Closely associated concepts also appear in the literature around the same time as Frenken et al. (2007). One example is Saviotti and Frenken (2008), who studied the relationship between

export variety and economic development in OECD countries, and found that related export variety stimulates national economic development. The literature on 'regional branching' similarly suggests that regions tend to diversify into related, rather than unrelated technologies (Frenken & Boschma, 2007; Boschma & Frenken, 2011a). Empirical studies on the notion of regional branching have operationalized relatedness with alternative measures such as revealed relatedness (Neffke et al., 2011) or product proximity (Boschma et al., 2013; Colombelli et al., 2014; Boschma & Capone, 2015a; Boschma & Capone, 2015b). This literature generally finds path-dependencies in how the productive structure evolves, meaning that diversification tends to occur mainly in related technologies. The influence of entrepreneurial activity on the regional branching process appears to be an overlooked question and a relevant gap, as identified by Boschma (2017). An implication could be that entrepreneurial activity reinforces either related or unrelated variety as entrepreneurs exploit opportunities by creating new firms that contribute to regional economic diversification. Some empirical evidence has emerged, as a recent study by Neffke et al. (2018) found that entrepreneurs, particularly non-local, were important agents of structural change in Swedish regions as they contributed to unrelated diversification. However, as far as the author is aware, no studies have addressed the notion of regional branching using an explicit measure of related variety as operationalized by Frenken et al. (2007). Given the implications of KSTE and regional branching, there is a scope for examining the causal relationship between related variety and entrepreneurship.

An associated literature has explored the role of labour mobility and skills-relatedness. These studies include for example Boschma et al. (2009), Eriksson (2011), Östbring and Lindgren (2013), Boschma et al. (2014), and more recently Östbring et al. (2017). This literature tends to find a productivity-enhancing effect of inflow of skills that are related to existing knowledge bases.

Our bibliometric analysis suggests that research on related and unrelated variety has taken greater interest in entrepreneurship and innovation during recent years. Tavassoli and Carbonara (2014) were the first to report an explicit positive relationship between related variety and regional innovation, measured as region-level patent applications in Sweden. Further evidence in support of a positive relationship between related variety and regional innovation has been reported by Castaldi et al. (2015) and Miguelez and Moreno (2018). In addition, Aarstad et al. (2016) analyzed Norwegian data and found that regional related variety fostered firm-level innovation. In regards to unrelated variety, a promising emerging literature

has reported evidence which suggests that unrelated variety is an important source of rare but radical innovations (e.g. Castaldi et al., 2015; Miguelez & Moreno, 2018; Barbieri et al., 2020). These combinations of previously unrelated technologies are analogous to Schumpeterian ‘new combinations’ that appear discontinuously and may have disruptive impacts. However, with the exception of Aarstad et al. (2016), studies on the relationship between related variety and innovation typically rely on patent-based measures and consider aggregate regional-level outcomes. There is a need for studies that consider alternative measures of innovation, as well as a need for studies that consider innovation outcomes at the firm-level to shed light on how firm-level characteristics influence the implications of related variety.

There is also an emerging literature which supports a positive relationship between related variety and entrepreneurship (Bishop, 2012; Colombelli, 2016; Guo et al., 2016; Content et al., 2019), including a positive influence on firm-survival (Basile et al., 2017; Tavassoli & Jienwatcharamongkhol, 2017). This is in line with the KSTE (Acs et al., 2009; 2013), which predicts that entrepreneurship is an important conduit for the spillover of knowledge. However, clarifying the explicit links between related variety, entrepreneurship and innovation as Content and Frenken (2016) called for in their review, remains an underexplored area. In addition, the extant literature has not provided clear theoretical advances on the role of unrelated variety for entrepreneurship (Content et al., 2019). These are the primary gaps that are addressed by the empirical work that is presented in this thesis.

### **3. Research design and methods**

This section introduces the overall research design that has been employed to address the research question stated in the first chapter. The thesis draws mainly on theoretical and empirical approaches from economic geography and the economics of innovation and entrepreneurship. Methodologically, this implies an emphasis on quantitative empirical approaches to analyze secondary data and derive findings of probabilistic nature.

#### **3.1 Overall research design**

The thesis comprises this introductory text and five appended papers: one bibliometric analysis and four empirical studies that rely on quantitative approaches to analyze secondary data. The bibliometric study was undertaken with the goal of characterizing the relevant literature on regional related variety in terms of how topics of interest have evolved and what the remaining research gaps are. Intermittent literature searches were also performed throughout the thesis work, including utilizing the technique of ‘snowballing’<sup>1</sup>. The aim was initially to develop an understanding about the concept of related variety itself and the relevant field, in terms of theoretical frames of reference and methodological approaches. Over time, the emphasis was increasingly to inform the thesis work about ongoing developments in relation to previous contributions, and emerging topics of interest.

The four quantitative analyses that are appended to this thesis all employ different empirical approaches that were chosen in order to address the corresponding research objective. Table 1 provides an overview of the methodological approaches used in each study. As shown, the thesis draws on several different databases and employs a variety of quantitative methods. The analytic strategies are discussed in more detail in section 3.6.

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<sup>1</sup> Snowballing involves carefully scanning the reference lists of relevant articles to find additional literature of interest, as described by De Groot et al. (2016).

**Table 1. Overview of methodological approaches**

| Paper | Main objective  | Unit of analysis   | Sample  | Databases  | Analyses  |
|-------|---|--|---|--|---|
| 1     | Provide bibliometric analysis of related variety-literature   | Peer-reviewed articles   | 136 peer-reviewed articles published in 55 journals between the years 2007 and 2020 | •Scopus  | Bibliometric analyses                                       |
| 2     | Examine how interregional disparities in industry variety and entrepreneurial activity manifests empirically  | Functional analysis (fa) region  | Cross-sectional data for (all) 60 Swedish fa-regions                                | <ul style="list-style-type: none"> <li>•Raps-RIS (regional economic statistics)</li> <li>•Swedish Agency for Growth Policy Analysis (new firm formation)</li> </ul>  | Cluster analysis; multiple discriminant analysis            |
| 3     | Analyze directional causality between related variety, entrepreneurship and innovation  | Functional analysis (fa) region  | Panel data for (all) 60 Swedish fa-regions  | <ul style="list-style-type: none"> <li>•Raps-RIS (regional economic statistics)</li> <li>•Swedish Companies Registration Office (no. of firm entries, exits, and incumbents)</li> <li>•Swedish Patent and Registration Office (no. of patent applications)</li> </ul>  | Cross-lagged SEM  |
| 4     | Analyze the relationship between related variety and innovation, and between related variety and entrepreneurship taking influence of knowledge appropriation mechanisms into account | Functional analysis (fa) region  | Panel data for (all) 60 Swedish fa-regions  | <ul style="list-style-type: none"> <li>•Raps-RIS (regional economic statistics)</li> <li>•Swedish Companies Registration Office (no. of firm entries, exits, and incumbents)</li> <li>•Swedish Patent and Registration Office (no. of patent applications)</li> <li>•Statistics Sweden (corporate R&amp;D expenditure by FA-region)</li> </ul> | Fixed effects model; Tobit model                            |
| 5     | Analyze the influence of regional related and unrelated variety on firm-level product innovation, and on firm-level entrepreneurial innovation  | Firm-level dependent variables; firm- and region-level explanatory variables | Panel data on 1160 Swedish firms, matched with Swedish fa-region panel data         | <ul style="list-style-type: none"> <li>•Swedish Community Innovation Survey (firm-level innovation activity)</li> <li>•Raps-RIS (regional economic statistics)</li> <li>•Statistics Sweden (corporate R&amp;D expenditure by FA-region)</li> <li>•Swedish Patent and Registration Office (no. of patent applications)</li> </ul>               | Multilevel (i.e. mixed-effects) logistic- and Tobit models. |

