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Determinants of high-tech entrepreneurship in Europe

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Title: Determinants of high-tech entrepreneurship in Europe

Abstract

High-tech entrepreneurship is one of the main means by which new knowledge and technologies are converted into economic and social benefits. This report analyses the levels and determinants of high-tech entrepreneurship across European countries. To this end, it uses country-level data on high- and low-tech total early-stage entrepreneurial activity provided by the Global Entrepreneurship Monitor (GEM). Panel data estimations for the period 2007-2014 reveal that EU Member States with better access to finance, less bureaucracy, more consistent policy regimes, favourable entrepreneurship education, and qualitative intellectual property rights that lower patent thickening strategies exhibit a higher proportion of high-tech firm creation. In addition, greater technological density is associated with a higher rate of high-tech entrepreneurship creation, suggesting beneficial influences of path-dependency and agglomeration effects.

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Foreword

This report was prepared in the context of the three-year research project on European Innovation Policies for the Digital Shift ([EURIPIDIS](#)), jointly launched in 2013 by JRC and [DG CONNECT](#) of the European Commission. EURIPIDIS aims to improve understanding of innovation in the ICT sector and of ICT-enabled innovation in the rest of the economy.

The project's objective is to provide evidence-based support to the policies, instruments and measurement needs of DG CONNECT for enhancing ICT innovation and entrepreneurship in Europe, in the context of the [Digital Single Market for Europe](#), the [Startup Europe Initiative](#) and the ICT priority of [Horizon 2020](#).

EURIPIDIS aims:

- to better understand how ICT innovation works, at the level of actors such as companies, and also of the ICT "innovation system" in the EU;
- to assess the EU's current ICT innovation performance, by attempting to measure ICT innovation in Europe and by measuring the impact of existing policies and instruments (such as FP7 and Horizon 2020); and
- to explore and suggest how policy makers could make ICT innovation in the EU work better.

In view of the need for better understanding the implications of innovation policy for the on-going digital transformation, a new joint DG JRC-DG CONNECT project (RISES: Research on Innovation, Startup Europe and Standardisation) started in January 2017 to further explore these issues.

This report analyses the levels and determinants of high-tech entrepreneurship across European countries. To this end, it uses country-level data on high- and low-tech total early-stage entrepreneurial activity provided by the Global Entrepreneurship Monitor (GEM). Overall, this report highlights the conditions that associate mostly to the creation of high-tech entrepreneurial activity in Europe and provides support for evidence-based policies.

Acknowledgements

This analysis was produced in the context of the European Innovation Policies for the Digital Shift ([EURIPIDIS](#)) project, jointly launched in 2013 by JRC and DG CONNECT of the European Commission. The purpose of the EURIPIDIS project is to provide evidence-based support to the policies, instruments and measurement needs of DG CONNECT for enhancing ICT innovation in Europe, as part of the Digital Agenda for Europe and of the ICT priority of [Horizon 2020](#), and for promoting entrepreneurship in Europe through the [Startup Europe Initiative](#).

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Executive summary

Europe's weak innovation performance is rooted in its specialization in low and medium-tech sectors. High-tech entrepreneurship is one of the vehicles through which scientific results are converted into economic benefits. However, current policy support does not seem to recognize the transformative role of high-tech entrepreneurship. *"Policy references to entrepreneurship are typically equated with SMEs in general or even numbers of self-employed. Neither of which fully captures the totality and complexity of entrepreneurship"* (OECD 2011). This report looks at the levels and framework conditions of high-tech entrepreneurship in Europe.

High-tech entrepreneurship ≠ entrepreneurship

In general, countries with high shares of total entrepreneurial activity have low shares of high-tech entrepreneurial activity and vice versa. The high-tech share in total entrepreneurial activity is negatively related to the total level of entrepreneurship. For example, China, a leading country in entrepreneurship activity, ranks last as regards the share of high-tech in this activity. There are similar patterns in European countries.

Trying is not enough for a high-tech venture to succeed

Since 2000, high-tech entrepreneurial activity in Europe has been steadily increasing. In 2014, 2.9% of the population was involved in setting-up a high-tech business and 1.2% owned or managed an established high-tech business in 2014. Despite the increase of high-tech entrepreneurial activity and the share of population owning an established business, the level of high-tech established businesses remained stable. This may suggest that it is more difficult to keep a high-tech business going than a low-tech one.

The vulnerability of high-tech entrepreneurship to business climate

The share of entrepreneurial activity that is high-tech in Europe seems to follow the overall level of economic development. The lowest level of new high-tech entrants was observed when the dot.com bubble burst and then during the recent economic crisis. The highest level of new high-tech entrepreneurial activity was in 2014.

High-tech entrepreneurship feeds on existing high-tech activity

The favourable effect technological density – as measured by the share of employment in high-tech sectors – has on starting high-tech entrepreneurial activities suggests that firm creation in high-tech sectors is influenced by path-dependency and agglomeration effects. This highlights the need for policy initiatives that facilitate clustering in existing and emerging industries.

High-tech entrepreneurship needs funding

The share of high-tech early-stage entrepreneurial activity is significantly affected by the availability of bank credit to the private sector and VC funding. This indicates that governmental efforts to ease access to finance would have a beneficial effect.

Regulation: the *to be or not to be* of high-tech ventures

Uber and Airbnb are examples of how regulation can curb new businesses or eliminate them from the market. Countries with less bureaucracy, consistent policies and a forward-planning orientation have higher shares of high-tech entrepreneurship.

Knowing how to start and how to succeed

Technological know-how needs to be paired with skills to commercialise technology-based products. This includes business, management and financial competences.

The balance between openness and incentives to innovate

Technological complexity of product and service development in high-tech requires a balance between the provision of incentives to innovate and the stimulation of

knowledge dissemination. Too strict intellectual property rights may act as entry barriers for new market entrants, thus hindering the expansion of high-tech sectors.

Evidence for high-tech entrepreneurship policy making

In this report, we make use of a unique longitudinal database that allows us to observe long-term changes in the overall levels of entrepreneurship and its composition. This not only helps us to obtain a more concise validation of the effective relationship between entrepreneurial determinants and actual entrepreneurial activity, but also to break down entrepreneurial activity and to identify factors that influence its various types. This report analyses the determinants that have the most influence on high-tech firm creation. Thus, it provides support for evidence-based policies that facilitate high-tech entrepreneurship in Europe and thus the upgrading of the European industrial structure towards more technology- and innovation-intensive activities.

1 Introduction

The reason behind Europe's relatively weak innovation performance is its low research and development (R&D) expenditures, as compared to, for example, the US or Japan (Van Pottelsberghe 2008; Hernandez et al. 2016). The main explanation for Europe's R&D gap is its specialization in medium-tech, rather than high-tech sectors (Moncada-Paternò-Castello 2016; O'Mahony and van Ark 2003). In particular, Europe is lagging behind in the information and communication technology (ICT) sector, which was the driver of growth in the late 1990s in the US (Cincera and Veugelers 2010). This pattern can, however, be generalised to most of the emerging sectors in which European firms are unable to benefit from first mover advantages (Moncada-Paternò-Castello 2016). As a result, Europe's innovation gap is a consequence of its slow-changing industrial structure, with few new high-tech firms succeeding globally. This indicates that new firms face barriers when they try to enter markets and subsequently grow in Europe. Bridging the innovation gap requires more new high-tech firms in emerging sectors (Cincera and Veugelers 2010). Policies need to address the specific barriers for development of new R&D-intensive sectors and firms, as they play a key role in tackling Europe's R&D deficit and its weak innovation performance.

This report analyses the evolution and framework conditions of high-tech entrepreneurship in Europe. It looks into the association between favourable entrepreneurial conditions and the relative prevalence of high-tech entrepreneurial activity in entrepreneurial activity overall. The results of this report highlight those entrepreneurial conditions which stimulate high-tech rather than low-tech entrepreneurial activity.

It is easy to see the differences in anatomy and performance of newly-created high- and low-tech firms. Young, high-tech firms are typically very R&D intensive and have higher sales/employment growth rates (Cincera and Veugelers 2010). Moreover, the particular role of high-tech entrants, commonly referred to as start-ups, in the economy is quite exceptional. Considering that a key enabler of a modern economy is the creation, exploitation and commercialisation of new technologies, high-tech start-ups are the main vehicles through which new knowledge from science and research is converted into economic benefits (Acs et al. 2009a; Acs et al. 2009b). These companies are more likely than others to pursue opportunities associated with radical innovations. These opportunities produce positive knowledge externalities and may have transformative consequences for society (Baumol et al. 2007) but they are often risky and challenging. Incumbent firms in established markets may therefore be less likely to pursue them. Hence, new high-tech entrants have an "attacker" advantage in commercialising new technologies that can disrupt the established trajectories of technological progress (Utterback 1994; Christensen and Rosenbloom 1995). Consequently, high-tech entrants shape new and emerging economic sectors and, by increasing the competitive pressure, they incentivize existing firms to be more R&D-intensive and innovative.

