Bachelor thesis

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Industry Specialisation and Innovation

-a study of the effects on economic growth

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The basis of our analysis is the two conflicting theories developed by MAR and Jacobs concerning what type of industry structure is best in explaining innovation and economic growth. Current research has been inconclusive on the matter and we wish to shed some further light on the issue. By performing two regression analyses on data from Swedish municipalities the study first aims to examine how industry specialisation affects innovation in terms of newly started companies, and second to what extent innovation contributes to economic growth. Our results point toward favouring Jacobian diversification as the driver of innovation. The study furthermore shows a weak positive link between innovation rates and economic growth.

Key words: Knowledge spillovers, externalities, Sweden, industry structure, innovation, economic growth.

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Introduction

The formation of industrial clusters and the growth of cities or regions have for long been a major concern within the economic sphere of research. Scholars have been interested in explaining why some regions grow and what kind of processes it is that drive this growth.

Cities exist because people and firms are attracted to each other and decide to move and establish in the same region. When agents decide to locate close to others, some externalities arise. These externalities can be both negative (such as pollution, traffic congestion etc.) as well as positive. The positive externalities in focus of this study are the knowledge spillovers that occur between firms located close to each other. These knowledge spillovers have been called the "engine of growth" (Romer 1986) and it has been argued that the proximity of firms and people in a city make this phenomena especially influential (Glaeser et al. 1992).

The debate has mainly been focusing on two conflicting theories that both highlight the importance of knowledge spillovers. The Marshall-Arrow-Romer (MAR) theory as formalised by Glaeser et al. (1992), suggests that valuable knowledge tend to be industry specific and that firms in a specialised industry cluster benefit from shared knowledge. More specialised industries are as a result argued to exhibit higher innovative activity. The other view developed by Jane Jacobs in 1969 states that the most important sources of new knowledge are external to the industry in which a firm operates. Thus a diversified industry structure will generate more innovation.

However, the literature on the subject is inconclusive. Studies have been done on different regional agglomeration levels as well as on industries in different stages in the life cycle. Evidence supporting both theories has been found depending on the focus of the analysis and hence no unanimous conclusion has been reached.

Putting innovation aside, there is also an economic aspect to the matter of industry specialisation versus diversification. With the current economic crisis, regional diversification has become an issue high on the political agenda because specialised regions like Detroit are especially hard hit during an economic downfall (Boschma et al. 2011). It is becoming increasingly more important for countries, regions and cities to be able to meet the competition resulting from a more globalised economy and adapt to macroeconomic changes. If failing to maintain a productive and profitable industry and meeting the demands from consumers and labourers a region will not survive. It is therefore vital to know what type of industry composition is desirable and which policies and regulations should be implemented in order to create the best conditions for this.

The aim of this study is to analyse the importance of industry structure and its effect on innovation rates. Is it the Marshallian specialisation or the Jacobian diversification that best foster innovations? Furthermore we will investigate if economic growth can be explained by the level of innovativeness.

This paper is structured such that the next section will provide a review of the current state of knowledge followed by our research questions. Next, the analytical framework on which we base our analysis will be presented. The subsequent section is the description of the data and the methods used. Finally, we will present the empirical results followed by the conclusions drawn from the conducted study.

Previous research

This study will compare the explanatory power of the contradictory Marshall-Arrow-Romer - and Jacobs theories on knowledge externalities. The work by Glaeser et al. from 1992 concerning spillover effects has been highly influential and the source of inspiration for many new studies on what causes innovation and growth. From studying large industries in 170 US cities between 1956 and 1987 Glaeser et al. found that local competition and urban variety encouraged economic growth. The result is thus consistent with Jacobs' theory that knowledge spillovers occur between rather than within industries.

Since the articles by Glaeser et al. (1992) the empirical literature investigating the impact of MAR and Jacobs externalities has expanded rapidly. The current literature however offers differing results.

Following the Glaeser approach, Shefer and Frenkel (1998) as well as Paci and Usai (1999) found evidence supporting that both specialisation and diversification externalities positively affect regional innovativeness in Israel and Italy, though it was found that innovation was more pronounced for high technology industries. Low technology sectors seemed not to be affected by these externalities. A more distinct conclusion is drawn from the study by Feldman and Audretsch (1999) arguing that diversification rather than specialisation externalities promote regional innovative activity in the United States.

