# The mediating role of settlement patterns on start-up activity in the urban-rural space

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## Abstract

This study addresses the mediating role of settlement patterns in the relationship between urbanization and start-up activity. The results show that settlement patterns can explain some of the ambiguous results found in previous research: the relationship between urbanization and start-up rates becomes more similar between countries when controlling for the regional context by including a spatially lagged urbanization variable and variables measuring the distance to urban centers. Therefore, the wider regional context should be taken into account when studying urban-rural relationships. Remarkably, the effect of urbanization on start-up activity is shown to be negative. However, increasing distance from an urban center has a negative effect on start-up rates. This implies that a region does not have to be very highly urbanized itself to be conducive for start-up activity, indeed, controlling for other factors, this even seems to have a negative effect; however, a region does have to be close to an urban center, preferably a larger one.

**Keywords: Entrepreneurship, start-up rates, urban-rural space, borrowed size, settlement patterns**

## Introduction

Cities are seen as entrepreneurial hotbeds (see, for example, Van Oort & Atzema, 2004; Fritsch & Mueller, 2007; Bosma et al., 2008; Audretsch et al., 2015). Densely populated urban areas offer agglomeration advantages resulting in higher start-up rates. However, the empirical evidence on the role of urbanization in start-up patterns is ambiguous as some authors find that start-up rates are higher in more sparsely populated rural areas (Fritsch and Falck, 2007; Pettersson et al., 2010; Delfmann et al., 2014). In the Netherlands there even appears to be a negative impact of urbanization on new firm formation (Van Stel & Suddle, 2008; Delfmann et al., 2014). An explanation for these ambivalent results may be the fact that earlier studies have not explicitly taken into consideration the possible mediating effects of countries' relative settlement patterns on the relationship between urbanization and start-up activity (Eliasson & Westlund, 2013). Hence, while in general there may be a positive relationship between urbanization and start-up activity, this relationship is likely to be mediated by two factors: the level of urbanization of neighboring regions and the distance of a region to (other) major urban centers.

For instance, a large city in a very densely populated and highly urbanized country may have lower start-up rates than surrounding regions, as these surrounding regions have a large enough population base to support positive urbanization economies without the negative effects - such as congestion, high land prices and high wage levels - of very high levels of urbanization found in the city. These surrounding areas may profit from 'crowding out' processes affecting the larger city, causing some firms to locate in the more sparsely populated neighboring areas (Meijers & Burger, 2015). Indeed, changing economic conditions, such as waning transportation and communication costs, economic restructuring and changing tastes for natural amenities, have led to a new form of urban-rural interdependence (Irwin et al., 2008). In addition, the distance of a region to major population concentrations can have an important mediating effect on the relationship between urbanization and start-up rates. Partridge et al. (2007) have shown for employment growth in Canada that rural areas within daily commuting distance from urban areas can benefit from urban proximity. The same pattern may hold for start-up activity. Hence, a more rural region can experience relatively high start-up rates if it is located close to a major city. Yet, a relatively urbanized area that is located in an otherwise distant-peripheral region and has weak connections to other major urban centers may experience lower start-up rates than expected based on its urbanization level.

Hence, urban and rural areas should not be treated as independent islands; one should also consider the impact of the surrounding geographical environment (Eliasson & Westlund, 2013). For example, Stockholm and Amsterdam are cities of a similar size, but the difference in the level of urbanization with the surrounding regions is much larger for Stockholm than for Amsterdam. Moreover, Amsterdam is located in very urbanized country, with many other cities nearby, whereas for Stockholm this is not the case. Indeed, the OECD (2008) states that the relationship between urban and rural regions in the Netherlands is a special case within Europe as the Netherlands is one of the most highly urbanized and densely populated countries of the OECD and Dutch rural regions are always relatively close to urban regions in geographical terms. Only Belgium is stated to have similar levels of urbanization and population density (OECD, 2008). These differences in the settlement patterns of Sweden and the Netherlands are likely to result in a different relationship between urbanization and start-up activity. Therefore, this study aims to uncover to what extent the relationship between urbanization and start-up activity differs between countries dependent on the relative settlement patterns of these countries.

In the remainder, the paper first discusses the theoretical considerations regarding urban-rural relationships and start-up dynamics. Then, the data and methods are discussed, after which the results and conclusions follow.

# Theoretical framework

## Urbanization economies and start-up activity

In general, urbanization has a positive effect on the rate of new firm formation (Wagner & Sternberg, 2004; Bosma et al., 2008; Baptista & Mendonça, 2010). Densely populated regions - generally cities - offer agglomeration advantages resulting in higher start-up rates. These urbanization economies offer a large differentiated consumer market, thereby increasing the returns to entrepreneurship, as well as providing easy access to the inputs required to produce goods or services (Stam, 2009; Delfmann et al., 2014; Bosma & Sternberg, 2014; Audretsch et al., 2015). In addition, the risk of starting a new firm in a large city is considered relatively low as cities provide rich employment opportunities that can function as a safeguard in case the new firm fails (Stam, 2009). Moreover, urban areas offer a large heterogeneous labor force and reduce the cost of information flows, resulting in greater knowledge spillovers (Delfmann et al., 2014; Bosma & Sternberg, 2014; Audretsch et al., 2015).

Indeed, new firm formation is generally seen as an innovative process (Kirchhoff et al., 2007; Baptista et al., 2008) and much of the knowledge relevant in these innovation processes is tacit, meaning that it is hard to codify and requires face-to-face contacts for exchange (Andersson & Karlsson, 2004). The high concentration of people in urban areas creates an environment in which tacit knowledge can move quickly from person to person, thus facilitating the spread of new knowledge that underlies innovation and the creation of new firms (Andersson & Karlsson, 2007; Shearmur, 2011). Moreover, serendipitous meetings are more likely to occur in more urbanized areas than in less urbanized areas, increasing the likelihood of new opportunities and collaborations that can result in a new firm formation (Stam, 2009). Also, the often diverse industry mix in large cities offers more opportunities for recombination of ideas across different industries (Frenken & Boschma, 2007). Assuming that more opportunities for recombination are reflected in higher start-up rates, this implies a positive relationship between urbanization and new firm formation. Frenken & Boschma (2007) even argue based on the principle of "recombinant growth" that the probability of innovation within a region increases more than proportional with the number of routines available for recombination resulting in an exponential relationship between urbanization and new firm formation.

However, there is a downside to high levels of urbanization as well (Bosma et al., 2008). The high concentration of jobs and people in large urban areas increases traffic congestion and the high competition for centrally located sites raises land prices (Bosma et al., 2008; Meijers et al., 2016). Moreover, competition for labor can lead to rising wages (Bosma et al., 2008). Indeed, Frenken & Boschma (2007) also indicate that the relationship between urbanization and innovation is not endlessly positive: a 'ceiling' will be reached when the positive feedback processes are offset by negative feedback processes.

Hence, highly urbanized areas - given their larger stock of people and firms - have a higher potential for new firm formation, until they reach a ceiling and the effect stabilizes. This can explain the negative impact of urbanization on start-up activity in the Netherlands (Van Stel & Suddle, 2008; Delfmann et al., 2014): it may be that intermediate regions now experience similar or higher levels of start-up activity than the most urbanized regions, as the most urbanized regions have already reached their ceiling and experience relatively more negative effects from urbanization. The surrounding intermediate areas can benefit from the 'crowding out' processes affecting their more urbanized neighbors, as these processes cause firms that are sensitive to wage and land costs to locate in the less urbanized areas (Meijers & Burger, 2015).

## Borrowed urbanization

Based on the literature it is assumed that the location of a region with respect to (other) key concentrations of population has an important mediating effect on the relationship between urbanization and start-up rates. A sparsely populated area located near a major urbanized area can experience relatively high start-up rates, while a city located in a peripheral region and with bad connections to other cities can have relatively low start-up rates. Shearmur (2011) even argues that local variations in the propensity to innovate may be attributable to each region's accessibility to key concentrations of activity and may be less attributable to local factor endowments. Hence, some locations are more propitious to innovative activities - such as new firm formation - than others, not because of their local characteristics, but because they provide better access to major urban centers (Shearmur, 2011).

Rural areas within daily commuting distance can benefit from urban proximity when urban growth spreads to the hinterlands (Partridge et al., 2007). Moreover, proximity to major urban centers facilitates access to the highest-order business services and urban markets (Partridge et al., 2007). The concept of "borrowed size" as proposed by Alonso (1973) suggests that smaller urban areas - or even rural areas - can borrow some of the urbanization benefits of their larger neighbors, while avoiding the negative urbanization effects (Meijers & Burger, 2015; Meijers et al., 2016). Indeed, Meijers et al. (2016) argue that urbanization externalities may not be confined to the borders of individual cities. Getting access to the functions and networks of large cities can lead to higher average urbanization benefits in nearby more sparsely populated areas, even though these functions are not present locally (Camagni et al., 2015). Meijers & Burger (2015) term this "borrowed performance". A study of Holl (2004) has shown that motorway networks can also act as extension of urban markets, resulting in increased new firm formation in regions surrounding these corridors. Non-urban areas that are well-connected to major concentrations of people may therefore experience population growth and higher start-up rates resulting from urban spillovers (Partridge et al., 2007). Moreover, when very large cities have passed a threshold and start to experience relatively more negative effects from urbanization, well-connected less urbanized areas may profit as firms are attracted to the lower land and labor costs in these regions while still retaining access to the densely populated urban centers (Partridge et al., 2007).

