ERASMUS UNIVERSITEIT ROTTERDAM

The effect of agglomeration externalities on early-stage entrepreneurial activity in European regions

Date: 12-7-2017
Student: Bas Geertman
Student number: 408710
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Thesis advisor: Nicola Cortinovis

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1. Introduction

Industry clustering can be observed around the globe. High-tech companies often thrive in one location, e.g. Silicon Valley, East London Tech City or Eindhoven. Growth has spurted in those regions, attracting even more companies and creating a positive feedback loop. This industry clustering is not only visible for high-tech regions, it can also be observed on a low-cost manufacturing level, e.g. the electronics cluster in Guadalajara and Córdoba.

A model based on Marshall (1890), Arrow (1962), and Romer (1986), formalized by Glaeser et al. (1992) as the Marshall-Arrow-Romer (MAR) model provides evidence that industry concentration leads to knowledge spillovers between firms and individuals in an industry, both external and internal. These MAR externalities might explain why so many cities in the world are concentrated by industry, rather than being a diverse mix of different firm types.

Marshall (1890) argued that geographical concentration bears two main benefits: labour market pooling and transport cost savings. Sharing inputs in an industry increases economies of scale and therefore decreases the average cost per product. Another benefit of localisation, i.e. geographical concentration, is that it increases the attractiveness of a region for potential workers and therefore increase the labour pool available to firms (Venables, 1996).

Disagreement exists on the effects of agglomeration externalities on economic performance. Jacobs, (1969) unlike Porter and MAR, argues that knowledge transfers come from outside the industry rather than as a result of industry concentration. Cities are an important source of knowledge spillovers and innovation because, Jacobs argues, knowledge may spill over in diverse rather than similar industries as ideas in one industry may be applied to another. This phenomenon is often referred to as Jacobs' externalities.

Induced by both Porter (1990) and Krugman (1991), economists have had increased interest in the agglomeration phenomenon for the last few decades. In spite of the strong interests both in academia and policy circles on the effects of agglomeration externalities on local economic performance, less attention has been drawn on the relation between agglomeration economies and entrepreneurship.

Some confirmation for the positive relationship between high-tech, innovative and knowledge intensive agglomerated regions and entrepreneurship has been found (Markusen, 1996; van Oort & Stam, 2006). Markusen argues that these types of industries benefit more from an increase in skilled labour and the spillover of knowledge from firms to potential entrepreneurs, while van Oort and Stam argue that not only concentration of industries, but also industry diversity, i.e. Jacobs' externalities, influence entrepreneurship positively.

Although a relationship of both Jacobs' externalities and MAR externalities with entrepreneurship was found, van Oort and Stam only focused on one sector in one country, the ICT sector in the Netherlands, while Markusens findings are not generally accepted (Porter, 1996).

In this paper, the effects of agglomeration externalities on European regional entrepreneurship were studied with data on 23 European countries in the period 2008-2014 using ordinary least squares (OLS) analysis. Considering the recent debate around the true source of agglomeration externalities, both a measure of Jacobs' externalities as well as a measure industry specialization will be used. A measure of Jacobs' externalities encompassed the effects of knowledge spillovers, whereas a measure of industry specialization was used to assess the effects of industry agglomeration on entrepreneurship. Furthermore, the relationship between entrepreneurship and the regional manufacturing industry structure were also assessed in this study, dividing industries in either low-tech or high-tech.

Entrepreneurship is a rather vague concept on its own. Although some researchers have tried to establish the effects of agglomeration externalities on the level of entrepreneurship, a distinction has yet to be made between the different types of entrepreneurship.
Therefore, some more specific measures, total early-stage entrepreneurial activity (TEA), opportunity TEA and necessity TEA, were used.

In this study, evidence was found for a positive effect of both Jacobs' externalities and MAR externalities on TEA. The same positive effect was also found with regards to necessity TEA and opportunity TEA. Furthermore, regions with higher levels of low-tech manufacturing agglomeration were exhibiting higher levels of necessity TEA.

2. Literature review

2.1 Definition of entrepreneurship

Entrepreneurship is a subject which has been both frowned upon and celebrated throughout history (Baumol, 1996). In medieval China, high social standings were denied for those who engaged in trade and commerce, while those climbing the ladders of imperial examinations, with topics such as philosophy and calligraphy, were rewarded by the leaders of imperial China. Enterprise in Roman periods and in early medieval Europe, was also frowned upon and often undertaken by freedman, Baumol notes. It was not until the fourteenth century that the rules of the game had changed and that military entrepreneurship, i.e. the development of weapons as a means of obtaining profits, that entrepreneurship gained track in importance. Nowadays, entrepreneurship is seen by many world's governments as one of the most important factors for economic growth in regions and entrepreneurship is a topic widely studied in academic circles today.

There exists no clear general definition of what the entrepreneur is and which activities he undertakes, according to Hebert & Link (1989). Diverse meanings have been written down by economists on the nature and the role of the entrepreneur. Hébert & Link (1989) propose the following definition: An entrepreneur is someone who specializes in taking responsibility for and making judgemental decisions that affect the location, form, and the use of goods, resources, or institutions (Hébert & Link, 1989, p.47). The definition incorporates the common themes of the entrepreneur: uncertainty, risk, innovating, ownership, arbitrage and resource allocation. Furthermore, Herbert & Link argue that the entrepreneur must be a person, rather than a set of individuals.