As a consequence of the inconclusive findings, researchers have tried to find the explanation to why this is the case. Combes et al. (2004) note that studies differ mainly in their methodologies: plant level versus regional studies, panel data versus cross section analyses; and productivity versus employment regressions. Additionally, samples are drawn from different periods in history and relate to different areas of the world. De Groot et al. (2009) revisited thirty-one studies containing over 200 parameter estimates; their meta-analysis found that both sample issues and methodological issues affect outcomes.

Van Beers (2007) looked at how MAR as opposed to Jacobs affects innovation and commercial success. The study found that Marshallian specialisation in an area increased regional innovativeness. However, industries in areas with Jacobian diversification received a larger commercial success with their innovations.

There has also recently been debated whether knowledge spillovers occur instantaneously or not. Audretsch (2007) argues that the occurrence of so called knowledge filters causes a barrier impeding investments in new knowledge from spilling over for commercialisation. This goes against the Romer (1986) model which states that knowledge will automatically spill over from the source into a commercial business. By serving as a channel for knowledge spillovers, Audretsch disputes that entrepreneurship is the missing link between investments in new knowledge and economic growth.

Braunerhjelm et al. (2009) continues on the line proposed by Audretsch (2007) and performs several regressions with data on the OECD countries during 1981 – 2002. Their results show that it is not the spending on Research & Development that constitutes economic growth. But rather that entrepreneurs and entrepreneurial activity are of major importance. The study is yet another evidence against the classical endogenous growth model. They further argue that entrepreneurs are the link between the actual knowledge and the commercialisation of it and thus that policies focusing on enhancing the role of the entrepreneurs is necessary.

One of the most recent studies on externalities conducted by Neffke et al. (2011) concerns the spillover effects in relation to the product life cycle. The regional focus of the study is the Swedish so called functional regions which are about 70 areas based on commuting distance and the main metropolitan areas. Neffke et al. found that Jacobs externalities occur in the beginning of an industry’s development whilst the importance of MAR externalities increases with the maturity of the industry. It was found that MAR externalities had a larger impact than Jacobs throughout the life cycle.

Neffke et al. have made some interesting conclusions, however one can questions some aspects of their study. We wish not to reject the results derived by Neffke et al., but rather to offer a complement that will provide a more nuanced understanding of the issue. In order to shed some further light on the debate on specialisation versus diversification externalities, our study will be conducted with the Swedish municipalities as the basis of our analysis.

First the appropriateness of the functional regions can be debated, since they are not a fixed classification but regularly modified over time, it is difficult to track any long-term trends. In addition, in today’s globalised world influences and new ideas are not limited to originate from the geographical proximity but rather through various global pipelines. Therefore, using a regional definition that is solely based on the labour market might diffuse the results. The data used in our study is in its fundamental characteristics similar to that of Neffke et al. However, as opposed to Neffke et al. we are using a panel data set for the full nine years. This allows us to study the continuous development over the years and to investigate if the results derived from earlier studies are valid also on this disaggregated level.

Moreover, it has been claimed that spillover effects are more prevalent in young industries as it develops new services and products in the beginning. In accordance with Romer (1990), we assume that knowledge spillovers are constant over time and therefore affect both mature and young industries. Additionally, there are difficulties involved with how to define an industry in a young, medium or mature stage. The same difficulty arises when using a binary classification of the externalities and creating two separate variables for MAR specialisation and Jacobs diversity. We believe that generating variables with arbitrary delimitations threatens to cause arbitrary results. Our interest is instead to look at the matter from a more general point of view by examining how changes in industry concentration affect innovation, and how innovation affects growth.

Another argument for why municipalities could be of interest is the fact that the service sector, both consumer services and producer services, is a major part of the economic activity today. The service sector is functioning on a very local scale, with the personal interaction being a vital aspect. Hence, the larger functional regions might not capture the spillover effects in a reasonable manner.

Aim of the study

Following the study by Neffke et al. on spillover effects in Sweden, the aim of our study is to complement their findings by analysing the effects of industry structure in Swedish municipalities in two ways. First, how the level of innovation in terms of newly started companies is affected by the industry specialisation and second if economic growth over time can be explained by differences in the number of startup companies.

