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Data-based Startup Profile Analysis in the European Smart Specialization Strategy: A Text Mining Approach

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Data-based Startup Profile Analysis in the European Smart Specialization Strategy: A Text Mining Approach

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Abstract

The aim of the paper is to develop novel scientific metrics approach to the European Smart Specialization Strategy. The European Union (EU) has introduced Smart Specialization Strategy (S3) to increase the innovation and competitive potential of its member states by identifying promising economic areas for investment and specialization. While the evaluation of Smart Specialization Strategy requires measurable criteria for the comparison of rate and level of development of countries and regions, policy makers lack efficient and viable tools for mapping promising sectors for smart specialization. To cope with this issue, we used a text mining approach to analyze the business description of startups from Nordic and Baltic countries in order to identify sectors in which entrepreneurs from these regions see new business opportunities. In particular, a topic modeling, Latent Dirichlet Allocation approach is employed to classify business descriptions and to identify sectors, in which start-up entrepreneurs identify possibilities of smart specialization. The results of the analysis show country-specific differences in national startup profiles as well as variations among entrepreneurs coming from developed and less developed EU regions in terms of detecting business opportunities. Finally, we present policy implications for the European Smart Specialization Strategy.

KEYWORDS: European Union, Smart Specialization Strategy (S3), S3 Implementation Handbook, Text Mining, Entrepreneurship, The Entrepreneurial Discovery Process (EDP) cycle, Innovation, opportunity search.

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Introduction

Smart Specialization Strategy (S3) is a new concept in territorial development (Foray et al., 2009; 2011; Boschma, 2016; Kaivo-oja et al., 2017). In particular, it is a place-based approach to strategic economic growth and development, in which regions define their strengths and focus on finding niche areas of specialization in a global value chain (McCann and Ortega-Argilés, 2015). Smart Specialization concept places great importance on geographical context (social, cultural and institutional characteristics) in elaborating industrial and innovation policies (Foray et al., 2009; 2011; Barca at al., 2012). Given that regions differ in terms of their business and research activities, they compete in various technology and product spaces and show different strengths and weaknesses. Correspondingly, they have different opportunities for growth and development (McCann and Ortega-Argilés 2015). Moreover, knowledge spillovers are geographically bounded and they are rooted in place (Arrow, 1962; Audretsch and Feldman, 2004; Balland et al., 2018). In other words, technological knowledge that is complex and tacit in nature is difficult to imitate and is sticky in space. This, in turn, can be a primary source for competitive advantage for territories in which they are generated (Balland et al., 2018). For these reasons, Smart Specialization Strategy (S3) shifts attention from traditional a 'one-size-fits-all' policy framework towards more embedded and locally relevant innovation policy.

The smart specialization approach is considered as a key instrument to promote smart, sustainable and inclusive economic growth in Europe (Foray et al., 2011; Paliokaitė et al., 2016). Facing increased global competition, the European Union (EU) strives to encourage its regions to define their unique capabilities and to identify areas of specialization in which they can have competitive advantages. By enabling each region to identify a niche market of specialization, the EU aims to avoid duplication and fragmentation of its investments and to make its research and innovation efforts as effective as possible. In order to tap into an endogenous potential of each region, Smart Specialization Strategy (S3) suggests that local actors from business and academia should discover the right areas of future specialization (Foray et al., 2009). In other words, it is a bottom-up approach in which local actors explore scientific and technological opportunities and their market potential. To build critical mass in the promising areas of specialization, regional governments should identify where local business and academia see potential for research and innovation activities and whether these activities show promise for excellence. This process, in turn, requires a deep analysis of local capabilities and competencies to identify unique features and strengths of each region and, based on this, to set priorities in innovation policies and to develop a regional vision. However, there is lack of clarity and consensus how to measure regional capabilities and competencies and how to implement Smart Specialization Strategy in practice.

Previous studies suggest measuring Smart Specialization Strategy based on patent and industry analysis (Paliokaitė et al., 2016; Santoalha, 2016; Kaivo-oja et al., 2017; Asheim et al., 2017; Balland et al., 2018), but both these approaches have drawbacks in defining indices of smart specialization. First of all, not all inventions are patentable and, for this reason, patent analysis lacks indices to measure knowledge capabilities and competencies in a region. Industry analysis based on structured data collected by statistical offices may also be inappropriate for formulating smart specialization strategy, because smart specialization policy should target certain activities instead of industries and firms. Furthermore, innovations introduced by startup companies often disrupt value network in a given industry and displaces incumbent firms from a market as well as make previous technological knowledge obsolete (Christensen, 1997; Kaivo-oja and Lauraeus, 2018). In contrast to prior studies in smart specialization, we analyze the business description of startup companies to identify activities in which entrepreneurs from different European regions see new business opportunities.