Given their peculiarities, high-tech firms may respond differently to the conditions of entrepreneurship ecosystems from firms carrying out traditional and low-tech activities. First of all, high-tech start-ups introduce new technology-based products and services. This involves a number of steps which are different from those taken in low-tech entrepreneurial activity (for example, opening a local shop, restaurant or just being self-employed). Here, the main challenge for the entrepreneur is to deal with the complexity of these innovations. The success of many technology-based innovations, e.g. digitally-enabled ones, often relies on technological interoperability (Tassej 2000). This typically requires the entrepreneur to master several technologies and competencies, along with business financial management skills (Lee et al. 2001). In addition, because advanced technologies are developed in ecosystems with various actors and players, e.g. universities, research organizations and other firms, the entrepreneur must also navigate through these nexus of relations and interdependencies (Pesole and Nepelski 2016). Technology transfer from universities, technology in-licencing or participation in technology standard-setting processes are typical examples of the additional steps high-

tech entrants may need to take when bringing an innovative product onto the market. The regulatory environment can be another hurdle. The existing regulation and legal framework may have the final word when it comes to many high-tech start ups' right to exist (Lee 1991). Digital start-ups with business models which disrupt existing industries illustrate the case. Uber and Airbnb are key examples of how regulation can curb or eliminate a new business from the market (Schneider 2016). Entrants operating in other sectors, e.g. medical products, biotechnology or new materials, are equally exposed to the legal rules and requirements, which impose on them large compliance costs. Finally, as the provision of high-tech products and services is not confined by regional or national borders like many low-tech activities are, e.g. tourism or local services, high-tech entrants have the opportunity to maximise on their innovative activities by building a presence on global markets. This, in addition to R&D expenditures, increases the demand for funding necessary to scale-up (Simon 2016).

Many studies have investigated the framework conditions of entrepreneurship in general (Ardagna and Lusardi 2010; Isenberg 2011; Mason and Brown 2014). However, to the best of our knowledge, despite the obvious differences between high- and low-tech entrepreneurship, the relationship between framework conditions and high-tech entrepreneurship activity have not yet been analysed.

Also the policy discourse on entrepreneurship seems to confine entrepreneurship activity to small and medium-sized enterprises (SME), ignoring the technological dimension altogether. According to an OECD study (2011) *"The pursuit and development of (...) policies (focused on the entrepreneurial environment) have until recently been hampered by the limited, albeit growing, empirical information relating to the factors that affect entrepreneurship and the benefits of it. Policy references to entrepreneurship were typically equated with SMEs in general or even numbers of self-employed. Neither of which fully captures the totality and complexity of entrepreneurship."* Given they are the main generators of economic growth, technology-based and innovation-intensive firms deserve more attention and should constitute one of the main targets of public policies in developed economies (OECD 2010). Hence, a better understanding of the relationship between framework conditions for entrepreneurship and the creation of high-tech entrepreneurship is especially relevant for scholars and policy makers.

In order to fill this gap in understanding the drivers and barriers to high-tech entrepreneurship, we took two steps. First, we analysed Global Entrepreneurship Monitor (GEM) data broken down by sector of activity, i.e. low- vs. high-tech, to explore the prevalence of high-tech entrepreneurial activity. The total (high-tech) early-stage entrepreneurial activity (TEA) and the (high-tech) established business ownership (EB) rates have been selected as key measures of entrepreneurial activity in Europe and selected countries in the period between 2002 and 2014. Second, using the selection of framework conditions of entrepreneurship discussed by Van Roy and Nepelski (2016), we ran an empirical analysis linking them to the shares of high-tech early-stage entrepreneurial activity in Europe. The results allow us to highlight the conditions that associate mostly to the creation of high-tech entrepreneurial activity in Europe and provide a valuable input to evidence-based policy.

The rest of the report is structured as follows: Section 2 lays out the theoretical arguments for the relationship between entrepreneurial conditions and the prevalence of high-tech entrepreneurship. Section 3 describes the data sources and the explanatory variables that we have used in this report. Section 4 provides descriptive statistics of high-tech entrepreneurial activity over time and across countries and highlights the relationship between high-tech entrepreneurship and the total level of entrepreneurial activity across countries. Section 5 presents the results and highlights the framework conditions that relate most to high-tech entrepreneurship at country level in Europe. Section 6 offers some conclusions and summarises the main lessons learned from these exploratory analyses.

2 Theoretical framework

From a policy perspective, a better understanding of the association between these framework conditions and high-tech entrepreneurship is particularly salient, given that firms in high-tech sectors are responsible for a large part of Europe's economic growth, innovation, value creation and employment. This section provides an overview of the factors that shape the local context in which economic activities are taking place in entrepreneurship ecosystems, with a special focus on high-tech entrepreneurship.

Acs et al. (2014) define the notion of entrepreneurial ecosystems as "(...) a dynamic, institutionally embedded interaction between entrepreneurial attitudes, ability and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures (...)". Along the same lines, Audretsch and Belitski (2016) define it as "(...) a dynamic community of inter-dependent actors (entrepreneurs, suppliers, buyer, government, etc.) and system-level institutional, informational and socioeconomic contexts (...)".

Building on the previous studies defining the key elements of entrepreneurial activity, Van Roy and Nepelski (2016) defined framework condition for firm creation and growth in Europe. Following this framework, this section provides theoretical arguments to lay out the relationship between these framework conditions and entrepreneurial activity in general. In addition, it presents hypotheses about the effect of the different framework conditions and entrepreneurial activities in high-tech sectors. The set of framework conditions that are analysed in this report are:

- Entrepreneurial culture,
- Entrepreneurial education,
- Intellectual property rights (IPR) protection,
- Market dynamics,
- Access to finance,
- Regulatory environment,
- Physical infrastructure.

2.1 Entrepreneurial culture

Entrepreneurial culture shapes the climate for entrepreneurship in a country and can be seen as a catalyst for entrepreneurial activity.

The concept of **entrepreneurial culture** encompasses the values, norms, interpretations and modes of behaviour that characterise societies or other social groups (Fukuyama 2001). In this respect, it is important to distinguish between values and beliefs at the individual level and the entrepreneurial culture and norms that prevail in a country at the collective level (Hayton et al. 2002). Culture can relate to general aspects such as trust, and individualism/collectivism, or to more specific features related to entrepreneurship such as risk taking, respect for leadership, need for achievement, need for autonomy, locus of control and self-efficacy (Vecchio 2003).

The cultural aspects at both the individual and collective level are **conducive to entrepreneurial activity** as they influence the attitudes and actual actions to become entrepreneur. As argued by Shane (2001, p. 205): "(...) when the individuals who discover opportunities are more experienced in firm creation (Carroll and Mosakowski 1987), more creative (Joseph Alois Schumpeter 1934), more imaginative (Shackle 1979), more risk tolerant (Kihlstrom and Laffont 1979), higher in need for achievement (Roberts 1991) or more tolerant of ambiguity (Begley and Boyd 1987), they tend to form new firms to exploit opportunities (...)".

A favourable entrepreneurial culture may have a greater effect on entrepreneurship in high-tech sectors than in low-tech ones. As high-tech cutting edge inventions have potentially higher economic value, the opportunity costs for prospective entrepreneurs in

these sectors are higher than for those in low-tech sectors. In addition, economic activities in high-tech firms exhibit a greater degree of inherent uncertainty, involving higher risks of business failure (Audretsch 2012). Hence, favourable entrepreneurial culture factors such as risk tolerance and need for achievement may increase the likelihood that a new high-tech firm will be founded (Shane 2001). Based on this argument, the following hypothesis is advanced:

Hypothesis for entrepreneurial culture

The more favourable the entrepreneurial culture in a country, the larger the proportion of high-tech entrepreneurial activity in the overall entrepreneurial activity, *ceteris paribus*.

2.2 Entrepreneurial education

Entrepreneurship education and training (EET) has received increasing attention from policy makers as it is seen as an important driver for entrepreneurship. First, it is vital for the formation of entrepreneurial activity as it provides the ability to recognise and grasp the right opportunities and to develop them into more elaborated business concepts (Alvarez and Barney 2007; Marvel 2013). Prospective entrepreneurs with a higher level of entrepreneurship education have a greater ability to identify opportunities and hence are more likely to engage in entrepreneurial activity (Davidsson and Honig 2003). Second, it positively influence venture performance as it provides the requested capabilities for the daily operations of firms such as problem-solving and decision-making qualities (Chandler and Hanks 1994). Third, it allows for the accumulation of new knowledge and the discovery and development of competitive opportunities (Corbett et al. 2007).

A reinforcement of (entrepreneurship) education and training is particularly important for the creation of business ventures in high-tech sectors. Economic activities in high-tech sectors build on advanced and cutting-edge technologies that require specialised (managerial) skills and competences as compared to the more traditional and mechanical technologies employed in low-tech sectors. This may infer that higher level of education and training in a country will result in a higher proportion of new high-tech business ventures. Based on this argument, the following hypothesis is advanced:

Hypothesis for entrepreneurial education

The higher the level of entrepreneurial education and training in a country, the higher the proportion of high-tech business ventures in the overall entrepreneurial activity, *ceteris paribus*.

2.3 IPR protection

The discovery process of new opportunities is facilitated by firms' research and development efforts. The resulting innovations have been widely recognised among economists as important drivers of economic development and prosperity (Griliches 1979; Romer 1990; Aghion and Howitt 1992).

The development of new goods and services is a long-term process that has multiple feed-back loops, implying that the first years of business activity are often devoted to the designing, prototyping, testing and demonstration of new goods and services. Hence, corporate activities in start-ups are often directed at research and development in order to come up with a scalable product or service that can be commercialized on the market.

