The institutional evolution of knowledge creation in Europe and entrepreneurship

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Document Identifier
D2.4

Version
1.0

Date Due
M22

Submission date
24th August 2017

WorkPackage
2

Lead Beneficiary
Utrecht University

Grant Agreement Number 649378

Change log

Version	Date	Action	Changes
1.0	16/07/17	Sent to Internal reviewers	Multiple changes made following comments from Koen Frenken and Mark Sanders
1.1	22/08/17	Revised version	

Policy Brief on

The institutional evolution of knowledge creation in Europe and entrepreneurship

Gerarda Westerhuis

Document Identifier
Annex 1 to D2.4 The institutional evolution of knowledge creation in Europe and entrepreneurship

Version
1.0

Date Due
M22

Submission date
29-08-2017

WorkPackage
2

Lead Beneficiary
UU

Grant Agreement Number 649378

Financial and Institutional Reforms for Entrepreneurial Society (FIRES)

Policy brief on

The institutional evolution of knowledge creation in Europe and entrepreneurship

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No.XX/August 2017

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importance of gender differences in education for entrepreneurship. Triggering women to engage in more ambitious entrepreneurship can be an important governmental instrument to foster the entrepreneurial climate across countries and regions, which could benefit these areas' competitiveness. We present three recommendations, and argue that policy changes should consider that gender differences already emerge at the early stages of the life course, particularly at the family level. An aspect that is often neglected in policy making, leading to possible failure of recent policies.

Introduction

For more than three decades, researchers have been interested in the relationship between knowledge institutions– including education, experience, and skills – and entrepreneurship. In contrast to the more traditional input of labour and capital, the economic value of knowledge is uncertain, it is non-rival in use and its potential value is asymmetric across economic agents. While many factors related to knowledge institutions contribute to entrepreneurial outcomes, one easily influenced determinant of entrepreneur outcomes is education.

Knowledge obtained through education is a crucial explanation for cross-national differences in entrepreneurial activity. More specifically, recent attention has been paid to

Grant Agreement Number 649378

the importance of the choice of subjects such as Science, Technology, Engineering and Math (STEM) for the promotion of entrepreneurial activity. Given that differences in STEM education are particularly large between men and women, in D2.4 we focus on the gender role.

Women constitute 52% of the total European population but only one-third of self-employed workers and all business starters in the EU (Eurostat 2007; OECD 2016). Triggering women to engage in more ambitious entrepreneurship can be an important governmental instrument to foster the entrepreneurial climate across countries and regions, which could benefit these areas' competitiveness. Female entrepreneurs not only contribute to employment creation and economic growth through their increasing participation but also add to the diversity and quality of entrepreneurship in the economic process

Methodology

Recent data is used to show the relevance of addressing the gender gap in education and then a historical analysis is applied to see if these gaps can indeed effectively be addressed and what policies would work.

The role of the gender differences in STEM education is analysed at the country level in promoting women's and men's perceived opportunities at three stages: (i) start a business, (ii) the knowledge intensiveness of the sector in which they start their business and (iii) their growth aspirations.

Results and conclusions

Our results in D2.4 show that women are generally less likely to engage in all three stages of entrepreneurial activity mentioned above. This seems to be a general phenomenon for all the European counties and the United States because the size of the gender gap does not vary much across countries.

When we look back and take a more historical perspective, an increase in science education in all 4 Variety of Capitalism (VoC) types since the 1990s becomes clear, with liberal market economy (LMEs) countries having the highest level followed by Managed Market Economies (MMEs), Continental Market Economies (CMEs) and Eastern Market Economies (EMEs), respectively (see Figure 1). However, despite the increase in the share of the population receiving science education, it did not translate into higher gender equality in science education. Instead, all VoC categories show a rather steep decrease in the share of women in science education compared to men since the mid-1990s.

Individual and social factors shape gendered motivation and young girls' and boys' career plans. For example, parents' beliefs differ according to the sex of their child, and these beliefs predict children's beliefs and behaviours. Thus, a gendered bias might emerge toward STEM fields, even though girls and boys do equally well in math and science throughout their schooling (Eccles 2014). The gender gap in STEM achievement widens with every step in one's educational and professional life, from high school to college to graduate school, and into the ranks of academia or industry. These more informal institutions related to gender roles and attitudes, which emerge at the family level, are highly embedded and have deep historical roots and are therefore difficult to change.

Implications

Based on the results in D2.4 we argue that in fostering entrepreneurship it is important to close the gender gap in education. As stated in the Introduction, getting women into more ambitious entrepreneurship can be an

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important policy to raise the entrepreneurial climate across countries and regions in general, which could benefit competitiveness.

We give three recommendations for policies.

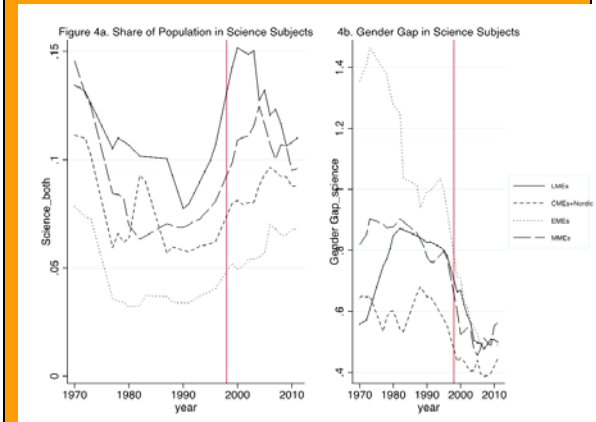
First, in general, closing the gender gap – especially in science education – is beneficial to increase engagement in more ambitious entrepreneurship, that is in knowledge-intensive sectors and high-growth entrepreneurial activity.

Second, the size of the gender gap in science seems to increase over time rather than decrease (see Figure 1). When defining policies to close this gender gap, it is very important to acknowledge that gender roles are deeply embedded cultural institutions. In 2016, the European Commission (COM 2016) recalled that education offers a unique opportunity to counter socio-economic disparities and gender stereotypes and make sure that nobody is left behind. However, most policies do not consider this high embeddedness of gender differences. So, we recommend that policies that aim to close the gender gap in science at the tertiary level should target gender differences that emerge at the early stages of the life course, particularly at the family level.

Third, closing the gender gap in science education is beneficial to stimulate entrepreneurial engagement in highly knowledge-intensive sectors particularly in institutional contexts that have a high-quality institutional environment with moderate levels of employment protection and high investment in education, such as Nordic/continental Europe

Also for policy making it would be helpful to consider that closing the gender gap in science education is less urgent for countries which receive highly skilled migrants (brain drain vs brain gain). More research is needed though to verify this claim.

Figure 1: Gender gap and overall study choice in science education over time



Further reading:

COM (2016) 941 final, 'Improving and modernising education', https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/COM-2016-941-F1-EN-MAIN.PDF

Dilli, Selin and Gerarda Westerhuis (2017), 'Institutions, Gender Differences in Human Capital, and Entrepreneurship'. Deliverable 2.4 in Financial and Institutional Reforms for the Entrepreneurial Society (FIRES).

Eccles, Jacquelynne S. (2014) 'Gendered Socialization of STEM Interests in the Family', *International Journal of Gender, Science and Technology.*

Disclaimer: *This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 649378. This policy brief expresses only the author's views and the Agency is not responsible for any use that may be made of the information it contains.*

Grant Agreement Number 649378

Manuscript Submission Report

Selin Dilli & Gerarda Westerhuis

Document Identifier

Annex 2 to D2.4 The institutional evolution of knowledge creation in Europe and entrepreneurship

Version

1.0

Date Due

M22

Submission date

24th August 2017

WorkPackage

2

Lead Beneficiary

UU

Grant Agreement Number 649378

Journal, Date and Time

Small Business Economics

Title

Institutions, Gender Differences in Human Capital, and Entrepreneurship

Abstract

Previous studies offer evidence that human capital obtained through education is a crucial explanation for cross-national differences in entrepreneurial activity. Recently, scholarly attention has focused on the importance of the choice of subjects such as Science, Technology, Engineering and Math (STEM) for the promotion of entrepreneurial activity. To our knowledge, empirical evidence on this link is scarce, despite the literature's emphasis on the choice of study at the tertiary level. Given that difference in STEM education are particularly large between men and women, we utilize data for 19 European countries and the United States from the Global Entrepreneurship Monitor and study the role of these differences at the country level for three stages of the entrepreneurial process: entrepreneurial awareness, the choice of the sector for entrepreneurial activity and entrepreneurial growth aspirations. We also test whether the balance of the effects of gender differences in the education field is moderated by the nature of the institutional environment in which entrepreneurs operate. Our findings show that individual-level explanations including education account for the gender differences in all three stages of early-stage entrepreneurial activity. Moreover, countries with greater gender equality in science education are characterized by higher entrepreneurial activity in knowledge-intensive sectors and high growth aspirations. Thus, next to individual-level education, closing the gender gap in science at the country level benefits the country as a whole by stimulating innovative entrepreneurial activity.

Keywords and JEL-classification

Keywords: field of education, entrepreneurship, gender, institutions

JEL codes: L26, P1, P46, J16

Current Status

Under Review

From: "Sanders, M.W.J.L. (Mark)"
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Subject: SBEJ Special Issue IES
Date: 8 Jun 2017 11:13:32 GMT+2
To: "Dilli, S.D. (Selin)" <S.Dilli@uu.nl<mailto:S.Dilli@uu.nl>>, "Westerhuis, G.K. (Gerarda)" <g.k.westerhuis@uu.nl<mailto:g.k.westerhuis@uu.nl>>
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Dear Selin,

Thank you once more for submitting your proposal: "Human Capital, Gender, and Entrepreneurship" to our special issue on Institutions for the Entrepreneurial Society in Small Business Economics. We are glad to inform you that the guest editors have selected your paper to be one of the 13 submissions we invite for the special issue. With this email we would like to inform you about the process we envision. The deadline for a full manuscript, ready for review is August 1. If you have submitted a full manuscript already, we will proceed to send it out for review. We encourage those submitting a proposal to develop their paper and submit the manuscript at their earliest convenience. We have allocated all selected papers to a handling guest editor and he/she will approach two reviewers and be your contact for the remainder of the process. As we have selected only 13 papers/proposals and the special issue can contain up to 13 papers, there will be no competition among the submissions beyond this stage and we will approach you (and your co-authors) also as reviewers. We hope you and/or your co-authors will also contribute to the special issue in that way.

