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Cost of Debt of SMEs and Local Credit Market Characteristics in Slovakia

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Too-Much-Branching: Cost of Debt of SMEs and Local Credit Market Characteristics in Slovakia*

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Abstract

We investigate nonlinear effects of bank branch saturation on SME costs of debt at regional level in Slovakia over the period 2013-2019. We adopt the two-step approach by firstly constructing an empirical model of bank branch localization, and then analyzing effects of positive and negative deviations from the optimal level of market saturation. We employ panel model with random effects in the first step and panel model with fixed effects in the second step with bootstrapped standard errors. We observe the 'too-much-branching' phenomenon with no effect of bank branch saturation in over-branched regions, but negative effect in under-branched regions. Firms mostly affected by this phenomenon are middle-sized, domestically owned, operating in low-tech industries and with better creditworthiness. Bank market characteristics tend to matter for pricing of firm's debt in over-saturated markets.

Keywords: costs of debt, bank branch localization, too-much-branching, quasi IV-2SLS estimator

JEL Codes: R11, R12, G21

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1 Introduction

Some people might consider the 'brick-and-mortar' bank branch to be an obsolete concept destined to become extinct. Almost every decade, it has been predicted that technology will render the physical presence of banks unnecessary (Petersen and Rajan, 1994, 2002). The COVID pandemic has only added more fuel to this argument. Concerns regarding loss of efficiency, the newest technological advancements, the regulatory environment and greater pressure from FinTech competitors have caused many countries to witness substantial redesign of their bank networks (Alessandrini et al., 2009a; Ho and Berggren, 2020; Galardo et al., 2021).

However, the bank branch has yet to be replaced as the primary source of soft information with an intrinsic spatial dimension (Papi et al., 2015). In addition, the bank branch often fulfils other important roles aside from its core function since it contributes to the accumulation of regional social capital (Calcagnini et al., 2019) or the physical manifestation of financial inclusion, drawing attention to uneven geographical development (Leyshon et al., 2008). The bank branch still represents an important distributional channel, the closure of which can have severe consequences for the local economy. This fact has been recently illustrated by several studies showing that bank branch closing is estimated to have an adverse effect on SME lending (Nguyen, 2019), household financial situations (Tranfaglia, 2018), or firm formation (Ho and Berggren, 2020).

That closing one of the most important distributional channels in the banking industry is associated with substantial negative effects for the local economy is something to be easily expected. On the other side of the spectrum, however, a few recent studies have also reported either zero or even a negative impact of improved access to local banking services on SMEs' economic performance and activity (Hasan et al., 2017), regional output (Rafaj and Siranova, 2020), or local economic development (Bernini and Brighi, 2018). For London, the global hub of international banking, Zhao and Jones-Evans (2017) show that the closer the proximity to the nearest bank branch, the *higher* the probability of being loan-constrained is.

The previously listed examples from the relevant literature point to the possible existence of nonlinearities in the relationships between financial access and relevant economic categories. A similar concept linking financial development and economic growth in a nonlinear fashion, the 'too-much-finance' phenomenon, has already been studied in the macro-finance literature (Arcand et al., 2012; Sahay et al., 2015; Aizenman et al., 2015). In the context of our study, we term this approach the 'too-much-branching' phenomenon.

To investigate the nonlinear effects of access to finance via a 'brick-and-mortar' bank branch network, we adopt a two-step approach. In the first step, we construct an empirical model of bank branch localization that allows us to calculate fundamentally driven optimal levels of credit market saturation. We use a panel data model with random effects and bootstrapped standard errors. Determinants of this optimal level are drawn from the literature on bank branch localization (Gobbi and Lotti, 2004; Alama and Tortosa-Ausina, 2012; Backman, 2015; Chen and Strathearn, 2020; Galardo et al., 2021). In the second step, we separately investigate the effects of positive and negative deviations from the optimal level of market saturation (under- and over-branching) on the costs of firms' bank debt. In addition, we analyse the specific features of SMEs that are associated with the most severe effects of limited access to finance and the qualitative characteristics of banks that could potentially mitigate the consequences of the 'too-much-branching' phenomenon. We again employ a panel data model with random effects and bootstrapped standard errors. From an econometric point of view, the two-step approach also has the advantage of mitigating the effect of potential endogeneity in the presence of the changing nature of the underlying bank network structure.

Our contribution to the relevant literature is therefore fourfold.

First, we extend the literature investigating the effects of the local credit market structure (Hasan et al., 2017) and its qualitative characteristics (Jackowicz and Kozlowski, 2016) on local economic performance (Rafaj and Siranova, 2020), firm performance (Jackowicz and Kozlowski, 2016; Hasan et al., 2017), or firm financing (Hasan et al., 2021) by introducing the nonlinear view based on local credit market saturation. We argue that to better understand the heterogeneous impact of bank network structure on the local economy, one must examine deviations from local equilibria.