In order to help firms in consolidate their market position and allow them to appropriate the benefits of their R&D efforts, **intellectual property rights** have been created

through patents, copyrights and trademarks. These rights protect innovative firms for a specific period of time and allow them to appropriate the benefits of their novel ideas and concepts.

Given that high-tech sectors are more innovation-intensive, favourable protection mechanisms to support the creation of knowledge may have a larger effect on firm creation in these sectors as compared to low-tech sectors (Shane 2001). Based on this argument, the following hypothesis is advanced:

Hypothesis for IPR protection

The more favourable the conditions for appropriating the results of new technology and product creation in a country, i.e. IPR protection, the higher the proportion of high-tech business ventures in the overall entrepreneurial activity, *ceteris paribus*.

2.4 Market dynamics

Market dynamics encompass the characteristics of a market in entrepreneurs are operating. "Market and industry structure and firm entry have been widely studied in the industrial organisation and entrepreneurship literatures (Geroski 1989, 1995; Klepper 1996, 2002; Klepper and Sleeper 2005). Studies have theorised both market- and technology life cycle effects, predicting higher rates of new firm entry near the beginning of a market's life cycle, as demand and supply increase rapidly, possibly facilitated by high levels of certain types of innovative and spin-off activity (Acs and Audretsch 1990; Malerba and Orsenigo 1996; Acs and Audretsch 1990; Carree and Thurik 2000; Klepper 2002). In early stages, new firm entry provides an important driving factor of market dynamism, but market dynamism, in itself, also opens opportunities for entry by entrepreneurial ventures." (Levie and Autio 2008, p. 15).

Market dynamics are particularly salient in high-tech sectors. High-tech sectors are often more volatile due to shorter life-cycles of high-tech products and services, which can cause major swings in the introduction of new technology products and services (Runiewicz-Wardyn 2013). Based on this argument, the following hypothesis is advanced:

Hypothesis for market dynamics

The higher the degree of market dynamics in a country, the higher the proportion of high-tech business ventures in the overall entrepreneurial activity, *ceteris paribus*.

2.5 Access to finance

Scholars commonly agree that **access to finance** is one of the most important framework conditions of entrepreneurship as the lack of finance impedes firms throughout the development process. In an attempt to avoid the leakage of new ideas and knowledge to external sources, the vast majority of start-up entrepreneurs rely on their own funds or savings or obtain financial assistance from family and friends (OECD and EC 2014). Given that self-financing and personal network funds are often not sufficient to cover the financial needs of new business ventures, entrepreneurs are forced to rely on other funding sources such as bank loans. Although bank loans are commonly taken out by firms to raise funding, start-ups particularly may face difficulties in obtaining them due to information asymmetries (Beck and Demirguc-Kunt 2006).

Information asymmetries arise from the fact that banks often lack sufficient skills and information to judge the viability of a business project. In addition, start-ups have fewer fixed assets than larger firms that can serve as collateral for bank loans, and therefore their capital requests are more likely to be rejected. Subsequently, start-ups have to search for alternative financing. The above mentioned financing methods are

increasingly supplemented by **seed and first stage venture capital funding** and private investments by business angels (Nepelski et al. 2016; OECD 2016).

New high-tech firms may face higher financial constraints than their counterparts in low-tech sectors due to the more risky invention activities which have uncertain outcomes (Carpenter and Petersen 2002; Guiso, 1998; Hall 2002). Greater information asymmetries and the absence of intellectual capital in the form of patents in newly-created high-tech firms may prevent them from accessing external sources of financing (OECD 2016). Based on this argument, the following hypothesis is advanced:

Hypothesis for access to finance

The more accessible finance is in a country, the higher the proportion of high-tech business ventures in the overall entrepreneurial activity, *ceteris paribus*.

2.6 Regulatory environment

The fiscal and regulatory environment is often seen as a barrier for entrepreneurial entry. The entry rate of start-ups firms can be severely restricted by cumbersome administrative procedures for the creation a new business. Entrepreneurs have, on occasion, aborted their business activities because the opportunity to launch a new and successful product or service on the market is passed by the time they have complied with the complex and often unnecessarily lengthy regulatory procedures.

High-tech firms particularly may suffer from the regulatory environment and miss opportunities as their products have shorter life-cycles (Shane 2001).

Entrepreneurs introducing disruptive innovations, e.g. digital ones, offering tremendous potential, but also creating new challenges, often meet social and political resistance. Regulatory responses initially intend to protect the status quo. Uber and Airbnb are among the show-cases of how regulation can curb or eliminate a new business from the market (Schneider, 2016). Based on this argument, the following hypothesis is advanced:

Hypothesis for regulatory environment

The more effective the regulatory environment in a country, the higher the proportion of high-tech business ventures in the overall entrepreneurial activity, *ceteris paribus*.

2.7 Physical infrastructure

A large strand of macro-economic literature has analysed the role of physical infrastructure in terms of transport facilities (e.g. highways and trains). In general, these empirical studies have found a positive relationship between the country/state infrastructure and its economic growth (Banister and Berechman 2001). However, there is very little literature specifically on the link between entrepreneurship and physical infrastructure remains rather scarce. Audretsch et al. (2015) is one of the only studies which analyses this issue. It found that infrastructure was positively associated with start-up firm activity. Good **quality infrastructure** and **logistic services** which perform well are essential to ensure the logistics towards clients and suppliers. Based on this argument, the following hypothesis is advanced:

Hypothesis for physical infrastructure

The more accessible the physical infrastructure in a country, the higher proportion of high-tech business ventures in the overall entrepreneurial activity, *ceteris paribus*.

3 Data

Empirical analyses in the current report use the Global Entrepreneurship Monitor's (GEM) adult population survey data. GEM has become a major database for internationally comparable entrepreneurship research that has been widely used in academic research (Bergmann et al. 2014). GEM provides longitudinal data about the entrepreneurial behaviour and attitudes of individuals. The adult population surveys are carried out once a year by means of at least 2000 random interviews (see Reynolds et al. (2005) for a detailed overview of the GEM surveying method). All the GEM survey data are weighted based according to relevant demographic variables to ensure that all data is fully representative of a country's adult-age population.

3.1 Data on high-tech entrepreneurship

The national-level indicators of (high-tech) entrepreneurship used in the current report stem from the GEM database which distinguishes between two types of entrepreneurial activities:

- Total early-stage Entrepreneurial Activity (TEA): Percentage of 18-64 population who are either a nascent entrepreneur, i.e. actively involved in setting up a business they will own or co-own; this business has not paid salaries, wages, or any other payments to the owners for more than three months, or owner-manager of a new business, i.e. a running business that has paid salaries, wages, or any other payments to the owners for more than three months, but not more than 42 months.
- Established business ownership rate (EB): Percentage of 18-64 population who are currently owner-manager of an established business, i.e., owning and managing a running business that has paid salaries, wages, or any other payments to the owners for more than 42 months.

The focal sectors in this study are medium and high-technology sectors (called high-tech henceforth). The high-tech sectors cover an aggregation of manufacturing industries which have a high technological intensity (based on R&D expenditure/value added) and knowledge-intensive services. The sectors that are classified as high-tech for the purposes of this report are presented in Table 1 in the Appendix.

In order to capture the high-tech dimension of entrepreneurial activity, the shares of high-tech in GEM's TEA and EB are computed. As a result, in the proceeding analysis the following indicators are used:

- High-tech total early-stage Entrepreneurial Activity (high-tech TEA): share of nascent entrepreneurs and owner-managers of a new high-tech business among all nascent entrepreneurs and owner-managers of new businesses.
- High-tech established business ownership rate (high-tech EB): share of owner-managers of high-tech established business among owner-managers of established business.

As such, both indicators provide an indication of the relative importance of high-tech entrepreneurship in a country rather than the population-level or volume. The indicators are calculated as 3-year moving averages (based on the previous, actual and following year of the observation) to smooth out excessive short-term business cycle fluctuations.

Regarding the geographical and time coverage, this study investigates the EU-28 countries (except Malta, Cyprus and Bulgaria for which data was not available) and Switzerland during the period 2007 to 2014. The descriptive statistics in Section 4 are presented for a wider time frame (2002-2014) and cover more countries in order to

compare European countries with international competitors¹, i.e. the EU-28 countries (except Malta, Bulgaria and Cyprus), plus Australia, Brazil, Canada, China, India, Israel, Japan, Norway, Russia, South Korea, Switzerland, Taiwan, Turkey, and United States.

3.2 Data on determinants of high-tech entrepreneurship

The selection of indicators that can be seen as determinants of high-tech entrepreneurship is guided by a study by Van Roy and Nepelski (2016) which explores the framework conditions for the creation and growth of firms in Europe. The indicators capture distinct aspects of the more general framework conditions that relate to entrepreneurial culture, access to human capital, support initiatives for knowledge creation, market conditions, availability of sufficient and appropriate financial sources, prevailing business regulations and the quality of supporting infrastructure.

The indicators are derived from a wide range of data sources, including GEM's national expert survey, the World Economic Forum, Eurostat, IMF, Dow Jones and Global Insights. The list of indicators and the data sources that are used in the estimation models are presented in Table 2 of the Appendix.

¹ The restricted geographical and time coverage for the empirical analyses in Section 5 are due to shortage of data availability for the determinants of high-tech entrepreneurship that are limited to EU-28 countries.