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	November 30	Submission of Revised Manuscripts Round 2
	December 1	Submission of Final Manuscripts and Complete Special

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Associate Editor of Small Business Economics
Guest Editor-in-Chief

Manuscript

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Institutions, Gender Differences in Human Capital, and Entrepreneurship

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Abstract

Previous studies offer evidence that human capital obtained through education is a crucial explanation for cross-national differences in entrepreneurial activity. Recently, scholarly attention has focused on the importance of the choice of subjects such as Science, Technology, Engineering and Math (STEM) for the promotion of entrepreneurial activity. To our knowledge, empirical evidence on this link is scarce, despite the literature's emphasis on the choice of study at the tertiary level. Given that difference in STEM education are particularly large between men and women, we utilize data for 19 European countries and the United States from the Global Entrepreneurship Monitor and study the role of these differences at the country level for three stages of the entrepreneurial process: entrepreneurial awareness, the choice of the sector for entrepreneurial activity and entrepreneurial growth aspirations. We also test whether the balance of the effects of gender differences in the education field is moderated by the nature of the institutional environment in which entrepreneurs operate. Our findings show that individual-level explanations including education account for the gender differences in all three stages of early-stage entrepreneurial activity. Moreover, countries with greater gender equality in science education are characterized by higher entrepreneurial activity in knowledge-intensive sectors and high growth aspirations. Thus, next to individual-level education, closing the gender gap in science at the country level benefits the country as a whole by stimulating innovative entrepreneurial activity.

Keywords: field of education, entrepreneurship, gender, institutions
JEL codes: L26, P1, P46, J16

1.Introduction

For more than three decades, researchers have been interested in the relationship between knowledge institutions– including education, experience, and skills – and entrepreneurship (Unger et al. 2009). Knowledge as an input into a production function is different from the more traditional input of labour and capital. The economic value of knowledge is uncertain, it is non-trivial in use and its potential value is asymmetric across economic agents (Thurik et al. 2013). Important institutions that hamper and/or favour knowledge circulation are for example large-scale corporate R&D labs. When they conduct applied research in relative isolation this might block knowledge circulation. The role of patents and intellectual property rights also can promote and hinder innovation (Jaffe and Lerner 2011; Acs and Sanders 2012). While many factors related to knowledge institutions contribute to entrepreneurial outcomes, one easily influenced determinant of entrepreneur outcomes is education (Van der Sluis et al. 2008). More recently, attention has been directed to the importance of gender differences in education for entrepreneurship (see for example Marques 2016), which is the focus of this study.

Women constitute 52% of the total European population but only one-third of self-employed workers and all business starters in the EU (Eurostat 2007; OECD 2016). Typically, women-owned businesses tend to be smaller, to concentrate on sectors considered to be less profitable by financiers, to involve highly routine tasks and to have lower growth than male-owned businesses (De Bruin et al. 2006; Minnitti 2009; McCracken et al. 2015; OECD 2016). In a globalizing world, these factors make female entrepreneurs particularly vulnerable (Marques 2017). Triggering women to engage in more ambitious entrepreneurship can thus be an important governmental instrument to foster the entrepreneurial climate across countries and regions, which could benefit these areas' competitiveness (van der Zwan et al. 2011:628). Female entrepreneurs not only contribute to employment creation and economic growth through their increasing participation but also add to the diversity and quality of entrepreneurship in the economic process (Verheul and Thurik 2001; Verheul et al. 2006; European Commission 2013; OECD 2016).

Given scholars' and policy makers' assertions that women represent a large pool of

entrepreneurial potential, the role of gender has received substantial attention in recent entrepreneurship research (see Minnitti and Naude 2010 and Hughes et al. 2012 for a review of the literature). Traditionally, gender differences in entrepreneurial activity have been attributed to differences in human and social capital (Greene, 2000), in risk tolerance (Jianakoplos and Bernasek, 1998), in access to finance (McCracken et al. 2015) and in family responsibilities (Minniti and Nardone, 2007). At the contextual level, scholars have focused on structural factors such as the size of the agricultural and service sectors (Reynolds et al. 2005; Terjesen), unemployment, national wealth, economic growth and economic freedom (Verheul et al, 2006; Minniti and Nardone, 2007), formal institutional factors such as a large state sector (Estrin and Mickiewicz 2011), public childcare (Elam and Terjesen 2010) and informal institutions, such as views on gender roles (Marques 2017). Among these factors, human capital obtained through education (i.e., average years of education and tertiary education) plays a crucial role in explaining the gender differences in entrepreneurial activity (e.g., Bates 1995, Delmar and Davidsson, 2000; Brush and Brush 2006).

In our view, general educational attainment provides some of the explanation for the gender gap in entrepreneurial activity, as greater educational attainment does not always translate into better labor outcomes for women. For instance, Duquet et al. (2010) show that despite their generally higher educational attainment, young women are characterized by lower labor market positions than men in Belgium. Notwithstanding the closing gender gap in higher levels of educational attainment since the second half of the twentieth century, the size of the gender gap in innovative sectors remains large (Marques 2017). Among entrepreneurs in most efficiency-driven economies in Europe and innovation-driven regions, women are more likely than men to have this level of education but exhibit total early-stage entrepreneurial activity (TEA) rates less than half those of men (Kelley et al. 2015). This study examines the relevance of two alternative explanations for this gap next to formal general education.

First, the choice of study can be important for understanding the gender gap, especially in innovative entrepreneurial activity. While the number of necessity-driven female entrepreneurs is relatively high globally, the size of the gender

differences is larger among high-growth businesses (Brush et al. 2004). To foster (high-growth) entrepreneurial activity, the European Commission (2013) and a number of scholars (e.g., McCracken et al. 2015) highlight that girls and young women should be encouraged to take up Science, Technology, Engineering, or Mathematics (henceforth STEM) subjects at schools and universities. The focus of this study is the impact of the population's distribution of education in STEM subjects because, to our knowledge, there is no individual-level data on entrepreneurs' choice of study, which would allow us to test our hypothesis at the individual level. Nevertheless, we argue that closing the gender gap in science education at the country level is beneficial for (female) entrepreneurial activity because it stimulates a gender-egalitarian environment by creating role models for female entrepreneurs.

Encouraging women's study of STEM subjects is not only relevant for closing the gender gap in entrepreneurial activity but also may have benefits for the overall level of entrepreneurial activity. Because women are largely underrepresented in STEM education, increasing the share of female students in STEM education can help overcoming skills shortage in STEM fields which received attentions as an important contributor of innovation and venture creation. However, there is little evidence on the relationship between the gender differences in STEM education and entrepreneurial activity (Blume-Kohout 2014).

Second, the relationship between human capital and an individual's occupational choice is sensitive to the institutional context (Estrin et al. 2016:454). There is a large consensus among scholars that institutions affect entrepreneurial activity. Many studies have paid attention to how institutions help to explain gender differentials in entrepreneurial activity (e.g., Verheul et al. 2006; Minitti and Nardone 2007, Elam and Terjesen 2010, Estrin and Mickiewicz 2011, Marques 2017). For instance, Estevez-Abe (2006) shows that the same institutions affect men and women differently and finds that vocational training systems and internal labor market systems exacerbate gender inequality. Therefore, one can expect that institutional arrangements in a particular country can affect the balance of returns to be obtained from human capital differently for male and female entrepreneurs. For instance, in contexts where attitudes toward gender roles are more traditional and STEM education is dominated by males, women might be discouraged to make a career

choice in STEM subjects.

With these issues in mind, this paper aims to answer three main research questions*: (1) To what extent is there a gender gap in different forms of entrepreneurial activity across 19 European countries and the United States; (2) To what extent do the (long-term) gender differences in STEM education at the tertiary level play a role in explaining the cross-national (gender) differences in entrepreneurial activity*?; and (3) *To what extent do institutions influence the relation between human capital and the gender gap in entrepreneurial activity?* To address these questions, we use the Global Entrepreneurship Monitor (GEM) database in combination with macro-level data from various online data sources. We use multilevel probit regressions to analyze our data.

In line with the report from the European Commission (2013), our findings show that the main features of female entrepreneurship are similar across European countries and the United States. On average, women see a lower opportunity to start a business, are less likely to start a business in highly knowledge-intensive business sectors and are less likely to have aspirations to grow their business. The individual characteristics such as network, skills and education explain why women are less likely to be involved in entrepreneurial activity in all three main stages of entrepreneurial activity. We show that while closing the gender gap in science education does not have gender-specific effects at the individual level, it stimulates the overall level of early-stage entrepreneurial activity in knowledge-intensive business sectors and highly aspirational entrepreneurial activity. Furthermore, the institutional setting is important for determining the returns of closing the gender gap in science. The highest returns are expected in the continental and Nordic institutional context, which is characterized by moderate employment protection, high government expenditures in education and female friendly policies. An implication of our study is that while the returns slightly differ between different institutional contexts, achieving gender equality in STEM education is an important tool to stimulate entrepreneurial activity and is thus "smart economics," as noted by the World Bank (2011). We also discuss the origins of gender differences in science education and whether it changes

over time in order to identify the possible challenges and feasibility of pursuing policy tools to close the gender gap in tertiary-level science education.

The paper is organized as follows. Section 2 provides a definition of entrepreneurship, followed by a discussion on the role of human capital in explaining the gender gap in entrepreneurial activity. This section then reviews the literature on how institutions shape the link between (type of) education and (female) entrepreneurship. Section 3 explains the data and measurements used to test the hypotheses outlined in section 2, while section 4 discusses the results and section 5 concludes.