A more recent conceptual framework on entrepreneurship by Shane & Venkataraman (2000) acknowledges two distinct phenomena regarding the entrepreneur: the presence of persons with entrepreneurial abilities and aspirations, and the presence of profitable opportunities. Entrepreneurial opportunities are situations in which new goods, services, materials and organizing methods can be introduced and sold at a price higher than the cost of production (Casson, 1982). Not every person is able to recognize and seize these profitable opportunities, Shane & Venkataraman argue. Only a relatively small portion of the population discovers a given opportunity (Kirzner, 1973) and these opportunities cannot be obvious to everyone (Hayek, 1945).

2.2 Opportunity and necessity entrepreneurship

Why do individuals undertake personal, financial and sometimes social risks in becoming an entrepreneur? Verheul et al. (2010) investigated the determinants of engagement in several stages of entrepreneurial activity using a 2007 survey for 27 European countries. Verheul et al. distinguish between two different motivational forces that come into play when an individual decides to set up a new venture: ‘Pull’ motivations and ‘Push’ motivations. Entrepreneurs are said to be led by ‘Pull’ motivations when there exists a desire to be independent and experience a need for achievement, while ‘Push’ motivations arise from the risk of unemployment, family pressure or a disequilibrium with the desired state. Unemployment, Verheul et al. argue, is a push effect because it lowers the opportunity cost of self-employment, pushing individuals into starting their own business. Several studies have provided evidence on the existence of this ‘Push’ effect (Storey & Jones, 1987; Audretsch & Vivarelli, 1996, Gilad & Levine, 1996).

The distinction between ‘Push’ and ‘Pull’ motivations can divide entrepreneurs into two forms: Necessity entrepreneurs and Opportunity entrepreneurs. Necessity entrepreneurs are motivated by ‘Push’ factors, whereas opportunity entrepreneurs are motivated by ‘Pull’ factors (Block & Sander, 2009).

2.3 Agglomeration externalities

In economics, an external effect can be defined as the utility of an individual, under his own control but also by definition under control of the activities of a second individual, who is presumed to be in the same social group as the first individual (Stubblebine, 1962). The occurrence of externalities is not limited to individuals, but also applies to firms and their environment. This way, the presence of firms in a region may have a positive or negative external effect on other entities in that region.

Marshall (1890) observed in his time that industries can be seen specialized geographically because proximity favours the intra-industry transmission of knowledge. Furthermore, it reduces transport cost of inputs and outputs and it creates a larger labour pool, making hiring more efficient. The factors mentioned by Marshall can be seen as agglomeration externalities, a concept which was not formalized in his time. Economies of scale also arise from sharing labour equipment and infrastructure with firms within a concentrated industry, which is often referred to as localization economies (Krugman, 1991).

More recently, Glaeser (1992) put forward the concept (MAR) externalities, based on the theories of Marshall Arrow and Romer. These externalities concern knowledge spillovers, externalities created by having a multitude of firms in proximity, between firms. The MAR model dictates that the concentration of an industry in a city helps knowledge spill over between firms and individuals and therefore helps the growth of that industry in that city. Porter (1990), in line with Marshall, Arrow and Romer, argues that knowledge spillovers in specialized concentrated regions stimulate growth.

Jacobs (1969) proposes a theory different from MAR and Porter, which is often referred to as Jacobs' externalities. He argues that the most important knowledge transfers come from outside the core industry of a city. Therefore variety and diversity, rather than geographical specialization stimulates economic development of regions. Evidence was found by studies (Glaeser et al., 1992; Henderson et al., 1995) that diversity, or Jacobs's externalities, contribute to regional growth. Interestingly though, Glaeser et al. found no evidence for the existence of MAR externalities, whereas Henderson et al. did find evidence for the positive effect of specialization.

The findings of Glaeser et al. are possibly not applicable for MAR externalities, as they note, due to the fact that these externalities matter most when industries grow. The data used by Glaeser et al. was data on already mature industry agglomeration in cities. However, many studies have been conducted on the topics MAR externalities and Jacobs' externalities, most of them providing evidence on either one of the theories (Beaudry et al., 2009). Table 1 gives an overview of the number of studies supporting MAR externalities, Jacobs' externalities, both or none. Out of 31 studies, 6 studies found evidence for both MAR externalities and Jacobs' externalities. Furthermore, 4 studies only supported MAR externalities, whereas 11 studies have found empirical evidence for the existence of Jacobs' externalities. 5 studies found negative results for either MAR or Jacobs' externalities on economic growth and innovation, whereas 5 other studies found non-significant effects of MAR externalities or both MAR and Jacobs' externalities on economic growth and innovation. Although empirical evidence yields mixed results, there is more evidence in favour of the existence of these externalities than against it.