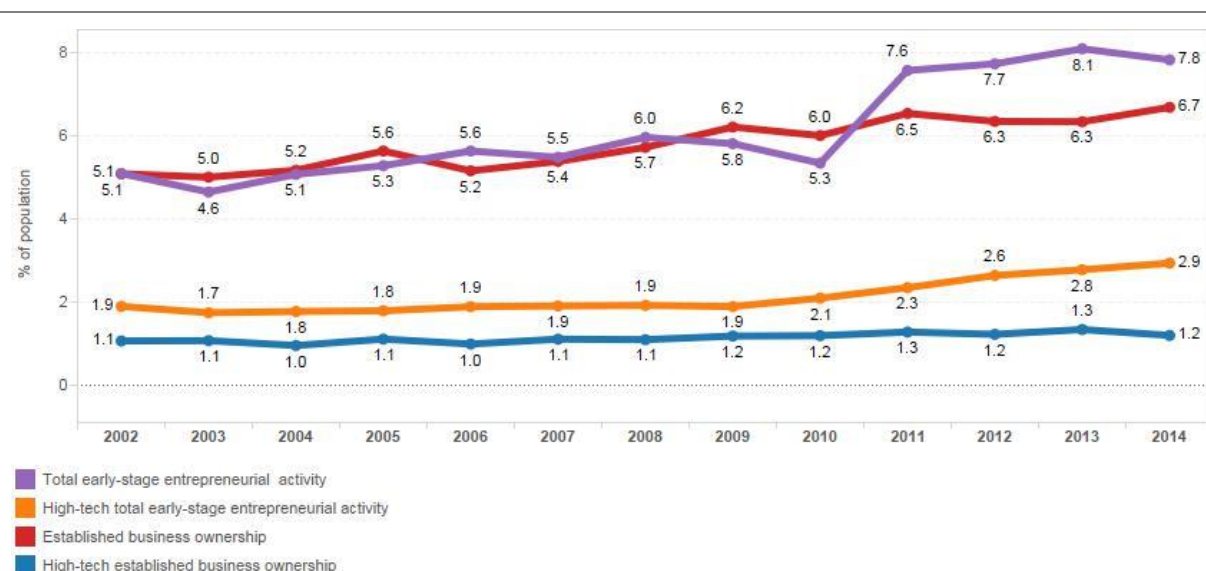
4 High-tech entrepreneurial activity

In order to reduce the R&D intensity gap between the EU and its main competitors, it is important to promote and support the more R&D-intensive sectors by, for example, increasing the share of high-tech entrepreneurship. A first step in understanding how this can be achieved is to assess differences across EU Member States in sectoral compositions. This section provides empirical evidence on high-tech entrepreneurship in Europe and compares it with a group of selected non-EU countries. First, it analyses the evolution of (high-tech) entrepreneurial activity in Europe over time. Second, it assesses the share of high-tech in the total level of entrepreneurial activity. Finally, to gain detailed insights into the composition of entrepreneurial activities in Europe and selected countries, total entrepreneurship figures are compared with shares of high-tech entrepreneurship. The analysis is based on Global Entrepreneurship Monitor data and covers the period between 2002 and 2014.

4.1 Total and high-tech entrepreneurial activity over time

Figure 1 presents the share of the European population which is actively involved in setting up a (high-tech) business (TEA) and owning or managing an established (high-tech) business (EB). Between 2002 and 2014, the level of (high-tech) TEA increased from (1.9%) 5.1% to (2.9%) 7.8%. In the same period, the level of (high-tech) EB increased from (1.1%) 5.1% to (1.2%) 6.7%. This allows us to conclude that the level of high-tech entrepreneurship is increasing together with the level of overall entrepreneurial activity. However, although the share of high-tech TEA and the EB are increasing, the level of high-tech EB remains relatively stable. This suggests that it is difficult to keep a high-tech venture going. As discussed in Section 2, high-tech businesses are more likely to fail for several reasons, such as the difficulty in finding appropriate financial support, poor management skills, or the lack of experience in bringing a new technology to the market.

Figure 1: % of population involved in entrepreneurial activity in Europe by year and sector of activity, 2002-2014



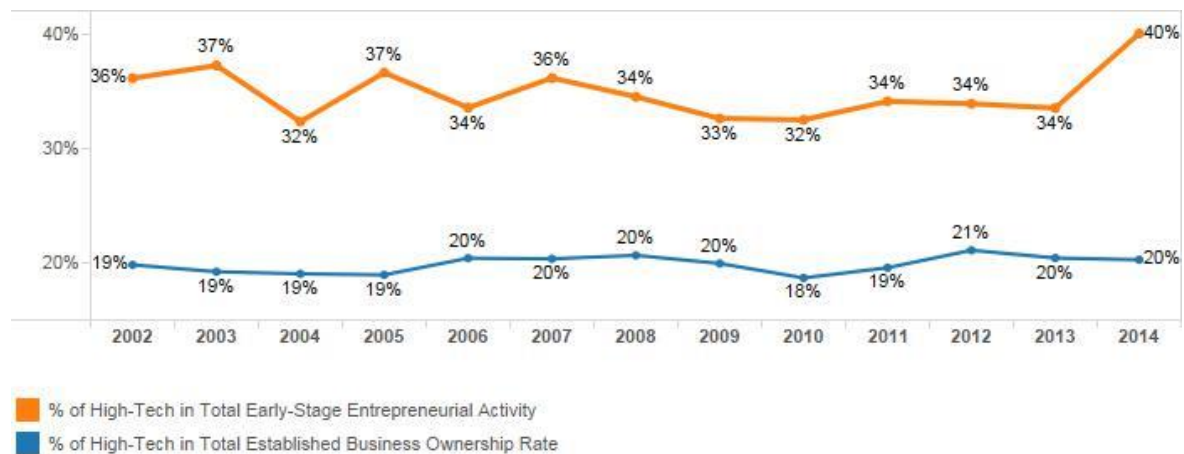
Note: Figure displays % of population involved in total (high-tech) early-stage entrepreneurial activity (TEA) and % of population currently owning/managing an established (high-tech) business (EB) in Europe. The values represent the means across countries between 2002 and 2014.

Data source: [Global Entrepreneurship Monitor](#). Calculations: [EC JRC](#).

4.2 High-tech entrepreneurial activity across time and countries

In order to illustrate the evolution of sectorial composition of entrepreneurial activity in Europe, Figure 2 presents the values of high-tech TEA and high-tech EB in the period between 2002 and 2014. According to Figure 2, the level of high-tech TEA varies between 32% and 40% of total early-stage entrepreneurial activity and, in general, there is no clear time pattern. One can only observe that high-tech TEA decreased following the dot.com burst and during the recent economic crisis. In both cases, high-tech TEA dropped to its lowest level in the observed period, i.e. of 32% of TEA. The highest level of high-tech TEA was recorded in 2014 (40%). Regarding the share of high-tech EB, it remained also relatively stable. In the observed period, between 18% and 20% of EB were in the high-tech sectors.

Figure 2: High-tech TEA and EB by year, Europe, 2002-2014

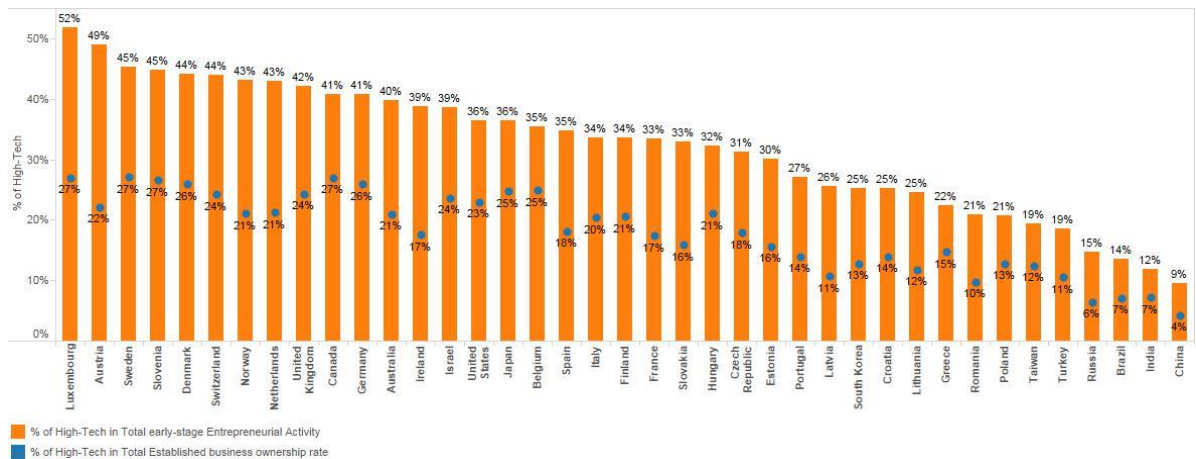


Note: Figure displays % of high-tech total early stage entrepreneurial activity and established businesses by year, average values for EU Member States. The values represent means across countries.

Data source: [Global Entrepreneurship Monitor](#). Calculations: [EC JRC](#).

