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Access to financial intermediaries and external capital acquisition

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Abstract: We examine whether low access to financial intermediaries works as an obstacle acquiring financial capital for Swedish firms by using information from the Community Innovation Survey indicating whether firms perceive the acquisition of external capital to be difficult. This perception is explained by the distance to the firms' nearest financial intermediaries and their total local supply. The results indicate that the distance to banks is related to a larger problem of obtaining external financial capital in rural areas.

Keywords: financial capital, bank offices, geographical distance, Community Innovation Survey

JEL-codes: D53, G21, G23, L25, O31

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1 Introduction

In this paper, we analyse whether low access to local financial intermediaries increases the problem of acquiring external financial capital. In the EU, banks are by far the most common provider of loans to firms (European Commission, 2011).¹ The same pattern can be observed in Sweden, which has a financial system that is bank-oriented and founded on relationships between banks and their customers (Avdeitchikova, 2008; Sjögren & Zackrisson, 2005). Most Swedish firms have bank loans; in particular, many small and medium-sized enterprises are reliant on banks for their external financial funding needs (Berggren, Lindström, & Olofsson, 2001). Venture capital is often highlighted as an alternative source but represents only 1.2 percent of the early firms founded in Sweden between 2002-2009 (Söderblom, 2012).

At the same time that banks are the main provider of financial capital to firms, we observe a drastic change in the organisation of the local financial infrastructure. In Sweden, approximately half of the local bank branches closed during the 1990 to 2010 period due to a centralisation of the banking sector; this is a tendency that is particularly prevalent in rural areas. This development is problematic since studies find that access to financial capital is important for both new firm formation (Backman, 2015) and firm-level innovations (B. H. Hall, Moncada-Paternò-Castello, Montresor, & Vezzani, 2016; O'Sullivan, 2005). In addition, studies find that it is the *local* financial infrastructure that is important for many firms (Backman, 2015; Cole, 1998; Cole, Goldberg, & White, 2004; Ferri & Messori, 2000; Fritsch & Schilder, 2008; Lutz, Bender, Achleitner, & Kaserer, 2013; Pollard, 2003). This finding implies that the geographical distance to financial intermediaries is an important factor for firms in their quest for the external financial capital related to their innovative activities.

Using this development as a starting point, our purpose is to analyse how access to financial capital, proxied by the Euclidian distance to bank branches, venture capital and public debt institutions, is related to firms' perceived difficulties of obtaining external financial capital for their innovation processes. We contribute to the existing literature by testing how the geographical distance to financial intermediaries influences firms' ability to acquire external capital. This extends the previous findings that financial obstacles impede firms innovative capabilities (Alessandrini, Presbitero, & Zazzaro, 2010; Blanchard, Huiban, Musolesi, & Sevestre, 2013; Canepa & Stoneman, 2008).

We use the Community Innovation Survey (CIS) wave from 2010, which includes a question regarding obstacles to innovation where the firms are requested to rank how large problems they have experienced when acquiring external financial capital. Our hypothesis is that a larger geographical distance to financial intermediaries will be associated with a larger perceived

obstacle for the innovation process. This hypothesis is examined using a logit model, where we include the distance to the nearest bank branch, Almi office², and venture capital firm in addition to proxies of the regional supply of financial capital as well as firm and regional level controls. The results show that a longer distance to the nearest bank branch is associated with a larger probability of experiencing external capital problems, especially for firms located in rural areas. For firms in the service sector, it is mainly the regional supply of bank branches that appears important, as a larger number of local bank branches is associated with a lower probability of experiencing external capital problems.

The results in this paper show that the access to financial intermediaries imposes a risk for firms to be less innovative, as they report that accessing external finance is an obstacle for innovation, i.e., firms encounter financial constraints. Financial constraints arise when there is a difference between the rate of return required by the owner investing internal funds and the rate of return required by external actors, assuming no externalities in the investment activity. Thus, a firm is financially constrained if the firm is unable to find external capital at the market price (B. Hall, 2002; Hubbard, 1998). If firms encounter financial constraints, and there are insufficient internal funds to cover the innovation investments, this leads to fewer innovation activities than optimal and thus a market failure. As new and more regulations, such as Basel III and MiFID, target the financial sector, the banks' reduced ability to provide finance leads to a tightened credit supply for small and medium-sized firms. However, as this credit tightening has occurred, the European Commission's objective is to develop a comprehensive range of financial policies and instruments to support these firms.

This paper is organised as follows. Section 2 presents an overview of why access to financial intermediaries matters to firms and presents a short background description regarding the Swedish financial sector. Section 3 presents the data, variables and the method. Section 4 presents the results from the empirical estimations, and section 5 concludes this paper.

2 Why is geographical proximity to financial intermediaries important?

The statement by J. Schumpeter (1911) that services provided by financial intermediaries are essential for economic growth has been confirmed in numerous studies (Becchetti & Trovato, 2002; Beck, Levine, & Loayza, 2000; Goldsmith, 1969; King & Levine, 1993). In this paper, we argue not only for financial intermediary's competitive advantage in handling information but also for their importance at the local level.

An economic actor striving to access financial capital must be able to provide sufficient information about the business idea to the investor, as an information asymmetry exists between

the agents. This information is often characterised by being tacit, i.e. the knowledge is difficult to communicate to others or record in a document (Udell, 2008). The information is therefore costly for the financial intermediary to acquire since it requires personal meetings and trust often built up by a long-term relationship (Gereffi, Humphrey, & Sturgeon, 2005; Storper & Venables, 2004). Relationship lending, which builds on the acquisition of soft information, is one means by which financial intermediaries can reduce this information gap. Except for the relevant information about the project, this information gap includes other tacit information about the borrower himself, such as personal characteristics and previous activities. The acquisition of soft information is usually done through interaction with the borrower, through other financial services (Boot, 2000; Elsas & Krahnén, 1998). Soft information is easier to convey over short distances, which implies that regional or local financial institutions matter particularly for firms that are more dependent on this type of information.