However, in addition to gaining access to the urbanization economies of their larger neighbor, smaller cities and rural areas also face spatial competition effects from proximity to a large urban center (Meijers et al., 2016). Indeed, New Economic Geography predicts a shadow effect from large cities over their surroundings, meaning that competition effects limit the growth of areas near large cities (Burger et al., 2015). However, while growth shadows can inhibit equal or higher-tier places from emerging next to an urban center, the relationship with smaller places and rural areas may be quite different (Partridge et al., 2009). Moreover, even when small cities or rural areas face spatial competition effects from a large urban center, they simultaneously gain access to the urbanization benefits of their more urbanized neighbor which can lead to faster growth (Meijers et al., 2016). Hence, spatial competition shadows may be overcome by offsetting positive urban spillovers (Partridge et al., 2009). Moreover, even as firms choose to locate in more sparsely populated areas, many still rely on access to higher-order services and consumer markets found in urban centers, and this will limit the remoteness of their location choice (Partridge et al., 2007). In distant-peripheral locations, urban growth can even create a backwash as firms choose to locate in or close to the urban centers (Partridge et al., 2007). Therefore, we hypothesize that, all else equal, positive effects from urban centers spread to the areas closest to an urban center, while negative effects prevail beyond the maximum daily commuting distance. Yet, there can also be a "distance-protection" effect as there may be a point at which greater distance insulates the sparsely populated area from urban competition (Polèse & Shearmur, 2004). For example, a remote community may be better able to support a basic retail store beyond a certain distance from an urban center.

Related are the ideas of Boschma (2005), who argues that geographical proximity is neither a necessary nor a sufficient condition for knowledge spillovers and innovation to take place, and of Torre (2008) who emphasizes that proximity need not be permanent. While geographical proximity in cities stimulates innovation and start-up activity due to an increased chance of face-to-face contacts resulting in tacit knowledge spillovers (Andersson & Karlsson, 2004; 2007), other forms of proximity - such as cognitive, organizational, social and institutional - may benefit new firm formation in more peripheral locations (Boschma, 2005). However, all types of proximity require some degree of face-to-face contact and while this requires not necessarily colocation, it does require a certain level of accessibility (Torre, 2008; Shearmur, 2011). Andersson & Karlsson (2004) argue that regional innovativeness is to a large extent dependent on how easily knowledge is exchanged within the region and on the speed at which new knowledge from other regions is introduced to the region. In this manner, it can be argued that while a sparsely populated rural region has a more limited ability to exchange knowledge within the region than an urban region, it can still be relatively conducive for start-up activity if it has a good accessibility to other (urban) regions. A high accessibility can be seen as adding additional routines for recombination to a region, resulting in more opportunities for innovation.

Hence, the location of a region relative to other concentrations of people is likely to have an important mediating impact on the general relationship between urbanization and start-up intensity. For example, a less urbanized area located in an otherwise urban region can have higher start-up rates than a more urbanized area located in a more peripheral region. Moreover, it is likely that in sparsely populated countries with a small number of cities there are many areas that are located too far away from any urban center to benefit from urban spread effects, while in highly urbanized countries most areas are affected by some urban center. In highly urbanized countries, entrepreneurs may therefore be more likely to start a business in more rural areas, as urbanization economies are often within close reach. As the influence of one urban center on a rural region declines with greater distance, another urban area may become significant for this region (Partridge et al., 2007). Thus, while in general there can be assumed to be a positive relationship between urbanization and start-up activity, this relationship is mediated by two important factors: the level of urbanization in the surrounding region and the distance of a region to (other) major urban centers. Earlier studies have not explicitly taken into consideration these mediating effects of geography on the relationship between urbanization and start-up activity, which may explain their ambivalent results (Eliasson & Westlund, 2013).

## Data and methods

The empirical analysis aims at identifying the influence of the relative geography of a country, in terms of access to cities and the level of urbanization, on the spatial patterns of start-up intensity. For this purpose, we estimate two linear regression models using Maximum Likelihood Estimation (MLE): one where we relate start-up rates with the level of urbanization without controlling for settlement patterns and a second where we do control for the settlement patterns. By looking at the differences in the two models it is possible to distill the mediating effect of a country's settlement patterns. The analyses focus on three European countries: The Netherlands, Belgium and Sweden. These countries provide interesting cases for this research, as the Netherlands and Belgium are among the most urbanized and densely populated countries of the OECD, while Sweden with its low population density and few large cities is a clear opposite.

The spatial unit of analysis is the municipality. This low level of aggregation is appropriate as new firm formation is a local phenomenon (Sternberg, 2011; Audretsch et al., 2015). Indeed, most entrepreneurs start their business close to where they live (Figueiredo et al., 2002; Michelacci & Silva, 2007; Dahl & Sorenson, 2012), and a sizeable share of all start-ups operate from home (Mason et al., 2011). Hence, it is plausible to assume that entrepreneurs are mostly influenced by local conditions. Moreover, we control for possible urbanization spillovers from surrounding neighboring municipalities by including a spatially lagged urbanization variable. The analyses are performed on all municipalities, based on the 2013 division.

## Measuring the mediating effects of settlement patterns

In general, start-up rates are expected to be higher in more urbanized municipalities; therefore, we focus on the level of urbanization as a main explanatory variable. The population density is used as a proxy for urbanization, similar to earlier studies (see, for example, Verheul et al., 2002; Delfmann et al., 2014; Freire-Gibb & Nielsen, 2014; Audretsch et al., 2015). Indeed, Freire-Gibb & Nielsen (2014) argue that "density is one of the key factors in the suitability of urban areas for entrepreneurship" (p. 141). However, as it is expected that the effect of urbanization on start-up activity is mediated by a country's level of urbanization and settlement patterns, we control for this "relative geography" in two ways.

First, we include a spatially lagged variable measuring the average level of urbanization - as measured by population density - in the surrounding municipalities. If a municipality is surrounded by very densely populated municipalities, this municipality may benefit in the sense that it can "borrow" urbanization economies from its neighbors. Indeed, the local Moran's I also indicates possible spatial autocorrelation for this variable. This may impact the effect of a municipality's own level of urbanization on start-up activity in the sense that a more sparsely populated municipality surrounded by more urbanized neighbors can have relatively higher start-up rates than expected based on its own level of urbanization, whereas a more urbanized municipality located in an otherwise more peripheral region can have relatively lower start-up rates. The spatial lag is calculated using a row-standardized spatial weights matrix based on inverse distances with a cut-off point of 50 kilometers. Hence, it is assumed that closer neighbors have a stronger influence on a municipality and that the impact of the level of urbanization of surrounding municipalities becomes zero after a distance of 50 kilometers[1]. This value is based on average and maximum commuting distances in the Netherlands, Belgium and Sweden (Sandow, 2008; Verhetsel et al., 2009; Statistics Netherlands, 2016), as most entrepreneurs start a new firm close to where they work or live (Figueiredo et al., 2002; Michelacci & Silva, 2007; Dahl & Sorenson, 2012). The value of 50 kilometers ensures that 90 per cent of all commuting travels are included (Sandow, 2008; Verhetsel et al., 2009; Statistics Netherlands, 2016). Since international borders greatly reduce the intensity of spatial interactions (Pumain, 2006), only neighboring municipalities within the same country are considered as neighbors.

Next, to assess the impact of proximity and location in the urban system on the relationship between urbanization and start-up rates, the distance of a municipality to the nearest urban municipality, as well as to successively higher-tiered urban centers, is included in the analysis. Specifically, we focus

[1] Different spatial weights matrices with different cut-off points were used as a robustness check: 30 kilometres, 70 kilometres and 100 kilometres. The results of this can be found in appendix I.

on how a municipality's geographic location in the urban hierarchy affects the relationship between a region's own level of urbanization and start-up activity. First, we measure distance from the geographical centroid of the municipality to the centroid of the nearest urban municipality. Municipalities are defined as urban based on the "degree of urbanization" classification of Eurostat. Based on this classification, a municipality is seen as urban if fifty percent or more of the population lives in a high-density cluster, where high density clusters are defined as contiguous grid cells of one square kilometer with a density of at least 1 500 inhabitants per square kilometer and a minimum population of 50 000 (Dijkstra & Poelman, 2012).