2. Literature Overview

2.1. Definition of Entrepreneurship

Various definitions and forms of entrepreneurship exist (Acs et al. 2014). For example, Schumpeter views entrepreneurs as innovators whose function is to carry out new combinations of means of production. According to Knight's (1982) seminal writings, an entrepreneur is someone who makes decisions under conditions of uncertainty. Estrin et al. (2013: 412) argue that entrepreneurship – "new entry" from the efforts to create a viable business – results from an individual's occupational choice to work on his/her own account.

In this study, we follow Wenneker and Thurik (1999: 29) who define entrepreneurship as an ill-defined and at best multidimensional concept that requires decomposition at different levels. They argue that two major stages of entrepreneurship can be identified. The first has to do with "new entry" and the second with "innovativeness" in general. As a result, later research started to make a distinction between different stages of entrepreneurial activity (Henrekson and Sanandaji 2014; Baumol 2011; Reynolds et al., 2005). Here, we concentrate on three different stages of entrepreneurial activity. In the first stage, we focus on entrepreneurial awareness, that is, whether an entrepreneur sees an opportunity to start a business. In the second stage, we focus on the sector in which the entrepreneur starts a business, as some sectors are more innovative and 'entrepreneurial' than others (Wenneker and Thurik 1999, Marques 2017). In the third stage, we examine

entrepreneurs' growth aspirations (Estrin and Mickiewicz 2011). An important motivation to study the role of education in different stages of entrepreneurial activity is Van der Zwan et al.'s (2011) argument that cross-country gender differences are largest in the conversion of start-up considerations into start-up activities and in business survival rates.

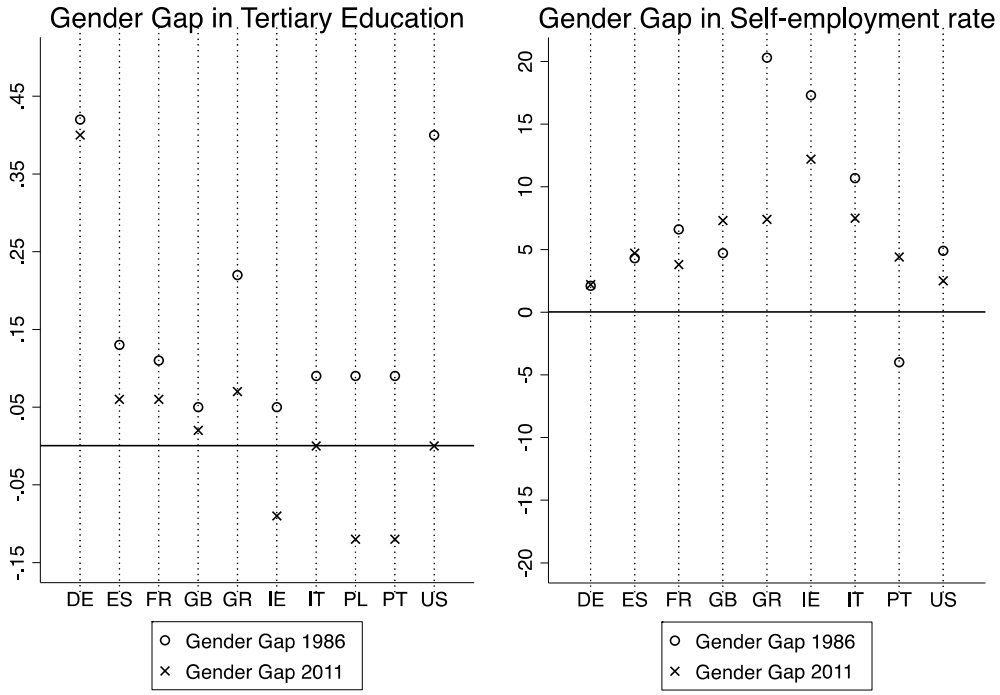
2.2. Human Capital, Gender and Entrepreneurship

A large body of literature shows that education benefits the entrepreneur's performance in different ways, such as business survival, firm growth, or the firm's return on investment (e.g., van der Sluis et al. 2008; Millan et al. 2014). For instance, at the country level, De Clercq et al. (2008) find a positive effect of tertiary education on the GEM's total early-stage entrepreneurial activity (TEA) rate. At the individual level, education can enhance managerial ability, which increases the probability of entrepreneurship. However, higher levels of education may also generate better outside options (i.e., more lucrative wage employment under better working conditions) and thus decrease the likelihood of entrepreneurship as the preferred choice (van der Sluis et al. 2008: 798). Empirical findings confirm this indeterminate effect of education level on advancement in the entrepreneurial process (see Zwan et al. 2013 for a review of the literature).

Studies that have considered the role of gender in entrepreneurship (e.g., Zwan et al. 2011; Caliendo et al., 2015; Stefani and Vacca 2015) also show evidence that the lower levels of female education is a crucial factor in explaining the gender differences in entrepreneurial activity. However, Figure 1 below shows that this link between education and the gender gap in entrepreneurial activity, captured here in terms of self-employment, is not always straightforward. Since the 1980s, the gender gap in tertiary education closed substantially and even reversed in some industrialized countries, such as Portugal and Ireland. However, despite this progress toward gender equality, the gender gap in self-employment rates persists over time in many European countries, such as Germany and Spain, and even increases in the case of Great Britain and Portugal. This could be because higher levels of female education create better opportunities for women's wage employment and therefore lead to lower levels of self-employment (see Verheul et al. 2006 for evidence of this link). This link

is expected to be strongest in countries where women are largely engaged in necessity-motivated entrepreneurial activity with low-paid businesses. However, because the trends in Figure 1 are very mixed across countries, the aggregate picture of general education and the overall level of self-employment activity provides limited insight on the link between education and entrepreneurial activity.

Figure 1. The gender gap in tertiary education versus self-employment rate



Source: The data on tertiary educational attainment comes from the World Bank and the figure on self-employment is based on OECD statistics.

First, we therefore argue that it is important to consider the differing impacts of various types of formal education in different stages of entrepreneurial activity. In their meta-analysis, Van der Sluis et al. (2008) show that education's impact on entrepreneurial activity differs depending on the stage of entrepreneurial activity. While the impact of education on the first stage of the entrepreneurial process, which is selection into entrepreneurship, is insignificant, that on performance, captured by indicators such as number of employees, is positive and significant (see also Zwan et al. 2013). However, other studies observed education's impact on selection into some sectors as self-employed, particularly in the so-called "knowledge industries", such as the information and communication technology (ICT) industry (Bosma et al. 2002).

Similarly, according to Bates (1995), increasing levels of women's education (captured by tertiary education) is the strongest predictor of why women are more likely to enter self-employment in skilled service fields in the United States. Likewise, focusing on GEM data for a single sector (hotels and restaurants), Ramos-Rodriguez et al. (2012) find that women are 50% more likely to enter this sector as entrepreneurs than men, whereas education has no impact on their choice.

H1: Entrepreneurs' education level is not linked with seeing opportunities; it is positively related with the engagement in highly knowledge-intensive sectors and high growth aspirations.

Second, it is important to consider whether the impact of education on entrepreneurial activity differ between men and women. The evidence on this link is contradictory. For instance, Marques (2017) finds that while education is positively associated with women's and men's higher participation in low-routine sectors, the influence of education level is not gendered. Similarly, Van der Sluis et al. (2008) show that the effect of college graduation on the probability of selection into an entrepreneurial position is higher in the United States than in European countries and the same for males and females. According to their analysis the link between education and performance seems to be stronger for women than for men. Still, a higher educational level can lead to less entrepreneurial activity among women because traditional gender role attitudes, care duties, and difficulty in access to resources such as financing can discourage women from pursuing entrepreneurship (Marques 2013). Therefore, we formulate the following hypotheses:

H2: The impact of education on entrepreneurial activity is expected to be lower for women than for men in all three stages of entrepreneurial activity.

Third, it is important to consider not only the entrepreneur's education but also the (type of) education of the population in which entrepreneurs start their business. Millan et al. (2014:613) measure educational attainment levels in the population through the share of the population having tertiary education and show that educational attainment at the country level is linked with an individual's entrepreneurship success in terms of survival, earnings and job creation by own-

account workers. According to Millan et al. (2014:613), there are many reasons why a higher education level among the population matters for entrepreneurial activity. Highly educated populations may be characterized by (i) a higher-quality workforce, (ii) a more sophisticated and diverse consumer market and (iii) more productivity and innovation. At the individual level, entrepreneurs may benefit from a highly educated population because it makes it easier to find qualified personnel. Additionally, a more highly educated consumer market positively affects the demand for consumer products in a qualitative sense such that the demand for innovativeness and diversity increases. Entrepreneurs may also benefit from more diverse consumer demand because it will create opportunities to enter and exploit niche markets.

More recently, policy makers and scholars have increasingly promoted STEM education as the major focus of enterprise and innovation and the belief that these disciplines will guide the development of new businesses and economic growth (Jones 2008). STEM subjects are of particular importance in creation of scientific knowledge and the entrepreneurship literature highlights the importance of scientific knowledge for the development of entrepreneurial ventures in general. Caprile et al. (2015) show that there is a skills shortage in STEM fields, creating recruitment challenges for employers in engineering, high-tech/IT and science sectors. Given that women are significantly underrepresented among STEM university graduates (OECD 2015), they represent an important potential to increase the share of graduates from STEM subjects. As such, increasing the share of women in STEM education can contribute directly to creation of scientific knowledge and as such to a more innovative and productive environment. A more innovative and productive environment can create opportunities both for men and women to start businesses in more knowledge-intensive sectors.[1]

H3: Closing the gender gap in STEM education increases the selection into knowledge-intensive business sectors by both men and women.

[1] While an entrepreneur's own education in STEM subjects can have direct implications for his/her entrepreneurial activity, we cannot test this link empirically as the GEM database does not provide this information.