Despite improved communication and technology processes, such as internet-banking, which allows for longer distances between lenders and borrowers, it has been found that banks remain dependent upon personal relationships (Boot & Marinč, 2008; Petersen & Rajan, 2002). A close relationship and a closer geographical proximity between the bank and the borrower also facilitate monitoring and screening activities (Boot, 2000). Another reason why a close proximity between the lender and borrower is important is that the financial intermediary in this case has access to knowledge about the local market (Hayek, 1945). Pollard (2003) stresses two possible explanations for why local knowledge is important: (i) the proximity between borrowers and lenders may increase the knowledge about the local firms and their owners, hence reducing the asymmetric information; and (ii) financial intermediaries can benefit from being well acquainted with the local economic conditions, which can be incorporated when deciding whether to grant the proposal.

The spatial reach for banking services that require personal relationships is thus limited, which means that firms are dependent on the local financial infrastructure to access external capital (Berger et al., 1999; Kwast, 1999; Collender and Shaffer, 2003). Several studies also find that financial intermediaries such as banks, business angels, and venture capitalists prefer to invest within a close geographical context (Cole, 1998; Cole et al., 2004; Ferri & Messori, 2000; Fritsch & Schilder, 2008; Lutz et al., 2013)..

Having a close geographical proximity to many financial intermediaries also signals the level of competition. There are ambiguous findings regarding whether competition within the financial sector is beneficial or not for the remainder of the economy. Some advocate that increased market power reduces the equilibrium amount of credit and increases the interest rate for borrowers (Beck, Demirgüç-Kunt, & Maksimovic, 2004; Berger, Demsetz, & Strahan, 1999; Degryse &

Ongena, 2005; Dinc, 2000; Gilbert, 1984; Sharpe, 1990). Others argue that some level of market power is needed for a bank to establish a fruitful lending relationship (Petersen & Rajan, 1995). Meaning that the interest rates can be smoothed over time to allow new firms to initially get a subsidised rate for which the bank can be compensated later in the relationship (Boot & Marinč, 2008).

2.1 The case of innovation

The importance of financial capital as an input in the innovation process has been verified by several scholars (Lundvall, 1992; Nelson & Winter, 1982; J. Schumpeter, 1939; J. A. Schumpeter, 1934). Despite the critical role of financial capital and the inclusion of it in major contributions within the innovation literature, O'Sullivan (2005) claims that research largely ignores the role of financial intermediaries. Financial capital supports firms in their innovative processes by means of investing in machines, knowledge, and changing routines. The importance of financial capital for innovations stems from the uncertain nature of the innovation process (B. Hall, 2002). Firms spend time and effort developing an idea, either through formal R&D activities or through regular operations. To cover the costs of these risky investments, firms need to be able to appropriate monopoly rents in those cases where the innovation is successful (Aghion & Howitt, 1992; J. A. Schumpeter, 1934). This statement implies that, with non-commercialised innovation, the firm does not know whether it will be successful, and potential profit streams have not been realised. Hence, other financial resources are needed to fund the actual process. If the innovation process was predictable, and investors could make correct estimates about the return on their investments, it would not be difficult to attract investors and receive financial capital for profitable innovations. However, as the innovation process exacerbates elements of uncertainty, which creates information asymmetries, investors have problems identifying the actual risk and thus may choose not to become involved (B. H. Hall et al., 2016).

Canepa and Stoneman (2008) analyse the relationship between financial constraints and innovative activities by using CIS data for British firms. They find that low access to finance is a factor that decreases the innovative probability in firms. Similar studies have been conducted on CIS data in other countries such as Netherlands (Mohnen, Palm, van der Loeff, & Tiwari, 2008), France (Blanchard et al., 2013), and Italy (Alessandrini et al., 2010). They all support the finding that financial obstacles hamper firms' innovation activities. Lööf and Nabavi (2016) analyse how financing constraints relate to patent applications and new export products for Swedish firms. They conclude that financial constraints have a negative relationship with patent applications in

high-tech firms, regardless of the business cycle. Based on the discussion and findings in previous studies, we formulate the following hypothesis:

Hypothesis: Limited access to financial capital, proxied by the geographical distance, creates an innovation hindrance.

2.2 The Swedish financial sector

The Swedish financial system has been characterised by a strong bank orientation³ that is heavily based on relationships (Avdeitchikova, 2008; Sjögren & Zackrisson, 2005). However, Stenfors (2014) claims that the rapid deregulation of the financial sector in the 1980s and 1990s have placed Sweden in between the typical dichotomy of bank-centred versus market-centred. The tax system was also reformed during this period, and debt is less favoured than previously (Månsson & Landström, 2006). However, a recent report by Företagarna (2015) highlights banks as the most important external source of capital, whereas a report by Söderblom and Samuelsson (2014) highlights public debt and grants as the most important external sources of capital. However, the researchers make the noteworthy statement that many of the innovative start-ups they examine have attempted to obtain bank loans but were rejected.

The number of bank branches has declined drastically over the last two decades. In total, nearly half of the bank branches have disappeared, but the largest difference has been observed in rural municipalities, where approximately half of the bank branches have closed during this period. For urban locations, the change in the number of bank branches has been less drastic. The same pattern is also confirmed by weighting the number of bank branches by the population in the respective regions.