Our main variable of interest is the cost of debt of SMEs, approximated by the effective interest rate calculated from firms' financial statements. Hence, we expand the relatively scarce literature analysing the determinants of costs the of debt of the SME sector conditional on bank market characteristics (Degryse and Cayseele, 2000; Bonini et al., 2016; Hasan et al., 2017; Bonfirm et al., 2020).

While constructing the empirical model of bank branch saturation, we also build upon the bank network literature (Zhao and Jones-Evans, 2017). By doing so, we provide further empirical evidence that geographical elements still play an irreplaceable role in shaping the bank branch network structure.

Finally, we also complement the recent literature on the effects of bank branch closures on local economies (Nguyen, 2019; Ho and Berggren, 2020) by indirectly controlling for bank branch closings when introducing adverse shocks to local credit market equilibria.

To study the nonlinear relationship between local credit market structures and SMEs' costs of debt, we focus on the Slovak banking system because of a few of its distinct features. First, the system consists solely of multi-market banks owned by foreign banks belonging to international banking groups. Without the presence of any truly local or domestic bank, we work with a relatively homogeneous set of institutions in terms of their objectives and offering a relatively homogeneous product, which can distinguish themselves by their prices or additional services. Second, all banks share the same access to hard information via participation in the two registries collecting data on all customers at bank and non-bank financial institutions. With the same competitive advantage for hard information, local bank branches should truly serve as the main sources of soft information that can distinguish the performance of one bank from another. Third, sufficient within-country heterogeneity in terms of overall bank efficiency remains present; thus, the qualitative characteristics of banks present in the local markets could affect local credit provisioning.

Last but not least, the bank branch network in Slovakia has undergone substantial redesign over the last couple of years. Not only did we observe a decrease in the total volume of bank branches, but also these closings have gone hand in hand with their concentration in a few local regional centres. In addition to the socio-economic determinants, the geographical element has apparently played an irreplaceable role. This recent trend allows us to investigate not only how the overall redesign responded to different economic incentives but also whether this concentration has possibly left behind regions with limited access to financial services (or even infamous 'banking deserts' by Kashian et al. (2018)).

To test our hypotheses, we combine four types of data. First, we use an official dataset of all bank branch locations in Slovakia for 2013–2019, published by the National Bank of Slovakia and collected at the LAU1 level. Second, we use LAU1-level data from the Slovak Statistical Office for regional characteristics. Third, we employ annual financial data for SMEs from the FINSTAT company. Finally, we gather annual financial data for the majority of bank brands operating in Slovakia from their official balance sheets and income statements.

Our results suggest that the 'too-much-branching' phenomenon is present in our data. SMEs located in regions with less saturated markets suffer from higher loan rates; however, SMEs in over-saturated markets do not benefit from any additional bank branch opening beyond the optimal level. Conversely, the qualitative characteristics of banks become important for determining the size of loan rates in the case of over-branched regions, which is not true for SMEs located in under-branched regions. We further confirm that while the recent redesign of the bank branch network can be explained by standard socio-economic considerations, it also follows a strong spatial pattern. Contrary to a priori assumption, inter-bank competition has not seemed to play a decisive role in shaping the new network structure.

Our findings convey important policy-oriented messages. The relocation or closure of bank branches in under-branched regions could be associated with higher loan rates charged predominantly to domestic SMEs operating in industries with smaller innovation potential. The combination of low levels of financial literacy in Slovakia (OECD, 2015), lowering the volume and quality of soft information and limiting access to financial consultation services, could potentially create an explosive mixture, especially if coupled with increasing levels of indebtedness. Conversely, a reduction in bank branch network size could be associated with an improvement in bank efficiency without worsening the credit conditions if it occurs in fully saturated markets.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature, specifically focusing on determinants of bank branch location and introducing the concept of the 'too-much-branching' phenomenon. Section 3 describes the Slovak banking system and its links to SMEs' financing. Section 4 outlines the empirical methodology and introduces our data. The findings and policy implications are discussed in section 5, and section 6 concludes the paper.

2 Literature Review

The majority of the relevant literature has investigated the effect of access to finance, approximated by a density-based measure of bank branch per capita or area size, on local economic development and firms' and households' economic situations. Within this group, special attention has been paid to the financial needs of the SME segment, for which bank funding often represents the core external source of finance (Kraemer-Eis et al., 2020); at the same time, the SME sector suffers from the most severe information asymmetries (Petersen and Rajan, 1994). Although there exist various concepts of financial inclusion (Demirgüç-Kunt and Klapper, 2013), in what follows, we focus on the spatial aspect of access to finance since it is the primary objective of our paper. While it has been argued that with the advent of technological innovations in the banking industry, the 'tyranny of distance will be slowly broken' (Petersen and Rajan, 2002), the findings of many recently published studies have shown otherwise (Zhao and Jones-Evans, 2017; Nguyen, 2019; Ho and Berggren, 2020).