Table 1: overview empirical evidence on externalities

Results	**MAR only**	**Jacobs only**	**Both[a]**	**Total**
Positive	4	11	6	21
Negative	2	3		5
non-significant	3		2	5
Total	9	14	8	31

[a] number of dependent variables for which both MAR and Jacobs' externalities are found

2.4 Agglomeration, industry structure and entrepreneurship

In the study by Beaudry and Shiffauerova (2009), industries were categorized according to R&D intensity. In low-tech sector, MAR externalities were more frequent than Jacobs' externalities. High-technology, R&D intensive companies were more frequently found in the more diversified urban areas. Evidence for MAR externalities in the high-tech sectors were also found, but were less significant than Jacobs' externalities, a finding which is in line with previous research by Henderson et al. (2001).

A study by van Oort and Stam (2006) found some confirmation for the existence of a positive effect of high-tech agglomeration on entrepreneurship. The effects of diversity and concentration measures were positively related with both firm growth and with new firm formation in the ICT sector in the Netherlands.

Markusen (1996) argues that the effects of agglomeration in industries are largest for industries that are high-tech, knowledge-intensive and innovative. These industries are able to capitalize on increasing availability of skilled labour to generate more entrepreneurship, promote the flow of information, ideas and integration and stimulate the development of localised producer services, Markusen notes.

Audretsch and Keilbach (2007) conducted research on the effects of knowledge spillovers within a region on entrepreneurship using OLS estimation on German regional data between 1998 and 2000. They found that regions with a high level of knowledge exhibit a higher rate of technology and ICT entrepreneurship compared to regions with lower levels of knowledge. Furthermore, no significant relationship between measures of entrepreneurship and low-technology was found.

2.5 Research question and hypotheses

In order to assess the relationship between agglomeration externalities and entrepreneurship - specifically in European regions - and to find how whether Jacobs' externalities or knowledge spillovers (MAR externalities) foster a greater effect on entrepreneurship, this thesis aims at answering the following research question:

What are the effects of agglomeration externalities on European regional entrepreneurship?

Based on the literature review in the previous chapter, the research question stated above is answered using four hypotheses. To investigate whether the relationship proposed by van Oort and Stam (2006) holds when considering all the different types of industries, rather than a single one, the first hypothesis is:

> *H1: The relationship between agglomeration externalities and total early-stage entrepreneurial activity (TEA) is positive*

Because of the nature of the two different entrepreneurial types, it is expected that more entrepreneurs are driven by 'pull' factors rather than 'push' factors in high-tech agglomerated regions. If knowledge spillovers and Jacobs' externalities exist, it is likely that this will affect opportunity entrepreneurship positively and necessity entrepreneurship negatively. Therefore the second and third hypotheses are:

> *H2: Necessity entrepreneurship has a negative relationship with agglomeration externalities in European regions*
> *H3: Opportunity entrepreneurship has a positive relationship with agglomeration externalities in European regions*

On the basis of previous research by Audretsch and Keilbach (2007), the effect of agglomeration externalities on the different levels of entrepreneurship is expected to be higher in high-technology regions relative to low-tech regions, and that in low-tech regions, more individuals are driven by 'push' dynamics rather than 'pull' dynamics, resulting in a higher level of necessity TEA. Therefore, the fourth and last hypothesis is:

> *H4: Necessity entrepreneurship is positively related to industry specialization in low-tech European regions*

3. Data and Methodology

This section aims at giving a description of the techniques and equipment used for gathering data. Furthermore, it will introduce the variables used and an explanation of how the raw data was compiled and analysed. Table 2 shows a brief overview of the variables and their data sources. The effect of agglomeration externalities on entrepreneurship will be studied for 144 NUTS 1 and NUTS 2 regions from 23 European countries[1], using a simple regression model. The main regional Nuts level[2] of our focus is Nuts 2, however, for the countries where Nuts 2 data was unavailable, Nuts 1 data was used. Table 2 shows for which countries Nuts 1 or Nuts 2 data was used.

3.1 Sources of data

Dependent variables

This study makes use of three different dependent variables using data from the Global Entrepreneurship Monitor (GEM) project[3]. The GEM has provided this data on a yearly basis from 2001 to 2016. For the dependent variables, the years 2012-2014 were used.
TEA is the principle measure of entrepreneurship for GEM and it refers to the share of Total early-stage entrepreneurial activity in a region. GEM identifies a two-way division of total early stage entrepreneurship (TEA): opportunity-driven entrepreneurship and necessity-driven entrepreneurship which, together with the total early stage entrepreneurial activity, are used as the dependent variables for this study.

The TEA index measures the percentage of the working age population (18-64 years old) who are currently involved in setting up a business (Nascent entrepreneurs) or those who are owner-manager of a new business less than 42 months after firm birth. Opportunity TEA[4] refers to those who are driven by a potential source of profit, material or not, as the proportion

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[1] The 24 countries are as follows: Austria, Belgium, Czech Republic, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Hungary, Croatia, Ireland, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia and the United Kingdom.

[2] The NUTS (Nomenclature of territorial units for statistics) classification is a hierarchical system for dividing up the economic territory of the EU. NUTS 1: Major socio-economic regions, average population 3-7 mil. inhabitants. NUTS 2: Basic regions for the application of regional policy, average population size: 800,000-3 mil. inhabitants.