The first two research objectives in table 1 can to some extent be viewed as descriptive. The thesis work has addressed them in exploratory approaches, where paper 1 conducts a bibliometric analysis and paper 2 employs classical techniques such as cluster analysis and multiple discriminant function analysis to analyze regional cross-sectional data. In doing so, paper 2 provides an unusual empirical perspective on how different levels of related variety and entrepreneurial activity manifests at the regional level, which will be discussed in more detail in later sections of this thesis. In addition, the research objective is to some extent addressed in section 3.5 of this introductory text, which uses maps to illustrate interregional disparities in variables that are central to this thesis.

The remaining three research objectives are of a more analytical nature. The thesis work has addressed them through an explanatory approach that follows the hypothetico-deductive method, which involves forming falsifiable hypotheses based on theoretical frames of reference in relation to current understandings found in the extant literature. These hypotheses are then subjected to empirical tests, where the thesis work has relied on analyses of secondary data and utilized methods such as structural equation modelling, multilevel (i.e. mixed-effects) modelling, and econometric models for panel data.

### **3.2 Literature search**

As a part of the thesis work, a structured search- and screening process was performed to collect the sample for the bibliometric study that is appended to this thesis. The notion of related variety (Frenken et al., 2007) was the main concept of interest. An initial search in the Scopus database resulted in 376 records that included the keyword “related variety” in their title, abstract, or as a keyword. A thorough screening process was performed, where a total of 240 documents were excluded from the sample as they were either not peer-reviewed articles, or published in clearly unrelated fields (e.g. chemistry, psychology, medicine, biology etc.), or published in other languages than English. Bibliometric analyses were then performed which have informed the overall thesis work on the most relevant articles, authors, research environments, topics, and academic journals that have contributed to advancing the knowledge of how regional related variety influences economic development.

As noted in the previous section, periodical literature searches were also performed throughout the thesis work, which has informed the process of developing papers 2 to 5. Besides the literature that explicitly deals with the concept of related variety, the work has relied on the wider literature on economic geography and the economics of innovation and entrepreneurship.

This literature includes a variety of books, journal articles and other resources on theoretical as well as methodological aspects that have been relevant for the thesis. The work has particularly benefitted from *Handbook of Regional Growth and Development Theories*, edited by Capello and Nijkamp (2009), and *Handbook of The Economics of Innovation*, edited by Hall and Rosenberg (2010). It should also be evident from the list of previous literature cited in this introduction, that the persistent scientific contributions made by particular individuals to the literature on entrepreneurship, innovation and economic geography, have been important sources of inspiration and learning that underpins the work that is presented in this thesis.

### **3.3 Empirical context**

The empirical research presented in this thesis considers the relationships between regional industry variety, entrepreneurship and innovation in Swedish regions. Before a more detailed discussion about the empirical context is given, it should be noted that the notion of ‘region’ requires a more careful specification. Agnew (2013) provides a survey of the use of regions in social sciences, and distinguishes between four general conceptions. First, regions may be viewed as *communities* that share socio-political characteristics. Second, regions have been conceptualized as geopolitical *territories*, particularly in analyses of geopolitical tensions and conflicts. Third, regions have been thought of as geographical *networks*, consisting of hierarchies of cities and their hinterlands. The fourth and final is the view of regions as *societies* that share social and cultural characteristics.

An alternative geographical unit is the administrative region. Sweden consists of 21 counties and 290 municipalities, which have different responsibilities for public services and are governed by elected assemblies (SKR, 2021). It is beyond the scope of this thesis to assess how these administrative regions relate to the conceptualizations suggested by Agnew (2013). For the purpose of this thesis it is however desirable to conceptualize ‘region’ in a way that resembles Agnew’s (ibid) notion of geographical networks in which individuals and firms interact, as the thesis is interested in knowledge spillovers that tend to be localized and decay rapidly as they are transmitted across space (Audretsch, 2003). For this reason, the Swedish functional analysis region (FA-region) classification is the spatial unit of analysis throughout this thesis. This classification, which is explicitly intended for regional analyses, divides Sweden into 60 regions that essentially reflect local labor markets as FA-regions are delineated based on commuting patterns (Tillväxtanalys, 2015). This notion of region is therefore not administrative, but ‘functional’ as it is based on economic behavior. Previous studies that have

used Swedish FA-regions as the spatial unit of analysis include for example Boschma et al. (2014), Tavassoli and Carbonara (2014), and Tavassoli and Jienwatcharamongkhol (2017).

As mentioned, the use of FA-regions is motivated by the thesis's interest in knowledge spillovers, and the choice is supported by previous research which has found that regional knowledge flows in Sweden tend to be bound within functional regions (Andersson & Karlsson, 2007). In addition, the use of FA-regions decreases the concerns for potential spatial dependence in the data, compared to the option to use smaller geographies such as municipalities which do not necessarily reflect labor markets (Tavassoli & Carbonara, 2014; Tavassoli & Jienwatcharamongkhol, 2017). Figure 1 provides a map of the 60 Swedish FA-regions.



**Figure 1. Swedish functional analysis regions (FA2015-classification)**

Source: Swedish Agency for Economic and Regional Growth

In addition to the spatial dimension of the empirical context, there is also a temporal dimension. The time period under consideration in the thesis varies to some extent between the individual

empirical analyses, but the overall period under consideration are the years 2008 to 2016. This demarcation is primarily due to limitations in data availability, which arise for two main reasons. First, there is a lead-time involved in the production and publication of detailed regional statistics. Second, Statistics Sweden introduced a new industry classification in 2008, which limits the possibilities to operationalize concepts that are central to the thesis such as related variety in longer time series.

### **3.4 Empirical data sources**

The thesis work has relied on several different databases, as table 1 in section 3.1 illustrates. As described in section 3.2, the bibliometric analysis provided in paper 1 relies on a sample collected from the Scopus database. Papers 2 to 5 rely on empirical data collected from several different sources. The main source of regional economic data has been the Raps-RIS database. Raps-RIS is provided by the Swedish Agency for Economic and Regional Growth and the database is maintained by Statistics Sweden. Data on regional population, educational attainment, employment, and economic output (gross region product, i.e. 'regional GDP') by FA-region were collected from this database and used in papers 2, 3, 4 and 5.