The research questions we aim to answer are:

- *Does industry concentration influence the innovation intensity in Swedish municipalities?*
- *If so, is the MAR theory of industry specialisation or Jacobs theory of industry diversification best in explaining regional differences?*
- *Finally, does the level of innovation affect economic growth?*

Analytical Framework

Knowledge spillovers and economic growth

Knowledge spillovers are defined as an exchange of ideas amongst individuals. It is assumed to be a public good, which implies that the knowledge possessed by one individual or firm cannot be kept a secret or perfectly patented. Hence investing in knowledge creates a natural externality in the sense that the creation of new knowledge by one firm has a positive external effect on the production possibilities of other firms (Romer 1986).

As stated above the Marshall-Arrow-Romer - and the Jacobs spillovers are the two main theories concerning how the knowledge transfer occur between firms located close to each other. According to the view developed by Marshall (1890) and then extended by Arrow (1962) and Romer (1986), a concentration of firms *within the same industry* transfers information between them leading to the development of new innovations and economic growth. It is when employees from different firms meet that the exchange of new ideas and products occur. A higher concentration of employees working in the same industry hence causes more opportunities for spillovers of knowledge to occur (Glaeser et al., 1992).

In contrast to the MAR spill over theory are the ideas put forward by Jane Jacobs in 1969. Jacobs developed a theory focusing on the *diversity of industries* in a region and she claims that the composition of people with different backgrounds and competencies is what drives innovation. The local variation creates opportunities for applying methods used in one industry to solve problems in another industry. Furthermore, the diversity also creates more stable demand conditions which allow firms to choose from a large variety of suppliers, which reduces their exposure to price fluctuations (Neffke et al., 2011).

The knowledge externalities are not independent of distance. Since it concerns tacit knowledge that is difficult to document, the spillovers can only take place through a process of social interaction. Due to this, geographical proximity between firms is a necessary requirement in order for these spillovers to occur.

The consensus amongst economists is that the rate of innovation plays a major role in driving economic growth, especially in the modern knowledge driven economic. A firm's ability to innovate (or imitate the innovations of others) determines its chances of survival (Segerstrom, 1991). OECD states that "An 'innovation' is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations." In business and economics, innovation is the catalyst to growth. With rapid advancements in transportation and communications over the past few decades, the old concepts of factor endowments and comparative advantage which focused on an area's unique inputs are outdated for today's global economy. Entrepreneurship is an important mechanism to facilitate the spillover of knowledge and ultimately generate economic growth.

Data description and methodology

Panel data obtained for each of the 290 municipalities in Sweden are the source of the analysis. The data set covers nine years from 2000 to 2008, and hence consists of 2610 observations at the most. Due to some missing variables the number of observations however varies. The data has been obtained mainly from the governmental organisation Swedish Statistics which certifies that the statistics are of a high validity and reliable to use. The data set includes primarily information on the gross regional product (comparable to the gross national product but limited to the Swedish municipalities). The original data reported the GRP in nominal values but in order to provide a more fair description of the economic growth it was converted into real values using the inflation rate in Sweden. Then we calculated the GRP growth which is the variable used in our analysis (grp_{it}).

Furthermore, we have information on the number of employees divided into 16 sectors for each municipality. The sectors in the data set have been divided and classified according to the Swedish SNI code system at the five digit level, and the division offers a reasonably detailed picture of the industry structure in each municipality.

The data on the number of employees per sector is used to calculate a modified version of the normalised Herfindahl-Hirschman index (HHI), which gives a measure on the level of industry specialisation in each region; $herfin_{it}$. The usual HHI includes market share of each firm in the industry and thus provides a measure of both industry concentration and firm level competition. However there exists no data on the number or size of firms at the municipality level. Therefore, we are not able to observe if the industries are characterised by equally sized firms with competition amongst each other or if there are sectors with a more monopolistic position in terms of market share. The modified HHI used in this study is instead a measure of industry concentration only. A very similar computation of industry concentration is also used in the study by Glaeser et al. (1992).