Figure 3 presents cross-time averages of the shares of high-tech TEA and EB in European and, for comparison purposes, some selected countries. In contrast to the development of entrepreneurial activity over time, the variations of the share of high-tech TEA and EB between countries are considerable. With 52% of TEA belonging to high-tech sectors, Luxemburg leads the ranking of countries. On the other extreme, with the level of high-tech TEA of 9%, China ranks last. Regarding the share of high-tech sectors in the total established business ownership rate, we can observe that the Western economies show the highest levels of high-tech among established businesses. Again, Luxemburg with a range of other Western European countries shows the highest share (27%) of high-tech EB. As in the case of high-tech TEA, China ranks last. Only 4% of established businesses in China are active in the high-tech sectors.

Figure 3: % of high-tech TEA and EB by country, average across years for European and selected countries



Note: Figure displays % of high-tech TEA and % of high-tech EB by country. The values represent means across the time range between 2002 and 2014.

Data source: [Global Entrepreneurship Monitor](#). Calculations: [EC JRC](#).

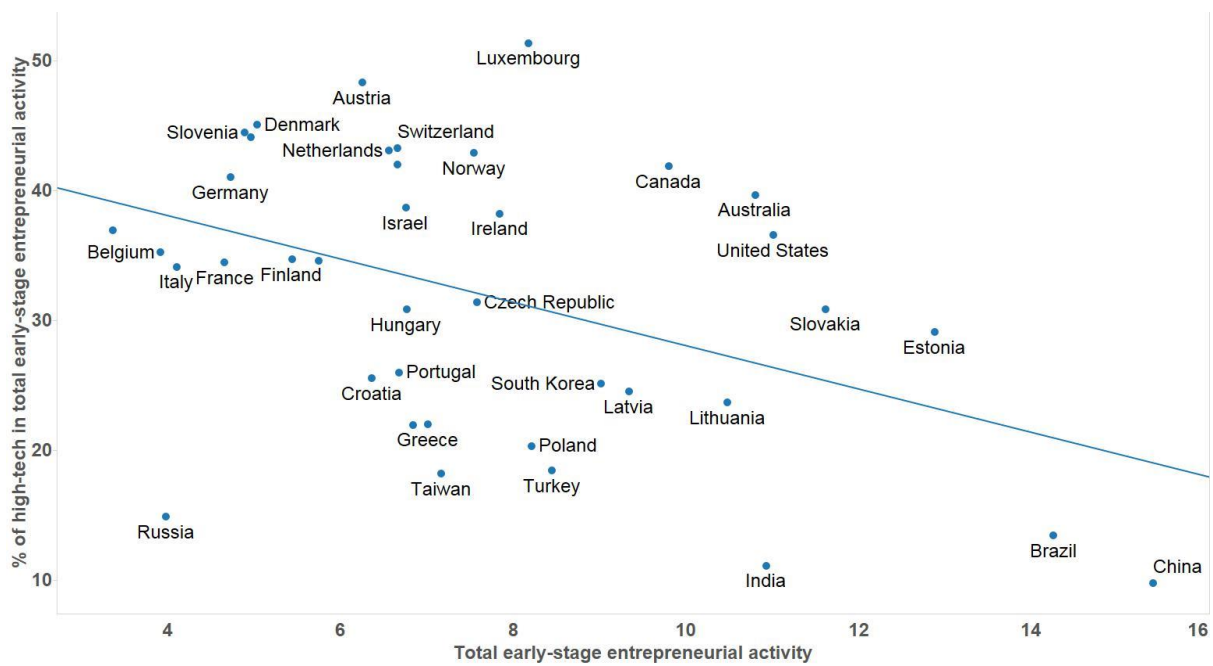
4.3 Total versus high-tech entrepreneurship

The following section analyses the relationship between the share of high-tech in entrepreneurial activity and the overall level of entrepreneurial activity across countries. The objective is to see whether higher levels of entrepreneurship also translate into higher levels of high-tech entrepreneurship.

4.3.1 Total early-stage entrepreneurship

Figure 4 presents the relationship between total early-stage entrepreneurial activity and the shares of high-tech in TEA for European and selected non-EU countries. The values are calculated as averages per country over the period between 2002 and 2014. One can observe that there is a clear negative relationship between high-tech TEA and total TEA. For example, though China has the highest level of overall entrepreneurial activity, it has the lowest share of high-tech in TEA.

Figure 4: Comparison of Total Early Entrepreneurial Activity and High-tech Early Stage Entrepreneurial Activity



Note: This figure compares the % of high-tech TEA and TEA in European countries and selected non-European countries. The values are calculated as averages per country.

Data source: [Global Entrepreneurship Monitor](#). Calculations: [EC JRC](#).

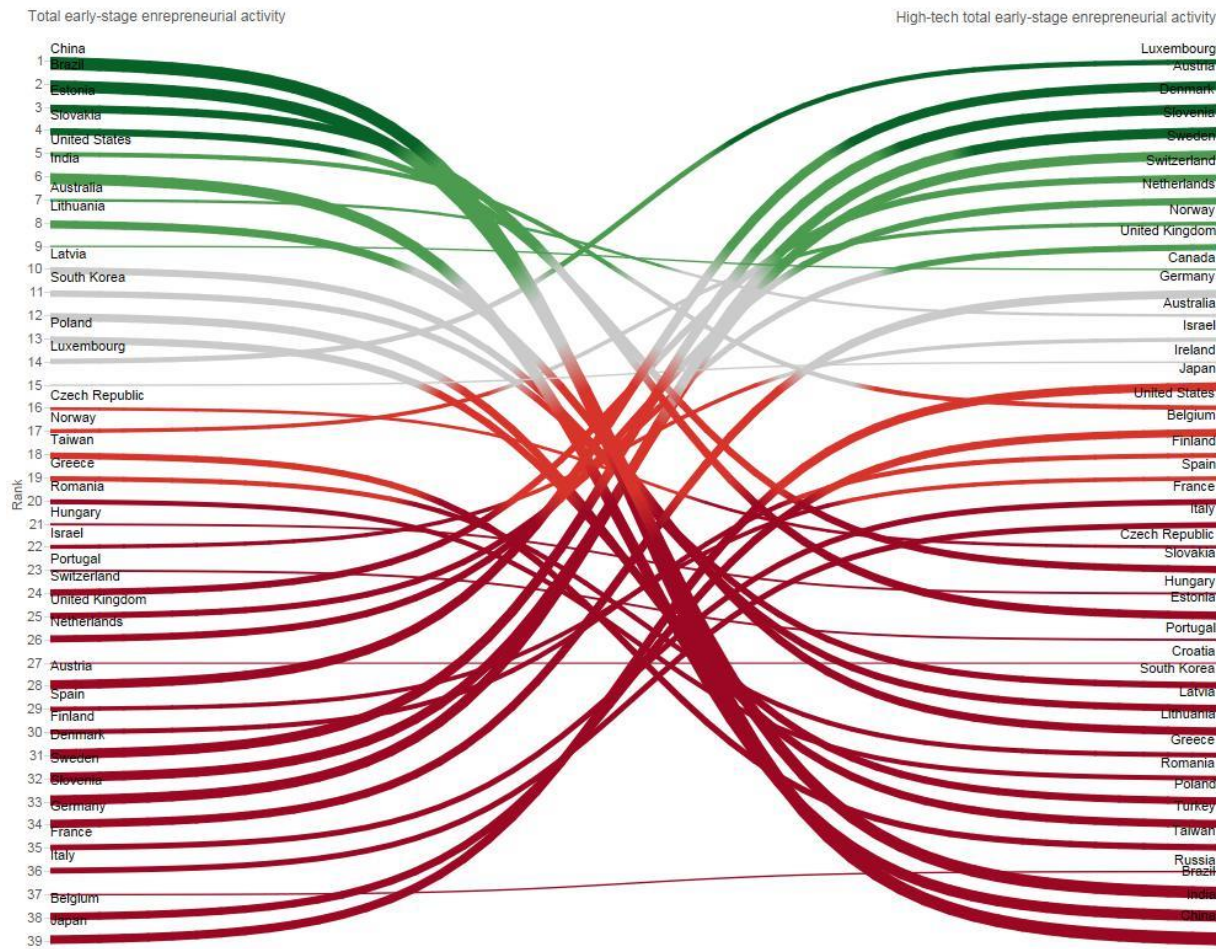
In order to illustrate the above observation, Figure 5 compares country rankings by share of total early-stage entrepreneurship in the adult-age population with their rankings by share of high-tech TEA. It allows us to understand how the relative intensity of entrepreneurship activity in a country compares with the relative prevalence of entrepreneurship in high-tech sectors. Large shifts in positions across the two rankings reveal that countries largely differ widely with respect to business creation in general and in high-tech sectors.

According to Figure 5, countries with excellent and relatively good rankings in the share of TEA, have low to very low rates of high-tech TEA. Only a few countries record similar rankings (e.g. rankings for Ireland and Canada are relatively good, whereas they are fair to low for Hungary, Portugal, Croatia and Russia). Most countries differ significantly on both rankings. Examples of countries for which rankings differ 20 positions:

- Excellent to good rankings in total TEA share but low shares on high-tech TEA: China, Brazil, Estonia, India, Lithuania, Turkey and Poland.
- Excellent to good rankings in shares of high-tech TEA but low shares of total TEA: Austria, Denmark, Sweden, Slovenia, Germany, Belgium and Japan.

Considering the above, high intensity of entrepreneurial activity in a country's population is independent of the rest of its sectoral composition.