Data on corporate R&D expenditure by FA-region was supplied by Statistics Sweden, and is used in papers 4 and 5. Municipality-level data on new firm formation was collected from the Swedish Agency for Growth Policy Analysis and aggregated into the FA-region classification. This data was used in paper 2. Municipality-level data on the annual number of new, existing, and terminated limited companies was collected from the Swedish Companies Registration Office, and aggregated to match the FA-region classification. This data was used in papers 3 and 4. The Swedish Patent and Registration Office supplied data on the total annual number of patent applications per municipality. This dataset was aggregated into FA-regions and used in papers 3, 4 and 5. Lastly, Statistics Sweden provided firm-level data from the Swedish Community Innovation Survey, which was used in paper 5.

### **3.5 Empirical data measures**

This section describes how the empirical measures that are central to the thesis were computed. In some cases, maps are used to illustrate interregional disparities in these measures.

#### *3.5.1 Industry composition*

Economies of scope that arise due to particular industry compositions are of key interest in this thesis. The level of regional related variety, which has been associated with Jacobs-externalities

(e.g. Frenken et al., 2007), is a main variable of interest throughout the empirical papers in this thesis. The associated concept of unrelated variety is central to paper 5. These empirical measures are entropy indices, which are used to characterize the regional composition of industries. This thesis follows the approach described by for example Frenken et al. (2007) and Fritsch and Kublina (2018), and use employment data at the five-digit level to operationalize the two forms of variety. The employment data is organized in the Swedish Standard Industrial Classification, which is compatible with the Nace Rev.2 classification used by Eurostat. The variables are computed as follows. Let employment in a five-digit industry  $i$  belong to a 2-digit aggregate sector  $S_g$  ( $g = 1, \dots, G$ ).  $P_g$  is the aggregate 2-digit sector's share of total employment in the region. Unrelated variety (UV) is then computed at the 2-digit level, as:

$$UV = \sum_{g=1}^G P_g \log_2 \left( \frac{1}{P_g} \right)$$

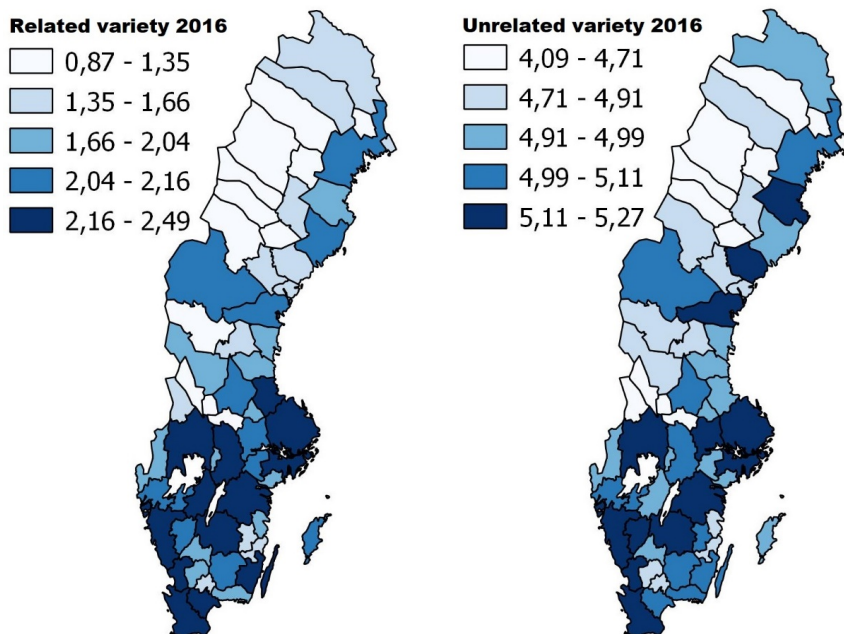
$P_i$  is the employment share of the 5-digit industry. Related variety (RV) is then computed as:

$$RV = \sum_{g=1}^G P_g H_g$$

where:

$$H_g = \sum_{i \in S_g} \frac{P_i}{P_g} \log_2 \left( \frac{1}{P_i/P_g} \right)$$

Figure 2 illustrates the levels of related and unrelated variety in Swedish FA-regions in 2016.

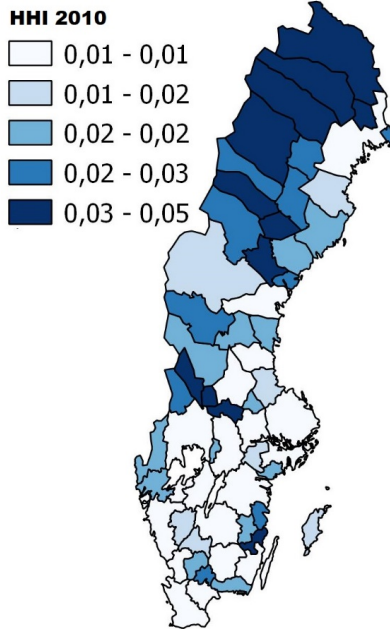


**Figure 2. Related and unrelated variety in Swedish FA-regions, 2016**

In addition to these notions of variety, more traditional ways of operationalizing diversity have also been considered within the thesis. De Groot et al. (2016) note that a large number of studies on the ‘MAR vs. Jacobs’ problem have used the Herfindahl-Hirschman index (HHI) as a measure of the overall diversity of a regional economy. This index is used in paper 2 of the thesis, and is computed as follows. Let  $S_i$  denote the number of industries in region  $i$ ,  $e_{si}$  is employment in region  $i$  in industry  $s$ ,  $e_i$  is total employment in region  $i$ . The HHI for each region is then:

$$HHI_i = \sum_{s=1}^{S_i} \left( \frac{e_{si}}{e_i} \right)^2$$

Following the advice by Kemeny and Storper (2015) to use disaggregated data, the HHI was computed using employment data at the five-digit level. A HHI near zero indicates that the regional economy is highly diversified, while a value of 1 would mean that the region is fully specialized in a single sector. Figure 3 illustrates how Swedish FA-regions scored on the HHI utilizing data for 2010, as in paper 2.