Venture capital firms are mainly concentrated in the two largest metropolitan regions in Sweden: Stockholm and Gothenburg; the Swedish Venture Capital Association has approximately 80 percent of its members here (Berggren & Silver, 2010). Several reports about the Swedish market confirm that this type of capital is not frequently used (Företagarna, 2015; Söderblom, 2012; Söderblom & Samuelsson, 2014). This view is reinforced by the Global Entrepreneurship Monitor (GEM), which notes that only a few super-star firms manage to acquire venture capital. Of the 100 000 firms examined, only 37 had actually received venture capital (GEM, 2003).

Another actor in the financial sector is the informal venture capitalists or business angels. These angels are wealthy individuals who decide to invest in firms with which they have no family connections. These individuals tend to be active investors, as with venture capital firms, but they usually invest lower sums, exit later, invest their own money rather than someone else's, and invest locally (Harrison & Mason, 1992; Riding, 2008). Avdeitchikova (2008) estimates that the

amount of capital provided in Sweden by business angels is approximately the same as the capital provided by the venture capital firms. Identifying and locating business angels is a problem, as they often are very private (Riding, 2008).

In addition to the private actors in the Swedish financial market, there is the state-owned organisation, Almi, which is the largest supplier of public debt (Söderblom, 2012). Almi is responsible for the government's incubator program and has approximately 40 locations all over Sweden. Almi provides loans, venture capital, and advisory functions to both start-ups and established firms (Almi, 2016).

3 Data, variables and method

Several data bases are combined to provide information about the innovation obstacles of the firms, access to financial intermediaries, firm information and information about the regions where the firms are located. Most of the data used in this paper are collected by Statistics Sweden and have restricted public access.

To identify innovative and non-innovative firms, we use the 2010 wave of CIS. The CIS is based on a harmonized survey that is compiled by Eurostat and is conducted in Sweden by Statistics Sweden on a two-year frequency. Hence, by using the CIS from 2010, the firms report innovative activities from 2008 to 2010. An advantage of this survey is the broad view on the concept of being innovative. The product and/or process is not required to be new to the market to be classified as being an innovation; it is sufficient that it is new to the firm. A disadvantage with using this data is that the survey is only sent to firms with at least ten employees. There is also a limitation as to which sectors are included in the survey.⁴ The firms are stratified based on size and sector, where all firms with at least 250 employees are included, and those with 10-249 employees are included based on a random draw.

In contrast to previous waves, the 2010 wave of CIS included a question regarding hindrances for innovation. Consequently, we are restricted to use only one wave of the CIS survey to measure the obstacles for innovation. This wave includes a total of 4552 firms. However, as the localisation of the firms is important for our hypotheses, it becomes problematic to include multi-establishment firms, i.e., firms that have more than one establishment (approximately a third of the firms). These firms are excluded unless we can observe that the firm consists of one large establishment where a vast majority of all employees are located and where the additional establishments have only 1-2 employees each, presumably sales offices. In this way, approximately 130 firms were kept in the data set together with the approximately 3200 single-

establishment firms. We also limit the data set to contain only private firms by excluding firms owned by the state, counties, and municipalities.⁵ To access detailed information about the firms, we use employee-employer matched data from Statistics Sweden. The data for the financial intermediaries are collected from Statistics Sweden for banks and for venture capital firms and from Almi for the public debt institutions.

3.1 Variables

3.1.1 Dependent variable

To test the hypothesis regarding whether the access to financial intermediaries relates to creating a hindrance for innovation in firms, we use a question from the CIS about obstacles for the innovation process. One of the obstacles included was “lack of financial capital from sources external to the firm” (Statistics Sweden, 2012, p. 114). The question asks the firms to indicate on a scale from 0 to 3 how large the problem of attracting external financial capital was during the 2008-2010 period, where 0 indicates no problem at all, and 3 indicates a large problem.

3.1.2 Access to financial intermediaries

As the dependent variable covers the 2008-2010 period, we use independent variables from 2007 to measure the situation before the period examined by the survey. The banks are identified by the NACE rev. 2 codes, which contains “other monetary intermediation” firms. The Euclidean distance is calculated between the coordinates of each bank branch present in the data and the coordinates of each firm in the CIS data. The minimum distance in kilometres is then used as the variable measures distance to the *nearest* bank branch.

We also include a measure of the regional supply of the banks by including *number of bank branches*. If there are several institutions in a region, being declined financial capital from one may not be as devastating since there are others nearby one could approach without the search cost increasing heavily. This variable also works as a proxy for regional size, as larger regions have more bank branches.⁶

The address for the Almi offices was identified based on information on its webpage and previous yearly reports.⁷ The coordinates were manually obtained and used to find the Euclidean distance to them from the firms in the CIS data. The minimum distance in kilometres is used as the variable measures distance to the nearest Almi office.

Venture capital firms were identified by industry classification, which contains “activities of investment companies and venture capital companies”. The Euclidean distance between the venture capital firm and the firms in the CIS data is used to find the minimum distance in kilometres to the nearest venture capital firm.⁸

3.1.3 Control variables

What banks and other financial intermediaries are attempting to establish, either with soft information or hard information from financial statements, is whether the firm is likely to be able to repay its loan. Any financial (hard) information available should facilitate the decision and is relevant to include in our model (Berger & Udell, 2006; Uchida, 2011). Hence, the first firm level variables we include represent two types of financial information: (i) Operating margin and (ii) total capital per employee. The former can be considered a flow and is equivalent to the EBIT (earnings before interest and taxes) divided by the turnover, which makes the measure less dependent on size. Hence, a firm with a negative value of the operating margin is running a loss, and a firm with a positive value could use the surplus to support innovative activities. It is important to note that, by definition, the EBIT is the earnings before the firm has been able to add potential interest incomes. The latter can be considered a stock and consists of tangible capital in terms of machinery as well as intangible capital such as patents and trademarks. This variable indicates whether the firm has any possible collateral to use for a loan (Berger & Udell, 2006; Mina, Lahr, & Hughes, 2013; Uchida, 2011). To normalise this variable for the size of the firm, we divide the value by the number of employees. Both the operating margin and the total capital are measured in millions of SEK.