To understand the gender differences in in the choice of study, it is important to consider the role of informal institutions. Informal institutions, in other words social norms and practices, play a key role in determining the societal position of women (Dilli et al. 2015). More specifically, Flabbi and Tejada (2012) find that gender differences in fields of study are strongly related to expectations about labor market outcomes. They show that women who graduate in STEM subjects are significantly less likely than men to pursue a career in those fields: 71% of male graduates work as professionals in STEM fields, compared to only 43% of female graduates (OECD 2015). In comparison, men and women who pursue degrees in the humanities or health sciences make much more similar choices about the kinds of careers they pursue (OECD, 2012). Traditional perceptions of gender roles strongly influence perceptions of what counts as "masculine" and "feminine" vocations, which are formed early in life (Kane and Mertz, 2011). In the 2012 PISA test, parents were more likely to expect their sons to work in STEM-related fields than their daughters – even if their children performed at the same level in mathematics (OECD, 2015). Closing the gender gap in STEM education can change the attitudes toward feminine and masculine vocations, thereby stimulating female involvement in more (knowledge intensive/innovative) entrepreneurial activity. We formulate the following hypotheses:

H4: The cross-national differences in STEM education explain gender differences in selection into highly knowledge-intensive business sectors and high growth aspirations.

2.4.Institutions, Education and Entrepreneurship

While there is a vast literature showing that institutions matter for entrepreneurial activity[2], fewer studies have paid attention to how institutions help explain gender

[2] Among formal institutions, there is empirical evidence on the relevance of government regulations, availability of capital, government quality (e.g., level of corruption) and public policies governing the allocation of rewards to enable, enhance or foster entrepreneurship at both the individual and the national levels (see Stenholm, Acs and Weubker 2013, and Bruton, Ahlstrom and Li 2010 for a review of the literature). More recently, attention has been directed toward informal institutions such as individual networks, local initiatives, national culture, such as individualism, trust and attitudes toward entrepreneurial activity as important factors (Simón-Moya et al. 2014, Hechavarria and Reynolds 2009, Breschi and Lissoni 2001).

differentials in entrepreneurial activity (e.g., Elam and Terjesen 2010, Estrin and Mickiewics 2011, Lewellyn and Muller-Kahle 2016, Marques 2017). In a comparative study of 55 countries, Estrin and Mickiewics (2011) find that women are less likely to undertake entrepreneurial activity in countries with a larger state sector and show that restrictions on the freedom of movement away from home make it less likely for women to have high aspirations for employment growth, even if their entry into entrepreneurial activities is not affected by these restrictions. Among cultural factors, Baughn et al. (2006) show that when the society has more gender egalitarian values, women show greater involvement in entrepreneurship. In contrast, Lewellyn and Muller-Kahle (2016:770) argue that in societies where women are expected to fulfill traditional family responsibility functions (child-rearing and housekeeping), entrepreneurial activity may provide greater flexibility than working in the established business sector. Moreover, such institutional structures are also important for understanding the link between education and entrepreneurial activity (Estrin et al. 2016). According to Estrin et al. (2016:454), the relationship between human capital and an individual's occupational choice is sensitive to the institutional context. They show that when the rule of law is strong, it ensures that commercial entrepreneurs benefit more from their human capital in their ventures whereas they do not observe such an effect for social entrepreneurs.

While studying the role of institutions for entrepreneurial activity, it is important to consider the complementarity between them (Dilli and Elert 2016). Research on the Varieties of Capitalism (VoC) approach shows large differences between national economies (e.g., in terms of their innovativeness and sectoral specialization) due to their institutional arrangements related to the supply of knowledge, interfirm relations, finance and labor, which support each other (Hall and Soskice 2001; Furman et al., 2002). Based on these four dimensions of institutions, Hall and Soskice (2001) identify two main clusters among the capitalist industrial nations, liberal market economies (LMEs) and coordinated market economies (CMEs). In LMEs, firms coordinate their activities via competitive market arrangements, while in CMEs, firms depend heavily on non-market relationships such as cooperation among economic actors to do so. Because LMEs are characterized by flexible labor market institutions, the education system supports investments in general skills (Hall and Soskice 2001). In CMEs, because the labor market is more regulated, educational

systems and in-house training encourage the development of industry-specific skills. Therefore, the returns to investment in specific human capital (e.g., in terms of vocational training or field of education) are expected to be higher in CMEs than in LMEs (Jackson and Deeg 2006). As formal education and investment in specific human capital is more important in CMEs, having less graduates from STEM subjects can matter more for the overall entrepreneurial activity in CMEs. We, therefore hypothesize the following:

H5: The impact of the gender differences in STEM education on entrepreneurship is smaller in LME institutional constellations where investment in general skills is more important.

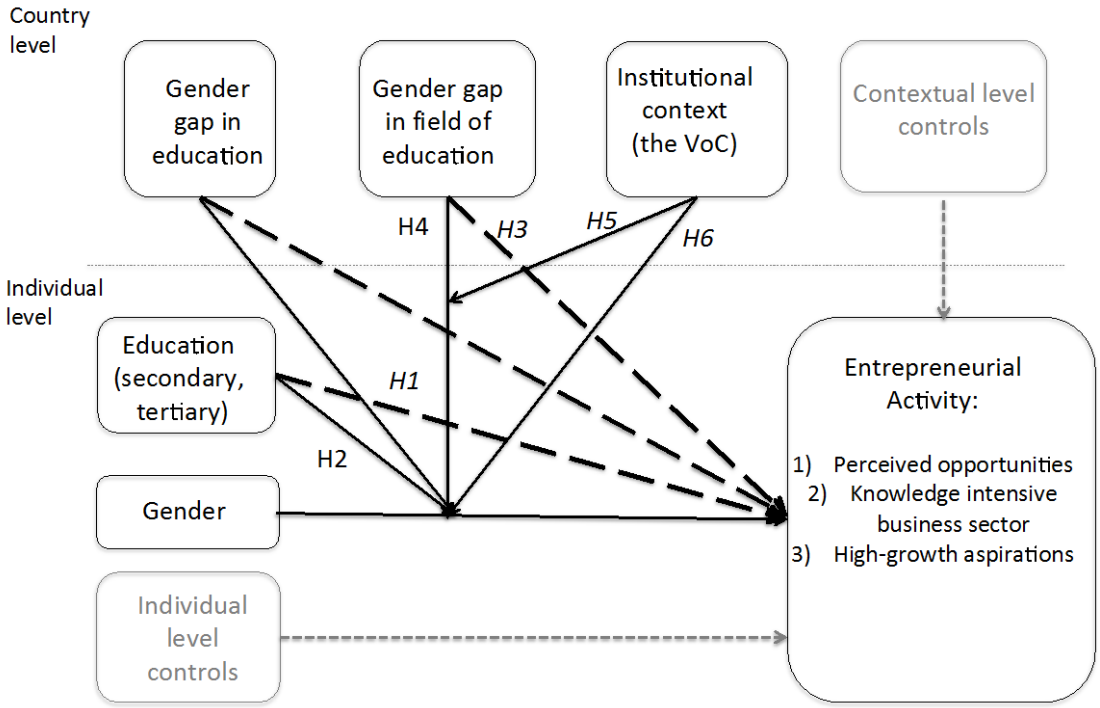
Within the VoC literature, a number of scholars have called for attention to gender dynamics (Estevez-Abe 2009, Folbre 2009, Mandel and Shalev 2009). For instance, Estevez-Abe (2006:152) shows that in CMEs, strong employment protection exacerbates employers' discrimination against women and promotes their investments in male human capital because firm-specific skills present high risks for women who are likely to interrupt their careers due to family-related contingencies. Moreover, typically CMEs have more generous social welfare policies including those related to family, such as maternal leave, childcare. When these welfare benefits are linked with job tenure, it can make it less attractive for women to pursue a career choice as entrepreneurs. Moreover, the flexibility which self-employment provides can be particularly attractive for women in contexts where there is no formal institutional support for childcare. However, in LMEs, while women's participation in the labor market is high, but the quality of this participation is low because competition is expected to eliminate systematic discrimination. The liberal market approach means that women who wish to combine employment with motherhood' are forced into low-paid, part-time jobs. This implies that women can be overrepresented in necessity based entrepreneurial activity in LMEs (Perrons 1995). Contrarily, the generous welfare environment of CMEs can be supportive of ambitious opportunity-driven female entrepreneurs as they would be likely to earn enough (in the long-run) to afford social security contributions and benefit from it. We formulate the following hypothesis:

H6: The size of the gender gap in all three stages of entrepreneurial activity is larger in LMEs.

It is important to note that in terms of their policies toward female integration into the workforce, European countries are characterized by a larger variation among the CME than in LME countries (Estevez-Abe 2009:6). For instance, Perrons (1995) shows that wage and participation differentials between women and men in the social democratic model, characterized by the Nordic countries, are among the lowest in the world due to the provision of low-cost, high-quality child care and the system of parental insurance. In Southern European countries, because family often provides the main means of welfare and general financial support, female participation in the labor market is low. Thus, the size of the gender gap in entrepreneurial activity would likely differ among the CMEs depending on the extent they follow gender-equality-friendly policies. This means that the size of the gender gap is likely to be smaller in social democrat countries than in the Southern European countries.

Figure 2 below summarizes our hypotheses. The solid lines in the figure highlight the gendered effect of education on (individual level) entrepreneurial activity whereas the dashed lines refer to the direct effect of the gender differences in educational attainment for the overall entrepreneurial activity.

Figure 2. Theoretical model and hypotheses



3. Empirical Evidence

3.1. Data

To test our hypotheses, we use the well-known GEM database. We limit our analysis to 19 European countries and the United States. First, we make a selection of the countries, which received the most attention in the Varieties of Capitalism approach. Second, our focus is the European context. However, we include the United States as it has received substantial attention in the literature as the example of an entrepreneurial society. Third, data availability plays a role in our case selection. The number of respondents for the 19 countries is given in parentheses. Our sample consists of Austria (91), Belgium (951), the Czech Republic (39), Denmark (1079), Finland (195), France (124), Germany (901), Greece (239), Hungary (217), Ireland (279), Italy (176), the Netherlands (248), Norway (282), Poland (30), Slovenia (244), Spain (1673), Sweden (284), Switzerland (210), the United Kingdom (UK) (1933), and the United States (1051). The GEM collects data on a representative national sample of at least 2000 respondents and offers comprehensive data on entrepreneurial activity, providing us a unique opportunity to answer our research questions. However, a limitation of the GEM data is that it does not provide information on entrepreneurs' choice of study at the university level.