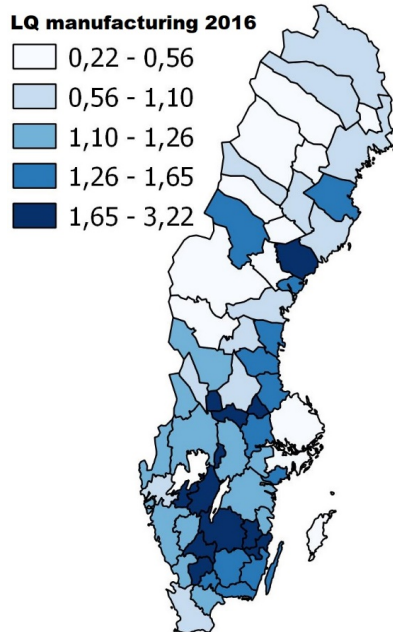


**Figure 3. Herfindahl-Hirschman index of specialization by Swedish FA-region, 2010**

Beside these overall measures of diversity, one might also consider sector-specific specializations to account for localization economies (MAR-type externalities). A common measure of sectoral specialization that frequently occurs in the literature on specialization versus diversity (e.g. De Groot et al., 2016) is the location quotient. These measures are typically specified as an industry's share of total regional employment relative to that same industry's share of national employment, thus reflecting relative specialization in that sector to capture localization economies. Papers 4 and 5 in this thesis include location quotients in the empirical analyses. Location quotients (LQ) for an industry  $i$  in a region are computed as:

$$LQ_i = \left(\frac{e_i}{e}\right) / \left(\frac{E_i}{E}\right)$$

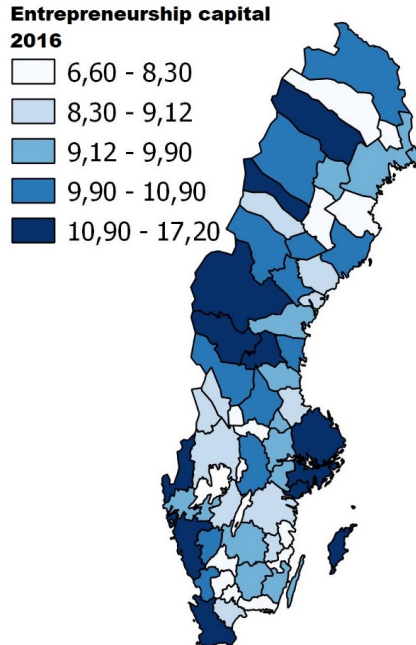
where  $e_i$  is employment in industry  $i$  in the region of interest,  $e$  is total employment in the region,  $E_i$  is national employment in industry  $i$  and  $E$  is total national employment. As a descriptive example, figure 4 illustrates the level of manufacturing industry specialization in Swedish FA-regions in 2016.



**Figure 4. LQ manufacturing industry employment by Swedish FA-region, 2016**

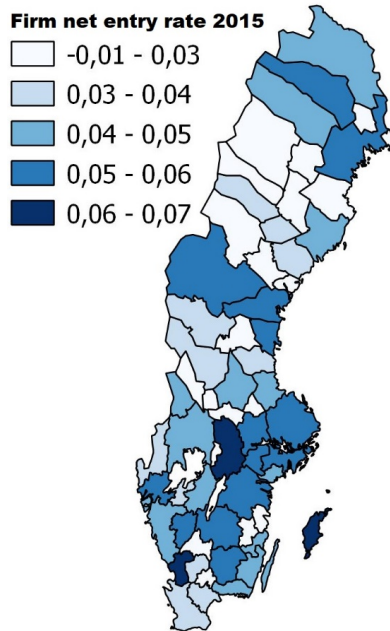
### 3.5.2 Entrepreneurship

Fischer and Nijkamp (2009) emphasize that the concept of entrepreneurship is challenging to measure empirically. This thesis has employed two approaches, supported by previous literature. In paper 2, the concept of entrepreneurship capital (Audretsch & Keilbach, 2004) was used in the empirical analysis. Entrepreneurship capital is measured as the number of startups in a region relative to its population, which we calculate as the number of new firms per 1000 inhabitants in the ages 16-64 (averaged for the years 2008-2010 in paper 2). Audretsch and Kielbach (ibid) interpret high values of entrepreneurship capital in a region as indicating “a regional milieu of agents that is conducive to the creation of new firms”. Figure 5 illustrates the level of entrepreneurship capital in Swedish FA-regions in 2016.



**Figure 5. Entrepreneurship capital by Swedish FA-region, 2016**

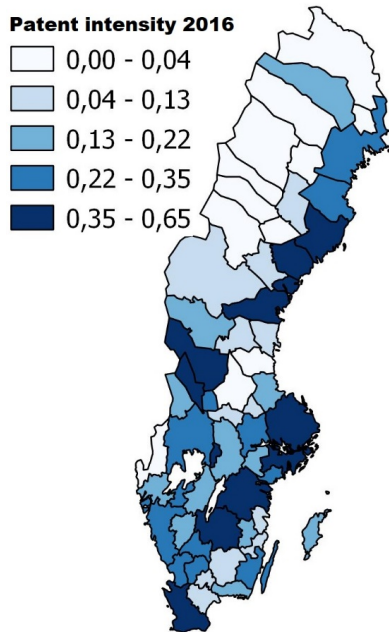
Papers 3 and 4 use an alternative way of operationalizing entrepreneurship from secondary data by computing the net entry rate of firms, as the number of new firms minus exits, divided by the number of incumbents. The resulting number can thus be interpreted as the percentage change in the number of firms. Dejardin (2011) has suggested that this proxy for entrepreneurial activity indicates to what extent entrepreneurial resources are moving towards profitable expanding industries. Figure 6 illustrates the net entry rate of firms in Swedish FA-regions, using data for 2015 as in papers 3 and 4.



**Figure 6. Firm net entry rate by Swedish FA-region, 2015**

### *3.5.3 Innovation*

Three approaches to measuring innovation were used in this thesis. The first approach relies on a patent-based measure which is common in the literature. In papers 3, 4 and 5, the number of patent applications relative to the number of employed persons (in thousands) was used as an indicator of innovative activity conceptualized as patent intensity, similar to measures employed by Deyle and Grupp (2005), Audretsch et al. (2008), and Miguelez and Moreno (2018). It should not be overlooked that patent-based measures are associated with well-known and potentially serious caveats when they are used as proxies for innovation, which papers 4 and 5 discuss in further detail. Figure 7 illustrates the level of patent intensity in Swedish FA-regions in 2016.



**Figure 7. Patent intensity by Swedish FA-region, 2016**

A second approach to measuring innovation was used in paper 5. The study uses firm-level data from four waves of the Swedish Community Innovation Survey. This data enables the paper to analyze firm-level product innovation as a binary outcome based on firm's survey responses to each wave, and thus overcomes some of the flaws that are associated with proxy variables such as patents.

The third approach to measuring innovation is again found in paper 5. Drawing on entrepreneurship literature, the paper attempts to build a theoretical argument that supports an operationalization of firm-level innovation specifically as entrepreneurial innovation (e.g. Autio et al., 2014), using the fraction of sales attributed to recent product innovation as a proxy variable. The paper recognizes that this proxy is associated with flaws, but maintains that it provides meaningful insights that are theoretically consistent with entrepreneurial innovation.