[3] Global entrepreneurship monitor (GEM) is a global study conducted by a consortium of universities. It measures entrepreneurship in more than 100 countries and analyses the entrepreneurial behaviour and attitudes of individuals as well as the impact of entrepreneurship.

[4] Individuals in the GEM survey were asked the following: “are you involved in this start-up to 1. take advantage of a business opportunity or 2. because you have no better choices for work?”. Respondents choosing the first answer are assumed to be opportunity entrepreneurs, whereas the individuals responding with the 2 are assumed to be necessity entrepreneurs.

of total-early stage entrepreneurial activity. Necessity TEA refers to the individuals who become entrepreneur because of a conflict between their desired and their actual state, as the share of total early-stage entrepreneurial activity.

The GEM method of data collection varies slightly, but each country is required to find a minimum of 2000 participants in their surveys. Participants are randomly chosen from the landline telephone network for countries where the landline coverage is larger than 85% of all households. For countries where landline coverage is less than 85%, face-to-face interview techniques, as well as mobile phones are used in the survey.

Table 2: Variables and data sources

Variable	Description	Source
Total Early-Stage Entrepreneurial Activity (TEA)	The percentage of the working population (aged 18-64) who are currently involved in starting a new business (Nascent entrepreneurs) or owner of a new business (<42 months after establishing the firm)	1
Necessity-driven entrepreneurship (Necessity TEA)	Percentage of individuals involved in TEA who claim to have no other option for work and have therefore become involved in TEA.	1
Opportunity driven entrepreneurship (Opportunity TEA)	Percentage of individuals involved in TEA who (i) claim to be opportunity driven opposed to having no other option for work and (ii) who claim their main reason for being involved in TEA is being independent or increasing income.	1
High-tech agglomeration	Captures labour market specialisation at a regional level. Measured as the employment in a region's high-tech sector relative to the total employment in that sector, divided by the relative employment of the high-tech sector in Europa.	2
Low-tech manufacturing Agglomeration	Measure of low-tech labour market specialisation in the manufacturing sector at a regional level.	2
High-tech manufacturing Agglomeration	Measure of high-tech labour market specialization in the manufacturing sector at a regional level	
Population Density	Ratio between the average population and the land area in that region	2
Patent application	Number of patent applications made to the European Patent Office, or via the Patent Cooperation per million inhabitants	2
Education level	Percentage of total population (age 25-64) who have completed tertiary education	2
Perceived opportunities	Percentage of 18-64 population who see good opportunities to start a firm in the area they live in	1
Unemployment	Unemployed individuals as a percentage of the total labour force	2

Sources: (1) GEM Surveys 2007 - 2014, (2) Statistical Office of the European Communities (Eurostat) databases 2007-2011

Table 3: overview of countries and their respective NUTS levels

Country	NUTS level:	Country	NUTS level:
Austria	2	Romania	2
Czech Republic	2	Sweden	2
Denmark	2	Slovenia	2
Estonia	2	Slovakia	2
Spain	2	Belgium	1
Finland	2	Germany	1
Hungary	2	Greece	1
Croatia	2	France	1
Ireland	2	Italy	1
Latvia	2	Netherlands	1
Lithuania	2	Poland	1
Portugal	2	United Kingdom	1

3.2 Independent explanatory variables

"Location quotients are one of the most widely used measured of export specialization and an important tool of regional scientists", Mayer and Pleeter (1975) argue. As Miller et al. (1991) state: the purpose of the location quotient technique is to yield a coefficient of how well represented a particular industry is in a given study region". This tool has been used since the beginning of the 1940's and its use is still prevalent in modern regional research, therefore it will be used to estimate the regional specialization for the data studied in this paper.

<u>High-Tech agglomeration:</u> Eurostat[5] has compiled the location quotient of European regions, a measure of labour market sector specialization, for the years 2008-2016. This location quotient is formed by dividing employment in the high-tech sector of a region by the total employment of the same region. The classification high-tech[6] is based on NACE rev. 2[7].
In this study, a slightly different measure in the period 2008-2011 is used. The regional location quotient is divided by the location quotient of high tech sectors in Europe:

[5] Eurostat is the statistical office of the European Union situated in Luxembourg and was established in 1953. This institution provides the education sector, businesses, journalists and individuals with statistics of European countries at a regional level.

[6] High-tech consists of the following industries: Water transport; Air transport; Publishing activities; Motion picture, video and television programme production, sound recording and music publish activities; Programming and broadcasting activities; Telecommunications; computer programming, consultancy and related activities; Information service activities; Financial and insurance activities ; Legal and accounting activities; Activities of head offices, management consultancy activities; Architectural and engineering activities, technical testing and analysis; Scientific research and development; Advertising and market research; Other professional, scientific and technical activities; Veterinary activities); Employment activities; Security and investigation activities; Public administration and defence, compulsory social security ; Education, Human health and social work activities ; Arts, entertainment and recreation.