Larger firms have the capability of producing more things, as they tend to have more resources, and they can also take advantage of economies of scale and scope (Cohen & Klepper, 1996; Scherer, 1965). This finding could be useful information for a financial intermediary that is attempting to determine whether a project proposal by the firm is likely to succeed; it could also affect the type of investor that is interested in investing. Consequently, we include the number of employees as a proxy for the firm's size.

Another useful variable is *Age*, which can be considered a proxy for the stock of experience existing in a firm. The firm may have tested and attempted many things over the years and know what works and what does not. The firm also has experience and knowledge about its industry as well as the region in which it operates (Balasubramanian & Lee, 2008; Majocchi, Bacchiocchi, & Mayrhofer, 2005). In addition, a higher age means that a longer history of financial statements is available for the financial intermediary (Gereffi et al., 2005; Storper & Venables, 2004). Unfortunately, the variable age in our data set truncates all firms that were established before 1986 to 1986. Therefore, we transform the truncated continuous variable to a categorical variable: below 5 years old, 5-9 years old, 10-14 years old, and at least 15 years old.

We also control for the *ownership structure* of the firm. As public firms are previously excluded in the CIS sampling process, there are two possible categories remaining: private Swedish firms and firms that are part of corporate groups. The ownership structure could be an indicator of

innovation success, as several studies have found that multinational firms are more innovative than others, possibly because of the intra-organisational knowledge spillovers (Cook, Pandit, Lööf, & Johansson, 2013; Dachs, Ebersberger, & Lööf, 2008; Johansson & Lööf, 2008). From a financial perspective, being owned by another firm could indicate the possibilities of being supported by other parts of the organisation if financial capital is needed. Hence, we include a dummy variable to indicate whether a firm is part of a corporate group.

Exporting firms are often more productive than others; therefore, they manage to sell goods in foreign markets, despite the sunk cost involved (Alessandria & Choi, 2007; Baldwin & Krugman, 1989; Bernard & Jensen, 2004; Bernard & Wagner, 2001; Das, Roberts, & Tybout, 2007). Hence, we include a dummy for *exporting status* as an indicator of firm productivity and foreign contacts, both of which could be relevant when determining the success of being granted a loan. Lastly, on the firm level, we include *Internal human capital* to explain the crucial knowledge input used in innovation processes (Thornhill, 2006).

In addition to the firm variables, we include region-specific variables. Regarding region in this case, we refer to municipalities; there are 290 in Sweden. Because financial intermediaries do not have unlimited resources, more firms competing for them should decrease the likelihood for each firm, all else being equal, to receive a loan or an investment. Hence, we include the measure *local establishments per bank*; this is measured as the number of establishments in the municipality divided by the number of bank branches in that municipality. We also control for the wealth of regions by including the variable *wage sum per inhabitant*.

In addition to including characteristics as independent variables, we split the dataset by type of region and type of industry. The regions we use are i) *metropolitan municipalities*, ii) *urban municipalities*, and iii) *rural municipalities*. These regions build upon the categorisation used by Westlund (2011), with the exception that we combine the two rural categories into one due to a low number of observations in the sparsely populated rural areas. As the probability of receiving loans and investments may differ between industries due to their possibility to have collateral, we run separate regressions for manufacturing and services. These two groups contain the majority of the firms, making it unfeasible to use the remaining observations in an “other group”, as the number of observations is low and the firm heterogeneity large.

3.2 *Descriptive statistics*

As the dependent variable is constructed on an ordinal scale, the distribution between the alternatives is also interesting; Table 1 displays that distribution. In all types of regions, the median is zero, as at least 50 percent of the firms have reported that they have no problems with acquiring external financial capital. However, changing perspective, this means that approximately 37 percent of the firms in metropolitan areas reported that they do have problems acquiring external financial capital. This figure is slightly higher, 40.5 percent, in urban regions and higher, at nearly 45 percent, in rural areas. The majority of the firms that reported having problems categorise those problems as small or medium, although one in five firms reporting problems in rural areas categorise them as large.

Table 1. Distribution of the dependent variable along the ordinal scale.

External capital difficulties	Metro		Urban		Rural	
	Count	Percent	Count	Percent	Count	Percent
Not a problem at all	597	62.45	454	59.50	638	55.14
Small problem	185	19.35	147	19.27	254	21.95
Medium problem	109	11.40	107	14.02	163	14.09
Large problem	65	6.80	55	7.21	102	8.82
Sum	956	100	763	100	1157	100

To concur with the split of the dataset by type of region, and to indicate that there are large differences motivating that division, the descriptive statistics for our independent variables are also presented, according to the region type, in Table 2.