### **3.6 Analytic strategies**

The empirical work that is presented in this thesis maintains a regional perspective. To address the overarching research question, the thesis work has relied on a variety of methods as shown in table 1, section 3.1. In order to inform the thesis work on the relevant literature, authors,

research environments, topics, and academic journals that have contributed to advancing the knowledge of how regional related variety influences economic development, a bibliometric analysis was performed using the RStudio package Bibliometrix. The outcomes of this work are provided in paper 1. Measurements of interest include citations per article, the top contributing authors, co-authorships, top journals, and trends in research topics over time.

An initial topic of interest for the thesis work was to explore how interregional disparities in industry variety and entrepreneurial activity manifests empirically in Swedish regions. To address this, a cluster analysis was first performed to create a taxonomy of different regional growth trajectories during the period 2010 to 2015. Multiple discriminant analysis was then employed to examine how different regional characteristics and endowments, including related industry variety and entrepreneurial activity, contribute to understanding the different outcomes observed in the taxonomy. This work is reported in paper 2. All analyses reported in paper 2 were performed using IBM® SPSS® Statistics Version 25.

The thesis work has also strived to approach the relationship between related variety and entrepreneurship based on a Schumpeterian understanding of the innovating entrepreneur as an agent of change. Due to this approach, the assumptions of the regional branching literature (e.g. Frenken & Boschma, 2007) which claim that regions tend to diversify in related technologies, have been considered in paper 3. The paper notes that the role of entrepreneurship in this process is neglected in empirical studies, and attempts to contribute with an analysis of reciprocal relationships between regional related variety, entrepreneurship and innovation. A cross-lagged structural equation model was used, as this approach enables analysis of directional causality. All analyses reported in paper 3 were performed using IBM® SPSS® AMOS™ Version 25.

Another objective has been to examine the assumption that the relationships between related variety and regional outcomes such as entrepreneurship and innovation are linear. To probe these relationships further, fixed-effects panel data models were employed in paper 4 to test a series of hypotheses on non-linear effects of related variety. In addition, mediating and moderating effect were examined to assess the influence of knowledge appropriation mechanisms on knowledge spillover entrepreneurship. Supplementary Tobit models were estimated as a robustness check due to the truncated nature of one of the dependent variables. All analyses reported in paper 4 were performed using StataSE 15.

Finally, the thesis has considered the relationship between regional related and unrelated variety, and firm-level innovation. A multilevel (i.e. mixed-effects) modeling approach was chosen to ensure that the regional context in which firms innovate was accounted for in the analysis. This work is reported in paper 5. The multilevel model was specified to estimate fixed effects whilst allowing for random intercepts – hence the term mixed effects. The analysis combines longitudinal firm-level data from four waves of the Swedish Community Innovation Survey with FA-region panel data. As the dependent variable is binary, a multilevel logistic model was used to analyze the relationship between regional industry variety and firm-level product innovation. A second analysis was performed, where the construct of entrepreneurial innovation was operationalized. As this proxy variable is truncated, a multilevel Tobit model was employed to estimate the regression. All analyses reported in paper 5 were performed using StataSE 15.

### **3.7 Methodological limitations**

The studies appended to this thesis are certainly not without limitations. One example is the bibliometric study which is appended as paper 1, where the possibility of file-drawer problems (e.g. Rosenthal, 1979) and publication bias means that one cannot rule out that the importance of the concept of interest may be somewhat inflated or otherwise skewed.

In addition, the findings and conclusions that are reported in the appended empirical studies (papers 2, 3, 4 and 5) are based on statistical analyses that result in probabilistic statements, and their results should therefore always be interpreted with some caution. Paper 2 uses cross-sectional data in addition to a small sample size, and one should therefore hesitate to draw conclusions about causality, which the paper does not claim to infer. The results are best viewed as describing some features of leading, lagging, and stagnating regions. Paper 3 similarly recognizes that the sample size is limited, and that the time period under scrutiny may be too short for entrepreneurial and innovative efforts to manifest as employment effects that have a palpable impact on regional related variety.

Furthermore, even though the thesis has argued that the use of FA-regions as the unit of analysis is well motivated, with support from previous literature, it is possible that some effects are obscured as they may operate at different spatial scales. In papers 4 and 5, the effect of urbanization economies is statistically insignificant, and in paper 5 regional private R&D expenditures yield statistically insignificant results, even though the knowledge production function approach (Griliches, 1979, and subsequent literature) suggests that R&D spillovers

are important. It is possible that these effects may be clouded by the spatial unit of analysis. One possibility is that in Sweden, R&D spillovers may operate at a greater spatial scale than FA-regions, since regional innovation systems are governed at the county-level, (which typically are substantially larger than FA-regions) and this may have contributed to establishing network relationships that reach beyond the borders of local labor markets. The much clearer results for external economies of scope due to related and unrelated variety at the FA-region level may reflect that tacit knowledge in the innovation process is best transmitted via frequent interaction and face-to-face contacts (Tödtling et al., 2006), and these effects thus operate at the smaller spatial scale of FA-regions.

## 4. Summary of papers

This section provides a summary of the five appended papers.

### 4.1 Paper 1

Örtqvist, D., & Ejdemo, T. Related variety: A bibliometric review and analysis. (*Submitted to journal*)

The literature on related variety has evolved rapidly since Frenken et al. (2007) introduced the concept to the larger research community. There has been a strong growth in the number of academic publications that consider this concept, and a variety of outcomes have been considered. This paper presents a bibliometric analysis that provides insights about this literature and directions for future research.

The aim of bibliometric analysis is to provide a general picture of a stream of literature using input from scientific publications. We employed a systematic literature review technique, together with bibliometric tools to identify key research topics and themes. The systematic approach enables us to illustrate how this literature has evolved over time and identify areas of current research interests, as well as potential directions for future research.

After searching the Scopus database and applying a thorough screening process, we identified a sample of 136 studies that had addressed related variety explicitly. There is only one previous published review of this stream of literature (Content & Frenken, 2016), which focused on the relationship between related variety and economic development. The aim of the study at hand is to present a comprehensive examination of the field. We note that research on the implications of related variety is still a young ‘field’, yet our findings show that 250 authors have so far contributed to the accumulated knowledge that is reflected in the extant literature. By applying a structured, bibliometric review methodology this study provides a guide for current and future scholars in the field. The study identifies the most prominent authors, articles, and research environments with respect to the literature on related variety.

The extant literature has linked regional related variety to various outcomes in terms of economic growth, innovation and entrepreneurship over a number of studies. A central notion is that related variety facilitates knowledge spillovers that are associated with positive externalities. In the initial growth of this literature, trending topics included for instance

regional branching. We note that more recent empirical work has increasingly focused on innovation, entrepreneurship and other aspects of economic development.

Our findings reveal an increasing diversity of research methods applied to test more nuanced influences of related variety. For instance, Aarstad et al. (2016) performed a multilevel analysis of the relationships between related variety and firm-level outcomes such as productivity and innovation. There are likely more opportunities for using multilevel approaches to examine how regional context influences firm-level outcomes. Another example of development is found in the study by Ejdemo and Örtqvist (2020) which reports a non-linear relationship between related variety and regional patent intensity, in addition to mediating and moderating effects between related variety and regional outcomes. These mentioned studies open up for further testing of conditions under which related variety influences regional and firm-level outcomes and contribute towards further clarifying the policy implications.