3.2. Measurement

Dependent Variable

We use three indicators to measure entrepreneurship. Our first indicator is perceived opportunities, which is a dummy variable for which 1 refers to the respondent who sees a good opportunity to start a business in the next 6 months and 0 otherwise.

Our second indicator of entrepreneurship is whether the respondent engages in TEA in knowledge-intensive business sectors (1) or engages in TEA activity in another

sector (0).[3] For this, we use the information from GEM, which provides individual level TEA activity by sectors classified based on 4-digit International Standard Industrial Classification of All Economic Activities (ISIC Rev 4). According to Eurostat, knowledge-intensive business activities include the manufacture of coke, refined petroleum products and nuclear fuel; the manufacture of chemicals and chemical products; the manufacture of office machinery and computers; the manufacture of radio, television and communication equipment and apparatus; the manufacture of medical, precision and optical instruments, watches and clocks; air transport; financial intermediation (except insurance and pension funding); insurance and pension funding (except compulsory social security); activities auxiliary to financial intermediation; computer and related activities; research and development; other business activities; and recreational, cultural and sporting activities.

Our third entrepreneurship indicator captures high aspirations in entrepreneurial activity, defined as entrepreneurs' aspirations at the time of entry to create 5 jobs or more over a period of 5 years (1) and (0) otherwise.

Independent Variables

Individual Level

The key independent variable of our analysis, gender, is a dichotomous variable with 0 referring to male and 1 to female.

We collect a set of socio-economic and demographic control variables from the GEM database. Education refers to the highest level of completed education of the respondent, measured by four categories: (1) primary (reference category), (2) secondary, (3) postsecondary, and (4) tertiary.

We add control variables for the respondents' personal characteristics of age, skills and network, which are related to (the gender gap in) entrepreneurial activity (e.g.,

[3] TEA combines information on two groups: start-ups (SU), who are those involved in setting up a business in the 12 months preceding the survey, and owner-managers (OM), who started paying wages within a period of less than 3.5 years prior to the survey (Marques 2017: 12).

Persons 2009; Estrin and Mickiewicz 2011; van der Zwan et al. 2011; Verheul et al. 2006, 2012; Marques 2017). Age is a continuous variable that is centered around its group mean.[4] We add a dummy variable for the entrepreneur's prior knowledge of starting a business, which codes whether the entrepreneur has the knowledge, skills and experience to start a new business (1) or not (0). This variable captures other important skills in establishing a business that can be learned not only through formal education but also through other channels, such as work experience. We also add a dummy variable on whether the respondent personally knows someone who started a business in the past 2 years (1) or not (0) to control for the importance of personal networks in our analysis.[5]

Table 1. Descriptive statistics for all individual-level variables across 19 European countries and the United States

	Range	Men	Women	Sig.	N
Dependent variables					
Perceived Opportunity	0/1	.58	.54	***	10244
TEA in Knowledge Intensive Business Sectors	0/1	.20	.14	***	8390
High aspiration entrepreneurial activity	0/1	.32	.21	***	9451
Independent Variables					
Female	0/1	.63	.37	-	10244
Education Level (Ref. primary)					10244
Secondary Education	0/1	.50	.48	**	10244
Post-secondary Education	0/1	.29	.28	n.s.	10244
Tertiary Education	0/1	.18	.20	**	10244
Know entrepreneur	0/1	.66	.56	***	10244
Required Skills	0/1	.88	.78	***	10244
Age[a]	15-97	39.29 (12.07)	40.52 (11.41)	*	10244

Source: Global Entrepreneurship Monitor (2002-2009)
*** p<.01, ** p<.05, * p<.10 (p-values are 2-sided) (significance tests for gender differences are conducted through t-tests)
[a] Variables are group mean-centered in our analyses

[4] We also introduced a quadratic term for age (Esrtin and Mickiewicz 2011). However, we do not find a significant effect of the quadratic term for age in two of our models (Model opportunity, p-age2=0.839, Model knowledge intensive p-age2=0.433). There is evidence for a U-shaped link between age and high-growth entrepreneurship, though this link is not very strong (p=0.06). Therefore, we exclude it from our analysis.

[5] Next to these indicators, we also tested for the effect of fear of failure and necessity as a reason to start a business on the gender gap. However, the results of the t test (p-failure=0.978 and p-necessity=0.88) do not show evidence of a significant difference between men and women in our sample, and therefore, we excluded these factors from the analysis.

Contextual Level

To capture the gender gap at the secondary and tertiary levels, we use the gender parity index constructed by UNESCO (2012). This index calculates the ratio of women to men enrolled in public and private schools in the secondary and tertiary levels. A score on the index less than 1 suggests girls are more disadvantaged than boys and a score greater than 1 suggests the other way around. Moreover, we gather data on the distribution of tertiary graduates by field of study for men and women from the UNESCO statistical yearbooks. We calculate the ratio of female to male graduates in the fields of (1) engineering, manufacturing and construction, (2) science, which composed of life sciences, physical sciences, mathematics and statistics and computing, and (3) social sciences, business and law. The data on both education variables are available for the 1970-2015 period.

To capture diversity in the institutional context, we use the classification provided by Dilli et al. (unpublished), who provide a typology for the institutional constellations relevant for entrepreneurial activity based on the VoC framework. They show four distinct bundles of institutional constellations relevant for the current study: (1) a liberal market economy (reference category), including the United States, the United Kingdom, Ireland and Switzerland; (2) a Nordic/Continental European model with Austria, Belgium, Germany, the Netherlands, Finland, Denmark, Norway, Switzerland and Sweden; (3) a Mediterranean model composed of France, Greece and Spain and (4) an Eastern European model including Hungary, Czech Republic, Slovenia, Slovakia, and Italy.

While Dilli et al.'s (2017) classification focuses on formal institutions, it is also important to consider the informal institutions to understand the gender gap in entrepreneurial activity (Verheul et al. 2006). We include a composite indicator provided by the GEM National Expert Survey database on attitudes toward gender roles at the country level. The composite indicator is based on an average of 5 items measured at the country level: (1) whether men and women have the same level of knowledge and skills to start a business; (2) whether men and women are equally exposed to good opportunities to start a business, (3) whether men are encouraged to

become self-employed or start a new business, (4) whether starting a new business is a socially acceptable career option for women, and (5) whether there are sufficient services available for women to start a business. A higher score on the index indicates more gender-egalitarian attitudes. We also control for the level of economic development, captured by log of GDP per capita, which is available from the World Bank (2016).[6] Table 2 provides descriptive statistics of the contextual country-level variables.

Table 2. Summary statistics for contextual-level variables in 19 European countries and the United States

Country	Year[a]	Gender Eq. Sec.. [b]	Gender Eq. Ter. [b]	Gender Eq, EMC[c]	Gender Eq. Science[c]	Gender Eq. Social[c]	VOC[e]	Ln GDP[c]	Gender Attitude[d]
Austria	2005, 2007-2009	0.95	1.191	0.21	0.99	1.26	CME	10.74	2.99
Belgium	2002-2009	1.02	1.22	0.21	0.68	0.96	CME	10.67	3.22
Denmark	2002-2009	1.02	1.44	0.41	0.64	0.78	CME	10.96	3.57
Finland	2002-2009	1.06	1.22	0.18	0.81	1.378	CME	10.74	4.00
Germany	2002-2009 (except 2007)	0.98	0.9	0.2	0.74	0.8	CME	10.57	2.84
Netherlands	2001	0.98	1.09	0.16	0.51	0.82	CME	10.79	3.13
Norway	2002-2009	1.01	1.55	0.21	0.65	0.75	CME	11.37	3.87
Sweden	2002-2007	1.05	1.54	0.26	0.75	0.97	CME	10.8	3.47
Switzerland	2002-2009	0.94	0.86	0.18	0.71	0.92	CME	11.15	2.72

[6] As is common in cross-country research, various observations were missing from some of our contextual indicators. We dealt with missing observations at the contextual level before conducting the regression analysis using the intrapolation method.

	(except 2004,2006, 2008)								
Czech Republic	2006	1.02	1.22	0.25	0.97	1.35	EME	9.86	3.17
Hungary	2002-2009 (except 2007)	0.99	1.39	0.23	0.55	1.2	EME	9.45	2.53
Italy	2001	0.98	1.38	0.31	1.06	0.93	EME	10.52	2.94
Poland	2004	1.01	1.4	0.06	0.49	1.11	EME	9.17	3.12
Slovenia	2002-2009	0.99	1.44	0.18	0.9	1.34	EME	10.02	3.39
Ireland	2002-2009	1.09	1.27	0.17	0.96	1.12	LME	10.83	3.24
United Kingdom	2002-2009	1.02	1.36	0.19	0.68	0.91	LME	10.58	3.2
United States	2002-2009	1.01	1.39	0.19	0.82	0.921	LME	10.76	3.82
France	2002-2007	1	1.26	0.24	0.72	1.39	MME	10.59	3.02
Greece	2003-2009	0.95	1.1	0.43	0.63	1.19	MME	10.26	2.98
Spain	2002-2009	1.06	1.24	0.28	1.06	1.26	MME	10.36	3.23

[a] Years in which the data are available from the Global Entrepreneurship Monitor (GEM). The indicators at the country level have been collected for the corresponding years. The presented values are the mean of the country level variables for the years indicated.
[b] Source: World Bank (2016).
[c] Source: UNESCO (2015).
[d] Source: GEM National Expert Survey (NES).
[e] Source: Dilli et al. (unpublished).