In general, firms appear to have the closest distance to bank branches, a longer distance to an Almi office, and the longest distance to a venture capital firm. The exception is the firms in metropolitan areas that are located slightly closer to venture capital firms than to Almi offices. The average distance to the nearest bank branch is similar in all three regions, especially in terms of the median firm's distance, which is approximately 0.5 km in metropolitan areas and 1.5 km in the remaining categories. Conversely, the distance to the nearest venture capital firm varies much between the different types of regions with the average distance being approximately 7 km, 51 km, and 85 km in the metropolitan, urban, and rural regions, respectively. This finding confirms that banks are evenly distributed and that venture capitalists tend to concentrate in the larger cities. The number of bank branches per municipality is also different in the metropolitan areas

Table 2. Descriptive statistics displayed separately for firms located in metropolitan areas, urban areas and rural areas.

VARIABLES	Description	Metropolitan regions			Urban regions			Rural regions		
		mean	median	sd	mean	median	sd	mean	median	sd
Dist. to nearest bank branch*	The Euclidean distance to the nearest bank branch in km.	1.001	0.559	1.352	2.402	1.521	2.846	3.448	1.458	5.124
Dist. to nearest Almi office*	The Euclidean distance to the nearest Almi office in km.	7.837	5.014	8.524	8.514	3.683	10.33	43.99	39.48	31.30
Dist. to nearest VC firm*	The Euclidean distance to the nearest VC firm in km.	6.707	3.717	8.551	51.36	41.34	44.44	84.50	74.79	48.33
Banks per municipality*	The number of establishments within the NACE rev. 2 code 64190 per municipality.	89.14	58	81.25	13.07	14	5.096	5.748	5	3.428
Operating margin	The EBIT in thousands of SEK divided by the turnover in thousands of SEK.	-0.155	0.050	2.933	-0.047	0.061	0.322	0.051	0.054	0.170
Total assets per employee*	The value of all assets in MSEK, divided by the number of employees.	1.078	0.068	11.33	0.298	0.130	0.590	1.528	0.233	34.81
Employees*	The number of employees in the firm.	55.28	20	130.4	49.59	21	84.42	63.07	27	115.3
Less than 5 years' old		0.152	0	0.359	0.108	0	0.310	0.063	0	0.243
5-9 years' old	Age of the firm where, <i>less than 5 years' old</i> is the base.	0.196	0	0.397	0.131	0	0.338	0.103	0	0.304
10-14 years' old		0.161	0	0.367	0.142	0	0.349	0.113	0	0.317
At least 15 years' old		0.491	0	0.500	0.619	1	0.486	0.721	1	0.449
Private Swedish firm	Ownership status of the firm, where <i>private Swedish firm</i> is the base.	0.299	0	0.458	0.343	0	0.475	0.357	0	0.479
Corporate group		0.701	1	0.455	0.657	1	0.475	0.643	1	0.479
Exporting status	1 if the firm was exporting in 2007 and 0 otherwise.	0.646	1	0.478	0.671	1	0.470	0.782	1	0.413
Internal human capital	The percent of the employees with at least a bachelor degree.	28.77	18.95	27.26	14.09	7.02	19.57	6.167	2.857	11.23
Manufacturing firm	1 if the firm belongs to the manufacturing sector.	0.388	0	0.488	0.542	1	0.499	0.714	1	0.452
Service firm	1 if the firm belongs to the service sector.	0.455	0	0.498	0.286	0	0.452	0.145	0	0.352
Innovation status in CIS 2008	1 if the firm was innovating in 2006-2008.	0.407	0	0.492	0.366	0	0.482	0.366	0	0.482
Establishments per bank*	The no. of establishments divided by the no. of bank branches per municipality.	329.6	307.0	85.85	361.5	364.8	93.54	239.6	223	90.75
Wage sum per inhabitant*	The wage sum in thousands SEK per municipality divided by the population.	163.8	162.475	64.77	116.6	120.1	18.44	96.37	93.08	18.90

*The natural logarithms of these variable are used in the estimations to reduce their skewness.

compared to the others, with an average of 89 offices compared to 6-13 offices. However, this finding is largely driven by Stockholm, which has the maximum value of 197 offices.

3.3 Method

The dependent variable consists of answers to a survey question whose categories have a natural order for a total of four categories. This type of ordinal information can be used in the estimations via an ordered logit model (Cameron & Trivedi, 2010).

However, one assumption for this model is the proportionality between the thresholds. By performing a Brant test after estimating the regressions, we concluded that the proportionality assumption could not be confirmed (Brant, 1990). In addition, a low percentage of responses in certain categories made the tests unstable. To solve both problems, we transformed the dependent variable into a binary variable, where 0 indicates no problem, and 1 indicates a problem without specifying the degree. The disadvantage of this transformation is the loss of certain information in the data. We observe y taking on the value 0 or 1, as displayed in equation (1).

$$y = \begin{cases} 1 & \text{if } y^* > 0 \\ 0 & \text{if } y^* \leq 0 \end{cases} \quad (1)$$

With this binary version of the variable, we estimate a logistic regression model instead, where the probability of y being equal to one is displayed in equation (2).

$$\Pr(y = 1) = \Pr(\mathbf{x}'\beta + u > 0) = \Pr(-u < \mathbf{x}'\beta) = F(\mathbf{x}'\beta) \quad (2)$$

This statement means that F is the cumulative distribution function of the error term, which is logistically distributed for a logit model and normally distributed for a probit model (Cameron & Trivedi, 2010; Greene, 2008). The regression parameters are estimated by maximising the log likelihood function associated with the probability function. Hence, a positive regression parameter means that the variable in question increases the probability of the outcome, y , being one.