There are of course a number of limitations related to this study. The first is the risk of having failed to include all relevant studies in the analysis. This risk arises from the potential that technical issues could have impacted on the literature search. Limitations could also arise from so called file drawer problems, meaning that reports of positive results are more likely to get submitted by authors, and more likely to get accepted by editors, compared to studies that report negative or inconclusive findings. While we acknowledge this risk, the potential problem is not unique to this study.

## **4.2 Paper 2**

Ejdemo, T., & Örtqvist, D. (2021). Exploring a leading and lagging regions dichotomy: Does entrepreneurship and diversity explain it? *Journal of Innovation and Entrepreneurship* 10 (6).

There has been a long debate about the role of industry structure in the literature on why some regions successfully achieve economic growth, while other regions stagnate or decline. This paper considers how interregional disparities in industry variety and entrepreneurial activity manifests empirically in Swedish FA-regions. A cluster analysis was first performed to create a taxonomy of different regional growth trajectories observed between the years 2010 and 2015. This taxonomy combines economic and demographic outcomes, and identifies three types of regional outcomes – leading, lagging, and stagnant. These labels should be understood in a quantitative sense, rather than as qualitative statements. Multiple discriminant analysis was then employed to examine how interregional disparities in entrepreneurship capital (defined as

in Audretsch & Kielbach, 2004), human capital endowment, economic diversity and industry relatedness, contribute to explaining why some regions are successful while others stagnate or decline.

The analysis indicates that leading regions in Sweden are characterized by diversified economies with high degrees of related variety, entrepreneurial activity and human capital endowment. Stagnant or lagging regions lack in structural and entrepreneurial dimensions to varying extents. Regions that lag behind tend to be located in the northern periphery and are characterized by specialized economies with an emphasis on primary production (i.e. agriculture, raw materials, energy supply). Many of them have relatively high entrepreneurial activity in a quantitative sense, but their economies may have become locked in to unfavorable development paths due to their specializations. The majority of Sweden's functional analysis regions are classified as stagnant in the quantitative approach that this paper employs. Their level of entrepreneurial activity is lower than both leading and lagging regions. In addition, spatial proximity to metropolitan regions appears to be important, as leading regions tend to be clustered around them. These findings can be understood as generally confirming the predictions of previous literature on entrepreneurship and regional development. The main contribution of this paper is thus not in the novelty of its findings, but in its methodological approach which illustrates how meaningful regional taxonomies can be generated and how their underlying characteristics can be disentangled using classical techniques. The empirical approach of this paper enables insights not only on the drivers of regional economic success or decline, but also simultaneously illustrates how the stagnant majority can be characterized.

A limitation is that we do not explicitly examine the presence of urbanization economies, nor does the paper consider a more disaggregated conceptualization of localization economies (industry-level specialization) other than in qualitative terms. This is mainly due to the small sample size, which limits the number of variables we can use. Potential future studies that use similar empirical approaches could overcome this limitation by using data that is more disaggregated at the geographical level to increase sample size, however this could exacerbate potential issues with spatial dependence.

The findings provide implications that are relevant to contemporary EU-cohesion policy which encourages regional 'Smart Specialisation'. The aim of this policy is to stimulate regional innovation and growth through the enhancement of regional capabilities in a few market niches, in order to develop competitive advantages (Foray, 2014). Our findings add further support to

the literature which favors the promotion of related variety as an appropriate smart specialization strategy (S3). Lastly, our findings emphasize the importance of the entrepreneurial dimension in order to distinguish between regions that prosper and those that stagnate or lag behind. This reinforces the notion that entrepreneurs serve as important conduits for knowledge spillovers and growth (Acs et al., 2009). Particularly in lagging regions, S3-policies should be accompanied by efforts to promote a regional milieu that is conducive to entrepreneurship, in order to diversify the economy based on its extant capabilities.

### **4.3 Paper 3**

Örtqvist, D., & Ejdemo, T. Cross-lagged Associations of Related Variety, Regional Entrepreneurship and Regional Innovation: A test of Regional Branching in Swedish Functional Analysis Regions. (*Submitted to journal*)

This study considers the regional branching literature (e.g. Frenken & Boschma, 2007) which suggests that regions tend to diversify in related technologies. We note that the role of entrepreneurship in this diversification process is neglected in empirical studies, and we therefore attempt to contribute with an analysis of reciprocal relationships between regional related variety, entrepreneurship and innovation. A cross-lagged structural equation model (SEM) is used to analyse a two-wave panel dataset on Swedish functional regions, as this approach enables analysis of directional causality.

Drawing on the extant literature, we derive four hypotheses on directional causality. We evaluate four models for the relationship between related variety (Frenken et al., 2007), regional innovation, and regional entrepreneurship: a stability model, a regular causation model, a reverse causation model and a reciprocal causation model. We argue that the explicit incorporation of reciprocal causation is a way to overcome some limitations of empirical approaches seen in the extant literature on related variety and regional branching.

The results give support for a reciprocal causation logic. Our findings indicate that there is a gain spiral relationship between related variety and regional entrepreneurship, such that related variety has a positive influence on regional entrepreneurship and in turn, regional entrepreneurship contributes to increased industry relatedness. In this study, we found no statistically significant relationship between related variety and regional innovation, irrespective of causal direction.

We argue that the study provides several contributions to the extant literature. It is among the first to examine directional causality between related variety, regional entrepreneurship and regional innovation. In some respects, our findings are consistent with the notion of regional branching, which suggests that regional diversification tends to occur in related technologies, rather than unrelated (Frenken & Boschma, 2007; Boschma & Frenken, 2011a). Thus, our study contributes to the empirical evidence in support of regional branching (e.g. Neffke et al., 2011; Boschma et al., 2013; Colombelli et al., 2014) with an analysis that explicitly points to entrepreneurship as a driver of related diversification.

Second, our findings provide no support for a relationship between related variety and regional innovation, irrespective of causal direction. We note that this contradicts several previous studies that, similarly to this study, have operationalized regional innovation with patent-based measures, using regional data on Europe (Migueluez & Moreno, 2018), Sweden (Tavassoli & Carbonara, 2014) and the U.S.A (Castaldi et al., 2015). The implications are unclear, as the use of patents as proxies for innovation is associated with well-known drawbacks. For one thing, patenting patterns vary across industries (Hall et al., 2014). Several studies have also demonstrated that patenting is done for strategic purposes beyond protecting intellectual property (Arundel, 2001; Hall & Ziedonis, 2001). Furthermore, the hypothesis of reversed causality between related variety and regional innovation is associated with some complexity. First, our measure of relatedness is employment-based, as in Frenken et al. (2007). As our study considers a relatively short time period, it may not be reasonable to expect tangible effects on employment and hence relatedness given this circumstance. Braunerhjelm et al. (2016) argue that "...in the short- or medium-run period the aggregate effects of innovation on employment growth may go either way: one firm's success may imply another firm's decay due to business stealing effects, or that the innovative firm reduces parts of its previous production". The lack of statistically significant relationships between related variety and regional innovation in this study should therefore be interpreted with caution.