Spatial distance in banking networks can acquire different forms (Papi et al., 2015): (i) operational distance, i.e., distance between customer and bank branches; (ii) functional distance, i.e., distance between local bank branches and bank headquarters; and (iii) inter-bank distance, i.e., distance between the local bank branch and nearest competitors. Spatial properties of bank network structures have been analysed with respect to local bank financial management (Aguirregabiria et al., 2019), credit provisioning (Nguyen, 2019),

bank effectiveness (Bernini and Brighi, 2018), and bank performance (Hirtle, 2007). The most comprehensive literature review is offered in Papi et al. (2015).

The lending conditions faced by SMEs have been the prominent subjects of such studies (see Alessandrini et al. (2009a)). Among the most recent contributions, Nguyen (2019), studying the impact of bank branch closings in US regions on local access to credit, concluded that closings of bank branches have led to a persistent decline in local small business lending. However, the impact was limited to a geographical radius of approximately five miles. For Sweden, Backman (2015) and Ho and Berggren (2020) confirm that an increase in the distance to the nearest bank branch negatively affects new firm formation. Zhao and Jones-Evans (2017) conclude that greater functional distance between bank headquarters and branches exacerbates the credit constraints faced by local SMEs. Bonfirm et al. (2020) investigate loan conditions charged to borrowers that switch banks following the closure of branches of incumbent banks. The authors report that in competitive local markets, when switching occurs under normal circumstances, the 'switchers' enjoy benefits in the form of an interest rate discount, but in the case of a forced transition, when banks close branches, firms simply do not benefit. Aguirregabiria et al. (2019) report strong local bias due to no fund-transferring policy among bank branches located in different regions yet belonging to one bank group. As a consequence, the authors identify the presence of spatial discrimination, which materializes due to management decisions made individually at the bank branch level and negatively affects the volume and price of available financial funds in local markets. Rafaj and Siranova (2020) show that operational distance does not affect the economic growth of city regions, except for regional city centres.

There have been only a handful of studies that, aside from quantitative measures of bank market saturation (i.e., size and competition) and spatial distance, have investigated the effects of bank-specific qualitative characteristics on SMEs' economic performance in local regional conditions. Jackowicz and Kozlowski (2016) find no evidence that the economic characteristics of cooperative banks in Poland boost SMEs' performance. This finding was confirmed by Hasan et al. (2017), who report that bank fundamentals within local banking markets turned out to be insignificant for firm creation, access to credit or economic performance. Hasan et al. (2021) provide empirical evidence on the causal link between the presence of healthy local banks and SMEs' vulnerability to other local banks' financial troubles in Poland. Rafaj and Siranova (2020) indicate that local bank markets in Slovakia populated by more efficient banks less oriented towards traditional lending activities result in higher regional productivity. However, this finding could be driven by the popularity of the mortgage-based banking business model when a dramatic increase in the provision of mortgages to households could have introduced the potential crowding-out effect of the private investments of local firms.

In terms of data coverage, most of the studies in this area of research have been country specific, focusing on major advanced economies (Backman, 2015; Zhao and Jones-Evans, 2017; Nguyen, 2019; Aguirregabiria et al., 2019; Bonfirm et al., 2020; Ho and Berggren, 2020) or other developed economies (Kozlowski, 2016; Hasan et al., 2017; Rafaj and Siranova, 2020; Hasan et al., 2021), with some notable exceptions such as China (Yu et al., 2017), Mexico (Canales and Nanda, 2012), Argentina (Berger et al., 2001) or India (Berger et al., 2008). To the best of our knowledge, Qi et al. (2018) and Beckmann et al. (2018) are the only studies spanning multiple countries and years; they use panel data covering 22 European countries (Qi et al., 2018) or a selection of CESEE countries (Beckmann et al., 2018).

Regarding the sources of data, on the supply side, the literature has used either credit survey data

(Petersen and Rajan, 2002; Alessandrini et al., 2009a) or data obtained from a single lender (Agarwal and Hauswald, 2010). In general, these studies have estimated the probability of receiving a loan (Zhao and Jones-Evans, 2017) and, if extended, its size and price (Bonini et al., 2016). On the demand side, financial data from firms' balance sheets are usually matched with data on bank branch penetration at the municipality level (Zhao and Jones-Evans, 2017; Bernini and Brighi, 2018; Rafaj and Siranova, 2020) and often take advantage of geocoded data to build their own geographically defined radius (Jackowicz and Kozlowski, 2016; Hasan et al., 2017; Nguyen, 2019; Hasan et al., 2021).

Contrary to the size of a firm debt (Hasan et al., 2021), volume of regional lending (Nguyen, 2019), or probability of receiving a bank loan (Alessandrini et al., 2009a; Agarwal and Hauswald, 2010; Zhao and Jones-Evans, 2017), the cost of debt, i.e., the effective interest rate paid by a firm of existing stock of bank loans, has been relatively under-represented in the bank branching literature. The business and management literature usually neglects the role of credit markets completely, e.g., Minnis (2011); Howorth and Moro (2012); Bauwhede et al. (2015).