3.3. Analysis

To model gender differences in three stages of the entrepreneurial process across 19 European countries and the United States, we use multilevel probit regression techniques, which are suitable due to the binary nature of our dependent variable (Long 1996). Since the GEM data used in our analyses are taken from 20 different countries and surveys for different years between 2002 and 2009, our data have a hierarchical structure, with individuals nested in countries and years. We can account

for this hierarchal structure with a multilevel model (Hox 2010). While multilevel techniques also allow us to model a random slope for gender, we do not add a random slope for "female" because the likelihood ratio tests show that adding a random slope does not significantly improve the estimation models [LR Chi^2 (1) perceived opportunity=0.46 p=0.49; LR Chi^2 (1) knowledge-intensive sector=0.00, p=0.99 LR Chi^2 (1) high aspiration=2.74, p=0.10]. This finding already supports the European Commission's view (2013:8) that the main features of female entrepreneurship are similar across these countries.

To test our hypotheses, we follow a similar strategy as Estrin and Mickiewicz (2011:404) and introduce random country-year effects to all our estimations, which accounts for unobserved heterogeneity across countries and for measurement errors and idiosyncrasies that are country-year sample specific. While the introduction of three levels with country and years as separate levels is an alternative, the unbalanced structure of the GEM database creates estimation problems. Moreover, even when we retest our (base) models with three levels instead of two, the interpretation of the results presented below does not change. Additionally, estimations with country fixed effects are not possible due to the slow-changing nature of our institutional indicators (e.g., Alesina et al. 2011).

In sum, we estimate the following equation:

$$Prob(Enprepreneurial\ Activity)_{ijt} = f(\text{Female}_{ijt},\ \text{Education}_{ijt}, \text{Individual} - \text{Level Controls}_{ijt},\ \text{Gender Gap in Secondary and Tertiary Education}_{jt,}\ \text{Gender Gap in the Field of Education}_{jt}, \text{Institutional Complementarities (VoC)}_{jt},\ \text{Gender Attitudes}_{jt}, \ln(\text{GDPpc})_{jt}, \text{Interaction Effects between}\ Individual\ Charactertics_{ijt},\ \text{Gender Gap in Education}_{jt}, \text{Institutions}_{jt}, \text{Female}_{ijt})$$

where i denotes individuals, j denotes countries and t denotes time. Entrepreneurial activity is a dummy variable denoting whether an individual sees an opportunity to start a business, whether she/he starts a business in knowledge intensive business sector and whether he/she is engaged in high-growth start-up activity. First, we estimate the relevance of individual predictors and then add the contextual indicators. To test our hypotheses, we also add the interaction effects of an individual entrepreneur being female and of education and institutional variables. All models

include year fixed effects to control for common shocks. We examine for multicollinearity issues by using Variance Inflation Factors (VIF) tests. While the inclusion of all direct effects together does not indicate problematic collinearity, we present the interaction models for each contextual variable separately to avoid biased estimates due to multicollinearity issues (Maas and Hox 2005). Moreover, for simplicity, we present only the interaction effects for contextual variables that are significant. For ease of comparison, all continuous variables (on both the individual and contextual levels) in the regression analyses are mean-centered. We present the results of the estimation model in Table 4 in the section below.

Although care must be taken when discussing causality, two points can partially address this issue. The first is the exogeneity of country-level variables relative to the individual. The second is the use of early-stage entrepreneurship data. Country-level variables of interest represent slow-moving cultural conditions that were already in place when individual entrepreneurs first thought about setting up a business (Marques 2017:14). The same reasoning applies to the variable on the entrepreneur's education, which he/she (very often) receives before establishing a business.

4. Results

4.1. Descriptive Results

Table 3 presents mean levels of three stages of the entrepreneurial process broken down by gender for all countries separately. Two important findings emerge from Table 3. First, women are underrepresented compared to men on average in all three stages of entrepreneurial activity, but the size of the gender gap gets larger in the later stages in many countries (see also Table 1). Additionally, we find no considerable or small gender differences in the perceived opportunity to start a business in many countries (i.e., Austria, France, the Netherlands, Finland, Norway, Sweden, the United States, the United Kingdom, Slovenia, and Italy). The gap becomes significant and larger in the later stages of starting a business in these countries. In Spain and Greece, there are no significant gender differences in selection into knowledge-intensive business sectors. In Poland and Ireland, the gender differences are present only in

perceived opportunities to start a business but disappear in later stages of the entrepreneurial process.

Table 3. Mean gender difference in entrepreneurial activity

	Perceived Opportunity			TEA in High Knowledge Sectors			High Aspiration			
Country	**Men**	**Women**	**Diff.**	**Men**	**Women**	**Diff.**	**Men**	**Women**	**Diff.**	**VoC**
Austria	0.57	0.62	-.05 (n.s.)	0.21	0.33	-.11(n.s.)	0.20	0.25	-.05 (n.s.)	CME
Belgium	0.60	0.54	.05*	0.13	0.06	.07***	0.41	0.28	.13***	CME
Denmark	0.49	0.41	.08***	0.09	0.03	.06***	0.40	0.29	.11**	CME
Finland	0.63	0.6	.03 (n.s.)	0.18	0.23	.05(n.s.)	0.25	0.10	.15***	CME
Germany	0.46	0.43	.03 (n.s.)	0.30	0.24	.14***	0.32	0.18	.14***	CME
Netherlands	0.57	0.59	-.02 (n.s.)	0.32	0.2	.12**	0.28	0.18	.10**	CME
Norway	0.68	0.72	-.04 (n.s.)	0.25	0.11	.14***	0.30	0.13	.17***	CME
Sweden	0.67	0.7	-.03 (n.s.)	0.28	0.18	.10**	0.33	0.18	.15***	CME
Switzerland	0.64	0.51	.12**	0.29	0.15	.13**	0.34	0.12	.22***	CME
Czech Republic	0.55	0.37	.18 (n.s.)	0.10	0.4	-.30***	0.45	0.47	-.02 (n.s.)	EME
Hungary	0.42	0.38	.04 (n.s.)	0.12	0.12	.00 (n.s.)	0.27	0.14	.13***	EME
Italy	0.49	0.48	.01 (n.s.)	0.18	0.16	.02 (n.s.)	0.35	0.28	.07(n.s.)	EME
Poland	0.54	0.12	.42**	0.1	0.24	-.15 (n.s.)	0.31	0.13	.19 (n.s.)	EME
Slovenia	0.53	0.62	-.09*	0.25	0.15	.10**	0.37	0.17	.14*	EME
Ireland	0.54	0.63	-.08*	0.30	0.27	.03 (n.s.)	0.25	0.21	.02 (n.s.)	LME
United Kingdom	0.69	0.66	.03 (n.s.)	0.14	0.12	.02 (n.s.)	0.37	0.23	.14***	LME
United States	0.70	0.65	.05*	0.22	0.17	.05**	0.38	0.23	.15***	LME
France	0.48	0.47	.01 (n.s.)	0.07	0.08	.01 (n.s.)	0.21	0.18	.03 (n.s.)	MME
Greece	0.36	0.51	-.15**	0.06	0.06	.00 (n.s.)	0.16	0.02	.14***	MME
Spain	0.53	0.45	.09***	0.20	0.17	.03(n.s.)	0.23	0.20	.03*	MME

Source: Global Entrepreneurship Monitor (2002-2009)
*** p<.01, ** p<.05, * p<.10 (p-values are 2-sided) (significance tests for gender differences are conducted through t-tests).

Second, Table 3 shows the importance of considering the country-level differences in entrepreneurial activity. The level of entrepreneurial activity in all three stages differs substantially across countries. For instance, in countries such as the United States, the United Kingdom, and the continental/Nordic countries, individuals on average see more opportunities to start a business and are more likely to start a business in highly knowledge-intensive business sectors. Below, we explore these cross-national differences in entrepreneurial activity in greater detail and test the extent to which they relate to individuals' characteristics and a country's level of gender equality at the tertiary level, the choice of study at the tertiary level, and the complementarity between institutional structure and attitudes toward gender equality in business.

4.2 Multivariate Analysis

The results of our multilevel probit regressions are presented in Table 4 below. Models 1, 4 and 8 in Table 4, which include only gender as a predictor, show that on average, women are significantly less likely to see opportunities, to be involved in highly knowledge-intensive sectors, and to engage in high-aspiration start-up activity than men, supporting findings of previous research (e.g., Verheul et al. 2006; Estrin and Mickiewicz 2011; Marques 2017). To obtain a better understanding of the coefficients, we calculate the marginal effects. Accordingly, on average compared to men, the probability that women will see an opportunity to start a business is 3 per cent points less, to engage in knowledge-intensive sectors is 6 per cent less and to have growth aspirations is 11 per cent less.

Model 2 adds the individual characteristics and their interaction with "female". After including individual-level covariates, the mean gender effect is not significant. This shows that in our sample of countries, gender differences are fully explained by differences in entrepreneurs' individual characteristics. These findings are in line with the results in the literature. Lefkowitz (1994) and Langowitz and Minniti (2007) show that men and women tend to react to the same set of incentives and that much of the difference across genders disappears after correcting for individual differences in socio-economic conditions. Similarly, a report from the European Commission (2013) identifies individual characteristics such as women's care responsibilities and lack of

role models, business networks and representation as the main barriers to female entrepreneurship.

In particular, tertiary education is associated with higher perceived opportunities and higher chances of selection into knowledge-intensive sectors, whereas it has no impact on high growth aspirations. This provides only partial support for hypothesis 1 which formulates that entrepreneurs' education level is not linked with seeing opportunities; it is positively related with the engagement in highly knowledge-intensive sectors and high growth aspirations. Earlier findings shows that education is not linked with whether one starts a business or not (see Zwan et al. 2013 for a review). The fact that tertiary education does seem to increase the probability of perceiving opportunities to start a business implies that other factors such as finance or the ease of starting a business possibly play a more important role than education in setting up a business. This supports the findings of Van der Sluis et al. (2008), who argues for a varying impact of education in different stages of entrepreneurship. An explanation for the difference between our findings and those from the previous literature on high growth aspirations (van der Sluis et al. 2008; Estrin and Mickiewicz 2011) may be related to the measurement of entrepreneurial performance. While van der Sluis et al. (2008) focus on the entrepreneur's income as a measure of performance, Estrin and Mickiewicz (2011) define a highly aspirational entrepreneur as someone who aspires for firm growth of more than 10 employees. We measure entrepreneurial performance as aspirations for firm growth of more than 5 employees. Thus, education can start to matter for entrepreneurial performance once a threshold is reached. Noticeably, the influence of educational level is not gendered. Thus, we do not find evidence, supporting H2 which formulates the impact of education on entrepreneurial activity is expected to be lower for women than for men in all three stages of entrepreneurial activity due to the social arrangements that discriminate against women.[7] This finding is in line with those of Marques (2017).