An alternative to the HH index is the entropy index and there is an on-going discussion on which of these two measurements is best in calculating industry concentration. However, results seem to suggest that entropy indices are better suited for the calculation of more concentrated industries in oligopoly (Hart, 1971). Since this is not reflected in our data we estimate that the Herfindahl index is better suited for our purposes. It is also shown that, due to its more stable range, the HH index displays clearer results than the entropy measure (Acar, 1999).

$$H = \sum_{i=1}^{N} s_i^2$$

The above calculation shows the computation of the industry concentration index that was calculated with the HH index approach. Where s_i^2 is the number of employees in industry *i* of the region divided by the total amount of employees, and N is the number of industries. The calculation is thus a measure of industry structure in each region. This is a distinction against the typical calculation of the HHI, where s_i^2 is the market share of firm *i* in the market, and N is the total number of firms in the chosen industry. Using the ratio of employees in each industry was preferred rather than observing the size in terms of output of the different firms. As mentioned in theoretical framework, knowledge spillovers occur in the interaction between people. Since spillovers materialise only in the personal encounter we believe that the number of individuals specialised in a certain industry can tell us more about how diversified or specialised the region is and how this contributes to innovation and growth. The ratio of employees per industry was also used in the computation of the industry specialisation measure by Glaeser et al.

In a second step a normalised HH index, HH*, is calculated. Whereas the HH index ranges from 1/N to one, the normalised HH* index ranges from 0 to 1.

$$HH* = \frac{(H - \frac{1}{N})}{1 - 1/N}$$

Below follow the interpretations of the Herfindahl index. The definitions should be viewed mostly as guidelines since there at the moment is no clear consensus of how the HHI index should be divisionalised.

A HH index < 0.01 indicates a highly diversified industry.
A HH index < 0.15 indicates an unconcentrated index.
A HH index of 0.15 – 0.25 indicates moderate concentration.
A HH index > 0.25 indicates a high industry concentration.

Furthermore, information on the number of new companies, $startups_{it}$, per 1000 inhabitants has been used in the study. In order to obtain a more intuitive result and to adjust for skewness the logarithm of $startups_{it}$ has been obtained and resulted in the variable log($startups_{it}$). The variable is used in order to study how the number of new startups responds to changes in the industry concentration index. Moreover, we would like to see how GRP reacts to changes in startup companies. There is reason to believe that there is a delayed response in output to changes in the number of startup companies and thus log($startups_{it}$) with a one year lag, $laglstartups_{it}$, has also been included.

The variables log($startups_{it}$) and $laglstartups_{it}$ are used as proxies for innovation rate. Startups is our proxy for innovation, since the primary reason for founding a new venture is that the entrepreneur has a unique product or service to offer that does not already exist on the market (Braunerhjelm, 2010). The use of patent announcements, a common research strategy in this context, was discarded since it only includes the manufacturing segment and we wish to include the growing service sector in the study. As furthermore argued by Audretsch (2007), Research & Developement expenditure is a rather weak measure of innovation since knowledge filters dampens knowledge spillovers. Entrepreneurship is an important mechanism for measuring the spillover of knowledge as it shows the number of ventures that has successfully overcome the issue of knowledge filter. Conversely, $startups_{it}$ as a measure of innovation does not take into account the innovation occurring within already existing firms. Although the measure does not capture all innovation, it is still a good indicator of regional inventive activity.

In addition to the variables grp_{it}, log($startups_{it}$), $laglstartups_{it}$ and log($herfin_{it}$) we will include two control variables that we believe will help reduce the omitted variable bias issue. Firstly, we use the logarithm of the unemployment levels, log($unempl_{it}$), in each region to correct for shifts in demand at the regional level. Secondly, we include the yearly returns of the OMX stock market with a one year lag, $lagstockmark_t$, to control for responses in the market to macroeconomic shocks. Our expectation is that there exists a delayed reaction in the municipalities to the macroeconomic factors and consequently we use the stock return with a one year lag. The intuition behind these variables is that both the level of innovation and the gross regional product are influenced by several factors in the economy. The general willingness to take risks, such as starting a new company, is highly affected by the well-being of the economy in general. The stock market volatility has previously been used as a proxy for financial stress and economic uncertainty (Mendoza et al., 2009), and thus we find it reasonable to include it in our study.