In our case, the estimated model is presented in equation (3), where the outcome variable *external capital problems* is estimated as a function of a vector of firm-specific variables (\mathbf{x}_i), including the distance to the various financial institutions and region-specific variables (\mathbf{z}_m).

$$\text{external capital problems}_i^* = \mathbf{x}_i'\beta + \mathbf{z}_m'\delta + u_i \quad (3)$$

One problem with survey data, such as the CIS, is that the firms have different probabilities of being selected for participation in their respective strata. If uncorrected, this difference could bias

the estimates. To alleviate that problem, we incorporate sample weights in all regressions; these were also provided by Statistics Sweden.

Another problem is endogeneity; as the data set is of a cross-sectional nature, reverse causality is particularly pertinent. To solve that problem, we used independent variables from 2007, which is the year before the 2008-2010 period that was covered by the survey and four years before 2011 when the firms responded to the survey. We also include a wide range of firm characteristics to reduce the problem of unobserved heterogeneity in the data set, as we are unable to extend it to a panel.

4 Empirical Results

The results are presented in Table 3, where all coefficients are displayed as odds ratios; this means that coefficients below 1 indicate a negative relationship with the outcome variable, and values above 1 indicate a positive relationship. The estimations are split according to the three regional categories (Metro, Urban and Rural) and the two industries (Manufacturing and Service).

4.1 Access to financial intermediaries

In metropolitan and urban regions, the distance to the nearest bank does not appear to be important for the perceived difficulties of obtaining financial capital. Thus, we cannot confirm our hypothesis for these regions. This finding also contradicts the result found in previous studies, e.g., Berger et al. (1999), Collender and Shaffer (2003), and Lutz et al. (2013). Conversely, the coefficients for the rural areas indicate that a longer distance to the nearest bank is indeed related to a higher probability to report external capital problems, thus partly confirming our hypothesis by suggesting that relationship lending may be of higher importance in rural areas.

The only significant coefficient for distance to the nearest Almi office is found in metropolitan areas. The value of the coefficient suggests that a closer distance between firms and state-financed capital is related to a higher probability of reporting external financial problems. However, if one remembers that Almi offices tend to be located centrally in the central business district, this finding may not be a specific Almi effect but rather a result of distance to the city centre. As rents are higher in the city centre than in the periphery, firms may find it easier to have sound finances if they are not located in the centre; thus, they have a better financial record to show investors.

Table 3. Regression results for external capital problems displayed as odds ratios.

VARIABLES	Metropolitan regions		Urban regions		Rural regions	
	Manuf.	Services	Manuf.	Services	Manuf.	Services
Dist. to nearest bank branch	1.842*** (0.331)	0.783 (0.127)	0.884 (0.108)	1.085 (0.205)	1.141** (0.0641)	1.711*** (0.174)
Dist. to nearest Almi office	0.745** (0.097)	0.842** (0.067)	1.072 (0.082)	1.044 (0.100)	0.945 (0.045)	1.044 (0.102)
Dist. to nearest VC firm	1.277 (0.214)	0.693*** (0.082)	1.134* (0.075)	1.326*** (0.122)	1.044 (0.068)	0.639*** (0.088)
Banks per municipality	1.155** (0.084)	0.718*** (0.043)	0.814 (0.152)	1.272 (0.397)	0.951 (0.089)	0.629** (0.143)
Operating margin	1.005 (0.046)	1.000 (0.0003)	0.460 (0.364)	0.548* (0.241)	0.365*** (0.116)	0.306 (0.285)
Total assets per employee	0.748 (0.172)	1.385** (0.219)	1.601 (0.452)	0.540 (0.263)	0.787 (0.132)	1.107 (0.226)
Employees	1.041 (0.080)	1.009 (0.078)	1.265*** (0.104)	0.849 (0.124)	1.185*** (0.062)	1.008 (0.133)
5-9 years old	1.758* (0.543)	1.155 (0.168)	1.225 (0.444)	1.443 (0.381)	0.688 (0.167)	0.534* (0.202)
10-14 years old	1.560 (0.483)	0.831 (0.147)	1.389 (0.421)	2.084*** (0.591)	0.694 (0.161)	0.973 (0.334)
At least 15 years old	1.924** (0.525)	0.704** (0.108)	1.173 (0.303)	0.741 (0.198)	0.469*** (0.098)	0.476** (0.157)
Corporate group	0.742* (0.115)	1.267** (0.148)	0.637*** (0.097)	3.495*** (0.680)	1.230** (0.113)	0.896 (0.197)
Exporting status	1.174 (0.191)	1.733*** (0.218)	2.715*** (0.439)	5.615*** (1.448)	1.994*** (0.212)	0.964 (0.213)
Internal human capital	1.286*** (0.069)	1.148*** (0.051)	1.017 (0.058)	1.378*** (0.090)	0.923** (0.036)	1.006 (0.074)
Establishments per bank	1.549 (0.432)	1.012 (0.293)	1.092 (0.287)	0.699 (0.305)	1.620*** (0.177)	1.402 (0.391)
Wage sum per inhabitant	0.535*** (0.106)	0.623*** (0.103)	6.004*** (2.937)	51.67*** (59.84)	1.201 (0.257)	0.401* (0.207)
Constant	0.166 (0.316)	21.55 (42.13)	2.32e-05*** (5.08e-05)	1.76e-09*** (9.92e-09)	0.017*** (0.021)	42.33 (117.8)
Observations	351	327	401	189	808	150
Pseudo R2	0.044	0.075	0.076	0.232	0.036	0.091
LR chi2	66.79***	164.71***	119.76***	276.52***	137.03***	86.88***
Akaike Information Criterion	1500.314	2070.166	1486.938	949.251	3667.691	901.120
Mean VIF	2.28	1.80	1.71	1.70	1.59	1.54