Entrepreneurs with the relevant knowledge, skill and experience to start a new business see more opportunities to start a business and are more likely to engage in

[7] While the interaction term between tertiary education and "female" on perceived opportunity is significant in Table 4, we look at the marginal effects and do not find any evidence (Wald Chi2(1)= 0.53,p-2s=0.46) that the effect of education differs significantly between men and women.

highly knowledge-intensive sectors and to become involved in highly aspirational entrepreneurial activity. This finding is in line with the earlier literature, which shows that in their capacity as 'Jacks-of-all-Trades', entrepreneurs may require a broad range of skills (Silva 2007). Being acquainted with an entrepreneur also increases the probability of entrepreneurial activity in all stages of the entrepreneurial process. Both skills and network are factors in which the size of the gender gap is the largest among the individual factors (Table 1) and therefore are fields to prioritize to close the gender gap in entrepreneurial activity. Consistent with the earlier findings, the probability of seeing opportunities to start a business, that of becoming an entrepreneur in knowledge-intensive sectors and possibilities for firm growth are lower for older people. This could be linked to generational constraints and family responsibilities. This is especially the case for women who are involved in highly knowledge-intensive sectors.

Because individual differences account for the gender gap in entrepreneurial activity, we do not find any support for our Hypotheses 4 and 6, which argue that cross-national differences in gender equality with regard to education and institutional environment should help to explain the gender differences in entrepreneurial activity. However, we test the role of gender differences at the contextual level in explaining the cross-national differences in overall levels of entrepreneurial activity, as argued in Hypotheses 3 and 5. The results of Models 3 and 10 in Table 4 show that countries with higher gender equality at the tertiary level also have more individuals who see an opportunity to start and grow their business. While the education field does not matter for determining whether an individual sees an opportunity to start a business, in countries with higher gender equality in science, individuals are more likely to engage in knowledge-intensive business sectors and to see opportunities to grow their businesses (Models 6 and 9 in Table 4). On average, in countries that achieve gender equality in science education, the probability of finding entrepreneurs in highly knowledge-intensive sectors is 25% higher and of finding those with high growth aspirations is 10% higher than in countries that do not. This finding provides support for Hypothesis 3. In line with the findings of Dilli et al. (unpublished), individuals see significantly fewer opportunities to start a business in the Mediterranean and Eastern European market economies than in the liberal market economies. Individuals also have lower growth aspirations in the Mediterranean economies than in the liberal

market economies. Interestingly, more individuals are engaged in knowledge-intensive sectors in coordinated/Nordic market economies than in liberal market economies.

Table 4. Dependent variables: perceived opportunity, knowledge-intensive business sector, and high-aspiration start-up activity

	Perceived Opportunity			Knowledge Intensive Business Sector				High Aspiration			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Female	Individual	Context	Female	Individual	Context	VoC*Science	Female	Individual	Context	VoC*Science
Female	-0.079***	0.280	0.288	-0.365***	-0.034	-0.044	-0.033	-0.332***	-0.135	-0.139	-0.136
	(0.027)	(0.178)	(0.178)	(0.059)	(0.237)	(0.238)	(0.237)	(0.030)	(0.204)	(0.204)	(0.205)
Age		-0.005***	-0.004***		-0.009***	-0.009***	-0.009***		-0.003**	-0.003**	-0.003**
		(0.001)	(0.001)		(0.002)	(0.002)	(0.002)		(0.001)	(0.001)	(0.001)
Age*female		0.000	-0.000		0.002	0.002	0.002		-0.002	-0.002	-0.002
		(0.002)	(0.002)		(0.003)	(0.003)	(0.003)		(0.003)	(0.003)	(0.003)
Secondary education		0.182	0.193*		-0.141	-0.139	-0.149		0.010	0.011	0.013
		(0.112)	(0.111)		(0.137)	(0.138)	(0.138)		(0.121)	(0.120)	(0.120)
Secondary education*female		-0.362**	-0.369**		-0.008	-0.005	-0.016		-0.034	-0.030	-0.040
		(0.171)	(0.171)		(0.224)	(0.225)	(0.225)		(0.191)	(0.191)	(0.191)
Postsecondary education		0.158	0.169		0.107	0.106	0.092		0.103	0.106	0.118
		(0.114)	(0.113)		(0.139)	(0.140)	(0.140)		(0.122)	(0.122)	(0.122)
Postsecondary education*female		-0.274	-0.286*		-0.034	-0.034	-0.041		-0.148	-0.148	-0.155
		(0.174)	(0.174)		(0.228)	(0.228)	(0.228)		(0.194)	(0.194)	(0.195)
Tertiary education		0.292**	0.281**		0.378***	0.385***	0.372***		0.176	0.171	0.173
		(0.116)	(0.116)		(0.141)	(0.141)	(0.141)		(0.125)	(0.124)	(0.124)
Tertiary education*Female		-0.389**	-0.399**		-0.127	-0.126	-0.135		-0.019	-0.014	-0.019
		(0.177)	(0.177)		(0.230)	(0.230)	(0.230)		(0.197)	(0.197)	(0.197)
Required Skills		0.378***	0.388***		0.111	0.108	0.106		0.192***	0.192***	0.190***
		(0.051)	(0.051)		(0.068)	(0.068)	(0.068)		(0.060)	(0.060)	(0.060)
Required Skills * female		0.041	0.039		-0.139	-0.134	-0.134		-0.103	-0.104	-0.105
		(0.072)	(0.072)		(0.103)	(0.103)	(0.103)		(0.092)	(0.091)	(0.091)
Know entrepreneur		0.291***	0.287***		0.075*	0.069	0.071		0.231***	0.226***	0.226***
		(0.035)	(0.035)		(0.044)	(0.044)	(0.044)		(0.038)	(0.038)	(0.038)
Know entrepreneur*female		-0.010	-0.008		0.007	0.009	0.008		-0.036	-0.034	-0.030
		(0.055)	(0.055)		(0.073)	(0.073)	(0.073)		(0.063)	(0.063)	(0.063)
Gender Equality Secondary			-0.738			0.683	-0.637			0.090	-0.606
			(0.715)			(1.085)	(1.142)			(0.615)	(0.589)
Gender Equality Tertiary			0.812***			-0.359	-0.323			0.393*	0.499***
			(0.228)			(0.348)	(0.363)			(0.203)	(0.192)

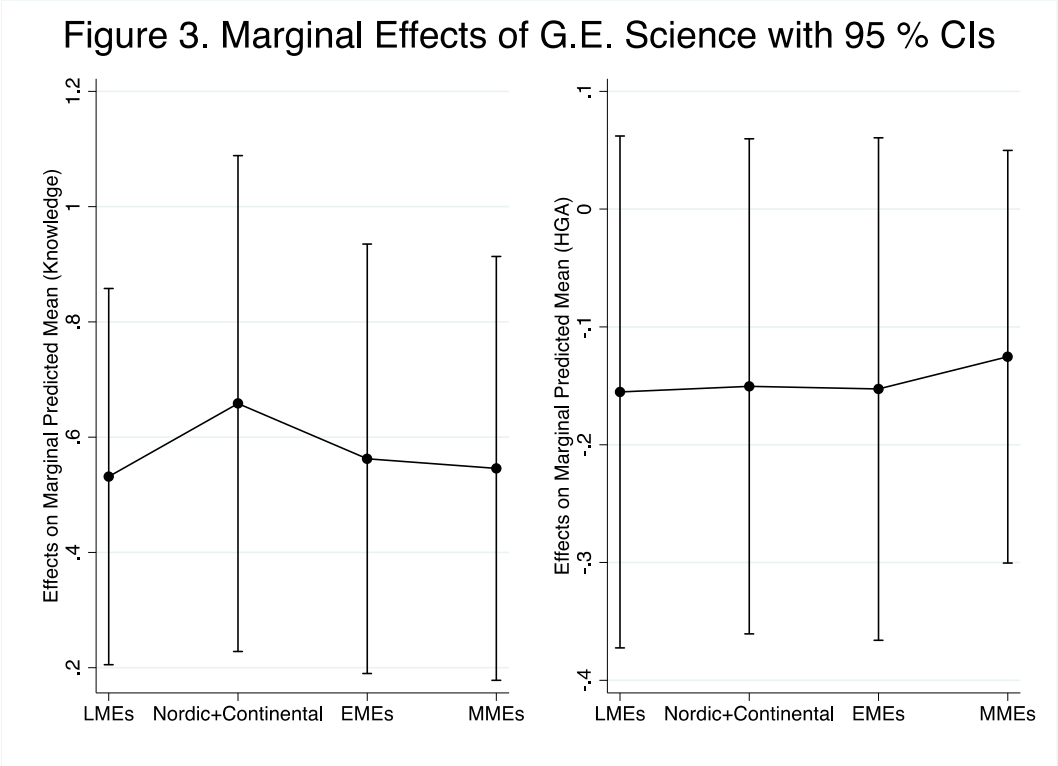
Gender Equality EMC.			-0.030			-1.089	-0.186			-0.215	0.112
			(0.467)			(0.755)	(0.831)			(0.442)	(0.465)
Gender Equality Science			0.068			0.930***	2.198***			0.276*	-0.451
			(0.190)			(0.307)	(0.726)			(0.171)	(0.321)
Gender Equality Social			0.064			-0.486	-0.158			-0.311*	0.114
			(0.199)			(0.309)	(0.358)			(0.181)	(0.192)
log GDP			0.160			-0.038	-0.022			-0.180*	-0.327***
			(0.120)			(0.194)	(0.232)			(0.108)	(0.119)
Gender Attitudes			0.038			-0.073	-0.098			-0.010	-0.069
			(0.095)			(0.146)	(0.148)			(0.082)	(0.073)
Nordic Continental			-0.039			0.269**	1.868***			0.040	0.066
			(0.076)			(0.122)	(0.693)			(0.064)	(0.319)
EMEs			-0.385***			0.150	1.396*			-0.075	-1.689***
			(0.140)			(0.218)	(0.779)			(0.124)	(0.373)
MMEs			-0.274**			-0.066	-0.223			-0.209*	-1.475***
			(0.128)			(0.206)	(0.843)			(0.111)	(0.424)
Nordic/Continental* G.E. Science							-2.178**				-0.072
							(0.866)				(0.414)
EMEs* G.E. Science							-1.728**				1.689***
							(0.836)				(0.403)
MMEs*G.E. Science							-0.180				1.266***
							(0.904)				(0.444)
Constant	0.163**	-0.519***	-2.578*	-1.039***	-0.796***	-0.561	-0.827	-0.313***	-0.705***	0.811	3.275**
	(0.082)	(0.122)	(1.462)	(0.183)	(0.181)	(2.315)	(2.623)	(0.059)	(0.142)	(1.291)	(1.343)
Variance Random Intercept	0.092***	0.091***	0.033***	0.431***	0.146***	0.103***	0.092***	0.031***	0.029***	0.014**	0.005
	(0.017)	(0.017)	(0.008)	(0.087)	(0.029)	(0.021)	(0.019)	(0.010)	(0.009)	(0.007)	(0.004)
AIC	13645.85	13394.53	13348.09	8414.998	8281.297	8270.705	8265.711	11226.28	11134.04	11122.25	11107.64
Log likelihood	-6812.926	-6682.267	-6642.047	-4198.499	-4119.649	-4104.353	-4098.856	-5603.141	-5545.022	-5529.124	-5515.821
ICC	0.08	0.08	0.03	0.12	0.13	0.09	0.08	0.03	0.03	0.02	0.01
Observations	10246	10246	10246	8390	8390	8390	8390	9453	9453	9453	9453
Country-year	127	127	127	115	115	115	115	127	127	127	127
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Source: Global Entrepreneurship Monitor (2002-2009)