If a municipality is classified as urban, the distance to the nearest urban municipality is zero for this municipality. Following Partridge et al. (2008), it is assumed that there is an incremental distance penalty for access to more populous higher-level urban areas. Specifically, remoteness from a larger city would carry an added penalty, but this penalty is only incrementally greater than the already existing distance penalty. Hence, the second distance variable represents the incremental distance to the nearest urban municipality of at least 50 000 inhabitants. This is the distance to the nearest urban municipality of at least 50 000 inhabitants minus the distance to the nearest urban municipality. Hence, if the nearest urban municipality has 50 000 or more inhabitants, this variable takes a value of zero. The third and fourth distance variables represent the incremental distances to an urban municipality of at least 100 000 and 250 000 people respectively. To control for a possible "distance protection" effect, we also include the squared distances in the analyses.

The cut-off points for the different urban tiers are based on the OECD-EC definition (Dijkstra & Poelman, 2012), according to which small cities have between 50 000 and 100 000 inhabitants, medium cities have between 100 000 and 250 000 inhabitants and large cities have more than 250 000 inhabitants. The distances are calculated using Euclidean distances. Although there may be measurement error bias when using straight-line distance rather than travel time, Apparicio et al. (2008) show that Cartesian distances (Euclidean and Manhattan distances) are strongly correlated with more accurate travel time distances. Moreover, Partridge et al. (2008) argue that such measurement error would bias the distance regression coefficient toward zero, suggesting that the effect of distance would be stronger than reported. Also, with the relatively well-developed road systems in the countries under consideration, the measurement error is expected to be small.

## Data

The national offices of statistics of the three countries under consideration are the basic data source for the explanatory and control variables. In the case of Belgium, the national statistics office also provides the data on the dependent variable: new firm formations. However, in the Dutch and Swedish case, this data is retrieved from different sources. For the Netherlands, the start-up data is provided by the Chambers of Commerce. This office handles the basic registration of firm units in the Netherlands. In Sweden, this data is provided by the Swedish Agency for Growth Policy Analysis. This is the official office responsible for producing official statistics within the areas of start-ups, bankruptcies and public composition, as well as international companies. All three sources of start-up data make no distinction between new establishments of existing firms and genuinely new firms; however, relocations are excluded. Although the data for this study come from different sources, the availability of general guidelines provided by Eurostat contributes to an increasingly harmonized and synchronized data collection in the European Union (Audretsch et al., 2015), and this results in good comparability between the different national data sources.

The dependent variable is the rate of new firm formation. To avoid coincidental occurrences in a particular year influencing the results, the average start-up rates from 2008 to 2013 were used. The start-up rates are calculated using the labor market approach. This approach uses the potential workforce in a region as the denominator for standardizing the number of new firm formations and is based on the assumption that each new firm is started by an individual person (Audretsch & Fritsch, 1994). Moreover, it implicitly assumes that the entrepreneur is in the same labor market within which his/her new firm operates (Delfmann et al., 2014). This is likely to be the case as most entrepreneurs start their firm at their place of living or in close proximity it (Stam, 2009; Mason et al., 2011; Dahl & Sorenson, 2012). The alternative, the ecological approach, uses the number of existing firms as the denominator, implying that new firms emerge from existing firms (Van Stel & Suddle, 2008). Using this measure can be misleading in areas with a small number of large firms (Garofoli, 1994).

## Control variables

In addition to the level of urbanization and the relative geography variables, we control for specific demographic, economic and cultural characteristics of a region which may also influence the start-up level in this region. The choice of control variables is based on previous literature on the determinants of regional start-up rates.

The age distribution of a region is an important demographic determinant for the level of new firm formation. Cowling (2007) finds that in most European countries, entrepreneurs are in the 41 to 45 years age range. However, in the Netherlands entrepreneurs are generally slightly younger (36-40 years), while in Sweden they are slightly older (>45 years). Therefore, we use the 35 to 50 year age group as a reference category, as we expect that the share of entrepreneurs is highest in this age group. Wagner & Sternberg (2004) expect an inverted 'U'-shape relation between age and the rate of new firm formation based on two arguments. On the one hand, age is seen a proxy for personal wealth as older persons have had more time to accumulate wealth, resulting in a positive relationship between ageing and start-up propensity. On the other hand, entrepreneurs need time to earn back the high sunk costs often involved in starting a new business. Hence, with respect to the reference category we expect a negative sign for the older age groups. Moreover, we also expect a negative sign for the youngest age groups, as younger persons have not had the time older persons have had to accumulate wealth. Also, young families with children may be more reluctant to take on the risk of starting a new firm (Delfmann et al., 2014). In addition to age, we control for the education level of the population and share of immigrants as both are found to be positively related to new firm formation (Armington & Acs, 2002; Acs & Szerb, 2007). Higher educated people generally have better resources to start a firm and immigrants are on average less risk-averse, making them more inclined to start a business (Delfmann et al., 2014).

In addition to these demographic control variables, we also include variables that control for the economic structure of a region. The effect of unemployment on start-up activity is ambiguous (Verheul et al., 2002). If unemployment is high more persons may be driven into self-employment because of the shortage of alternative job opportunities, resulting in a positive relationship between unemployment rates and new firm formation. However, a high unemployment rate may also indicate a weak economy, which would limit start-up activity. In addition to unemployment, the sectoral structure is important. A high degree of services is generally positively related to new firm formation, due to the lower average start-up costs in this sector (Delfmann et al., 2014). The share of the public sector is also included as several studies show that a large government sector has a negative impact on new firm formation (Nyström, 2008; Aidis et al., 2012). Delfmann et al. (2014) argue that the share of the public sector in a region can be used as a proxy for an entrepreneurial culture, in the sense that regions with a high public sector share are less entrepreneurial. Indeed, Buurman et al. (2010) show that public sector employees are on average more risk-averse and this makes it less likely that they start a new firm.

**Table 1. Descriptive statistics**

| **Variable** | | **Mean(SD)** | | | |
|---|---|---|---|---|---|
| | | Total<br>*(n = 1287)* | NL<br>*(n = 408)* | BE<br>*(n = 589)* | SE<br>*(n = 290)* |
| **New firm formation – dependent variable** | | | | | |
| *Start-up rate*; calculated using the labor market approach, average 2008-13 | | 10.34<br>(2.84) | 12.90<br>(2.78) | 8.99<br>(1.76) | 9.47<br>(2.21) |
| **Explanatory variables** | | | | | |
| *Population density*[1] (ln), average 2008-13 | | 5.32<br>(1.66) | 6.14<br>(1.04) | 5.73<br>(1.16) | 3.34<br>(1.66) |
| *Distance (km) to the nearest urban municipality* | | 33.64<br>(52.76) | 10.43<br>(9.53) | 22.27<br>(19.75) | 89.38<br>(85.57) |
| *Incremental distance (km) to the nearest urban municipality >50 000* | | 1.24<br>(3.47) | 1.99<br>(5.25) | 1.26<br>(2.40) | 0.12<br>(0.90) |
| *Incremental distance (km) to the nearest urban municipality > 100 000* | | 5.23<br>(9.23) | 7.03<br>(10.55) | 6.01<br>(9.52) | 1.12<br>(3.89) |
| *Incremental distance (km) to the nearest urban municipality >250 000* | | 62.95<br>(78.97) | 45.34<br>(42.48) | 53.61<br>(33.96) | 106.67<br>(142.57) |
| **Control variables** | | | | | |
| *Age;* as % of total population, average 2008-13 | < 15 | 17.19<br>(2.11) | 17.92<br>(2.06) | 17.14<br>(1.89) | 16.23<br>(2.20) |
| | 15-25 | 12.00<br>(1.25) | 11.48<br>(1.51) | 12.11<br>(0.99) | 12.55<br>(1.00) |
| | 25-35 | 10.81<br>(2.13) | 10.17<br>(2.09) | 11.75<br>(1.74) | 9.80<br>(2.12) |
| | 35-50 | 21.48<br>(1.75) | 22.36<br>(1.25) | 21.80<br>(1.22) | 19.61<br>(1.90) |
| | 50-65 | 20.46<br>(1.95) | 21.31<br>(2.00) | 19.95<br>(1.72) | 20.28<br>(1.89) |
| | 65+ | 18.06<br>(3.48) | 16.76<br>(2.76) | 17.26<br>(2.56) | 21.52<br>(3.74) |
| *Immigrant;* as % of the population aged 15-65, average 2008-13 (Due to data availability BE: 2012) | | 16.94<br>(11.97) | 14.13<br>(8.29) | 18.85<br>(14.87) | 16.99<br>(8.52) |
| *Higher educated;* as % of the population aged 15-75, average 2008-13 (Due to data availability BE: 2011) | | 23.98<br>(8.76) | 23.87<br>(5.91) | 28.31<br>(7.33) | 13.55<br>(5.86) |
| *Unemployment;* unemployed as % of the labor market population, average 2008-13 | | 11.82<br>(9.50) | 4.55<br>(0.78) | 9.22<br>(5.41) | 27.29<br>(3.54)[2] |

| | | | | |
|---|---|---|---|---|
| *Service;* share of the service sector in total employment, average 2008-13 | 42.49 (10.95) | 47.59 (9.33) | 43.99 (9.81) | 32.24 (8.24) |
| *Public;* share of the public sector in total employment, average 2008-13 | 31.01 (10.07) | 30.63 (10.74) | 29.03 (10.86) | 35.55 (4.43) |

[1] *As a proxy for urbanization.*
[2] *The Swedish data on employment only makes the distinction between gainfully employed persons and non-gainfully employed persons. Hence, the unemployment rate is here actually the ratio between the inactive and active population.*

## Results

This section first presents descriptive results illustrating the link between urbanization and start-up activity in different regional contexts. Second, it shows multiple linear regression models that describe the relationship between start-up rates and the level of urbanization while controlling for the settlement patterns in a country.