As noted above, this study is not without limitations. First, the sample size is relatively small and our study only considers the empirical context of functional analysis regions in Sweden. Second, as noted above, the time-period under consideration is short, and future studies could explore longer periods. Our findings may also be sensitive to events that are particular to the time-period we study. Future studies that use similar approaches could examine different time-

periods, and possibly extend the scope of the analysis to incorporate other countries and regional contexts as well.

#### **4.4 Paper 4**

Ejdemo, T., & Örtqvist, D. (2020). Related variety as a driver of regional innovation and entrepreneurship: A moderated and mediated model with non-linear effects. *Research Policy* 49 (7).

This study focuses on the core hypothesis of the notion of related variety, which states that related variety fosters innovation and employment growth by facilitating Jacobs-externalities through spillovers between firms that have complementary knowledge. A modest number of empirical studies have reported empirical evidence on a positive relationship between regional related variety and explicit measures of innovation (e.g. Tavassoli & Carbonara, 2014; Castaldi et al., 2015; Aarstad et al., 2016; Miguelez & Moreno, 2018). In addition, the role of entrepreneurship has received little attention in the literature, even though the knowledge spillover theory of entrepreneurship (Acs et al., 2009; 2013) emphasizes that entrepreneurs are important conduits for knowledge spillovers and innovative activity.

The paper contributes to the extant literature with an analysis that attempts to probe deeper into the mechanism through which related variety fosters innovation. We differentiate between two properties of patent-based measures: (a) patents as intermediate innovation outputs, with unknown economic value (Acs & Audretsch, 2003), and; (b) patents as formal knowledge appropriation mechanisms. We argue that knowledge spillovers are a source of entrepreneurial opportunities (e.g. Shane & Venkataraman, 2000), and we examine how knowledge appropriation mechanisms affect the entrepreneurial opportunities that external knowledge presents. We use panel data on 60 Swedish functional analysis regions for the years 2008–2016 and estimate fixed effects models and supplementary Tobit-specifications to examine the relationships between related variety, regional innovation and entrepreneurship. Conceptually, our results disentangle the effects of regional knowledge stocks and related variety on the rate at which new ideas are commercialized through knowledge spillover entrepreneurship. We find a direct effect of regional knowledge stocks, and an important indirect effect via knowledge spillovers between firms that have complementary knowledge, as approximated by related variety. The paper contributes with novel findings that suggest diminishing marginal returns to related variety with respect to innovation and entrepreneurship. A key contribution of this paper is that we show that the magnitude of the external economies of scope that arise due to related

variety is conditional on the extent to which incumbents implement formal knowledge appropriation mechanisms.

#### **4.5 Paper 5**

Ejdemo, T., & Örtqvist, D. Entrepreneurial innovation, multilevel knowledge flows and regional industry variety: A longitudinal study of Swedish firms. *(Submitted to journal)*

This paper contributes with new evidence on the influence of regional industry compositions in the forms of related and unrelated variety, on firm-level product innovation. The paper employs a multilevel modelling approach to analyze longitudinal data from four waves of the Swedish Community Innovation Survey, taking into account the regional context in which firms innovate. According to our findings, related variety, but not unrelated variety, is positively associated with the probability of firm-level product innovation. The study thus provides further evidence of external economies of scope that arise from regional related variety.

The paper then explores how the implications of related and unrelated variety can be understood in relation to the notion of entrepreneurial innovation (e.g. Autio et al., 2014). This notion is contrasted against innovation processes that have become routinized (Baumol, 2002). It is argued that there is a scope for further theorizing the microfoundations of the emerging insights on entrepreneurial pursuits in relation related and unrelated variety. Drawing on entrepreneurship literature, we propose that firm-level innovation can be operationalized specifically as entrepreneurial innovation. The paper attempts to outline a theory of how combinations of related as well as unrelated knowledge bases can be viewed as entrepreneurial pursuits. It is argued that this theory has stronger implications for unrelated knowledge combinations, whilst related knowledge combinations offer a greater scope for innovative processes that have become routinized (Baumol, 2002).

Our empirical findings indicate that both related and unrelated variety are positively associated with entrepreneurial innovation, but the relationship is indeed more pronounced for unrelated variety. It is argued that the notion of entrepreneurial innovation provides a relevant lens that can advance extant understandings of how spillovers of knowledge among related and unrelated firms are internalized and commercialized. The paper emphasizes that commercialization involves business decisions, which is largely overlooked in the extant literature on related and unrelated variety and knowledge combinations.

We theorize that knowledge bases that are unrelated due to their cognitive distance can be understood as asymmetric distributions of information, knowledge and beliefs about technologies, business models and markets. This asymmetry has implications for the transfer of knowledge when two firms interact, or when one firm observes the other. It is argued that these asymmetries lead to Knightian uncertainty about the potential to commercialize ideas that emerge from spillovers of unrelated knowledge. Such combinations are new and unprecedented, and it is argued that attempts to pursue them will defy the conventional decision-making logics of corporations where innovation is routinized (Baumol, 2002) as the returns cannot be estimated *ex ante*. This endeavor is instead strongly associated with entrepreneurial pursuits such as 'risky' experimentation with novel ideas. We therefore advance the idea that the pursuit of new combinations of previously unrelated knowledge can be viewed fundamentally as acts of entrepreneurial innovation.

## **5. Discussion**

This chapter summarizes the main conclusions and theoretical contributions of the thesis. Some implications for future research as well as for policy are discussed.

### **5.1 Conclusions and theoretical contributions**

As shown in a previous review by Content and Frenken (2016), extant literature offers support for a positive relationship between regional related variety and the presence of positive knowledge externalities, but this has mainly been documented at a relatively aggregate level and the underlying mechanisms have remained rather implicit. Contributions on the more explicit links between related variety, and drivers of economic development such as entrepreneurship and innovation have been scarce until recently. The bibliometric study that was performed as part of the thesis (i.e. paper 1) shows that the empirical literature on related variety has evolved towards an increased attention to outcomes such as entrepreneurship and innovation, and the work that is contained in the appended papers 2 to 5 offers contributions to this ongoing research effort.

The overall purpose of the thesis work has been to examine and explain the relationship between regional related variety and regional economic change, in terms of: (a) entrepreneurship, and; (b) innovation. The potential determinants of regional economic change are many and complex and it should be emphasized that the thesis has only set out to explore these in a narrow sense. The overall conclusions of the work can be summarized as follows.