*** p<.01, ** p<.05, * p<.10 (p-values are 2-sided). Standard errors are reported in parentheses.

Models 7 and 11 in Table 4 show tests whether the impact of gender equality in science on entrepreneurial activity varies across different institutional constellations. Figure 3 presents the marginal effects based on Models 7 and 11 in Table 4 to have a better understanding of the interaction terms. According to Figure 3, the benefits of closing the gender gap in science for entrepreneurial activity in knowledge intensive business are highest in coordinated/Nordic market economies. This could be due to the fact that the coordinated/Nordic economies have moderate employment protection and high governmental expenditure in education higher than other institutional contexts that can stimulate investment in high specific skills. Moreover, Nordic/continental countries generally pursue more female-friendly policies, which means that women who pursue education in science subjects can be more likely to pursue a career in the same field. This provides partial evidence for our hypothesis 5 which argues that *the impact of the gender differences in STEM education on entrepreneurship is smaller in LME institutional constellations where investment in general skills is more important.* However, we do not find any evidence that the impact of gender equality in science education on perceived opportunities or high growth aspirations varies substantially among different institutional constellations.

Figure 3. Marginal effects of gender equality in science



5. Gender Equality in Education and Entrepreneurship Over Time

Our two main findings from recent data are as follows: (i) gender differences in entrepreneurial activity are explained by differences in individual characteristics – for example, female entrepreneurs are less involved in entrepreneurial networks and have less prior start-up experience – and (ii) closing the gender gap in science education will increase a country's general level of entrepreneurial activity in knowledge-intensive sectors and its high growth aspirations. We now discuss the origins of gender differences in science and whether these differences change over time to identify the possible challenges and the feasibility of pursuing policy tools for closing the gender gap in tertiary-level science education.

Figure 1 shows that gender gaps in self-employment persists and even increased between 1986 and 2011 in some countries. At the same time, tertiary education expanded enormously in all EU member states, and women have attained equality with men in terms of educational attainment (Reimer and Steinmetz 2009, Figure 1). However, as argued above, despite initiatives to promote gender equality in STEM education, the gap between women and men in these fields has only slightly lessened since 2000, and women continue to be largely underrepresented (OECD, 2012).

Figures 4a and b show that there has been a clear increase in science education in all 4 VoC types since the 1990s, with LME countries having the highest level followed by MMEs, CMEs and EMEs, respectively (Figure 4a). However, despite the increase in the share of the population receiving science education, it did not translate into higher gender equality in science education. Instead, all VoC categories show a rather steep decrease in the share of women in science education compared to men since the mid-1990s. The only exception occurred in the 1970s, when women in LMEs became relatively more inclined toward science education on the tertiary level. Interestingly, while the size of the gender gap biased against women was largest in CMEs, followed by LMEs and MMEs, and EMEs before the 1990s, a convergence toward gender inequality in science education occurred. A sharp decline was visible, particularly in EMEs after the collapse of the Soviet Union. An explanation for this increasing gap

can be due partially to the change in women's choices to pursue careers in other fields, such as health.[8]

Figure 4. Gender gap and overall study choice in science education over time

Why do women choose STEM education less frequently than men? This question is often explained by analyzing how individual and social factors shape gendered motivation and young girls' and boys' career plans. The gender gap in STEM achievement widens with every step in one's educational and professional life, from high school to college to graduate school, and into the ranks of academia or industry (Leaper, 2014; Schoon 2014). For example, Eccles (2014) describes families' influences on gender differences in STEM disciplines, how parents' beliefs differ according to the sex of their child, and how these beliefs predict children's beliefs and behaviors. The paper shows how a gendered bias might emerge toward STEM fields, despite the fact that girls and boys do equally well in math and science throughout their schooling (Eccles 2014). These more informal institutions related to gender role attitudes, which emerge at the family level, are highly embedded and have deep

[8] While interpreting these trends, a word of caution is necessary. UNESCO stopped presenting its data in a statistical yearbook in 1998 and shifted to publishing it online (highlighted with a red reference line in the figures) which may explain part of the decline in the figures.

historical roots and are therefore difficult to change. The worsening gender equality ratios in science education over time in Figure 4 also indicate that long-term institutional explanations – not development – are important for explaining gender differences (Dilli et al. 2015), which should be kept in mind while designing policies aimed at achieving gender equality in science education.

6.Conclusion

The flow of knowledge to entrepreneurs via education is one of the relevant pillars for creating a European entrepreneurial ecosystem. This article investigated the (gendered) role of individual-level and country-level educational factors in different stages of entrepreneurial activity in 19 European countries and the United States in the 2002–2010 period. In particular, we study the role of the gender differences in STEM education at the country level in promoting women's and men's perceived opportunities to start a business, the knowledge intensiveness of the sector in which they start their business and their growth aspirations. Gender roles, we show, are highly embedded informal institutions and persist over time. This implies that while aiming to create an entrepreneurial society in Europe, it is important to consider the gender specific policy tools.

Our findings show that women are generally less likely to engage in all three stages of entrepreneurial activity. This seems to be a general phenomenon for all the European counties and the United States because the size of the gender gap does not vary much across countries. Individual differences in prior knowledge on starting up a business and the individual's network explain the gender differences. Furthermore, we show that while the gender differences in STEM education do not directly impact female entrepreneurial activity, the gender gap in science education is negatively correlated with entrepreneurial activity in knowledge-intensive sectors and high growth aspirations. The benefits of closing the gender gap in science education on involvement in knowledge intensive business sector are likely to be the most in Nordic/continental Europe. With its good legal systems, moderate employment protection, high governmental expenditure in education, and more female-friendly policies in general, the complementarity to the overall institutional framework

enhances these returns.

From a policy perspective, a number of directions have emerged from the current study. First, when closing the gender gap in entrepreneurial activity, it is important to target eliminating the gender differences in individual resources, particularly in relevant skills related to entrepreneurial activity learned through channels other than education, such as internships, and to create opportunities for women to network with other entrepreneurs. Women remain disadvantaged in these two areas. Second, our findings show that closing the gender gap – especially in science education – is beneficial to increase engagement in knowledge-intensive sectors and high-growth entrepreneurial activity. Third, closing the gender gap in science education is beneficial to stimulate entrepreneurial engagement in highly knowledge-intensive sectors, particularly in institutional contexts that support female-friendly policies and have a high-quality institutional environment with moderate levels of employment protection and high investment in education. Fourth, the size of the gender gap in science seems to increase over time rather than decrease. Gender roles are deeply embedded cultural institutions. Policies that aim to close the gender gap in science at the tertiary level should target gender differences that emerge at the early stages of the life course, particularly at the family level (OECD 2012, Dilli 2015).

An interesting direction for future research is to consider the migration flows of highly skilled migrants with a science education background as closing the gender gap in science education can be less urgent for countries, which receive highly skilled migrants. Thus, while the demand for employees with science education is increasing (OECD 2012), the challenges for entrepreneurial activity that are created by gender inequality in science education are likely to differ across countries depending on whether they are receiving or sending countries. This would be an important dimension to consider in policy making too. More research, however, is needed to verify this claim.

Another direction for future research is related to data collection. A limitation of our research is the lack of individual-level data, which would provide information on entrepreneurs' choice of study at the tertiary level. Therefore, further measures of education that capture different skills learned in different subjects should be

developed. Moreover, the lack of historical data on entrepreneurship remains a shortcoming in the literature. Such a long-term perspective would provide a better understanding of the progress that has been made toward gender equality in different aspects and drivers of entrepreneurial activity.

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