Descriptive statistics of all the variables included in the analyses can be found in Table 1. Especially of interest in this table are the descriptive statistics of the start-up rates, the population density and the "distance to urban municipalities" variables. First of all, start-up rates are highest in the Netherlands, which is also the most densely populated – i.e. most urbanized – country of the three countries under consideration. However, Belgium has lower start-up rates than Sweden. This is probably due to demographic and economic differences between the two countries. Moreover, the Swedish population may be simply more entrepreneurial. Indeed, the Global Entrepreneurship Monitor (Kelley et al., 2016) shows that perceived opportunities and capabilities are higher in Sweden than in Belgium, whereas the fear of failure is lower. Second, from the descriptive statistics of the distance to the nearest urban municipality and the incremental distances to the nearest urban municipality of a certain size one can see that while the Netherlands and Belgium are quite similar in terms of their settlement patterns, Sweden clearly differs. In Sweden, the average distance from a municipality to the nearest urban municipality is much greater than in Belgium and the Netherlands. In fact, on average, in Sweden one has to travel further to the nearest urban municipality than one has to travel in Belgium or the Netherlands to the largest urban municipalities, i.e. those of 250 000 inhabitants or more. On average, travel distances to urban municipalities are the smallest in the Netherlands, which is to be expected as the Netherlands is also the most urbanized country (OECD, 2008). The small average incremental distances to the nearest urban municipality of at least 50 000 or at least 100 000 may indicate that urban municipalities are located quite close to each other. However, it may also imply that the nearest urban municipality is already of this size, indicating that the urban areas generally are of a larger size.

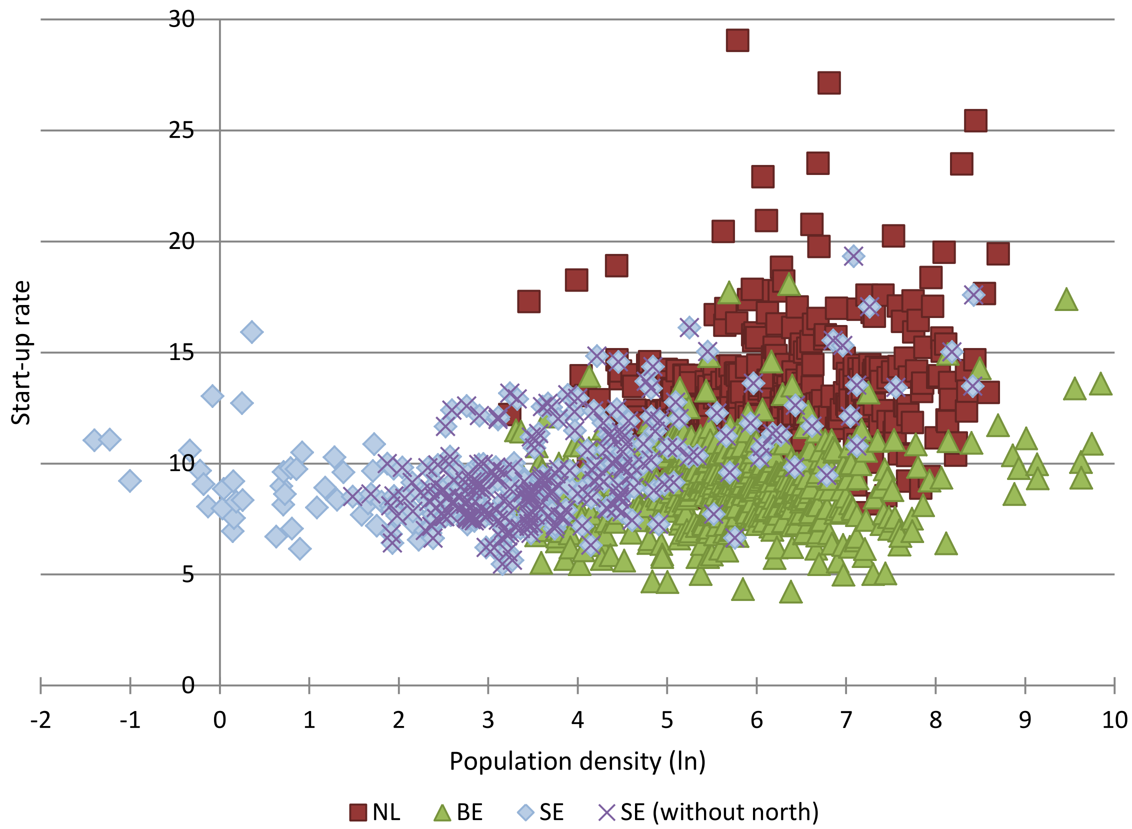


**Figure 1. Start-up rates by degree of urbanization (as measured by population density)**

Figure 1 shows start-up rates by degree of urbanization, while distinguishing between the three countries under consideration. The figure shows a positive relationship between urbanization and start-up activity. Generally, start-up rates are higher in more urbanized municipalities. This differs from earlier findings which found a negative effect of urbanization on start-up activity in the Netherlands (Van Stel & Suddle, 2008; Delfmann et al., 2014). This might be caused by the fact that figure 1 does not control for other factors influencing start-up activity such as the share of higher educated people or the share of services in the economy (Armington & Acs, 2002; Acs & Szerb, 2007; Delfmann et al., 2014). Hence, the higher start-up rates found in urban areas may be due to specific characteristics of cities and not due to the urbanization economies these areas offer. It may be that after controlling for these factors, the remaining effect of urbanization on start-up activity is negative. Moreover, especially for the Netherlands, there are some clear outliers: more intermediately urbanized municipalities sometimes have higher start-up rates than the most urbanized municipalities. Likewise, in Sweden there are also some very sparsely populated municipalities that have relatively higher start-up rates. This may be caused by the location of these municipalities with respect to the major urban areas. However, for Sweden the outliers are also likely to be caused by the fact that municipalities in the north are quite large, which cause them to have very low population densities, whereas often most of the population lives concentrated in one part of the municipality. Hence, in some areas of these municipalities the level of urbanization is actually much higher. Moreover, the lower population level of these municipalities causes the start-up rates to be more volatile. Indeed, looking only at the southern municipalities, there seems to be a more distinct positive linear relationship between urbanization and start-up activity for Sweden.

## Regression analysis

Table 3 presents two models of start-up rates as a function of a series of explanatory variables for the three countries[2]: the first model does not control for geography while the second model includes the spatial lagged urbanization variable and the distance to urban centers. This section first discusses the estimation results in general (model 1) and the differences between the individual countries therein before turning to the relative geography variables and how their inclusion influences the results (model 2).

The results of the first model, as shown in table 3, indicate that in the Netherlands there is indeed a negative effect of urbanization on start-up activity when controlling for other regional characteristics such as income levels and the share of higher educated people. Moreover, for Belgium there is a similar relationship. So, although figure 1 indicates that there is a positive relationship between urbanization and start-up activity, this relationship does not hold after controlling for other factors. Hence, start-up rates may be higher in urban areas, but this is not because of the urbanization economies these urban areas offer but due to specific characteristics of the urban areas, such as a higher share of higher educated people (Armington & Acs, 2002; Acs & Szerb, 2007; Van Stel & Suddle, 2008; Delfmann et al., 2014). However, for Sweden the effect of urbanization on start-up activity is not significant when controlling for other regional characteristics. This may be explained by the fact that in Sweden there can be two opposing forces: one the one hand, compared to the most urbanized municipalities, start-up rates may be higher in the more sparsely populated municipalities relatively close to the urban centers due to specific local characteristics in combination with positive urban spillovers and limited negative agglomeration economies; on the other hand, sparsely populated municipalities located at a large distance from any urban center are likely to have lower start-up rates than the most urbanized municipalities. In the Netherlands and Belgium these contradictory forces are less likely to exist, as most municipalities are located close to an urban center due to the high levels of urbanization.