Figure 5: Country rankings by TEA and high-tech TEA



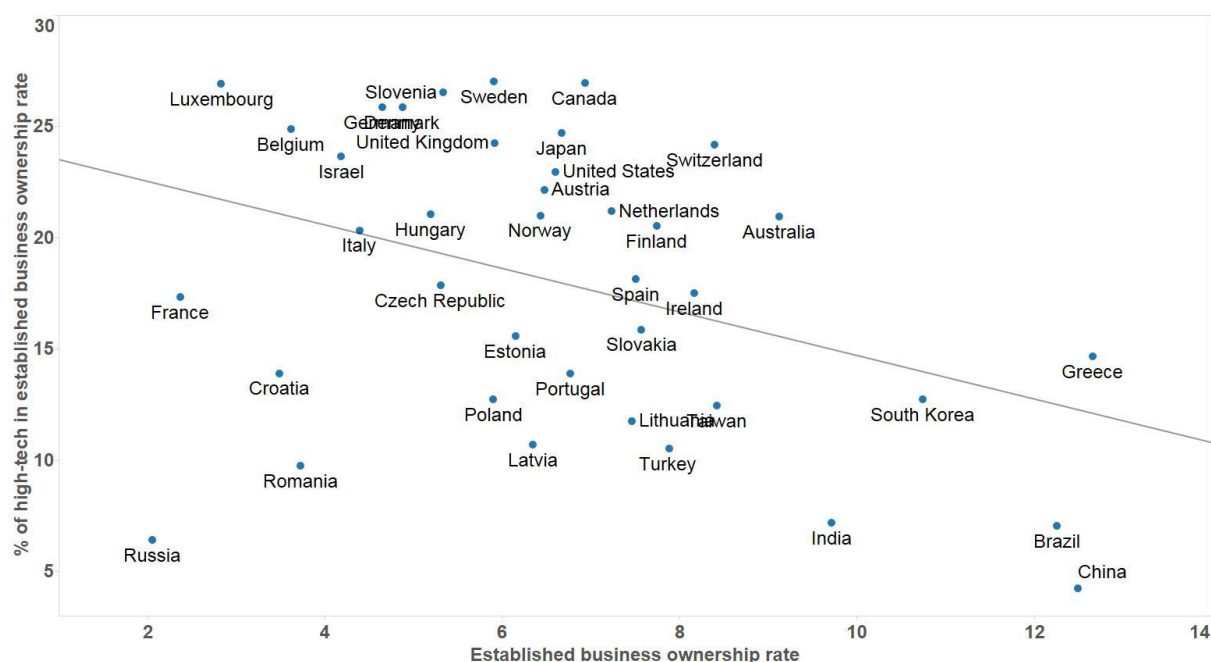
Note: This figure represents a comparison of country rankings by TEA and high-tech TEA. Both shares are calculated as 3-year averages and averaged across the period 2002-2014.

Data source: [Global Entrepreneurship Monitor](#). Calculations: [EC JRC](#).

4.3.2 Established firms

Figure 6 presents the relationship between the total established business ownership rate in population and the share of high-tech in EB for European and selected countries. The values are calculated as averages per country over the period between 2002 and 2014. As in the previous section, one can observe that there is a clear negative relationship between the share of high-tech in EB and the total EB. Again, the case of China illustrates this point. It has one of the highest levels of overall EB (12.5%) and the lowest share of high-tech in EB (4.2%).

Figure 6: Comparison of Established Business and high-tech Established Business



Note: This figure compares high-tech EB and EB in European countries and selected non-European countries. The values are calculated as averages per country.

Data source: [Global Entrepreneurship Monitor](#). Calculations: [EC JRC](#).

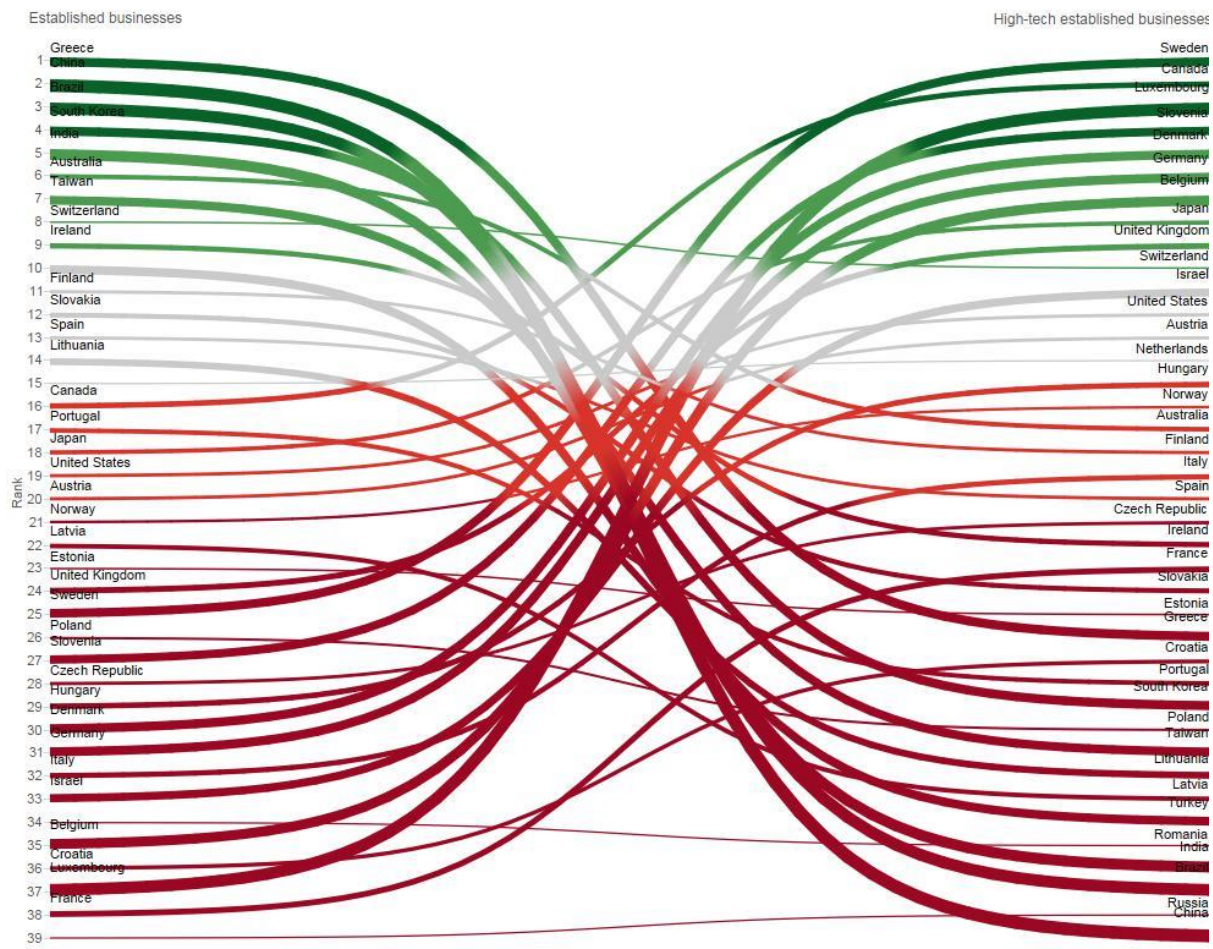
The above observation is visualised by Figure 7 comparing country rankings by share of total Established Businesses in the adult-age population with their rankings by share of high-tech in EB. It allows us to understand how the relative intensity of EB in a country compares with the relative prevalence of entrepreneurship in high-tech sectors. Large shifts in positions across the two rankings reveal that countries largely differ widely with respect to business creation in general and in high-tech sectors.

In general, countries with higher rankings by share of EB, have lower rankings by the share of high-tech established firms and vice versa. Only a few countries record similar rankings, being Russia, Netherlands and Romania. Most countries differ significantly on both rankings. Examples of countries for which country rankings differ 20 positions:

- Excellent to good rankings by share of EB but low shares of high-tech EB: Turkey, Taiwan, South-Korea, Greece, India, Brazil, and China.
- Excellent to good rankings by share of high-tech EB but low shares of EB: Luxembourg, Belgium, Germany, Denmark, Sweden, Slovenia, and Israel.

Summing up, the fact that countries diverge significantly in their sectoral composition of entrepreneurial activity, may imply that general framework conditions of entrepreneurship – as currently measured at national level - do not necessarily equally affect all types of entrepreneurial activities in an economy. This observation justifies the need of more fine-grained analyses as provided in Section 5.

Figure 7: Country rankings by EB and high-tech EB



Note: This figure represents a comparison of country rankings of the total share of established firms and the share of high-tech established firms. Both shares are calculated as 3-year averages and averaged across the period 2002-2014.

Data source: [Global Entrepreneurship Monitor](#). Calculations: [EC JRC](#).

5 Determinants of high-tech entrepreneurship

The results presented in this section are based on a random effects panel estimation model that explores the association between the share of high-tech entrepreneurship and the framework conditions of entrepreneurial activity that were presented in Section 4. The results of this model are presented in Table 3 in the Appendix. All independent or predictor variables are observed for the same year as the dependent variable, except for the technological density. The technological density is one year lagged and captures the differences in industry structures of the EU Member States. This variable has been added to the model to control for the path dependency of sectoral compositions and agglomeration effects at national level, implying that countries with a higher technological density in a given year are expected to exhibit higher shares of high-tech firm creation in the following year.