Among the bank branching literature, Bonini et al. (2016) investigate the costs of a firm's debt conditional on the level of credit market competition in the US. The authors conclude that relationship lending reduces the interest markup imposed by banks, while concentration in the credit market results in the opposite. Hasan et al. (2017) show that cooperative banks, which presumably rely more on soft information, are able to provide less expensive loans to small businesses. Bonfirm et al. (2020) report that while switching of a loan provider during normal conditions introduces an economically significant discount to the loan rate, change following the closure of a bank branch does not. Degryse and Cayseele (2000) reveal that the loan rate increases with the duration of a bank—firm relationship. However, the purchase of other information-sensitive products from a bank at a comparatively lower price substantially decreases the overall loan's interest rate. Additionally, the second effect, i.e., discount at other services, usually dominates the former. Howorth and Moro (2012) support the lock-in argument by providing evidence that the length of a borrower-bank relationship increases the costs of bank debt.

A unique study by Agarwal and Hauswald (2010) argues that there exists a trade-off between the probability of extending a loan and the price of a loan. While closer proximity of a firm to a bank, i.e., operational distance, improves this probability, it happens at the cost of an increased loan rate offered by a bank. However, the increase in the loan rate can be mitigated if a competitor is located nearby. Thus, the subjective proprietary intelligence collected by local bank branches more likely than not depends on borrower proximity and allows for easing credit constraints faced by SMEs at the expense of higher debt costs. These findings are in some sense reminiscent of a study by Berger et al. (2005), who show that adoption of a scoring system increases availability and volume of credit but at the expense of a higher loan rate.

2.1 Determinants of Bank Branch Location

Access to finance, as understood in its spatial dimension, is inevitably related to bank management decisions regarding the localization of a bank branch. Factors influencing this decision include economic and socio-demographic determinants on the demand side, as well as elements of spatial distance on the supply side.

Starting with the demand side factors, Leyshon et al. (2008) reveal that closures of branches of banks and building societies in Britain tend to be disproportionately concentrated in poorer areas. Hence, economic and socio-demographic attributes that carry information about the potential opening (closing

down) of a bank branch include population density, demographics, population growth rate, size of the employed population and household income. Chen and Strathearn (2020) find that in Canada, income is positively and significantly correlated with bank-branch density, which is refuted in the case of US banks in rural areas (Cohen and Mazzeo, 2010). Gobbi and Lotti (2004) document that in Italy, population size and overall level of economic development approximated by GDP per capita increase the probability of bank entry. Backman (2015) argue that banks might also be more attracted to regions with a larger proportion of the younger population that have a greater degree of entrepreneurial activities than to a region with a larger share of the retired population. Chen and Strathearn (2020) confirms this hypothesis in the case of large banks but shows that smaller banks tend to concentrate in markets with older populations due to their higher demand for physical presence and sizeable accumulated income. In Italy, Galardo et al. (2021) reveal that the broadband diffusion used as a proxy for technological progress increases, while a large presence of small firms and altitude decreases the probability of a bank branch closure. For Spain, Alama and Tortosa-Ausina (2012) report that population size (domestic and immigrants), unemployment rate, various indicators of economic activity, tourism included, and population density serve as significant determinants of the number of branches located in municipalities.

Turning our attention to supply side factors, the literature has been scarce. According to findings in Gobbi and Lotti (2004) working with data from Italy, pre-entry higher concentration signalling higher gross margins in lending activity attracts de novo entries (i.e., new banks are established), while entry of outside institutions through the opening of branch offices is preferred when competition in the market is fierce, and the costs of obtaining proprietary information are high. In this case, banks aim to exploit business opportunities in which proprietary information is likely to be less important than in lending. Again, for Italy, Galardo et al. (2021) show that banks in Italy are more prone to close branches in those areas where other proprietary branches and competitors' branches are closer. This finding indicates that banks tended to close branches, especially in those areas where their proprietary networks were relatively more populated, and the competition was fiercer. For US banks located in rural areas, Cohen and Mazzeo (2010) report that bank branch networks are larger in more competitive markets, as banks increase their network to discourage entry of a new competitor or as a winning strategy in more saturated markets. However, this finding is valid only for the entry of multi-market banks; the competition among single-market banks is not characterized by expansion in their branch networks. Chen and Strathearn (2020) distinguish between small and large banks. They show that smaller banks have a tendency to move away from areas where large banks have a foothold, but larger banks often do not target areas where small branches and credit unions are already dominant players. This result infers a strong presence of a possible lock-in effect for both types of banks.

Bank networks are often characterized by high levels of spatial auto-correlation (Crocco et al., 2010; Yu et al., 2017). Qi et al. (2018) develop a theoretical model explaining concentration patterns in bank network structures based on the information sharing hypothesis. In this model, greater clustering of bank branches might attract more customers due to a broader assortment of financial services (market-size effect), thus introducing benefits from participation. In contrast, inter-bank proximity also implies more vigorous competition (price-cutting effect). Depending on which effect dominates, banks prefer either clustering or spreading out their networks. Information sharing can help attract distant borrowers and increase the likelihood of entering new markets that were previously not active. Domestic banks (owners of soft information) are predicted to cluster more, while foreign banks (relying on hard information) are predicted to expand to

new localities.