[7] NACE stands for the statistical classification of Economic Activities in the European Community and is the industry standard with regards to industry classification in Europe. NACE rev.2 is the most recent version and is therefore used as standard in this study for all three location quotients.

$$Location\ quotient\ High\ Tech, Region\ X = \frac{(\frac{Employment\ HT\ Region\ x}{Total\ employment\ Region\ x})}{(\frac{Employment\ HT\ EU}{Total\ employment\ EU})}$$

<u>High-Tech[8] and Low-Tech[9] manufacturing agglomeration:</u> This variable is used as a measure of agglomeration in the high-tech manufacturing sector (whereas the location quotient discussed above also included advanced and knowledge intensive services, as mentioned in footnote 6). Similar to the variable 'high-tech agglomeration', this variable uses Eurostat data for the years 2008-2011 to focus on effect of entrepreneurship on regional sectorial industry differences. The high-tech Location Quotient per region was calculated as follows:

$$LQ\ High - Tech\ manufacturing, Region\ X = \frac{(\frac{Employment\ High\ Tech\ man.Region\ x}{Total\ employment\ Region\ x})}{(\frac{Employment\ High\ Tech\ man.EU}{Total\ employment\ EU})}$$

$$LQ\ Low - Tech\ manufacturing, Region\ X = \frac{(\frac{Employment\ Low\ Tech\ man.Region\ x}{Total\ employment\ Region\ x})}{(\frac{Employment\ Low\ Tech\ man.EU}{Total\ employment\ EU})}$$

The focus on the manufacturing sectors for this variable was intentionally chosen. Eurostat gathers information on the low-tech manufacturing sectors in specific, but it does not gather information on other low-tech sectors general in Europe, such as the low-tech service sector. If the distinction between low-tech and high-tech was made using the low-tech manufacturing sector along with both the high-tech manufacturing and the knowledge intensive services, there would be a downwards bias for the effect of low-tech manufacturing.

<u>Population density:</u> This variable is used as a measure of Jacob's externalities. Jacobs' (1969) argued that cities are an important source of knowledge spillovers and innovation because knowledge may spill over in diverse rather than similar industries as ideas in one industry may be applied to another. Using Eurostat data for the years 2007-2011, regional population density is calculated as persons/km2.

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[8] High-tech manufacturing consists of the following manufacturing industries: Manufacture of basic pharmaceutical products and pharmaceutical preparations; Manufacture of computer, electronic and optical products

[9] Low-tech manufacturing consists of the following manufacturing industries: Manufacture of food products, beverages, tobacco products, textile, wearing apparel, leather and related products, wood and of products of wood, paper and paper products, printing and reproduction of recorded media; Manufacture of furniture; Other manufacturing

3.3 Control variables

Several control variables were added to the model to prevent a potential omitted variable bias, which would occur when a variable affecting both the explanatory independent variable and the dependent variable would also be correlated with the explanatory variable.

Patent applications: Studies have found the number of patent application to be affecting the model's explanatory variable: high-tech agglomeration. A study by Fischer et al. (2009) using NUTS-2 regions in Europe, observed that knowledge spills over in specialized industries between firms. Fischer et al. observed that the number of patent applications were significantly higher in specialized high-tech industries relative to non-high-tech industries. The control variable patent applications is measured as the ratio of patent applications to the European patent office per million inhabitants, using Eurostat data in from the period 2007-2011.

Education level: studies have shown that holding a university degree negatively impacts necessity entrepreneurship (Acs, 2006). Although Acs found the relationship not to hold with regards to opportunity entrepreneurship, necessity entrepreneurship is always included in our model as a dependent variable, either directly or indirectly as part of total early-stage entrepreneurial activity (TEA). The measure is composed by using Eurostat data from the period 2007-2011 on the percentage of the total population, aged 25-64, who have completed tertiary education.

Perceived opportunities: respondents of GEM surveys were asked whether they thought that good opportunities exist in the area they live in. Studies have shown perceived opportunities positively impact the level of entrepreneurship in a region (Arenius & Minniti, 2005), therefore perceived opportunities in the period 2007-2011 is added as a control variable in this study.

Unemployment rate: this variable is measured as the share of the total labour force which is unemployed and are looking for a job. A study by Thurik et al. (2008) found unemployment to positively effect entrepreneurship and therefore, unemployment is added as a control variable in this study. The dataset is provided by Eurostat on a yearly basis, but for this study, the years 2007-2011 are used.

3.4 Methodology

In order to evaluate the effect of agglomeration on the different levels of entrepreneurship, an Ordinary Least Squares method (OLS) will be used. For each of the four hypotheses, a different model is used. In the first model, the coefficient of agglomeration externalities, both MAR and Jacobs' externalities, on total early-stage entrepreneurship will be estimated. In the second model and fourth, the dependent variable are Necessity TEA and Opportunity TEA. For the Third model, two different measures of agglomeration externalities are added: the location quotient of high-tech manufacturing and the location quotient of low-tech manufacturing. This is done to be able to assess whether industry structure matters in estimating entrepreneurship.