The thesis work has shown that regional entrepreneurial activity and economic diversity characterized by related variety are key elements in explaining why some Swedish regions are leading while others stagnate or lag behind. Furthermore, the research presented in this thesis suggests that knowledge spillover entrepreneurship (Acs et al., 2009) underpins the external economies of scope that arise from related variety, and that entrepreneurship is an important driver of economic diversification in related activities.

The thesis work provides initial empirical evidence of a positive gain spiral between related variety and regional entrepreneurship, which is a novel finding. Although this finding should be regarded with caution until it has been substantiated by additional studies, a tentative interpretation is that related variety facilitates knowledge spillovers that unlock entrepreneurial opportunities, in line with the knowledge spillover theory of entrepreneurship (Acs et al., 2009). As regional entrepreneurs act on these opportunities, the findings suggest that they

commercialize in activities that enhance related variety within the region. This aligns with the Schumpeterian notion that the entrepreneur is an important agent of change.

It is concluded that successful regional economies in Sweden enjoy Jacobs-type externalities that are underpinned by entrepreneurial activity. This conclusion does not rule out that highly specialized regions may experience periods of substantial economic growth, but implies that some part of the surplus generated during periods of prosperity should be allocated towards pursuing increased economic diversification. The findings reported in the appended papers support the notion that the pursuit of related variety is the key to successful economic diversification, as proposed in European regional policy discourse (e.g. Foray et al., 2012). The thesis work emphasizes that successful regional economic change depends on entrepreneurial processes that take place in practice, which has clear policy implications that are addressed in section 5.3.

Furthermore, the relationship between regional related variety and innovation has been examined explicitly as part of the thesis work. Different approaches to measuring innovation that occur in previous literature have been utilized, including patent-based proxies as well as firm-level data on self-reported product innovation. A novel firm-level construct intended to approximate entrepreneurial innovation (e.g. Autio et al., 2014) has also been proposed in paper 5. The outcomes of these efforts largely align with previous literature that has found evidence of a positive influence of related variety on innovation (e.g. Tavassoli & Carbonara, 2014; Castaldi et al., 2015; Aarstad et al., 2016; Miguelez & Moreno, 2018; Barbieri et al., 2020), which indicates the presence of Jacobs-type externalities that operate at the FA-region level and enhance innovation. It is however argued that the thesis work extends on previous findings by emphasizing the relevance of the innovating entrepreneur in the relationship between related variety and explicit measures of innovation. Paper 4 finds novel evidence of diminishing marginal effects of related variety with respect to patenting activity, and concludes that high relatedness appears to particularly foster innovative processes that do not tend to rely on patenting, such as when tacit knowledge is important which is often the case within innovative SMEs (e.g. Thomä & Bizer, 2013). The paper also reports evidence of a positive effect of regional related variety on knowledge spillover entrepreneurship, which is conditional on the extent to which formal knowledge appropriation mechanisms are implemented by innovative firms in the region. This leads to the conclusion that innovative entrepreneurship plays a key

role in realizing the knowledge spillover effects of related variety, which is further reinforced by the findings reported in paper 5.

Finally, it is argued that the thesis work has contributed towards advancing theory on the role of unrelated variety and its link to innovation and entrepreneurship, which is underpinned by empirical evidence as reported in paper 5. Previous literature (Content et al., 2019) has pointed to a lack of clear theoretical implications regarding the link between unrelated variety and entrepreneurship. The work presented in paper 5 argues that combinations of highly asymmetric unrelated knowledge represent something new and unprecedented, and the pursuit of such combinations defy the conventional decision-making logics of corporations where innovation is routinized (Baumol, 2002) as the returns cannot be estimated *ex ante* due to Knightian uncertainty. The paper suggests that this endeavor is instead strongly associated with entrepreneurial pursuits, such as ‘risky’ experimentation with novel ideas that are associated with uncertain outcomes. This argument is supported by empirical findings, which suggest a positive relationship between regional unrelated variety and firm-level entrepreneurial innovation. In this regard, the paper contributes to emerging evidence (e.g. Castaldi et al., 2015; Miguelez & Moreno, 2018; Barbieri et al., 2020) which suggests that unrelated variety is an important source of radical innovations. The findings reported in paper 5 lead to the conclusion that the process of innovation may require business decisions under ‘true’ uncertainty about expected returns, particularly when combinations of unrelated knowledge are attempted, and such pursuits can be understood as acts of entrepreneurial innovation.

## **5.2 Implications for future research**

It is argued that the thesis work results in a number of relevant findings and implications for future research. First of all, the thesis contributes with a bibliometric analysis that provides a resource for future studies. The thesis work has also illustrated how cross-lagged SEM can be employed to study directional causality, which is an approach that can be further explored in future studies. Paper 3 utilized this approach and found evidence of a positive gain spiral between related variety and entrepreneurship. This finding is interesting and has relevant policy implications, but more research is needed to substantiate this finding before strong conclusions can be drawn.

Furthermore, the findings reported in paper 4 suggest that high levels of related variety fosters innovative processes that do not tend to result in patents, for example when tacit knowledge is particularly important. There is a clear scope for future research to examine this further. This

could be explored in multilevel approaches that combine firm-level and regional data as in paper 5. Another relevant implication is that future research could pay more attention to the potential presence of non-linear relationships and interactions.

In addition, the notion of entrepreneurial innovation is a construct that could be fruitful to explore in future research efforts. Such efforts could involve an assessment of appropriate ways of operationalizing entrepreneurial innovation and not least further empirical analyses that incorporate this construct.

And finally, the work that is appended to this thesis, specifically in paper 5, emphasizes the importance of recognizing that innovation involves business decisions. These decisions are always associated with more or less risk, and sometimes with ‘true’ uncertainty, meaning that the outcomes of a decision are unknowable (Knight, 1921). The literature which this thesis attempts to contribute to has typically not considered the implications of incentives, risk, and uncertainty in the process of innovation. Future empirical studies on the links between regional industry variety and outcomes in terms of innovation and entrepreneurship could explore how these aspects could be addressed in meaningful ways that could enhance the implications for policy makers.

### **5.3 Implications for policy**

The main policy implications that emerge from this thesis naturally emphasize the role of entrepreneurship, given the stated purpose of this work. The overall conclusions reinforce the prevailing notion that diversification across related technologies in pursuit of related variety is an appropriate strategy for economic diversification, which EU’s ‘Smart Specialisation’ policy has embraced (Foray et al., 2012). A clear implication of the thesis is that regional policy makers should aim to foster the development of entrepreneurial competencies within the region, as well as environments that are conducive to entrepreneurship and exchange of knowledge. Possible policy measures could involve facilitating access to funding, as experimentation with new ideas is generally associated with risks and sometimes with ‘true’ uncertainty in the Knightian sense, and may therefore be difficult to reconcile with typical business decision-making heuristics. A final implication of the work is that governing bodies that wish to promote innovation should consider how to foster increased interaction, collaboration and transfer of knowledge between related as well as unrelated firms.

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