The properties of the variables used are shown in table 1

TABLE 1 DESCRIPTION OF THE VARIABLES

	N	Mean	Std. Dev.	Min	Max
grp_{it}	2606	0.042	0.081	-0.447	0.781
$startups_{it}$	2318	7.809	3.017	2.746	29.446
$herfin_{it}$	2607	0.087	0.049	0.025	0.440
log($startups_{it}$)	2318	1.998	0.327	1.010	3.383
log($herfin_{it}$)	2607	-2.567	0.465	-3.705	-0.821
$laglstartups_{it}$	2317	1.998	0.327	1.010	3.383
$lagstockmark_t$	2609	-0.014	0.254	-0.339	0.348
log($unempl_{it}$)	2605	-3.451	0.375	-4.837	-2.286

In order to conduct our analysis we will run two different OLS regressions that are obtained from the data set. The first regression aims at studying if there exists a correlation between the trend of regional industry specialisation and newly started companies in the area. Will high industry specialisation hamper or encourage new ventures? The second regression investigates how economic growth in the region (GRP growth) is affected by the regional startup activity over time.

$$\log(startups_{it}) = \beta_0 + \beta_1 \log(herfin_{it}) + \beta_2 lagstockmark_t + \beta_3 \log(unempl_{it}) + \varepsilon_{it} \quad (1)$$

$$grp_{it} = \beta_0 + \beta_1 \log(startups_{it}) + \beta_2 laglstartups_{it} + \beta_3 lagstockmark_t + \beta_4 \log(unempl_{it}) + \varepsilon_{it} \quad (2)$$

Empirical Results

Swedish municipalities are diversified in general

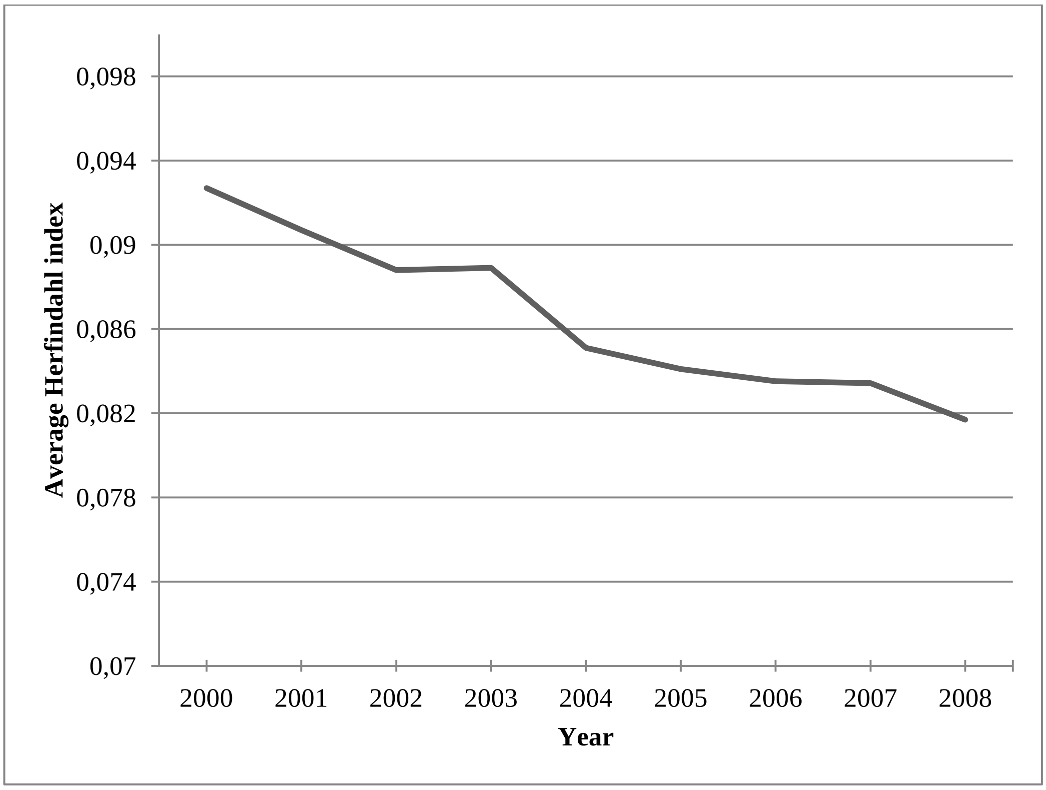
As described above, we are using a modified version of the normalised HH index to display the industry structure of each municipality in Sweden. The number of employees per industry is used as the basis of the index which ranges from 0 to 1 where a higher index implies a more concentrated and specialised industry structure.

The characteristics of the HHI are shown in table 2 and in figure 1 the trend for the average index over the years is displayed.