Entrepreneurship is an important engine of economic growth and development (Wennekers and

Thurik, 1999; Zacharakis et al., 1999). Specifically, it is considered a source of innovative and competitive power of an economy (Wennekers and Thurik, 1999; Zacharakis et al., 1999; Praag and Versloot, 2007). As Wennekers and Thurik (1999) suggest, entrepreneurs play an indispensable role in economic growth because their activities create variety of ideas and initiatives. As a result, "variety, competition, selection and also imitation (...) expand and transform the productive potential of a regional or national economy" (Wennekers and Thurik, 1999: 50). This implies that entrepreneurs facilitate the operation of market selection mechanisms and promote innovation activities as well as stimulate industry evolution. For these reasons, entrepreneurial activities explain a substantial portion of variations in rates of economic growth across regions (Zacharakis et al.,1999).

Entrepreneurial activities can be highly geographical and it may depend on local economic and institutional characteristics (Boschma, 2016). Moreover, entrepreneurial search process for business opportunities can be substantially shaped by local research and development activities (Acs et al., 2013). In other words, the asymmetries in knowledge accessibility across individuals can determine their capabilities to deliver high-valued solutions to market problems (Shane, 2003; Acs et al., 2013). As skills and know-how (e.g. tacit knowledge) are geographical bounded, entrepreneurs across regions may develop different business opportunities and identify diverse areas of specialization. In this line of reasoning, we use a text mining approach to analyze the business description of startup companies from Nordic and Baltic countries in order to identify key economic areas in which entrepreneurs from these regions see new business opportunities. Specifically, a topic modeling approach is employed to classify full-text business descriptions and to identify economic activities, in which start-up entrepreneurs identify possibilities of smart specialization.

The rest of the paper is organized in the following way. Section 2 reviews the related literature and provides theoretical framework. Section 3 presents the dataset and empirical methods used in the study. Section 4 discusses the findings from the empirical analysis and, at the end, section 5 summarizes and concludes.

Theoretical framework

Smart specialization is a knowledge-driven growth strategy (Foray et al., 2009; 2011). In particular, it is an innovation policy which aims to identify promising economic areas in a region for investment and specialization (Foray at al., 2011; Kaivo-oja et al., 2017). The European Union (EU) introduced Smart Specialization Strategy (S3) to help its member states discover the right sectors and fields of future Specializations in which they can have competitive advantages and, in this way, to increase their innovation and competitive potential (Foray et al., 2009; Foray et al., 2012; Kaivo-oja et al., 2017; Roman and Nyberg, 2017). Given that EU lacks economic and technology specialization as well as has low capability to prioritize innovation and research efforts at regional level (Benner, 2013), adopting to Smart Specialization Strategy (S3) can support EU to develop innovative and resilient economy by specializing and concentrating on each region's research and innovation strengths and, at the same time, avoiding duplication and fragmentation of investment efforts (Foray et al., 2012).

Smart Specialization Strategy (S3) is a novel approach to regional economic development policy (Kaivo-oja et al., 2017). The major idea that differentiates Smart Specialization Strategy (S3) from traditional industrial and innovation policy is its emphasis on a place-based and bottom-up approach in priority-setting (Foray at al., 2011; Boschma, 2016; Paliokaitė et al., 2016). In traditional industrial and innovation policy, a decision making process in mapping promising sectors for investment and specialization was mainly centralized and top-down (Barca at al., 2012). In other words, decision makers were in a position to select and prioritize areas of economic ac-