With regard to the control variables, there are some interesting differences between the countries as well. In the Netherlands there is a significant positive effect of the share of the population aged below 15 year with respect to the reference category: the share of 35-50-year-olds. Moreover, the effect of the share of people aged above 65 is also weakly significantly positive. Thus, these results do not support the inverted 'U'-shaped relationship hypothesized by Wagner & Sternberg (2004): a younger or older population with respect to the reference category has a positive instead of a negative effect on new firm formation An explanation for the positive effect of the below-15-year olds can be that young families with children are more inclined to start a business due to the fact that the flexibility self-employment offers outweighs the risks involved with starting a firm (Delfmann et al., 2014). For the older ages, it may be that entrepreneurship offers a form of partial retirement, as self-employment offers greater flexibility to accommodate tastes for leisure (Quinn, 1980). In Belgium the effect of the age group under 15 is significantly negative, indicating that municipalities with many young families, as compared with the reference category age 35 to 50 years, on average generate less start-ups. Remarkably, the effect of the share of 15-25-year-olds and the share of 25-35-year-olds is significantly positive, implying that with respect to the share of 35-50-year-olds,

[2] For Sweden, we have also run the models while excluding the northern municipalities, due to the possibility of the different sizes of the northern municipalities in Sweden impacting the results. The results of this can be found in appendix II.

municipalities with a younger population are more conducive for start-up activity. Moreover, whereas the effect of the share of 50-65-year olds is significantly negative - though only weakly so -, the effect of the share of the population aged over 65 is again significantly positive. This again contradicts the inverted 'U'-shape hypothesis of Wagner & Sternberg (2004). This may be explained by the increasing importance of internet-based service firms operating from home, which require less capital to start which enables one to start a firm with less capital and to earn back the investment costs over a shorter time period (Colombo & Delmastro, 2001). In Sweden there is also a positive effect of an older age group, the 50-65-year-olds, on start-up activity, as compared with the reference category. This can however also be explained by the fact that entrepreneurs are generally older in Sweden (Cowling, 2007). In all three countries the effect of a higher share of higher educated people is positively significant, as expected. For the Netherlands the effect of a higher share of immigrants is also positive; however, this effect is not significant for Belgium and Sweden. The effect of unemployment rates on start-up activity is insignificant; this may be due to the fact that there are simultaneously positive supply and negative demand effects of unemployment, balancing each other out (Verheul et al., 2002). A higher service share in the economy also has a positive effect on start-up activity in Sweden and the Netherlands, whereas the effect is insignificant for Belgium.

Let us now turn to the second model, which includes the relative geography variables. Interestingly, the effect of population density - i.e. the level of urbanization - becomes significantly negative for all countries after controlling for the relative location of a municipality. Moreover, the effect of urbanization becomes of a similar strength for all three countries. This implies that differences in the settlement patterns of countries partly explain the ambivalent results of earlier studies (see, for example, Fritsch and Falck, 2007; Bosma et al., 2008; Pettersson et al., 2010; Delfmann et al., 2014; Audretsch et al., 2015). Also remarkable is the fact that whereas in the Netherlands the direct effect of the level of urbanization of the neighboring municipalities on start-up activity is negative, the effect is positive in Sweden. This indicates that in Sweden, a municipality is more conducive for start-up activity if it is located in a more densely populated region; however, if the municipality itself is very densely populated this can negatively affect start-up activity.

Turning now to direct effect of the distance to urban centers variables, it can be seen that, in general, increasing distance from an urban center has a negative effect on start-up rates. Furthermore, there is an additional penalty for distance from larger cities. Hence, a municipality does not have to be very densely populated itself to be conducive for start-up activity, indeed, controlling for other factors, this can even have a negative effect; nevertheless, the municipality does have to be close to an urban center, preferably a larger one. However, the squared distance variables are generally positive, implying that there is a point where greater distance from an urban center has a positive influence on start-up activity as it insulates the municipality from urban competition – i.e., the "distance-protection" effect as noted by Polèse & Shearmur (2004).

Remarkably, for Belgium, only the squared distance from the nearest urban center has a significant negative effect. Hence, only those municipalities very far from an urban center are less conducive for start-up activity. This may be explained by the fact that those municipalities relatively far from urban municipalities are generally located in Wallonia, where start-up levels are lower on average. Indeed, after excluding the Walloon municipalities from the analysis, the squared term becomes insignificant[3]. For Flemish municipalities only increasing distance from an urban center of at least 100 000 inhabitants has a significant negative effect on start-up activity. In addition, there seems to be a slight “distance-protection” effect from the largest urban centers, i.e. those of 250 000 inhabitants or more. The insignificant effects of increasing distance from cities of other sizes may be explained by the fact that the small size of Belgium in combination with its high level of urbanization ensures that rural areas may never experience backwash from any urban center before they encounter positive urban spillovers from another (Partridge et al., 2007). However, for the Netherlands, also a small and highly urbanized country, all urban tiers have a significant effect. This can be due to differences in the perceptions of the population: Belgians may be willing to travel further for work than Dutch people. In that case, urban spillovers may also extend over a larger distance. Indeed, average commuting distances are longer in Belgium than in the Netherlands (Verhetsel et al., 2009; Statistics Netherlands, 2016).

For Sweden, only distance to the nearest urban center and the incremental distance to the largest urban centers - i.e. those of 250 000 inhabitants or more - have a significantly negative effect on start-up activity. This might be caused by the fact that Sweden hosts fewer smaller urban areas than the Netherlands or Belgium which makes it harder to detect a significant effect for the incremental distances. Stated otherwise, often the nearest urban center in Sweden has already 50 000 or 100 000 inhabitants - as is also indicated by the low average incremental distances in table 2 - and thus there is no additional distance penalty for distance from a higher-tiered center, as the nearest urban center is already of this tier. In addition, in Sweden there is also a “distance-protection” effect for the municipalities located very far from an urban center. Interestingly, this “distance-protection” effect sets off at a much larger distance in Sweden than in the Netherlands. For example, in the Netherlands, the squared term for distance to the nearest urban center indicates that around 40 kilometers the distance effect becomes positive, whereas for Sweden this “distance protection” effect only starts at about 200 kilometers. This may be explained by differences in perceptions (Delfmann & Koster, 2013): what is considered as a long travel distance in the Netherlands may be different from that what is considered as far in Sweden (Sandow, 2008; Statistics Netherlands, 2016).

The inclusion of the relative geography variables also impacts some of the control variables. For the Netherlands, the positive effect of the oldest age group is now highly significant. An explanation for this may be the fact that for older people living in more peripheral areas, internet-based service firms operating from home are an attractive for of partial retirement (Quin, 1980; Delfmann & Koster, 2013). For Belgium, the effect of unemployment becomes weakly positively significant and the effect of the youngest age group becomes insignificant. For Sweden the effect of the share of 25-35-year-olds becomes weakly positively significant, as well as the effect of the share of people aged over 65. This further weakens the inverted ‘U’-shape hypothesis of Wagner & Sternberg (2004). In addition, the share of immigrants has now a significant negative effect on start-up activity, whereas the effect of the public sector disappears. This implies that the effect of these variables on start-up activity is largely driven by the fact that these variables are higher in municipalities situated at a good location for start-up activity, i.e. close to urban centers.