TABLE 2 CHARACTERISTICS OF THE HERFINDAHL-HIRSCHMAN INDEX

Year	Obs	Mean	Std. Dev.	Min	Max
Total	**2607**	**0.087**	**0.049**	**0.025**	**0.440**
2000	288	0.093	0.059	0.030	0.440
2001	289	0.091	0.054	0.033	0.404
2002	290	0.089	0.051	0.032	0.386
2003	290	0.089	0.049	0.033	0.377
2004	290	0.085	0.048	0.030	0.366
2005	290	0.084	0.045	0.028	0.342
2006	290	0.084	0.045	0.028	0.333
2007	290	0.083	0.045	0.025	0.322
2008	290	0.082	0.045	0.026	0.316

FIGURE 1 HERFINDAHL-HIRSCHMAN INDEX - AVERAGE YEARLY DEVELOPMENT



The general picture is that the municipalities in Sweden are diversified in their industry structure. According to the existing somewhat subjective definitions of HHI, 90.6 % of the data have a concentration less than 0.15, 7.9 % display a moderate concentration, and a mere 1.5 % display high industry concentration.

The trend throughout the years exhibits a decreasing HHI, which implies that the industry structure in Sweden is becoming even more diversified. The average HHI has declined with approximately 12 % from 0.093 in 2000 to 0.082 in 2008.

A diversified industry structure beneficial for innovation

To investigate whether MAR- or Jacobs knowledge spillovers as formulated by Glaeser (1992) have any effect on the innovation rates in Sweden we estimated the linear regression model (1).

The purpose of this regression is first to see if the number of new companies in each region, log($startups_{it}$), are affected by industry specialisation, log($herfin_{it}$), and second if a high or low industry specialisation leads to more innovations. Included as control variables are the lagged average stock market performance ($lagstockmarket_t$) and the unemployment levels for each municipality, log($unempl_{it}$). The results from the regressions are displayed in table 3.

Table 3 Regressions of Herfindahl index on number of startups

	(a)	(b)
log($herfin_{it}$)	-0.249*	-0.264*
	(-17.25)	(-19.12)
$lagstockmark_t$		0.138*
		(5.55)
log($unempl_t$)		-0.141*
		(-7.98)
Constant	1.359*	0.824*
	(35.89)	(11.23)
F-statistic	297.70	150.12
N	2318	2316
R^2	0.122	0.155

All regressions are estimated with OLS and with robust standard errors.

* Coefficients are significant on a 1 % level. T-statistic are displayed in brackets.

When using only the Herfindahl index as the independent variable in regression (a) it results in an R^2 of 0.122 (shown in table 3). When adding the stock market performance and unemployment control variables in regression (b), the R^2 rises to 0.155 which indicates that they increase the explanatory power of the regression. All three coefficients are significant on a 1% level and the industry concentration index, log($herfin_{it}$), is observed to have a negative effect on the number of startups. The estimated coefficient on the Herfindahl variable is -0.264 which implies that a 10 % increase of the Herfindahl index decreases the number of new companies by 2.6 %. Since the average yearly change in log($startups_{it}$) is an increase of 1.8 % this implies that a one percentage increase in industry concentration will result in 14.4 % decline in the average growth of new companies. The impact of these results is best understood when studied over a longer horizon. In table 4 one can observe the effects over several years. It is shown that an increase of HHI with 1 % per year over 20 years will result in a reduced incidence of new firms with 7.3 percent points. Small changes in industry concentration can thus have a quite considerable effect on innovation in terms of started up companies over a period of accumulated growth.

TABLE 4 YEARLY 1 % INCREASE EFFECT OF HHI ON STARTUPS

Year	Average increase of log($startups_{it}$)	log($startups_{it}$) change as log($herfin_{it}$) rise 1 % / year	Difference in %-points
2001	1.8 %	1.6 %	0.3
2006	9.5 %	8.1 %	1.4
2011	19.9 %	16.9 %	3.1
2016	31.4 %	26.3 %	5.0
2021	43.9 %	36.6 %	7.3
2026	57.5 %	47.6 %	9.9
2031	72.5 %	59.6 %	12.9
2036	89.0 %	72.5 %	16.4
2041	106.9 %	86.5 %	20.4

The control variables, $lagstockmark_t$ and log($unempl_{it}$) are similarly significant on a 1 % level. The beta coefficients are 0.138 and -0.141 respectively. The economical interpretation of this is that a good performance of the stock market affects the number of new companies in a positive way while the unemployment has a negative effect on the innovation rate. The signs of these coefficients are expected and one can observe that the level of entrepreneurship is quite dependent on changes in the business cycle.