tivity with the highest growth potential and then to focus the development of clusters and innovation activities in these areas. Given that many uncertainties are involved in setting priorities in innovation policies and governments lack sufficient knowledge and expertise to design and implement such policies effectively, top-down sectoral approaches often fail to promote local economic development (Barca et al., 2012; McCann and Ortega-Argilés, 2016). In particular, "the evidence from numerous development policy examples worldwide demonstrates that regions have made many mistakes in terms of their policy choices, and often this was because policies were chosen on the basis of criteria which were not appropriate or relevant for the local context" (McCann and Ortega-Argilés, 2016: 282). To put it another way, top-down policy mostly assumes that a 'one-size-fits-all' policy framework is generally effective and relied on imitating successful innovation policies applied in very different contexts (Storper, 1997; Pike et al., 2006; Barca et al., 2012; McCann and Ortega-Argilés, 2016). Moreover, top-down centralized-organized policy fails to engage with small local actors and to reflect their interests in the policy design due to lack of their lobbying power, whereas major local players with dominant monopoly positions are able to influence the top-down policy formulation and to shape it in their own interests (Foray, 2015). In contrast to traditional industrial and innovation policy, Smart Specialization Strategy lets entrepreneurs and small local actors to discover the right areas of future specialization (Foray et al., 2011). Specifically, Smart Specialization Strategy relies Entrepreneurial Discovery Process (EDP) in setting innovation policy priorities (Foray at al., 2011; Coffano and Foray, 2014). Entrepreneurial Discovery Process is a bottom-up approach in which local actors from business and academia are discovering new market niches as well as scientific and technological opportunities (McCann and Ortega-Argilés, 2016; Boschma, 2016). The role of government in this process is to identify those entrepreneurial discovery projects or new activities and to develop clusters and innovation activities in these prioritized areas (Foray et al., 2011). Hence, the information necessary for setting priorities in a smart specialization perspective comes from local actors such as firms, laboratories and specialized services. This process intends "to allow innovation policies to emerge which are 'placebased', which build on a sound analysis of each region's strengths and potential for excellence, and which involve a broad range of actors and their knowledge of market potential" (Boschma, 2016: 17). Although a broad range of actors are involved in Entrepreneurial Discovery Process, entrepreneurs have a prominent role in this process (Coffano and Foray, 2014; Rodríguez-Pose and Wilkie, 2015), because they possess a valuable understanding of market dynamics and the commercial feasibility of scientific research activities due to their interaction with the market (Cities Alliance, 2007). Moreover, entrepreneurs serve as "agents of change" by facilitating the operation of market selection mechanisms and forcing established companies to become more productive and competitive as well as by promoting innovation activities and stimulating industry evolution. Specifically, their activities create variety of ideas and initiatives, and rivalry between these different ideas and initiatives lead to the selection of the most innovative and productive companies and the displacement of obsolete ones (Wennekers and Thurik, 1999). In other words, innovative entrepreneurs create new markets and industries by disrupting existing structures, value and actors. As a result, entrepreneurs provide a significant contribution to the innovative and competitive power of a region by generating novel solutions to market problems and renewing economic activities (Wennekers and Thurik, 1999; Zacharakis et al., 1999; Fölster, 2000; Praag and Versloot, 2007).

The ability to identify complex problems and to deliver high-valued solutions is a key component of entrepreneurship (Shane, 2003). It allows entrepreneurs to recognize valuable business opportunities and, through a creative combination of resources, to bring into existence new products and services. Discovery of entrepreneurial opportunities can be considered as re-

combination activities, because an innovation is a new combination of the existing knowledge (Schumpeter, 1934). This implies that individuals operating in a knowledge-rich environment are more likely to develop business opportunities than others acting in a knowledge-impoverished context. The knowledge output in a given region is considered to be the function of R&D curried out by local universities and industries (Jaffe, 1986), and all the knowledge created by research institutions within a region is a potential source of entrepreneurial opportunities (Plummer and Acs, 2014). As knowledge spillovers are localized and knowledge spillovers are more intensive in regions with higher R&D investments (Audretsch and Feldman, 1996), regions vary in terms of their pool of knowledge and the knowledge-based opportunities generated for entrepreneurial exploitation (Acs et al., 2013). Therefore, identifying where entrepreneurs see business opportunities within a region can be an important instrument for defining local strengths and potential as well as developing a vision of regional smart specialization. To set priorities in a smart specialization perspective, policy makers should focus not on individual entrepreneurial initiatives but a large set of them that can provide systematic processes in regional economic development. "Even though the entrepreneurial discovery is related to a micro level (individual initiatives that may result in new business projects), the approach of smart specialization model seeks to overcome it to reach a macro level" (Del Castillo Hermosa et al., 2015: 10). For this purpose, we analyze business descriptions of individual early stage enterprises and aggregate them to provide a macro picture where entrepreneurs from Nordic and Baltic countries see business opportunities.

Data and methodology

The empirical analysis of the paper is based on startup dataset of Nordic and Baltic countries. Specifically, we collected publicly available business descriptions of startup companies from the following website https://angel.co/europe, which provides information about startup activities from all over the world. In the empirical analysis, we focus on variations among entrepreneurs coming from developed and less developed EU regions in terms of detecting business opportunities. Global Entrepreneurship Monitor (GEM) study differentiates economic development levels among factor-driven, efficiency-driven and innovation-driven. Given that no factor-driven regions are presented in EU, we analyze business descriptions of early stage startup companies from efficiency-driven (Estonia, Latvia, Lithuania) and innovation-driven economies (Denmark, Finland, Sweden). According to GEM study, early stage entrepreneurs are those started business activities in the last 24 months. Therefore, we restricted our dataset to only companies started operations in 2016 and 2017[1] (Please see Table 1).