[3] See appendix III for the regression results

**Table 2. Regression results: Maximum Likelihood Estimation for the Netherlands (NL), Belgium (BE) and Sweden (SE)**

| Dependent variable: start-up rate | NL Model 1 | Model 2 | BE Model 1 | Model 2 | SE Model 1 | Model 2 |
|---|---|---|---|---|---|---|
| Population density (ln) | -0.386*** | -0.503*** | -0.211*** | -0.514*** | -0.0671 | -0.589*** |
| | (0.146) | (0.162) | (0.0679) | (0.109) | (0.0884) | (0.105) |
| Spatial lag population density | | -0.00221*** | | 0.000167 | | 0.00108** |
| | | (0.000453) | | (0.000117) | | (0.000448) |
| Dist to nearest UC | | -0.0683*** | | -0.000344 | | -0.00775*** |
| | | (0.0211) | | (0.00768) | | (0.00162) |
| Square of dist to nearest UC | | 0.00174* | | -0.000377*** | | 3.85e-05*** |
| | | (0.000927) | | (0.000109) | | (7.35e-06) |
| Inc Dist to UC >50 000 | | -0.178*** | | 0.00520 | | 0.255 |
| | | (0.0390) | | (0.0622) | | (0.262) |
| Square of Inc Dist to UC > 50 000 | | 0.00198* | | 0.0189 | | -0.0198 |
| | | (0.00110) | | (0.0131) | | (0.0303) |
| Inc Dist to UC > 100 000 | | -0.0630*** | | -0.0127 | | 0.0371 |
| | | (0.0167) | | (0.0117) | | (0.0678) |
| Square of Inc Dist to UC > 100 000 | | 0.000844 | | -0.000647 | | -0.000358 |
| | | (0.000587) | | (0.000560) | | (0.00337) |
| Inc Dist to UC > 250 000 | | -0.0379*** | | -0.00855*** | | -0.0110*** |
| | | (0.00534) | | (0.00307) | | (0.00131) |
| Square of Inc Dist to UC > 250 000 | | 0.000124* | | -0.000107* | | 1.56e-05*** |
| | | (6.45e-05) | | (5.78e-05) | | (3.54e-06) |
| Age < 15 | 0.348** | 0.265** | -0.297*** | -0.125 | -0.0366 | 0.116 |
| | (0.140) | (0.130) | (0.0949) | (0.0905) | (0.167) | (0.142) |
| Age 15-25 | -0.0942 | -0.0847 | 0.252*** | 0.374*** | -0.105 | -0.0298 |
| | (0.114) | (0.106) | (0.0784) | (0.0785) | (0.137) | (0.122) |
| Age 25-35 | -0.0440 | -0.0110 | 0.277*** | 0.412*** | -0.0698 | 0.179* |
| | (0.137) | (0.131) | (0.0850) | (0.0800) | (0.118) | (0.102) |
| Age 35-50 | *Reference* | *Reference* | *Reference* | *Reference* | *Reference* | *Reference* |
| Age 50-65 | -0.201 | -0.129 | -0.153* | -0.110 | 0.370*** | 0.408*** |
| | (0.151) | (0.139) | (0.0901) | (0.0856) | (0.129) | (0.108) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Age 65+ | 0.152* | 0.268*** | 0.121** | 0.273*** | 0.00117 | 0.160* |
| | (0.0916) | (0.0859) | (0.0580) | (0.0572) | (0.102) | (0.0870) |
| Higher educated | 0.200*** | 0.153*** | 0.131*** | 0.132*** | 0.161*** | 0.166*** |
| | (0.0219) | (0.0216) | (0.0103) | (0.0107) | (0.0258) | (0.0231) |
| Immigrant | 0.0968*** | 0.0975*** | -0.000650 | 0.000304 | 0.00116 | -0.0340** |
| | (0.0219) | (0.0206) | (0.00385) | (0.00362) | (0.0157) | (0.0150) |
| Unemployment | 0.0978 | 0.131 | 0.0158 | 0.0350* | -0.0500 | 0.00952 |
| | (0.126) | (0.116) | (0.0172) | (0.0185) | (0.0324) | (0.0280) |
| Service | 0.0884*** | 0.0770*** | 0.00952 | 0.00444 | 0.191*** | 0.153*** |
| | (0.0173) | (0.0159) | (0.00785) | (0.00753) | (0.0174) | (0.0156) |
| Public | 0.0128 | 0.0120 | -0.0473*** | -0.0414*** | -0.0625*** | -0.0167 |
| | (0.0154) | (0.0143) | (0.00687) | (0.00645) | (0.0230) | (0.0198) |
| Constant | -1.227 | -0.774 | 5.835 | -3.760 | -0.244 | -12.61 |
| | (8.831) | (8.138) | (5.411) | (5.135) | (9.061) | (7.715) |
| Log Likelihood | -849.4091 | -808.6055 | -1022.125 | -973.9487 | -482.0974 | -420.1934 |
| AIC | 1724.818 | 1661.211 | 2070.25 | 1991.897 | 990.1948 | 884.3868 |
| Wald chi2 | 390.33*** | 567.87*** | 376.65*** | 548.27*** | 579.80*** | 1042.99*** |
| Observations | 405 | 405 | 589 | 589 | 290 | 290 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

## Conclusion

The main goal of the current study was to determine whether the relationship between urbanization and start-up activity differs between countries dependent on the relative settlement patterns of these countries. Hence, can differences in the settlement patterns of countries explain the ambiguous results found in previous research? It was found that the "relative geography" of a country does impact the relationship between urbanization and start-up activity. Not controlling for settlement patterns, there is a significant negative effect of urbanization on start-up rates in the Netherlands and Belgium, whereas the effect is insignificant for Sweden. When controlling for settlement patterns by including a spatially lagged urbanization variable and variables measuring the distance to the urban centers of different sizes, there is a significant negative effect of urbanization on start-up rates in all three countries. Hence, the relationship between urbanization and start-up activity becomes more similar between countries when controlling for the relative settlement patterns of countries.

Remarkably, the effect of urbanization is found to be negative after controlling for settlement patterns and other regional characteristics. Hence, although start-up rates may be higher in urban areas, this is not due to the urbanization economies these areas offer, but because of the specific characteristics of these regions. However, as expected, increasing distance from an urban center has a negative effect on start-up rates and there is an additional penalty for distance from higher-tier cities. This implies that a region does not have to be very highly urbanized itself to be conducive for start-up activity, indeed, controlling for other factors, this even seems to have a negative effect; however, a region does have to be close to an urban center, preferably a larger one. Yet, at a larger distance from an urban center, there is a "distance-protection effect", where greater distance insulates rural areas from urban competition. Interestingly, the distance over which urban spillovers are felt differs between countries, possibly due to national differences in people's perceptions and willingness to commute. Partly, this may also be influenced by the settlement patterns. Hence, people living in a more sparsely populated country such as Sweden are generally willing to commute further than people living in a highly urbanized country such as Belgium or the Netherlands. However, cultural differences likely also play a role.

While this study focused on start-up activity, it would be interesting to assess the mediating impact of settlement patterns on the urban-rural relationship while focusing on other factors, such as gross domestic product or employment growth. Moreover, a limitation of this study is that we focused on the municipality level in our analysis and that the results may therefore be sensitive to the size of the municipality. This is mainly a problem for the large municipalities in the north of Sweden; however, robustness checks excluding the north of Sweden did not show very different results. Even so, it might be interesting to do a similar analysis using one by one population grid data. Also, this study focused only on three countries in the European Union, and while these countries provided interesting cases, it might be interesting to do a similar analysis for a wider cross-country dataset.

In conclusion, it can be stated that a rural or urban area in the north of Sweden is not the same as a rural or urban area somewhere in the Netherlands or Belgium, or even in the south of Sweden. Hence, the wider regional context should be taken into account when studying the relationship between urban and rural regions. Moreover, regional policy makers should also take into account the influence of the relative location of a region, especially the distance to (other) urban areas. The impact of major urban areas is felt over a long distance, and rural areas or smaller cities in close proximity to major cities behave differently from those that are located in a more area. Hence, location matters.