2.2 'Too-much-branching' or Nonlinear Effect of Bank Branching

From a different perspective, nonlinear effects of banking sector size have been recently emphasized in the macro- and micro-finance literature. To investigate the effects of financial development, authors usually work with fairly heterogeneous samples consisting of developed and developing countries (Valickova et al., 2015) or regions characterized by major regional disparities (e.g., Silva et al. (2019)). This heterogeneity allows for the existence of a significant relationship between finance and the variable of interest. However, country-specific studies focusing on developed countries might see their level of financial development sufficiently close to the optimum to practically exclude any hypothesized positive effect of marginal increase in financial development.

The 'too-much finance' paradigm in macro-finance literature ventures even further by postulating that over-financialization of an economy brings about adverse economic consequences (Arcand et al., 2012). Sahay et al. (2015) and Aizenman et al. (2015) show that many developed economies are beyond the turning point where financial deepening still contributes positively to economic development and could pose a significant threat to the financial stability of the system itself. The complementary concept, the 'competition-fragility' hypothesis, argues that a high level of competition in the banking sector could lead to greater fragility of banks because they are forced to loosen up credit standards and to extend credit to less creditworthy customers. Using individual bank-level data, Kocisova (2018) showed that above a certain threshold, a higher market share of an individual bank in Slovakia is likely to exacerbate individual risk-taking behaviour and could be detrimental to the performance of the banking sector. Similar observations have been made by Kozlowski (2016) and Jackowicz and Kozlowski (2016) for Polish cooperative banks that have reported worsening asset quality in the presence of a large number of competitors.

A very similar pattern, which we term 'too-much-branching', has been found in a few studies from the bank branch literature. Hasan et al. (2017) report a negative but not statistically significant effect of access to finance on SMEs' economic activity in Poland. A negative but not statistically significant effect is also reported in Rafaj and Siranova (2020) for the economic growth of city regions in Slovakia. According to Bernini and Brighi (2018), bank branch expansion in Italy has had a negative impact on local bank efficiency and was exacerbated by increased distance between headquarters and branches, except for banks with more diversified product offerings. While efficient local banks and larger credit availability indeed boost the local economy, simple expansion of the branch network generated a negative effect in terms of local economic development. Last but not least, Zhao and Jones-Evans (2017) find that while smaller functional distance in the UK alleviates the financial constraints faced by SMEs, closer operational proximity *increases* the probability of being loan constrained, especially in the case of firms located in London.

We place these findings into context by relating them to the literature examining the links among spatial distance, competition and bank branch localization discussed in the previous subsections.

First, increasing the network size beyond its optimal level might be perceived as a winning strategy to either prevent entry of a new competitor or force some of the less powerful incumbents to leave the market (Cohen and Mazzeo, 2010). Signalling the willingness to engage in severe competition via bank branching could even serve as a pre-emptive tool in markets with already established dominant players. Similar behaviour was observed in Chen and Strathearn (2020).

Additionally, multi-market banks (often foreign banks) that do not possess soft information at a scale similar to that of local banks (domestic banks) are more likely to engage in a strategy of expanding their network size over multiple markets, while local banks tend to concentrate their activities in individual local centres (Qi et al., 2018). As relationship lending is often associated with improving the probability of credit approval, yet at the expense of increasing its price (Agarwal and Hauswald, 2010; Howorth and Moro, 2012), markets populated with local banks might face an increase in average costs of debt, while expecting to be compensated by the provision of less expensive additional services (Degryse and Cayseele, 2000) or services for which proprietary soft information is less needed Gobbi and Lotti (2004).

As shown by Bernini and Brighi (2018), the effect of bank network expansion is often conditional on other fundamental factors, such as the efficiency of the banking business. Assuming that diseconomies of scale enter the equation, expanding the bank branch network could introduce long-term adverse effects on individual banks, as well as the local economies populated by them. Last but not least, if bank branch expansion serves just as a necessary condition for establishing fiercer competition in credit provisioning, all adverse consequences of 'too-much finance' discussed previously are to be expected to materialize sooner or later.

3 Slovak Banking System and SME's Access to Credit

he Slovak banking system is considered to be stable and sound yet strongly homogeneous, with the share of foreign banks surpassing 90% of the total assets and capital of the entire banking sector. In the majority of cases, local banks are owned by either some of the systematically important international banks or by multinational investment groups oriented towards investments in the CESEE region (Cupic and Siranova, 2018). In contrast to Poland (Hasan et al., 2017) or other large economies (Agarwal and Hauswald, 2010; Cohen and Mazzeo, 2010; Galardo et al., 2021; Chen and Strathearn, 2020), no truly local banks are present; thus, all banks can be considered multi-market banks. There are no regulatory barriers to entry due to being part of the European common market.