Table 1
Number of startup companies in Nordic and Baltic Countries in 2016 and 2017

Economic development level	Country	Number of Startups
Efficiency-driven	Estonia	227
	Latvia	108
	Lithuania	103
Innovation-driven	Denmark	298
	Finland	291
	Sweden	283

Source: https://angel.co/europe

For analyzing unstructured texts that describe businesses of startup companies, we use topic modeling technique. Topic modeling is an unsupervised machine learning method which automatically clusters words that frequently occur together and discovers the abstract "topics". In

1 Startup data for Denmark available only from June 2016 and for Sweden only from September 2016.

particular, given a collection of documents, topic modeling treats each document as a vector of word counts and present it as the mixture of topics, where each topic consists of relevant words. In the analysis, we use Latent Dirichlet Allocation of topic modeling algorithm (Blei et al., 2003; Shi et al., 2016), which associates business descriptions from each country to defined number of topics and each topic to a set of relevant keywords. Before applying the topic modeling algorithm, we used natural language processing methods to clean business description of startup companies, which include removing stop words and punctuations as well as stemming words (reducing each word to a single root word).

Results

We use natural language processing to identify which words are most often used in descriptions of startup companies in Nordic and Baltic economies. Table 2 shows that user experience-centric words like service, app, design and platform are the most popular keywords in startup descriptions. In particular, early-stage entrepreneurs from Sweden (29%), Lithuania (23%) and Latvia (12%) refer to an app in their business descriptions. The term "service" is also mentioned frequently in descriptions for startups from Estonia (38%), Latvia (14%), Finland (23%) and Sweden (29%) as well as the word "platform" in descriptions of early-stage companies from Denmark (33%), Sweden (30%), Estonia (29%) and Finland (16%). Lithuania and Latvian companies in our dataset also frequently mention the term "design" in their description (21% and 14%, respectively). In Finnish startup businesses, the words "mobile" and "game" are among the top five referred terms (see Table 2).

Table 2
The most popular keywords in startup company descritpions in Baltic and Nordic countries

Estonia

Rank	Word	Share
1	servic	38%
2	provid	33%
3	compani	32%
4	custom	30%
5	platform	29%

Latvia

Rank	Word	Share
1	servic	14%
2	design	14%
3	product	14%
4	app	12%
5	digit	11%

Lithuania

Rank	Word	Share
1	app	23%
2	develop	22%
3	design	21%
4	web	21%
5	product	20%

Denmark

Rank	Word	Share
1	platform	33%
2	product	28%
3	custom	27%
4	develop	26%
5	compani	23%

Finland

Rank	Word	Share
1	servic	23%
2	mobil	18%
3	game	16%
4	platform	16%
5	learn	14%

Sweden

Rank	Word	Share
1	platform	38%
2	app	33%
3	servic	32%
4	help	30%
5	develop	29%

Figure 2

Word cloud of startup company business descritpions

Looking at word cloud of startup company descriptions - 50 most popular keywords in startup company descriptions, Figure 1 shows that following terms app, platform, software, design, service, solution, data, market, digital, web, product and mobile appear often in startup landscape description of represented Nordic and Baltic countries. In qualitative analysis, these terms indicate key trends in start-up ecosystems in Nordic and Baltic countries. In general, the most popular keywords in startup company descriptions provide broad picture, but they do not show where startup companies from these economies see business opportunities. For this reason, we use topic modeling to classify business descriptions and to identify economic activities, in which start-up entrepreneurs identify business opportunities and possibilities of smart specialization.