Results of the random effects estimation provide support for various hypotheses mentioned in Section 2. Findings reveal that the following framework conditions are significantly associated with the relative prevalence of high-tech entrepreneurship:

- the access to finance as measured by the domestic credit that is provided to the private sectors by banks and the availability of venture capital funding;
- the regulatory environment as measured by a government effectiveness in terms of bureaucracy, policy consistency and forward planning;
- the entrepreneurial education as measured by the extent of incorporation of entrepreneurial education and training in the higher education system;
- the market dynamics as measured by the extent by which markets change from year to year in terms of firm births and deaths;
- the strength of IPR protection.

All the above mentioned framework conditions are positively associated with the proportion of high-tech firm creation in a country, except for the intellectual property indicator, which is negatively associated.

Findings demonstrate the importance of **early-stage fund raising**, such as bank loans and private venture capital. Especially high-tech entrepreneurs have often more problems in securing funding given the complex nature of the innovative solutions they propose. This problem may increase even more in the future since the availability of venture capital is decreasing in Europe – venture capitalists are de-risking their investments by targeting companies at later stages of development instead of supporting young innovative and high-risk enterprises (Nepelski et al. 2016). Europe's venture capital market is relatively small and fragmented compared to competitive economies such as the United States and Asia.

A recent study by A.T. Kearny (2014) highlighted the fact that "(...) *European high-tech companies face a maze of **regulatory regimes** in home markets and Europe as a whole including labor laws, tax red tape, security and environmental standards, data protection laws, product standards, and investment support – which reduces their home-market advantage against other markets (...)*" (A.T. Kearny 2014, p. 15). Being an engine for innovation in Europe, a healthy high-tech sector can be fostered by improving and simplifying the regulatory environment.

Entrepreneurship education has been widely claimed to influence the intention to start up an entrepreneurial activity and the actual action of doing so (Maresch et al. 2014; Krueger et al. 2000). In addition, a study by Charney and Libecap (2000) which assesses the impact of entrepreneurship education programmes, reveals that entrepreneurship graduates are more often active in high-tech firms and in developing new technological products. These two findings corroborate the idea that **entrepreneurship education** is an effective means of producing innovation champions and has a positive effect on high-tech firm creation.

Concerning the **strength of IPR protection**, the following reasons can be advanced to explain the less intuitive relationship between IPR and the share of high-tech entrepreneurship. First of all, IPR are not mentioned as very important drivers of competitive advantage in such high-tech sectors as ICT (Biagi et al. 2016). Moreover, technological complexity combined with the cumulateness of the innovation process leads to fragmentation of IPR and to the emergence of patent thickets (Shapiro 2001). The pervasiveness of thickets is likely to harm companies which need to in-license technologies, e.g. new entrants. In addition, thickets make searching for prior art more difficult, thus potentially reducing the quality of patents granted by patent offices. As a consequence, the role of IPR for the technological progress in high-tech sectors is not so clear-cut and instead of driving may actually harm innovation (Comino and Manenti 2015).

Regarding other variables included in the model, the measure of **technological density** has a very strong effect on the share of high-tech in entrepreneurial activity. This confirms reinforcing effects of agglomeration and path dependency of a country's sectoral composition. The favourable effect of the technological density is in line with the literature that studies the co-evolutionary process of innovation and entrepreneurship ecosystems (Arthur 1994; Narula 2002). This literature stipulates that the sectoral composition of a given national economy influences the operations and the structure of its innovation system and vice versa. Hence "*(...) sectoral characteristics (and the needs of firms in these sectors) influence the development of the knowledge infrastructure, institutions and policies at the national level, while these factors influence the subsequent evolution of the national economy, including its sectoral composition (...)*" (Fagerberg et al. 2009, p. 5). The dynamics by which new industries are created, and by which these develop over time, are relatively slow and follow an evolutionary path-dependent pattern and hence are determined by the technological density of a country. The dynamics are grounded in the interplay of structural change, i.e. the change of the industrial composition of an economic system, and technological change (Malerba 2007; Quatraro 2012, Kenney and von Burg 1999; Agarwal et al. 2015). Very often the creation of new industries is made possible by technological progress as stipulated by Schumpeter (1942) with the notion of creative destruction. The idea of path dependency and the role of technological density has been deployed in discussions of the "lock-in" of regions in particular economic specialisations and of the emergence and self-reinforcing growth of "high-tech" clusters (Martin and Sunley 2010). Existing clusters may in turn attract newcomers that develop new creative ideas and technologies that can disrupt established trajectories of technological progress and lead to new emerging industries. Thus, economies with a well-developed high-tech industry exhibit a strong knowledge infrastructure that forms a fertile ground for new high-tech firm creation.

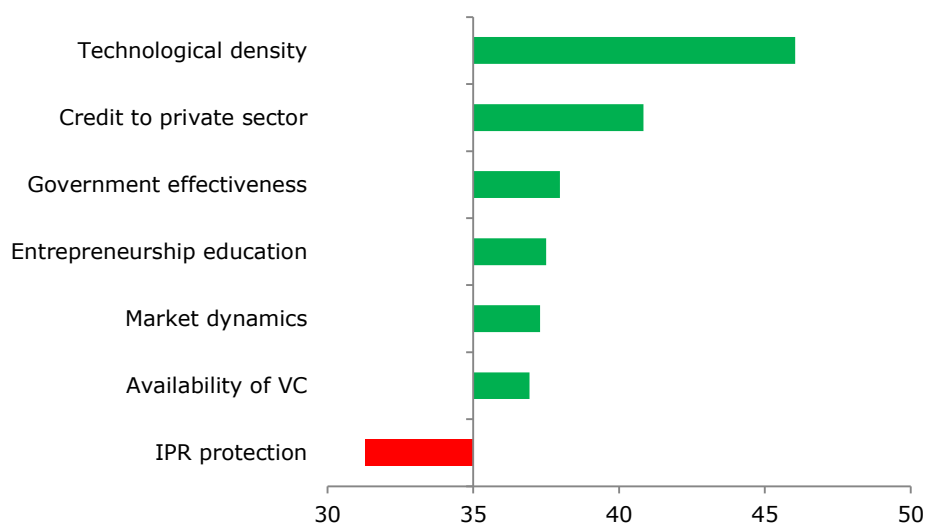
After controlling for all these factors, the GDP per capita and the entrepreneurial culture are not significantly associated with the share of high-tech firms in total entrepreneurship. As a country's GDP per capita is relatively highly correlated with its technological density, its effect is most probably captured by this latter factor. Reasons for the insignificance of entrepreneurial culture are less conclusive. Findings are suggesting that the level of entrepreneurial culture does not affect the share of high-tech entrepreneurship. However, in general, Europe has deficit in entrepreneurial culture: individual risk aversion is high and start-up failure is seen as a confirmation of this mindset.

In order to visualise the impact of these framework conditions, linear predictions of the random effects model have been used to estimate the positive effect of each framework condition on the share of high-tech firm creation in two distinct scenarios. In the first scenario the share of high-tech firm creation is predicted by keeping all the indicators at their mean value, hence simulating the outcome of high-tech share for a country with average level of framework conditions for high-tech entrepreneurship. The second scenario simulates the effect on the predicted shares of high-tech firms when each indicator listed above is successively changed from its mean value to its maximum value

in the sample, while leaving all other indicators at their mean. Hence, it simulates the hypothetical case that a country with average entrepreneurship framework conditions may obtain the maximum value for one of them.

Figure 8 presents the predicted shifts for the two scenarios. The greatest effect is observed for technological density. The predicted values of the relative prevalence of high-tech firm creation in total entrepreneurial activity shift from 35% to 46%. The share of high-tech firm creation due to an improvement of the availability of bank credits to the private sector rises by 5 percentage points. The impact of the remaining framework conditions – including the government effectiveness, market dynamics, entrepreneurial education and the availability of venture capital funding – is slightly lower and oscillates around 2-3 percentage points. Finally, the negative impact of the intellectual property rights factor is 3 percentage points.

Figure 8: Shifts in predicted shares of high-tech TEA



Note: This figure presents the effects on predicted high-tech TEA due to changes in the value of framework conditions of entrepreneurship. Results are based on a random effect panel estimation conducted on an unbalanced panel of EU-28 countries (except Malta, Bulgaria and Cyprus) and Switzerland in the period 2007-2014 (total of 132 observations).

Data source: [Global Entrepreneurship Monitor](#). Calculations: [EC JRC](#).

6 Conclusions

This section summarises the conclusions on the characteristics and framework conditions of high-tech entrepreneurship in Europe and provides some policy recommendations.

Large divergences in the shares of high-tech entrepreneurship

In general, countries with high shares of total entrepreneurial activity have low shares of high-tech entrepreneurial activity and vice versa. These sector divergences may imply that general framework conditions of entrepreneurship do not necessarily affect all types of entrepreneurial activities equally in an economy. In other words, to support this type of entrepreneurial activity, it is necessary to design specific policies favouring high-tech firm creation.

What makes high-tech entrepreneurship different from entrepreneurship?