This fact creates a rather uniform environment when a homogeneous product is offered by an entity that aims to distinguish itself from its competitors by lower prices or by offering extra services. Since 2004, all banks have had access to the common registry of bank information that allows for sharing of hard information regarding clients' credit histories across all banking institutions. The registry is linked to the non-banking registry of client information gathering information on clients at non-bank financial institutions. As a result, all banking institutions share and have access to hard information about the majority of customers in the credit market in Slovakia. The only way to gain an advantage, aside from the quality and range of offered services, is therefore the possession of soft information.

In terms of efficiency, while the transition period at the end of the last century brought about a substantial increase in efficiency, most Slovak banks have not yet achieved costs and price efficiency comparable to those of banks in Western countries (Kocisova, 2016). Substantial heterogeneity within countries ensues from either oversized business models sometimes carrying over the legacy of the past (Cupic and Siranova, 2018) or differences in the managerial decision-making process (Boda et al., 2014). The overall distribution of more and less efficient banks has remained unchanged, even in the post-crisis period (Grmanova and Ivanova, 2018).

Banks' business models almost uniformly rely on the traditional relationship-based model of banking, with a primary focus on financing the needs of the general population (mortgages and consumer loans) and the SME segment. For all intents and purposes, the Slovak capital market is practically nonexistent; thus, commercial banks represent the only reliable source of middle to large investment funding. Banks serve as the source of corporate financing to predominantly domestically owned firms or foreign-owned SMEs. Large businesses belonging to international conglomerates often rely on intra-company lending and hence are intentionally cut off from local bank funding (Siranova, 2019). This combination creates an explosive mixture that could greatly expose the Slovak economy to external financial shocks.

Table 1: Bank Branches per Year and Bank Group

	Privat	**Postova**	**SLSP**	**VUB**	**OTP**	**UniCredit**	**CSOB**	**Tatra**	**Sberb.**	**Prima**	**Total**
2013	12.00	41.50	305.25	244.25	73.50	74.25	136.75	160.25	41.75	85.00	1,175
2014	12.00	42.00	298.75	239.50	71.75	75.00	136.50	175.75	43.00	98.00	1,192
2015	12.00	44.00	297.75	235.50	70.00	73.25	136.25	182.75	42.75	104.50	1,199
2016	12.00	46.00	292.00	236.75	70.50	71.00	133.00	195.50	42.00	108.50	1,207
2017	12.50	48.75	282.00	237.00	70.50	63.00	131.25	188.25	19.75	119.50	1,173
2018	12.00	51.25	261.50	220.75	72.00	57.25	131.00	181.25	0.00	124.50	1,112
2019	13.00	50.00	242.50	204.50	68.00	57.00	128.25	174.25	0.00	123.75	1,061
Average	12.21	46.21	282.82	231.18	70.89	67.25	133.29	179.71	42.38	109.11	**1,175**
Share	1.04%	3.93%	24.07%	19.67%	6.03%	5.72%	11.34%	15.29%	3.61%	9.29%	**100.00%**

Table 2: Bank Branches and Bank Groups Descriptive Statistics

	# of bank groups						**# of bank branches**				
	Mean	**St.Dev.**	**Min**	**Max**	**HHI***		**Mean**	**St.Dev.**	**Min**	**Max**	**HHI***
2013	6.65	2.38	2.00	10.00	8.73	**2013**	16.31	27.05	2.50	224.00	13.63
2014	6.69	2.32	3.00	10.00	8.22	**2014**	16.56	27.11	3.00	224.25	12.59
2015	6.74	2.29	3.00	10.00	8.02	**2015**	16.65	27.25	3.00	225.00	12.15
2016	6.78	2.35	3.00	10.00	8.05	**2016**	16.77	26.76	3.00	215.75	12.34
2017	6.76	2.40	3.00	10.00	8.26	**2017**	16.28	25.10	3.00	194.50	13.23
2018	6.44	2.09	3.00	9.00	8.74	**2018**	15.44	23.23	3.00	178.50	13.25
2019	6.40	2.13	3.00	9.00	8.97	**2019**	14.74	21.28	2.75	161.75	13.10
Average	**6.64**				**8.43**	**Average**	**16.11**				**12.90**

Note: HHI* denotes Herfindahl-Hirschman index normalized to be bounded in range 0-100.