Innovation and GRP

The second step of our analysis is to study the relationship between the number of newly started companies and economic growth in the municipalities. In order to do this we regress grp_{it} on log($startups_{it}$) as well as the lagged version $laglstartups_{it}$ together with the control variables stock market performance and unemployment (regression 2).

The results from the regression are presented in table 5. If first taking grp_{it} on log($startups_{it}$), no significance of the beta coefficient is obtained on any reasonable level. However, when controlling for more variables the results improve significantly.

TABLE 5 REGRESSION OF GROSS REGIONAL PRODUCT ON THE NUMBER OF STARTUPS

	(a)	(b)
log($startups_{it}$)	-0.002	-0.013**
	(-0.38)	(-2.20)
$laglstartups_{it}$		0.012**
		(2.10)
$lagstockmark_t$		0.028*
		(4.05)
log($unempl_{it}$)		-0.01**
		(-2.11)
Constant	0.044*	0.008
	(4.01)	(0.41)
F-statistic	0.15	8.16
N	2317	2026
R^2	0.0001	0.014

All regressions are estimated with OLS and with robust standard errors.

* Coefficients are significant on a 1 % level. **Coefficients are significant on a 5 % level. T-statistics are shown in brackets

The coefficients of log($startups_{it}$), $laglstartups_{it}$ and log($unempl_{it}$) are all significant on the 5 % level while the coefficient of $lagstockmark_t$ shows significance on the 1 % level. The economic interpretation of the coefficients is as follows: the number of newly started companies during the current year has a negative effect on the economic growth, while the previous year's number of new companies affects gross regional product in a positive way. The coefficients implies that a 10 % increase in the number of new companies this year decreases GRP with 0.1 % while an increase of new companies last year with 10% will increase GRP with the same amount.

Concerning the control variables of unemployment and stock market performance, their influence on economic growth is that a 10% increase of the unemployment levels will decrease GRP with 0.1% while a 10 % percentage point increase of the stock market performance will raise GRP by 3 percentage points.

Discussion of results

The signs of the coefficients from regression (2) are expected. A company will often exhibit negative results during the first year, while simultaneously hindering the founder from working in a productive firm that contributes to the economy. Some time of economic loss is thus generally anticipated in the beginning before a new company starts being productive and displaying positive results.

The size of the coefficients however implies that a quite large increase in the amount of new companies is required in order for any effect to show on the gross regional product. One reason for this is that the gross regional product is rather complex to explain as it (as similar to GDP) is composed of several variables[1]. The regression of GRP on new companies therefore only takes into account a small fraction of the total economic output.

In addition, how to define innovation and construct a measure that is fair and captures all dimensions of it is an almost impossible task. Using the number of new companies as a proxy for innovation is in no way exhaustible, but it captures to some extent the entrepreneurial activity in a municipality. One must also be aware that an individual can be incentivised to start a new company for different reasons. It can be because an unexploited business opportunity exists or simply because no other employment opportunity is available. If the latter is the case, the number of start up companies is rather a sign of a dysfunctional labour market and the startup activity would therefore instead be an indication of slow growth (Acs, 2006). Using the number of surviving startup companies after a given set of years may be a solution to this problem as the economic success of a company can suggest the entrepreneur's innovative quality.

In contrast to our results, Braunerhjelm et al. (2010) in particular, found substantially significant results pointing towards that entrepreneurs affect economic growth. There are potentially several reasons for this discrepancy. The most important difference in their use of variables is that innovation is measured in terms of shares of entrepreneurs in relation to the total population. They also include the share of researchers in relation to the population at large in order to control for the amount of knowledge available for the entrepreneurs to explore. Using an innovation measure in terms of share of entrepreneurs in the population as well as a control measure consisting of the share of researchers is something that we thus believe would increase the economic significance of our results considerably.

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[1] The GDP identity shows the basic equation of GDP where GDP=consumption + investment + government spending + net exports.