The regressions will be as follows:

Model I: $TEA = \alpha + \beta 1\ LQht + \beta 2\ PD + \beta 3\ Pta + \beta 4\ Edu + \beta 5\ PO + \beta 6\ U + u$

Model II: *Necessity* $TEA = \alpha + \beta 1\ LQht + \beta 2\ PD + \beta 3\ Pta + \beta 4\ Edu + \beta 5\ PO + \beta 6\ U + u$

Model III: *Opportunity TEA* = $\alpha + \beta 1\ LQht + \beta 2\ PD + \beta 3\ PPta + \beta 4\ Edu + \beta 5\ PO + \beta 6\ U + u$

Model IV: *Necessity* $TEA = \alpha + \beta 1\ LQhtM + \beta 2\ LQltM + \beta 3\ PD + \beta 4\ Pta + \beta 5\ Edu + \beta 6\ PO + \beta 6\ U + u$

Where:

TEA = Total Entrepreneurial Activity

LQht = Location Quotient high-tech

LQhtM = Location quotient high-tech manufacturing

LQltM= Location quotient low-tech manufacturing

PD = Population Density

Edu = education level

Pta = patent applications

PO = perceived opportunities

U = unemployment

As stated in section data section, the control variables patent applications, education, perceived opportunities and unemployment will be added to model: I-IV. This will be done to prevent a violation of one of the three assumptions of OLS estimations: the zero conditional mean assumption. This assumption is violated in our models when the measures of agglomeration externalities are correlated with TEA, opportunity TEA and necessity TEA and are also correlated with a left out variable, resulting in an omitted variable bias.

A second assumption of OLS estimations is that the observations are independent and identically distributed (i.i.d.).

The outcome of one observation should therefore not influence another observation. As described in the data section, the method for sample drawing by GEM from the same population, using simple random sampling, ensures independence of observations.

The final assumption of OLS estimations is that large outliers for our variables are unlikely. Especially for small databases, outliers may make OLS regression results misleading. The size of the database used in this paper is quite substantial, containing 144 observations. For some variables however, no data was provided by either Eurostat or GEM. Table 5 shows the descriptive statistics with the number of non-missing observations per variable. A few prominent outliers exist in the database. It concerns the three UKI, DE1, DE2[10] regions. None of the outliers seem to be measurement errors and will therefore not be dropped. The UKI region has in fact a very high population density, while the DE1 and DE2 regions are characterized by their industrial development, hence the high patent application rate in both German regions (Eurostat, 2015).

To conduct the OLS method, software program Stata will be used. Regressions will be carried out using robust standard errors. When the errors of the error term don’t have the same variance across all observation points, the errors are heteroskedastic. The option robust standard errors, also known as Eicker-Huber-White standard errors, allows the fitting of a model that contains heteroscedastic residuals (Long & Ervin, 2000).

[10] UKI: London; DE1: Baden-Württemberg; DE2: Bayern

4. Results

Table 4 displays the correlations between the variables. Results of some descriptive statistics are displayed in table 5. Table 6 shows the regression results with standardized beta coefficients and appendix A show the regression results with robust standard errors.
The total number of observations varies, since there is missing data for some independent variables. The mean value of TEA was 0.0695, indicating that for 100 individuals out of the working age population, approximately 7 individuals would be engaged in total early stage entrepreneurial activity.

Opportunity TEA was found to have a high correlation with high-tech agglomeration, r = 0.32. Furthermore, necessity TEA was found to be negatively correlated with high tech agglomeration, r = -0.18. The correlation between opportunity TEA and low tech manufacturing was found to be low and negative, r = -0.03, whereas the correlation between the variables necessity TEA and low-tech manufacturing was found to be both positive and high, r = 0.44. The correlations between population density and the different types of entrepreneurship were found to be similar, though weaker, than those of high-tech agglomeration.

Although the above mentioned correlations cannot give a decisive conclusion, these results do indicate some potential relations between agglomeration and entrepreneurship. It appears that in high-tech regions, more people are driven to entrepreneurship by opportunity, whereas in low-tech regions, more individuals are driven by necessity.

Moreover, as expected, opportunity TEA was found to be negatively correlated with unemployment, r = -.33, whereas necessity TEA was found to be positively correlated with unemployment, r = 0.22. Areas which are less dynamic and harbour more unemployment seem to experience lower levels of opportunity entrepreneurship.

Table 4: Correlations of variables

No	Description	1	2	3	4	5	6	7	8	9	10	11
1	TEA	1										
2	Opportunity TEA	0.92	1									
3	Necessity TEA	0.6	0.25	1								
4	Population Density	0.14	0.19	-0.05	1							
5	Patents	-0.2	-0.1	-0.3	0.08	1						
6	HT Agglomeration	0.18	0.32	-0.18	0.26	0.25	1					
7	LT man. agglomeration	0.15	-0.03	0.44	-0.24	-0.16	-0.43	1				
8	HT man. agglomeration	0.09	0.09	0.06	-0.08	0.17	0.51	0.07	1			
9	Education level	-0.13	0.01	-0.36	0.28	0.19	0.57	-0.5	-0.12	1		
10	Perceived opportunities	0.18	0.39	-0.37	0.1	0.33	0.4	-0.27	-0.02	0.37	1	
11	Unemployment	-0.19	-0.33	0.22	0.04	-0.34	-0.29	0.02	-0.2	0.00	-0.49	1