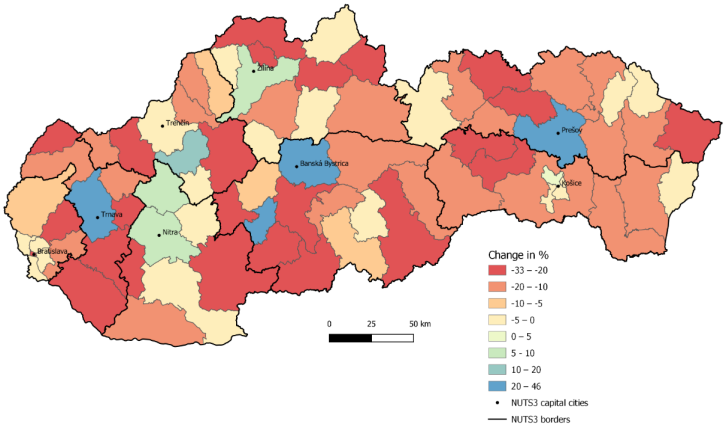
On the one hand, financing of internationally owned large firms representing the backbone of Slovak industry is highly sensitive to their parents' economic situation. On the other hand, the SME segment is dependent on local bank funding, yet the majority of local banks in the hands of international banking institutions' spillovers from external shocks affecting their parents might again be transmitted to the local firms, affecting their access to credit.[1] However, in terms of payment services, the Slovak banking sector is highly innovative, often serving as a hub of international banks for testing various e-banking applications before their release to other countries in their bank networks (Siranova, 2019).

In general, the bank networks of individual bank groups in Slovakia have undergone some significant restructuring in terms of their activities and division of competences. Currently, most of the major players have their banking network designed as a three-tier structure. Local bank branches serve households and

[1]The existence of spillover effects within international banking groups from home to host countries in the CEE region has been found in, e.g., Allen et al. (2017) or Gattini and Zagorisiou (2016). However, establishment of the Vienna initiative as a response to the high exposure of the CEE region to their parents in Western Europe helped to avoid a credit crunch and decreased the credit reduction during the last financial crisis (Temesvary and Banai, 2017)

small and medium enterprises and are located in practically all Slovak regions. Corporate centres servicing important large businesses are located in core regional cities and do not necessarily overlap with eight official NUTS 3 regional centres. Each bank has its headquarters located exclusively in the capital city, Bratislava, where most of the back-office activities are concentrated.[2]

Figure 1: Growth rate of bank branches at LAU1 regions in 2019 versus 2014



Examining the bank network structure based on their physical presence (Table 1), the market is dominated by two major bank houses, namely, Slovenska sporitelna (ERSTE group) and VUB bank (Intesa Sao Paolo group), accounting for almost half of the total bank branches. The next three banks cover an additional one-third of the market, leaving a relatively small proportion to the last five competitors. On average, local markets are serviced by six to seven out of ten different bank brands in a total of sixteen bank branches (Table 2).

Until the peak in 2016, the overall number of bank branches increased at a steady pace. However, in the subsequent three years, the reduction in the total number of bank branches resulted in the lowest bank penetration during the period observed. While part of this finding can be explained by the take-over of one of the foreign banks (Sberbank), a significant part of the reduction is to be attributed to the ongoing bank network rationalization in the three dominant bank houses (SLSP, VUB, Tatra). These tendencies have brought about a steady increase in market concentration measured at the bank group or bank branch levels (Table 1).

Figure 1 provides an overview of changes in the total number of bank branches across regions. From a spatial point of view, the largest decrease in the number of bank branches between 2014 and 2019 occurred in the LAU1 regions of northern and northeastern Slovakia (Tvrdosin, Stara Lubovna, Sabinov), southern Slovakia (Krupina, Velky Krtis), and southwestern Slovakia (Dunajska Streda, Sala). In these areas, banks reduced their branches by more than 25% over 5 years. Conversely, the increase in the number of bank branches occurred mainly in the NUTS 3 regional capitals (Trnava, Nitra, Zilina, Banska Bystrica, Presov), with the exception of Bratislava, where banks reduced their numbers of branches.

The official causes of this rebranching activity occurring around 2017 are not widely known and

[2]Some of the processing units focusing predominantly on accounting, reporting and loans processing activities are located outside of Bratislava.

have not yet been thoroughly researched, and only colloquial evidence exists. Fiercer competition from the flourishing fintech industry, which has been further supported by legislative changes (adoption of Payment Service Directive 2 effective as of 2018), is likely to have played a role. The advent of new e-banking services as a result of ongoing technological progress has traditionally been the most common culprit (Petersen and Rajan, 2002). A few studies have also pointed out the ongoing need to cut costs to increase efficiency since the traditional model of banking has been thoroughly exploited. A prolonged period of highly accommodative ECB monetary policy has surely exerted additional pressure on the standard banking model, which is very prevalent in Slovakia (Siranova, 2019).

It is necessary to note that this picture is not unique for Slovakia. The concentration of banks in financial centres, dynamic regions and metropolitan areas has become a trend practically all over the world (Alessandrini et al., 2009b). Other countries have also reported a decrease in banking network size due to ongoing redesign of their local banking networks (Ho and Berggren, 2020; Galardo et al., 2021). However, closing down of local bank branches, which often serve as educational sites, and shifting to potentially easier access to finance via e-banking services, when coupled with lower levels of financial literacy in Slovakia (OECD, 2015), could create an explosive mix of increased indebtedness and a greater likelihood of individual defaults.