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# Appendix I

**Table A 1. Robustness check: 30 km cut-off**

| Dependent variable: start-up rate | NL | | BE | | SE | |
|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
| Population density (ln) | -0.386*** | -0.516*** | -0.211*** | -0.531*** | -0.0671 | -0.610*** |
| | (0.146) | (0.164) | (0.0679) | (0.109) | (0.0884) | (0.107) |
| Spatial lag population density | | -0.00146*** | | 0.000167** | | 0.000387 |
| | | (0.000337) | | (7.78e-05) | | (0.000353) |
| Dist to nearest UC | | -0.0609*** | | 0.000119 | | -0.00808*** |
| | | (0.0210) | | (0.00759) | | (0.00163) |
| Square of dist to nearest UC | | 0.00159* | | -0.000389*** | | 3.87e-05*** |
| | | (0.000929) | | (0.000109) | | (7.41e-06) |
| Inc Dist to UC >50 000 | | -0.165*** | | -0.0126 | | 0.402 |
| | | (0.0388) | | (0.0630) | | (0.258) |
| Square of Inc Dist to UC > 50 000 | | 0.00211* | | 0.0216 | | -0.0336 |
| | | (0.00110) | | (0.0131) | | (0.0300) |
| Inc Dist to UC > 100 000 | | -0.0609*** | | -0.0134 | | 0.107* |
| | | (0.0168) | | (0.0116) | | (0.0601) |
| Square of Inc Dist to UC > 100 000 | | 0.00104* | | -0.000600 | | -0.00272 |
| | | (0.000590) | | (0.000559) | | (0.00322) |
| Inc Dist to UC > 250 000 | | -0.0309*** | | -0.00880*** | | -0.0113*** |
| | | (0.00456) | | (0.00290) | | (0.00131) |
| Square of Inc Dist to UC > 250 000 | | 8.27e-05 | | -9.56e-05* | | 1.62e-05*** |
| | | (6.21e-05) | | (5.81e-05) | | (3.55e-06) |
| Age < 15 | 0.348** | 0.302** | -0.297*** | -0.134 | -0.0366 | 0.0921 |
| | (0.140) | (0.131) | (0.0949) | (0.0904) | (0.167) | (0.143) |
| Age 15-25 | -0.0942 | -0.0785 | 0.252*** | 0.361*** | -0.105 | -0.0876 |
| | (0.114) | (0.106) | (0.0784) | (0.0785) | (0.137) | (0.121) |
| Age 25-35 | -0.0440 | 0.0102 | 0.277*** | 0.403*** | -0.0698 | 0.183* |
| | (0.137) | (0.132) | (0.0850) | (0.0799) | (0.118) | (0.103) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Age 35-50 | *Reference* | *Reference* | *Reference* | *Reference* | *Reference* | *Reference* |
| Age 50-65 | -0.201 | -0.114 | -0.153* | -0.110 | 0.370*** | 0.396*** |
| | (0.151) | (0.140) | (0.0901) | (0.0847) | (0.129) | (0.109) |
| Age 65+ | 0.152* | 0.275*** | 0.121** | 0.264*** | 0.00117 | 0.141 |
| | (0.0916) | (0.0866) | (0.0580) | (0.0572) | (0.102) | (0.0873) |
| Higher educated | 0.200*** | 0.160*** | 0.131*** | 0.131*** | 0.161*** | 0.173*** |
| | (0.0219) | (0.0216) | (0.0103) | (0.0107) | (0.0258) | (0.0232) |
| Immigrant | 0.0968*** | 0.0967*** | -0.000650 | 0.000380 | 0.00116 | -0.0332** |
| | (0.0219) | (0.0207) | (0.00385) | (0.00361) | (0.0157) | (0.0151) |
| Unemployment | 0.0978 | 0.144 | 0.0158 | 0.0358** | -0.0500 | 0.0121 |
| | (0.126) | (0.116) | (0.0172) | (0.0182) | (0.0324) | (0.0283) |
| Service | 0.0884*** | 0.0781*** | 0.00952 | 0.00343 | 0.191*** | 0.155*** |
| | (0.0173) | (0.0160) | (0.00785) | (0.00749) | (0.0174) | (0.0157) |
| Public | 0.0128 | 0.0135 | -0.0473*** | -0.0416*** | -0.0625*** | -0.0203 |
| | (0.0154) | (0.0144) | (0.00687) | (0.00644) | (0.0230) | (0.0199) |
| Constant | -1.227 | -3.036 | 5.835 | -3.145 | -0.244 | -10.82 |
| | (8.831) | (8.174) | (5.411) | (5.125) | (9.061) | (7.755) |
| Log Likelihood | -849.4091 | -810.9724 | -1022.125 | -972.6557 | -482.0974 | -422.4457 |
| AIC | 1724.818 | 1665.945 | 2070.25 | 1989.311 | 990.1948 | 888.8914 |
| Wald chi2 | 390.33*** | 556.57*** | 376.65*** | 553.28*** | 579.80*** | 1022.45*** |
| Observations | 405 | 405 | 589 | 589 | 290 | 290 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A 2. Robustness check: 70 km cut-off

| Dependent variable: start-up rate | NL | | BE | | SE | |
|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
| Population density (ln) | -0.386*** | -0.541*** | -0.211*** | -0.509*** | -0.0671 | -0.577*** |
| | (0.146) | (0.164) | (0.0679) | (0.108) | (0.0884) | (0.105) |
| Spatial lag population density | | -0.00235*** | | 0.000244 | | 0.00112*** |
| | | (0.000612) | | (0.000157) | | (0.000395) |
| Dist to nearest UC | | -0.0653*** | | 0.000435 | | -0.00741*** |
| | | (0.0219) | | (0.00776) | | (0.00163) |
| Square of dist to nearest UC | | 0.00154 | | -0.000380*** | | 3.77e-05*** |
| | | (0.000935) | | (0.000109) | | (7.33e-06) |
| Inc Dist to UC >50 000 | | -0.165*** | | 0.00672 | | 0.260 |
| | | (0.0391) | | (0.0620) | | (0.256) |
| Square of Inc Dist to UC > 50 000 | | 0.00179 | | 0.0183 | | -0.0201 |
| | | (0.00111) | | (0.0130) | | (0.0299) |
| Inc Dist to UC > 100 000 | | -0.0604*** | | -0.0121 | | 0.0490 |
| | | (0.0169) | | (0.0117) | | (0.0620) |
| Square of Inc Dist to UC > 100 000 | | 0.000826 | | -0.000660 | | -0.000683 |
| | | (0.000594) | | (0.000559) | | (0.00324) |
| Inc Dist to UC > 250 000 | | -0.0378*** | | -0.00768** | | -0.0108*** |
| | | (0.00627) | | (0.00328) | | (0.00131) |
| Square of Inc Dist to UC > 250 000 | | 0.000104 | | -0.000100* | | 1.52e-05*** |
| | | (6.70e-05) | | (5.85e-05) | | (3.53e-06) |
| Age < 15 | 0.348** | 0.263** | -0.297*** | -0.119 | -0.0366 | 0.113 |
| | (0.140) | (0.131) | (0.0949) | (0.0904) | (0.167) | (0.141) |
| Age 15-25 | -0.0942 | -0.0937 | 0.252*** | 0.380*** | -0.105 | -0.0410 |
| | (0.114) | (0.107) | (0.0784) | (0.0786) | (0.137) | (0.119) |
| Age 25-35 | -0.0440 | 0.00625 | 0.277*** | 0.414*** | -0.0698 | 0.175* |
| | (0.137) | (0.133) | (0.0850) | (0.0800) | (0.118) | (0.101) |
| Age 35-50 | *Reference* | *Reference* | *Reference* | *Reference* | *Reference* | *Reference* |
| Age 50-65 | -0.201 | -0.140 | -0.153* | -0.103 | 0.370*** | 0.404*** |
| | (0.151) | (0.140) | (0.0901) | (0.0861) | (0.129) | (0.107) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Age 65+ | 0.152* | 0.273*** | 0.121** | 0.277*** | 0.00117 | 0.154* |
| | (0.0916) | (0.0871) | (0.0580) | (0.0571) | (0.102) | (0.0863) |
| Higher educated | 0.200*** | 0.152*** | 0.131*** | 0.132*** | 0.161*** | 0.166*** |
| | (0.0219) | (0.0219) | (0.0103) | (0.0107) | (0.0258) | (0.0228) |
| Immigrant | 0.0968*** | 0.0968*** | -0.000650 | 0.000334 | 0.00116 | -0.0351** |
| | (0.0219) | (0.0208) | (0.00385) | (0.00361) | (0.0157) | (0.0149) |
| Unemployment | 0.0978 | 0.134 | 0.0158 | 0.0314* | -0.0500 | 0.0104 |
| | (0.126) | (0.117) | (0.0172) | (0.0191) | (0.0324) | (0.0279) |
| Service | 0.0884*** | 0.0779*** | 0.00952 | 0.00448 | 0.191*** | 0.152*** |
| | (0.0173) | (0.0161) | (0.00785) | (0.00749) | (0.0174) | (0.0155) |
| Public | 0.0128 | 0.0129 | -0.0473*** | -0.0417*** | -0.0625*** | -0.0201 |
| | (0.0154) | (0.0145) | (0.00687) | (0.00646) | (0.0230) | (0.0197) |
| Constant | -1.227 | -0.520 | 5.835 | -4.170 | -0.244 | -12.02 |
| | (8.831) | (8.237) | (5.411) | (5.148) | (9.061) | (7.630) |
| Log Likelihood | -849.4091 | -812.9258 | -1022.125 | -973.7585 | -482.0974 | -419.1093 |
| AIC | 1724.818 | 1669.852 | 2070.25 | 1991.517 | 990.1948 | 882.2186 |
| Wald chi2 | 390.33*** | 547.34*** | 376.65*** | 549.01*** | 579.80*** | 1053.00*** |
| Observations | 405 | 405 | 589 | 589 | 290 | 290 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A 3. Robustness check: 100 km cut-off