se in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Varied results are also observed for the distance to the nearest venture capital firm. In urban regions, the odds ratios suggest that a shorter distance to venture capital is beneficial, such as the odds ratios observed for distance to the nearest bank in rural areas. For service firms located in metropolitan and rural areas, the probability of experiencing external capital problems is higher for firms located closer to the venture capital firms. In the metropolitan areas, this finding could partly be explained by the same logic as the negative relation between the distance to nearest Almi office and the external capital problems. In the rural areas, we are suggesting that this finding could be a consequence of the very uneven distribution of the venture capital firms. In 2007, there were five venture capital firms located in 197 rural areas. Alternatively, in other terms, approximately 8 percent of the venture capital was located in 68 percent of Sweden's regions. Hence, there may be other financial institutions that matter in these regions that the firms may benefit from more, such as banks. Therefore, a long distance to the venture capital firm may be beneficial.

The last financial variable is the number of banks in the region. For service firms in general, a higher number of banks in the region or a larger regional supply of financial capital, is associated with a lower probability of the firms reporting external capital problems. The results for manufacturing firms in metropolitan areas suggests the opposite, which could be explained by land prices. The central municipalities have a larger number of banks than the more peripheral ones in metropolitan areas; in addition, as a manufacturing firm, one would not want to be located in the most central areas due to the land prices and the physical size of the firm.

4.2 *Control variables*

Regarding the financial information of the firms, the odds ratio for the operating margin indicates a negative relationship with the probability of experiencing external capital problems when significantly different from one, confirming previous studies (Berger & Udell, 2006; Mina et al., 2013; Uchida, 2011). Conversely, the total assets per employee is, with one exception, not related to the external capital problems. The exception is service firms in metropolitan areas, where the odds ratio indicates a positive relation; the more assets, the higher the probability of experiencing external capital problems. This finding is possibly a result of tangible capital, as opposed to intangible capital, being useful as collateral. Hence, having intangible assets implies that resources are available yet restricted and cannot be used as collateral.

The remaining firm characteristics show a mixed picture. There appears to be an urban-rural divide where firm age in urban and metropolitan areas appears to be positively associated with external capital problems and negatively so in rural areas. The results for the rural firms are in accordance with previous studies, such as Mina et al. (2013) and Balasubramanian and Lee

(2008), who suggest that experience and financial track records increase with age. The findings for metropolitan and urban firms could, to an extent, be driven by lock-in effects, but that does not appear plausible for whole sectors.

Being part of a corporate group is positively related to external capital problems for some samples and negative for others, indicating that no general conclusion can be derived. Exporting status is consistently positively related to external capital problems, suggesting that investors do not regard involvement as a positive sign of productivity. A possible reason for this is offered by Mina et al. (2013), who suggest that being involved in international markets could lead to decreased transparency of the firm's operations and increased agency problems and thus discourage investments. The last firm-specific variable is internal human capital, which, in most cases, is positively related to external capital problems. This variable suggests that more highly educated employees increase the probability of experiencing problems, which is in accordance with Mina et al. (2013).

The odds ratio for the first region-specific variable suggests that manufacturing firms located in areas where the ratio of establishments per bank branch is high have larger problems of acquiring external capital, possibly due to larger competition for the region's financial supply. The odds ratio for the second, the regional wealth, indicates that firms located in wealthier rural and metropolitan regions are less likely to experience external capital problems. This finding could be due to a larger regional supply; however, this does not hold in urban regions, where the opposite is observed.

4.3 Sensitivity analysis

One factor that is not considered in our model is previous innovative behaviour, which could be relevant as the firms in the CIS survey have reported whether they have financial constraints hindering their innovation processes. In addition, many studies have concluded that firms that have innovated processes learn from those processes and use their accumulated knowledge to generate future innovations (Geroski, Van Reenen, & Walters, 1997; Malerba, Orsenigo, & Peretto, 1997; Roper & Hewitt-Dundas, 2008). The problem in the CIS data is that all questions are asked during the same period, but we want to know their past behaviour. To remedy that problem, we add information from the previous CIS survey covering the 2006-2008 period. The disadvantage with adding this information, and the reason we opted for not using this as our main model, is that we lose 30-51 percent of the sample. The largest losses are in the urban and rural service sectors, where over half of the observations disappear. Nevertheless, we add the information as a robustness check; the results are presented in Table 4.

In most cases, the results regarding the access to financial capital are the same in this model, particularly for the bank-related variables. The largest difference is observed for the age variables, where age is now consistently negatively related to external capital problems. The odds ratio for the previous innovation status consistently shows a positive relationship with external capital problems. This finding contradicts the reasoning that previous success is more likely to induce future success and reduce the perceived risk of investors.

Another potential disadvantage with our main model is that the firms may experience changes in the distance to financial intermediaries during the period the CIS survey covers, as the respondents state how they experienced the whole period from 2008-2010. In those cases where the bank relocates, it is impossible to separate the effect from the distance in 2007 and the changes occurring in the subsequent years. To remedy that problem, we also estimate our model on samples where we have excluded firms that have their nearest bank branch relocating during the 2008-2010 period.

Unfortunately, this exclusion was not possible to do for venture capital firms, as the whole industry was rapidly relocating during this period. Approximately 82 percent of the firms in the data set experienced a change in distance to its nearest venture capital firm. Hence, excluding those firms would result in a loss of most of the sample; instead, we excluded the distance to the nearest venture capital firm from those estimations. These results are also presented in Table 4 and confirm the previous results regarding the access to financial capital, particularly regarding the access to banks. All odds ratios that are significantly different from one indicate that a longer distance to the nearest bank branch is positively associated with the probability of experiencing external capital problems.