Table 5: descriptive statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
TEA	144	0.0695	0.0247	0.0209	0.142
Opportunity TEA	144	0.0514	0.0196	0.0132	0.113
Necessity TEA	144	0.0155	0.0103	0,007	0.0489
Population Density	142	841.8	2,796	3.300	31,113
Patents	138	191.3	347.8	0.237	2,770
High-tech Agglomeration	141	0.933	0.469	0.184	2.513
Low-tech manufacturing agglomeration	142	1.030	0.472	0.237	2.917
High-tech manufacturing Agglomeration	121	1.089	0.723	0.159	3.932
Education level	144	24.72	8.592	8.280	46.44
Perceived opportunities	144	0.306	0.145	0.123	0.761
Unemployment	144	8.970	4.066	2.960	22.74

4.1 Results model I

Model I was aimed at testing the first hypothesis: agglomeration externalities positively influences TEA. Both population density and high-tech Agglomeration were found to positively impact TEA at a significance level of 1%. The standardized coefficient of high-tech agglomeration was 0.335 compared to 0.193 for population density, indicating that the effect of 1 standard deviation change in high-tech agglomeration has a larger effect on TEA than population density. The R-squared of this model is 0.261, indicating that the 26.1% of the total variance in TEA is explained by the independent variables in our model. Furthermore, at a significance level of 1%, patents, education level, and unemployment were found to negatively influence TEA, while perceived opportunities was found to impact TEA positively.

The findings suggest that agglomeration externalities influences TEA positively, albeit the coefficient and thereby the effect of Jacobs' externalities was found to be relatively small. This supports the first hypothesis. In agglomerated high-tech regions and in regions which are population dense and therefore more diverse, on average, more total early stage entrepreneurial activity exists. This finding is in line with previous research by van Oort and Stam (2006).

The results for the control variables of the first model are in line with previous research on the effect of perceived opportunities on entrepreneurship (Arenius & Minniti, 2005). Previous research has also shown a negative effect of unemployment on entrepreneurship (Thurik et al., 2008). However, this control variable in Table 6 was found to be not statistically significant.

4.2 Results model II

Model II was constructed to test whether necessity entrepreneurship was negatively influenced by agglomeration externalities. high-tech agglomeration and population density were both found to positively affect necessity TEA at a 5% significance level. The standardized coefficient of population density however, was found to be low compared to that of high-tech agglomeration. Comparing models, the standardized coefficients of the independent variables high-tech agglomeration and population density model 2 were smaller than those of the first model. The effects of both variables were therefore found to be smaller on the dependent variable necessity TEA, than the effects of the same independent variables on TEA itself. With a R-squared of 0.275, the explanatory power of the second model was comparable to the first model. Patents ($P<0.05$) and education level ($P<0.01$) were, just as in the first model, both found to negatively influence the dependent variable.

The second hypothesis can be rejected with the findings of model II. Necessity entrepreneurship does not have a lower presence in regions which are specialized in high-tech sectors, nor does it have a lower presence in regions which are more diverse due to a higher population density. This result is counterintuitive in particular for specialized high-tech regions. It was expected that knowledge spills over from firms to individuals, and that it would therefore promote prosperity in those regions and limit the 'push' factors which drives necessity entrepreneurs (Storey and Jones, 1987).

With regards to the control variable, unemployment was found to positively influence necessity TEA at a 10% significant level. Furthermore, education level negatively influences necessity TEA at a 1% significance level, which is in line with previous research (Acs, 2006).

4.3 Results model III

In model III, opportunity TEA was used as the dependent variable with the same independent variables as in the previous two models. At a 1% significance level, population density and High Tech agglomeration were both found to positively influence opportunity TEA. The explanatory power of this model is higher than in the previous models: the R-squared value is 0.359. The results support the third hypothesis and suggest that in specialized high-tech or population dense regions, the number of individuals driven by opportunity is likely to be higher. These findings are in line with previous research by van Oort and Stam (2006), who found a positive relationship between both diversity and the concentration of industries with the level of entrepreneurship in the Dutch ICT sector. However, the results from this study show that this relationship in specific holds for opportunity TEA.

4.4 Results model IV

Model IV used different independent variables than the previous three models, to allow for a division in industry structure: low-tech manufacturing agglomeration and high-tech manufacturing agglomeration. At a 1% significance level, a positive effect of low-tech manufacturing agglomeration on necessity TEA was found. In contrast, high-tech manufacturing agglomeration was not found to influence necessity TEA at a 10% significance level. The explanatory power of the fourth model is comparable to that of the third model: approximately 36.1% of the variance can be explained by the independent variables of this model. These results support the last hypothesis. In regions specialized in low-tech manufacturing, more individuals are driven by necessity entrepreneurship, relative to regions specialized in high-tech manufacturing.