Table 3
Topic modeling of startup company descritpions in Baltic and Nordic countries

Estonia

	Topic 1	Topic 2	Topic 3	Topic4	Topic 5	Topic 6	Topic 7	Topic 8
1	car	solut	service	service	team	time	provide	market
2	custom	provid	truck	data	develop	service	user	manag
3	compani	busi	cryptocurr	provide	app	custom	project	provide
4	rental	time	blockchain	product	manag	student	service	platform

Latvia

	Topic 1	Topic 2	Topic 3	Topic4	Topic 5	Topic 6	Topic 7	Topic 8
1	service	design	reality	real	experi	service	market	product
2	softwar	digit	world	build	fit	financi	manag	hour
3	cryptocurr	develop	app	industri	smart	app	digit	employe
4	custom	first	augment	construct	tool	use	agenc	engag

Lithuania

	Topic 1	Topic 2	Topic 3	Topic4	Topic 5	Topic 6	Topic 7	Topic 8
1	web	start	estat	user	train	develop	home	product
2	design	game	real	busi	tool	inform	accessori	improv
3	market	employe	service	product	product	design	app	realiti
4	develop	search	claim	deliveri	swimmer	hous	artist	online

Denmark

	Topic 1	Topic 2	Topic 3	Topic4	Topic 5	Topic 6	Topic 7	Topic 8
1	busi	develop	content	team	service	event	product	new
2	people	platform	art	experi	product	app	busi	develop
3	custom	compani	design	product	custom	compani	app	system
4	develop	custom	platform	market	time	employe	world	manag

Finland

	Topic 1	Topic 2	Topic 3	Topic4	Topic 5	Topic 6	Topic 7	Topic 8
1	service	compani	service	digit	mobil	artifici	inform	product
2	smart	softwar	app	busi	game	learn	manag	natur
3	home	service	car	platform	app	educ	communic	server
4	busi	develop	pet	will	develop	intellig	mobil	food

Sweden

	Topic 1	Topic 2	Topic 3	Topic4	Topic 5	Topic 6	Topic 7	Topic 8
1	digit	platform	game	servic	data	app	product	servic
2	music	manag	develop	offer	solut	user	system	help
3	app	use	brand	people	smart	help	market	platform
4	market	develop	experi	need	product	publish	platform	compani

Topics discovered through Latent Dirichlet Allocation of topic modeling algorithm are displayed in Table 3. Overall, Latent Dirichlet Allocation algorithm shows that there are some differences and similarities in the startup landscape in Nordic and Baltic countries. Looking first at efficiency-driven economies, early-stage Estonian entrepreneurs identify business opportunities in car rental service (Topic 1), cryptocurrency and blockchain related service (Topic 3), and data-based business solution service (Topic 2 and 4) as well as in developing project and team management (Topic 5 and 7), and market management apps (Topic 8). Somewhat similarly, start-up entrepreneurs from Latvia see new business opportunities in creating cryptocurrency and customer service software (Topic 1), digital design development (Topic 2), real estate and financial sectors (Topic 4 and 6), digital market management (Topic 7) and employee engagement service (Topic 8), and also in developing augmented reality apps (Topic 3). Lithuania companies are also active in real estate service, web design and development as well as in home design and accessories.

As to the startup landscape of innovation-driven economies, companies from Denmark focus on developing event and employee management apps (Topic 6) as well as system development and management apps (Topic 8). Moreover, they are active in developing art and content design platforms (Topic 3) and also customer service and management platforms (Topic 1, 2, 5, 7). In Finland, early-stage entrepreneurs detect opportunities in smart home business (Topic 1), software service development (Topic 2 and 4), mobile game app development (Topic 5) as well as in developing apps for car rent, food service and also related to pets (Topic 3 and 8). Furthermore, in contrast to other countries, Finnish entrepreneurs identify possibilities of smart specialization in developing artificial intelligence for learning and education. Looking at Swedish startup companies, they are active in creating digital music apps (Topic 1), providing data smart business solutions (Topic 5), developing games (Topic 3) and market management platforms (Topic 7).

Conclusions

- In this study, we explored the business descriptions of startup companies to get insight about startup landscape in Nordic and Baltic countries. We used Latent Dirichlet Allocation algorithm to discover economic activities in which entrepreneurs from these countries start new businesses and detect possibilities of smart specialization. The result suggests that there are some similarities and differences in startup communities in Nordic and Baltic countries. Our analysis shows that Smart Specialization Strategy approach and start-up community can be integrated by using text mining approaches. This methodological approach provides a lot of promising opportunities for European S3 research. For innovation ecosystem analyses text mining provides new understanding.
- This paper is first attempt to develop automated tools that can help governments to map promising sectors for smart specialization without human intervention. Next steps are to measure competitiveness of startup activities across EU regions and to link entrepreneurial activities with patents, trademarks and brands generated in a region. Also focused data analyses to Industry 4.0 and Manufacturing 4.0 production structures would provide new insights to changing innovation ecosystems in Europe. Understanding the Entrepreneurial Discovery Process (EDP) in the European Union would benefit much from large data-based text-mining analyses.

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