Table 4. Regression results for the main variables from alternative specifications displayed as odds ratios.⁹

ALTERNATIVE SPECIFICATION	VARIABLES	Metropolitan regions		Urban regions		Rural regions	
		Manuf.	Services	Manuf.	Services	Manuf.	Services
Controlling for previous innovation status in CIS 2008	Dist. to nearest bank branch	2.992*** (0.677)	0.948 (0.213)	0.607*** (0.0952)	2.317*** (0.754)	1.271*** (0.0905)	1.664*** (0.266)
	Dist. to nearest Almi office	0.911 (0.153)	1.184 (0.138)	1.502*** (0.147)	0.743* (0.131)	0.874** (0.0532)	1.065 (0.185)
	Dist. to nearest VC firm	1.303 (0.273)	0.449*** (0.0738)	1.091 (0.0927)	1.256 (0.248)	1.178** (0.0948)	0.427*** (0.105)
	Banks per municipality	1.151 (0.110)	0.727*** (0.0603)	0.898 (0.222)	0.757 (0.458)	1.103 (0.126)	0.578 (0.197)
	Observations	242	206	273	91	563	74
	Excluding firms whose nearest bank relocated during 2008-2010	Dist. to nearest bank branch	2.663*** (0.570)	0.788 (0.143)	1.142 (0.174)	1.447* (0.298)	1.206*** (0.0749)
Dist. to nearest Almi office		0.719*** (0.0661)	0.767*** (0.0493)	1.033 (0.0989)	0.855 (0.0945)	0.993 (0.0523)	0.918 (0.0803)
Banks per municipality		1.230** (0.110)	0.681*** (0.0422)	0.569*** (0.0970)	0.367*** (0.106)	0.852 (0.0864)	0.495*** (0.121)
Observations		281	276	283	145	699	132

5 Conclusions

The purpose of this paper is to examine whether the distance to financial intermediaries relates to firms' perception that attracting external capital is an obstacle to perform innovations. This question is particularly important, as firms may need external capital to finance their innovative activities (Canepa & Stoneman, 2008; B. H. Hall et al., 2016).

We fulfil this purpose by utilising a question regarding external capital difficulties from the 2010 wave of the Community Innovation Survey, covering the 2008-2010 period for Swedish firms. This question was combined with independent variables from 2007, where our main variables of interest were the Euclidean distance to the nearest bank, as well as the change of this distance between 2003 and 2007, the nearest distance to an Almi office, and the nearest distance to a venture capital firm. In addition, we added two regional financial variables, the number of banks in the municipality and the number of establishments per bank in the same municipality, to provide information about the total supply in the region in addition to the distance to one of the available branches.

Our hypothesis that increased distance to financial intermediaries is associated with larger external capital difficulties is generally rejected for venture capital firms and Almi offices. Conversely, the hypothesis is confirmed for banks, particularly in rural areas, where firms appear to be more dependent upon geographical proximity to transfer relevant information. As is shown, the results for firms in the rural areas confirms the hypothesis, and the results for firms in metropolitan and urban areas are more mixed. This finding suggests that one cannot claim that geographical proximity is necessary in general; however, that does not mean that it is unimportant for certain groups or regions.

In summary, it appears that our hypothesis that increased distance to financial intermediaries is associated with larger external capital difficulties is rejected for some types of financial institutions. In general, the hypothesis is confirmed for banks, particularly in rural areas, where firms appear to be more dependent upon a geographical proximity to transfer relevant information. This confirmation partly supports previous studies such as Lutz et al. (2013), Degryse and Ongena (2005), and Fritsch and Schilder (2008). In certain cases, it is not necessarily the distance to the one closest bank that is relevant but the total supply of banks in the municipality, which is in accordance with Degryse and Ongena (2005) and (Beck et al., 2004).

It is important to note is that this study is of a cross-sectional nature; it is therefore difficult to make any causal claims about the effects of the relocation of banks that have been prominent in Sweden during the last two decades. If more waves of the CIS with the question regarding

hindrances for innovation activities, as the one used here as a dependent variable, were available, a longitudinal study could be conducted to follow these firms over time. Another interesting means to examine the issue would be to utilise actual firm level investment information, similar to what was done by Mina et al. (2013).

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¹ In total, 87 percent of the firms that were granted a loan during 2009-2011 obtained it from a bank. Only four percent obtained their loan from a private individual, such as a family member or friend, while eight percent obtained their loan from another source, such as micro-finance institutions or government-related sources.

² Almi is a state-governed institution that provide loans, venture capital, and advisory functions to both start-ups and established firms (Almi, 2016).

³ The four Swedish-owned commercial bank corporations—Swedbank, SEB, Nordea, and Handelsbanken—hold together about 70 % of the market, depending slightly upon type of service (Bankföreningen, 2010).

⁴ Hotels and restaurants, as well as agriculture and forestry, construction, and the public sector are excluded.

⁵ In theory, these firms would not be included in the CIS at all, but as the reference point for the stratification was done a few years after our measure point (2007), there were a few such firms included in the data set.

⁶ This variable is heavily correlated with population size or wage sum, and including two of these in the model results in very large VIF values. To avoid that problem, only the number of bank branches was included. Correlation matrices can be obtained from the authors upon request.

⁷ Personal contact with a representative from the agency confirmed that the location of offices has been stationary for many years and would not induce a problem in this study.

⁸ To avoid inclusion of the same firms several times, all firms belonging to the 2-digit code 64 are excluded from the CIS data set as study objects.

⁹ The full tables can be obtained from the authors upon request.