Table 6: Regression results

VARIABLES	(1) TEA	(2) Necessity TEA	(3) Opportunity TEA	(4) Necessity TEA
Population Density	1.70e-06***	1.81e-07**	1.45e-06***	3.66e-07***
	(0.193)	(0.0486)	(0.208)	(0.105)
High-tech Agglomeration	0.0179***	0.00456**	0.0138***	
	(0.335)	(0.203)	(0.328)	
Low-tech manufacturing agglomeration				0.00991***
				(0.421)
High-tech manufacturing Agglomeration				0.00142
				(0.0972)
Patents	-2.24e-05***	-4.98e-06**	-1.69e-05***	-4.25e-06**
	(-0.316)	(-0.166)	(-0.301)	(-0.149)
Education level	-0.00119***	-0.000479***	-0.000704***	-6.05e-05
	(-0.419)	(-0.399)	(-0.313)	(-0.0492)
Perceived opportunities	0.0436***	-0.0148***	0.0522***	-0.00672
	(0.254)	(-0.205)	(0.385)	(-0.0922)
Unemployment	-0.000256	0.000388*	-0.000629	0.000510*
	(-0.0397)	(0.143)	(-0.123)	(0.175)
Constant	0.0748***	0.0254***	0.0477***	0.00377
Observations	135	135	135	116
R-squared	0.261	0.275	0.359	0.361

Robust normalized beta coefficients in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

Although increasing interest exists in research on both entrepreneurship and agglomeration economies, the combined topic agglomeration and its effect on entrepreneurship is in its infancy. Policy makers often view entrepreneurship as the magic bullet which transforms economic regions (Shane, 2008). Findings of quantitative research on this topic can provide important insights on the characteristics of entrepreneurship in agglomerated regions for these politicians to make more informed choices.

As stated in the literature review, some evidence has been found for a positive relationship between the effects of agglomeration externalities on entrepreneurship, but these studies have been often been conducted on only one type of TEA, only one type of industry or only using a small database of regions. This study adds to the existing stream literature a more diverse look on these effects using data on 144 different regions from 23 different European countries and distinguishing between opportunity TEA and necessity TEA. Furthermore, industry structure was also taken into account.

Four hypotheses were constructed to establish the relationship between agglomeration externalities and the level of entrepreneurship. In line with previous research, evidence for the existence of an effect of agglomeration externalities on total early-stage entrepreneurial activity was found. Furthermore, regions with a higher high-tech agglomeration level also exhibit higher levels of opportunity TEA.

A positive significant relationship between high-tech agglomeration and necessity entrepreneurship was found. Furthermore, the last model showed that areas more specialized in low-tech industries tend to have more individuals pushed into entrepreneurship by reasons of necessity. Comparing standardized beta coefficients, the effect of industry specialization on entrepreneurship was found to be higher than the measure of Jacobs' externalities in models 1,2 and 3. This suggests that localization matters more with regards to entrepreneurship than Jacobs' externalities. According to the estimates of this paper, entrepreneurship is influenced more by knowledge spillovers within an industry due to industry specialization, rather than by knowledge spillovers due to diverse industries in a region.

However, the results presented in the paragraph above should be interpreted with caution. Researchers have argued that the definitions necessity and opportunity are dynamic, rather than static (Williams, 2008). Williams found evidence that individuals often switch their view, so that they may present themselves as driven by opportunity at one point of time, but as driven by necessity at another point of time and vice versa.

Furthermore, population density was used as an explanatory variable. This variable can be considered a raw measure for Jacobs' externalities, therefore the real effect of industry diversity on entrepreneurship may be biased. To be able to distinguish between low-tech and high-tech, this paper focused on the manufacturing industry, which makes the results less generalizable to different industries.

For research in the future, it is recommended that the limitations mentioned above are addressed. A more elaborate measure of Jacobs' externalities than population density, such as related and unrelated variety (Frenken et al. 2007), is recommended in order to draw better conclusions. Another recommendation is to take a different approach with regards to measuring opportunity and necessity TEA. For instance, the same individuals could be interviewed at different time intervals to enable selecting only those entrepreneurs who have not changed their views. Another approach would be to develop a static definition of opportunity and necessity entrepreneurship.

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7. Appendices

Appendix A: Regression results with Robust standard errors displayed

VARIABLES	(1) TEA	(2) Necessity TEA	(3) Opportunity TEA	(4) Necessity TEA
Population Density	1.70e-06***	1.81e-07**	1.45e-06***	3.66e-07***
	(4.24e-07)	(8.72e-08)	(4.08e-07)	(1.32e-07)
High-tech Agglomeration	0.0179***	0.00456**	0.0138***	
	(0.00509)	(0.00201)	(0.00367)	
Low-tech manufacturing agglomeration				0.00991***
				(0.00266)
High-tech manufacturing agglomeration				0.00142
				(0.00108)
Patents	-2.24e-05***	-4.98e-06**	-1.69e-05***	-4.25e-06**
	(7.36e-06)	(2.50e-06)	(5.10e-06)	(1.96e-06)
Education level	-0.00119***	-0.000479***	-0.000704***	-6.05e-05
	(0.000250)	(9.39e-05)	(0.000190)	(0.000104)
Perceived opportunities	0.0436***	-0.0148***	0.0522***	-0.00672
	(0.0152)	(0.00493)	(0.0120)	(0.00575)
Unemployment	-0.000256	0.000388*	-0.000629	0.000510*
	(0.000554)	(0.000225)	(0.000427)	(0.000268)
Constant	0.0748***	0.0254***	0.0477***	0.00377
	(0.00868)	(0.00364)	(0.00651)	(0.00575)
Observations	135	135	135	116
R-squared	0.261	0.275	0.359	0.361

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1