The main framework conditions significantly associated with the share of high-tech in entrepreneurship are:

- **Technological density:** The importance of existing technologies for the creation of new high-tech ventures is very pronounced. This suggests that firm creation in high-tech sectors is influenced by path-dependency and agglomeration effects of regions and countries. This highlights the need for policy initiatives that facilitate clustering in existing and emerging industries.
- **Funding:** The share of high-tech entrepreneurial activity is significantly affected by the availability of funding. Bank credit to the private sector and venture capital funding are critical for creating high-tech ventures and keeping them going. This suggests that government efforts to ease access to finance and reduce information asymmetries between technology-based entrepreneurs and the providers of funding would be beneficial.
- **Government regulation:** Regulation appears to play a role in fostering firm creation in high-tech sectors. Countries with less bureaucracy, and more consistent policy regimes which plan ahead, create more high-tech firms.
- **Entrepreneurial education:** The provision of entrepreneurship education and training is positively associated with high-tech firm creation. Hence, complementing the technical know-how of prospective entrepreneurs with entrepreneurial skills and competences seems to have a real impact on their decisions to launch high-tech business ventures.
- **Moderate strength of IPR:** Too strict IPR protection and the resulting negative effects of intensive use of IPR, e.g. patent thickets, patent inflation and decreasing IPR quality, may impede technological progress, innovation and competition in high-tech sectors. Strict protection of intellectual property rights may hinder the expansion of high-tech sectors as it may act as an entry barrier for new market entrants. Technological complexity combined with the cumulateness of technology-based innovation requires a balance between two conflicting goals: the provision of incentives to create new products and the stimulation of knowledge dissemination.

Evidence for high-tech entrepreneurship policy making

In this report, we make use of a unique longitudinal database that allows us to observe long-term changes in the overall levels of entrepreneurship and its composition. This not only helps us to obtain a more concise validation of the effective relationship between entrepreneurial determinants and actual entrepreneurial activity, but also to break down entrepreneurial activity and to identify factors that influence its various types. This report analyses the determinants that have the most influence on high-tech firm creation. Thus, it provides support for evidence-based policies that facilitate high-tech entrepreneurship in Europe and thus the upgrading of the European industrial structure towards more technology- and innovation-intensive activities.

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Appendix

Table 1: High- and medium manufacturing and knowledge intensive services

High- and medium-technology manufacturing sectors

High-technology manufacturing sectors:

- Manufacture of basic pharmaceutical products and pharmaceutical preparations (21);
- Manufacture of computer, electronic and optical products (26);
- Manufacture of air and spacecraft and related machinery (30.3).

Medium-high-technology manufacturing sectors:

- Manufacture of chemicals and chemical products (20);
- Manufacture of weapons and ammunition (25.4);
- Manufacture of electrical equipment (27);
- Manufacture of machinery and equipment n.e.c. (28);
- Manufacture of motor vehicles, trailers and semi-trailers (29);
- Manufacture of other transport equipment (30) excluding Building of ships and boats (30.1) and excluding Manufacture of air and spacecraft and related machinery (30.3);
- Manufacture of medical and dental instruments and supplies (32.5).

Knowledge-intensive services

High-tech knowledge-intensive services:

- Motion picture, video and television programme production, sound recording and music publishing activities (59);
- Programming and broadcasting activities (60);
- Telecommunications (61);
- Computer programming, consultancy and related activities (62);
- Information service activities (63);
- Scientific research and development (72).

Knowledge-intensive market services (excluding financial intermediation and high-tech services):

- Water transport (50);
- Air transport (51);
- Legal and accounting activities (69);
- Activities of head offices; management consultancy activities (70);
- Architectural and engineering activities; technical testing and analysis (71);
- Advertising and market research (73);
- Other professional, scientific and technical activities (74);
- Employment activities (78);
- Security and investigation activities (80).

Knowledge-intensive financial services:

- Financial service activities, except insurance and pension funding (64);
- Insurance, reinsurance and pension funding, except compulsory social security (65);
- Activities auxiliary to financial services and insurance activities (66)
- Other knowledge-intensive services:
- Publishing activities (58);
- Veterinary activities (75);
- Public administration and defence; compulsory social security (84);
- Education (85);
- Human health activities (86);
- Residential care activities (87);
- Social work activities without accommodation (88);
- Creative, arts and entertainment activities (90);
- Libraries, archives, museums and other cultural activities (91);
- Gambling and betting activities (92);
- Sports activities and amusement and recreation activities (93).

Notes: The economic activity sectors are based on classifications of Eurostat at NACE Rev.2 codes at two and three digit level.

Table 2: Indicators included in the panel estimations

Determinants of high-tech entrepreneurship		
Indicator	Definition	Source
Technological density		
Technological density	Share of employment in high-technology and knowledge-intensive sectors.	Eurostat
Entrepreneurial culture		
Entrepreneurial culture	The extent to which social and cultural norms encourage or allow actions leading to new business methods or activities that can potentially increase personal wealth and income.	GEM
Entrepreneurial education		
Entrepreneurial education	The extent to which training in creating or managing SMEs is incorporated within the education and training system in higher education such as vocational, college, business schools.	GEM
Intellectual property rights protection		
Intellectual property rights	Intellectual property protection in the world (1 = is weak or nonexistent, 7 = is equal to the world's most stringent).	WEF
Market dynamics		
GDP per capita	Real GDP (in PPP) per capita.	Eurostat
Market dynamics	The level of change in markets from year to year.	GEM
Access to finance		
Friends, family and fools funding	Percentage of 18-64 population who have personally provided funds for a new business, started by someone else, in the past three years.	GEM
Credit to private sector	Domestic credit to private sector by banks (% of GDP): the indicator refers to financial resources provided to the private sector - such as through loans, purchases of non-equity securities, and trade credits and other accounts receivable - that establish a claim for repayment.	IMF
Availability of VC	Amount of seed and first-stage funding raised (€ thousands) per GDP in PPP.	Dow Jones
Regulatory environment		
Government effectiveness	A composite indicator measuring the following dimensions: 1) the assessment of the quality of the country's bureaucracy and 2) policy consistency and forward planning.	Global insights
Physical infrastructure		
Physical infrastructure	Ease of access to physical resources—communication, utilities, transportation, land or space—at a price that does not discriminate against SMEs.	GEM

Notes: The above mentioned indicators have been collected at national level for the EU-28 countries (except Malta, Bulgaria and Cyprus) and Switzerland for the period 2007-2014.

Table 3: Results from panel estimations

	Share of high-tech in TEA	
	Fixed effects	Random effects
Technological density	0.739 (0.595)	0.861*** (0.305)
Entrepreneurial culture	0.006 (0.101)	-0.051 (0.118)
Entrepreneurial education	0.265*** (0.091)	0.283** (0.115)
IPR protection	-0.265 (0.268)	-0.386** (0.160)
GDP per capita	-0.295 (0.287)	0.088 (0.147)
Market dynamics	0.061 (0.092)	0.160* (0.089)
Friends, family & fools funding	-0.005 (0.011)	-0.009 (0.011)
Credit to private sector	0.003** (0.001)	0.001** (0.001)
Availability of VC	0.024 (0.015)	0.019* (0.010)
Government effectiveness	0.496** (0.209)	0.479** (0.237)
Physical infrastructure	0.214 (0.220)	0.156 (0.136)
Year dummies	<i>included</i>	
Constant	3.330 (4.264)	-0.617 (0.994)
R-squared	0.441	0.652
Observations	132	132
Number of countries	26	26

Notes: The table presents the results of fixed and random effects panel models with estimations for the period 2007-2014 for the EU-28 countries (except Malta, Bulgaria and Cyprus) and Switzerland. Robust standard errors are presented in parentheses. *, **, *** indicate 10%, 5% and 1% significance levels. A Hausman test to determine whether random or fixed effects model is preferred reveals that the random effects model is more efficient. Hence, results presented in this report are based on this model.

Calculations: [EC JRC](#).

Table 4: Correlation table

	1	2	3	4	5	6	7	8	9	10	11	12
1 Share of high-tech in TEA	1.000											
2 Technological density	0.772	1.000										
3 Entrepreneurial culture	0.189	0.284	1.000									
4 Entrepreneurial education	0.243	0.181	0.403	1.000								
5 IPR protection	0.687	0.827	0.485	0.341	1.000							
6 GDP per capita	0.731	0.796	0.386	0.288	0.832	1.000						
7 Market dynamics	-0.248	-0.249	-0.127	-0.284	-0.388	-0.392	1.000					
8 Friends, family & fools funding	-0.155	-0.105	0.085	0.128	-0.240	-0.167	0.119	1.000				
9 Credit to private sector	0.466	0.385	0.255	-0.009	0.488	0.486	-0.488	-0.418	1.000			
10 Availability of VC	0.575	0.704	0.535	0.261	0.805	0.661	-0.283	-0.093	0.431	1.000		
11 Government effectiveness	0.625	0.685	0.347	0.142	0.755	0.659	-0.381	-0.015	0.497	0.684	1.000	
12 Physical infrastructure	0.354	0.482	0.312	0.354	0.529	0.339	-0.284	0.268	0.156	0.462	0.561	1.000

Notes: Correlation table for the covariates of the panel estimations presented in the current report. The estimations contain 132 observations and include EU-28 countries (except Malta, Bulgaria and Cyprus) and Switzerland observed in the period 2007-2014. Year dummies are omitted for space limitations.

Calculations: [EC JRC](#).

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