| Dependent variable: start-up rate | NL | | BE | | SE | |
|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
| Population density (ln) | -0.386*** | -0.540*** | -0.211*** | -0.545*** | -0.0671 | -0.585*** |
| | (0.146) | (0.162) | (0.0679) | (0.108) | (0.0884) | (0.105) |
| Spatial lag population density | | -0.00344*** | | 0.000624*** | | 0.00106** |
| | | (0.000750) | | (0.000186) | | (0.000453) |
| Dist to nearest UC | | -0.0705*** | | 0.00306 | | -0.00735*** |
| | | (0.0216) | | (0.00763) | | (0.00165) |
| Square of dist to nearest UC | | 0.00154* | | -0.000389*** | | 3.74e-05*** |
| | | (0.000924) | | (0.000108) | | (7.39e-06) |
| Inc Dist to UC >50 000 | | -0.164*** | | -0.00924 | | 0.278 |
| | | (0.0387) | | (0.0617) | | (0.260) |
| Square of Inc Dist to UC > 50 000 | | 0.00233** | | 0.0222* | | -0.0214 |
| | | (0.00110) | | (0.0129) | | (0.0302) |
| Inc Dist to UC > 100 000 | | -0.0627*** | | -0.00729 | | 0.0574 |
| | | (0.0168) | | (0.0118) | | (0.0636) |
| Square of Inc Dist to UC > 100 000 | | 0.000772 | | -0.000714 | | -0.000897 |
| | | (0.000590) | | (0.000552) | | (0.00330) |
| Inc Dist to UC > 250 000 | | -0.0421*** | | -0.00538* | | -0.0108*** |
| | | (0.00631) | | (0.00316) | | (0.00132) |
| Square of Inc Dist to UC > 250 000 | | 8.10e-05 | | -5.70e-05 | | 1.54e-05*** |
| | | (6.11e-05) | | (5.97e-05) | | (3.55e-06) |
| Age < 15 | 0.348** | 0.257** | -0.297*** | -0.119 | -0.0366 | 0.106 |
| | (0.140) | (0.130) | (0.0949) | (0.0897) | (0.167) | (0.141) |
| Age 15-25 | -0.0942 | -0.0799 | 0.252*** | 0.373*** | -0.105 | -0.0525 |
| | (0.114) | (0.106) | (0.0784) | (0.0779) | (0.137) | (0.119) |
| Age 25-35 | -0.0440 | 0.00327 | 0.277*** | 0.404*** | -0.0698 | 0.170* |
| | (0.137) | (0.132) | (0.0850) | (0.0794) | (0.118) | (0.102) |
| Age 35-50 | *Reference* | *Reference* | *Reference* | *Reference* | *Reference* | *Reference* |
| Age 50-65 | -0.201 | -0.129 | -0.153* | -0.0840 | 0.370*** | 0.399*** |
| | (0.151) | (0.139) | (0.0901) | (0.0848) | (0.129) | (0.107) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Age 65+ | 0.152* | 0.281*** | 0.121** | 0.272*** | 0.00117 | 0.145* |
| | (0.0916) | (0.0865) | (0.0580) | (0.0567) | (0.102) | (0.0865) |
| Higher educated | 0.200*** | 0.150*** | 0.131*** | 0.129*** | 0.161*** | 0.169*** |
| | (0.0219) | (0.0218) | (0.0103) | (0.0106) | (0.0258) | (0.0228) |
| Immigrant | 0.0968*** | 0.101*** | -0.000650 | 0.000925 | 0.00116 | -0.0354** |
| | (0.0219) | (0.0207) | (0.00385) | (0.00359) | (0.0157) | (0.0150) |
| Unemployment | 0.0978 | 0.129 | 0.0158 | 0.0220 | -0.0500 | 0.0124 |
| | (0.126) | (0.116) | (0.0172) | (0.0188) | (0.0324) | (0.0281) |
| Service | 0.0884*** | 0.0757*** | 0.00952 | 0.00284 | 0.191*** | 0.152*** |
| | (0.0173) | (0.0160) | (0.00785) | (0.00738) | (0.0174) | (0.0156) |
| Public | 0.0128 | 0.0103 | -0.0473*** | -0.0413*** | -0.0625*** | -0.0215 |
| | (0.0154) | (0.0145) | (0.00687) | (0.00639) | (0.0230) | (0.0197) |
| Constant | -1.227 | 0.265 | 5.835 | -4.499 | -0.244 | -11.44 |
| | (8.831) | (8.181) | (5.411) | (5.101) | (9.061) | (7.656) |
| Log Likelihood | -849.4091 | -809.8983 | -1022.125 | -969.3787 | -482.0974 | -420.3584 |
| AIC | 1724.818 | 1663.797 | 2070.25 | 1982.757 | 990.1948 | 884.7169 |
| Wald chi2 | 390.33*** | 561.68*** | 376.65*** | 566.06*** | 579.80*** | 1041.48*** |
| Observations | 405 | 405 | 589 | 589 | 290 | 290 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

# Appendix II

**Table A 4. Regression results: Maximum Likelihood Estimation for Sweden excluding north Sweden**

| Dependent variable: start-up rate | SE<br>Model 1 | Model 2 |
|---|---|---|
| Population density (ln) | -0.00873 | -0.417*** |
| | (0.137) | (0.126) |
| Spatial lag population density | | 0.000888** |
| | | (0.000450) |
| Dist to nearest UC | | -0.0112*** |
| | | (0.00210) |
| Square of dist to nearest UC | | 6.85e-05* |
| | | (3.62e-05) |
| Inc Dist to UC >50 000 | | 0.333 |
| | | (0.256) |
| Square of Inc Dist to UC > 50 000 | | -0.0306 |
| | | (0.0296) |
| Inc Dist to UC > 100 000 | | 0.0721 |
| | | (0.0672) |
| Square of Inc Dist to UC > 100 000 | | -0.00135 |
| | | (0.00328) |
| Inc Dist to UC > 250 000 | | -0.0173*** |
| | | (0.00305) |
| Square of Inc Dist to UC > 250 000 | | -3.24e-05 |
| | | (3.57e-05) |
| Age < 15 | -0.00622 | 0.0654 |
| | (0.195) | (0.169) |
| Age 15-25 | -0.0985 | -0.0305 |
| | (0.147) | (0.134) |
| Age 25-35 | -0.0642 | 0.171 |
| | (0.130) | (0.115) |
| Age 35-50 | *Reference* | *Reference* |
| Age 50-65 | 0.435*** | 0.332*** |
| | (0.144) | (0.124) |
| Age 65+ | 0.0112 | 0.182* |
| | (0.121) | (0.106) |
| Higher educated | 0.164*** | 0.156*** |
| | (0.0265) | (0.0238) |
| Immigrant | 0.0127 | -0.0541*** |
| | (0.0188) | (0.0184) |
| Unemployment | -0.0588* | 0.0121 |
| | (0.0330) | (0.0296) |
| Service | 0.182*** | 0.133*** |
| | (0.0195) | (0.0177) |
| Public | -0.0303 | -0.0348 |
| | (0.0267) | (0.0230) |
| Constant | -3.173 | -9.238 |
| | (10.38) | (9.054) |
| Log Likelihood | -372.8916 | -327.0549 |
| AIC | 771.7833 | 698.1099 |

| | | |
|---|---|---|
| Wald Chi2 | 599.99*** | 1004.80*** |
| Observations | 231 | 231 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

# Appendix III

**Table A 5. Regression results: Maximum Likelihood Estimation for Belgium excluding Wallonia**

| Dependent variable: start-up rate | BE<br>Model 1 | Model 2 |
|---|---|---|
| Population density (ln) | -0.787*** | -0.833*** |
| | (0.117) | (0.139) |
| Spatial lag population density | | -0.000291* |
| | | (0.000154) |
| Dist to nearest UC | | -0.0119 |
| | | (0.00959) |
| Square of dist to nearest UC | | -0.000307 |
| | | (0.000336) |
| Inc Dist to UC >50 000 | | -0.0275 |
| | | (0.0745) |
| Square of Inc Dist to UC > 50 000 | | 0.0186 |
| | | (0.0143) |
| Inc Dist to UC > 100 000 | | -0.0253** |
| | | (0.0128) |
| Square of Inc Dist to UC > 100 000 | | 0.000699 |
| | | (0.000671) |
| Inc Dist to UC > 250 000 | | 0.00493 |
| | | (0.00677) |
| Square of Inc Dist to UC > 250 000 | | 0.000277** |
| | | (0.000135) |
| Age < 15 | -0.523*** | -0.492*** |
| | (0.109) | (0.107) |
| Age 15-25 | 0.329*** | 0.246** |
| | (0.0876) | (0.0967) |
| Age 25-35 | 0.0603 | 0.0516 |
| | (0.0983) | (0.0981) |
| Age 35-50 | *Reference* | *Reference* |
| Age 50-65 | -0.355*** | -0.455*** |
| | (0.103) | (0.102) |
| Age 65+ | 0.0607 | 0.0741 |
| | (0.0645) | (0.0704) |
| Higher educated | 0.121*** | 0.142*** |
| | (0.0117) | (0.0136) |
| Immigrant | -0.00456 | -0.00255 |
| | (0.00413) | (0.00404) |
| Unemployment | 0.256*** | 0.297*** |
| | (0.0318) | (0.0369) |
| Service | -0.00422 | -0.00135 |
| | (0.00859) | (0.00853) |
| Public | -0.0440*** | -0.0439*** |
| | (0.00818) | (0.00789) |
| Constant | 16.11*** | 17.47*** |
| | (6.143) | (6.153) |
| Log Likelihood | -507.8379 | -493.1667 |
| AIC | 1041.676 | 1030.333 |
| Wald Chi2 | 225.00*** | 276.82*** |

| | | |
|---|---|---|
| Observations | 327 | 327 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1