Many studies have been conducted in similar ways as in regression (1) with conflicting results. Neffke et al recently (2011) performed a study in Sweden with results that was rather indecisive, but that favoured MAR to a larger extent than Jacobs in the aspect of innovation. Our results point in a different direction since they show stronger signs of Jacobs' externalities and are thus more in line with Glaeser et al.'s seminal study from 1992. The differing results are likely to be due to several factors. Neffke et al. conducted their research on a firm level whereas our point of study takes place at the industry level.

The different regional focus is also expected to influence the results significantly. When conducting analysis on spatial regions, there are some risks that need to be considered and if possible addressed. In order for studies done on regions to be relevant and useful, the characteristics of the actual region need to be defined and understood. Data is often collected for non-modifiable units such as people and households but are then aggregated and reported in rather arbitrary and highly modifiable entities (counties, municipalities, urban areas etc). Choosing a different regional division while using the same data may thus result in different results. This bias is known as the Modifiable Areal Unit Problem (Openshaw, 1984) and is something that one should be aware of when conducting studies on modifiable geographical regions. The implications of the modifiable areal unit problem, or similar aggregation problems could be partly the reason why the previous research on the subject is so inconclusive. Perhaps the varying results obtained from rather similar data can be due to the fact that these studies have been conducted on different regional levels.

Another aspect that separates our study from previously executed research is the manner in which we measure industry structure. Several studies have included two variables, one displaying the Jacob's externalities and one representing the MAR-externalities. We believe that a single measure of the total industry specialisation is appropriate in order to avoid arbitrary variables that are biased towards one type of externality. However, not distinguishing between what we consider to be a diversified or specialised region will perhaps influence our results, making the effects less visible.

A further concern discussed in the literature on Jacobs externalities is which type of diversity that is optimal in order for knowledge spillovers to occur. Two firms from sectors that are too unrelated are not likely to benefit from being located close to each other. Knowledge will only spill over between sectors when the cognitive distance is not too large (Nooteboom, 2000), and there needs to be some form of related variety for the knowledge spillovers to exist. It could thus be important to distinguish between different forms of regional diversity since they might involve different economic effects (Asheim et al., 2011).

Conclusion

The purpose of our conducted study is to investigate whether any evidence of knowledge spillovers can be found in the Swedish municipalities and if Jacobian diversity or Marshallian specialisation is most beneficial in generating regional innovation. The aim is also to observe how economic growth in the municipalities is affected by the innovation rate measured as the number of new companies.

Based on a panel data set for all 290 municipalities in Sweden covering the years 2000 – 2008 we have obtained results that to some extent allows us to answer our research question. Two regressions were conducted, first on the effect of the number of new companies ($startups_{it}$) on industry specialisation ($herfin_{it}$) and second the effect of economic growth (grp_{it}) on new companies. The estimated beta coefficient for the $herfin_{it}$-variable in regression model (1) is negative indicating that a more specialised industry in a municipality results in fewer new companies. This supports the theories developed by Jane Jacobs in her 1986 paper *The Economy of Cities* in which she argues that a diversified industry will lead to more innovations and growth. Hence the answers to the first and second research questions are:

- Yes, industry concentration does affect the innovation intensity in terms of the number of newly started companies
- The results indicate that a more diversified industry increases the number of startup companies and hence some support for the Jacobs externalities can be found.

In regression model (2) the gross regional product on the number of start-up companies displays expected results, yet weak economic significance. The number of new companies formed the current year has a negative effect on economic growth while the companies founded the previous year affects the economy in a positive way. The answer to the third and final research question is thus:

- Innovation in terms of new companies have a small positive effect on economic growth, but only if one take into account that the innovation variable has a delayed effect on GRP in the Swedish municipalities.

From this study we conclude that innovation intensity is clearly affected by the degree of industry concentration of a region. We also observe that innovations do affect GRP in a positive although minor way. In order to improve the results and get a more influential effect of GRP on innovations one solution could be to alter the innovation measure. To use the amount of active entrepreneurs as a share of the population, in accordance with Braunerhjelm et al. (2010), might produce better results.

The research on industry structure and knowledge spillovers has wider implications for the society. As described by Audretsch in his 2007 paper, it is the entrepreneurs that transform the ideas into business that have a real impact on the economy. Hence decision makers must know which policies to implement in order to create a setting that favours new companies and where the prerequisites to succeed exist. This subject is of great importance and we would thus firmly encourage more research conducted on the relationship between innovations and economic growth.

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