3.1 SMEs Landscape in Slovakia

Small and medium-sized enterprises have a dominant position in the field of job creation in the Slovak economy. According to a report on the SME sector, the share of small and medium-sized enterprises in employment in the corporate economy reached 73.8%, and in terms of total employment in the Slovak economy, it reached 59.2% (SBA, 2020).

The regional structure of SMEs has long been characterized by a dominant representation of business entities based in the Bratislava region (NUTS3). According to the report, approximately one in five (21.9%) active small and medium-sized enterprises had their registered offices in this region. Other regions contribute more evenly to the total number of SMEs, from 9.4% (Trencin region) to 13.7% (Zilina region). The number of small and medium-sized enterprises increased in all regions of the Slovak Republic, while the most significant increase was recorded in the Presov region (by 8.0%). In contrast, the smallest growth was achieved by the Banska Bystrica region (by 4.5%).

The highest level of business activity is achieved in the districts (LAU1) of the cities of Bratislava and Koice and in selected districts of northern Slovakia. The regions of western and northern Slovakia are generally characterized by a higher rate of business activity, while a low rate of business activity is achieved in eastern Slovakia and southern central Slovakia. Business activity rates for all LAU1 regions, calculated as shares of SMEs together with self-employed persons in an economically active population, provide Figure 2. A similar picture emerges when depicting regional unemployment rates (Figure 3. LAU1 regions with the highest unemployment rates are located in the southeast and northeast parts of Slovakia. As a point of interest, the underlying spatial distribution of economic activity or unemployment levels does not seem to be mirrored by the observed change in the bank branch network (Figure 1).

According to the report assessing the challenges faced by SMEs in Slovakia, most SMEs do not consider access to credit to be a major issue. Credit card and bank account overdrafts represent the main sources of funding for the SME sector, followed by leasing and bank credit. However, compared to the

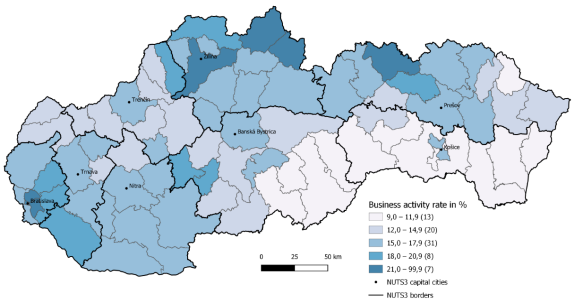


Figure 2: Business activity rates across LAU1 regions in 2019

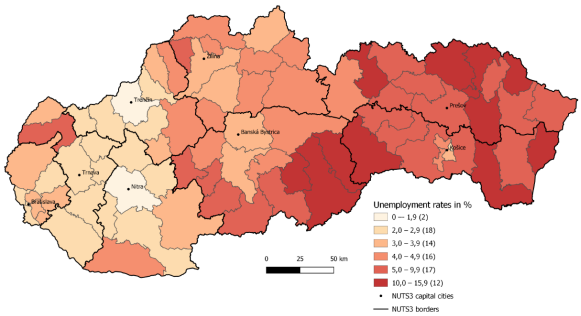


Figure 3: Unemployment rates across LAU1 regions in 2019

EU28 average, 34% of the Slovak SMEs report that they could not receive the requested amount of bank credits, while the EU-28 average was 17%. Costs related to financing, including interest rates and prices, are mentioned as the most important limiting factor by 17% of SMEs (SBA, 2017). The reduction in bank branch saturation after 2017 came at a time when we observed a stagnating trend in the volume of short-term firm loans and only a modest growth rate in the long-term investment loan segment (Siranova, 2019).

4 Model and data

Empirical evidence shows that the relationship between financial and economic development is likely to be bi-directional (Horvath et al., 2017). Financial access itself might be driven by the economic considerations of bank managers who might prefer to locate their offices in regions with better growth potential (see Section 2.1).

This choice introduces potential endogeneity bias due to the existence of reverse causality when a measure of financial access might be correlated with the error term in the benchmark regression. To address either endogeneity or omitted variable bias, authors usually employ an instrumental variable (IV) 2SLS approach (Alessandrini et al., 2009a). As a suitable instrument, the historical spatial distribution of bank branches exogenous to local economic conditions is used (Alessandrini et al., 2009a). Information regarding mergers and acquisitions in the area was exploited in Nguyen (2019). Instead of the full-fledged IV-2SLS estimator, some authors have used fitted values from the first-stage regressions that are imputed into the main specification (Bonini et al., 2016).

In our case, we develop a quasi IV-2SLS approach by first estimating a stylized model of theoretical local credit market size and then imputing deviations from equilibrium values into the main equation of interest, the cost of debt regression. While not normally used in the relevant regional science literature, a similar approach is applied in the macroeconomic literature that addresses the effects of exchange rate under-/over-valuation (Baxa and Paulus, 2020; Fisera and Horvath, 2021). This two-step approach enables us to introduce fundamentally different treatments of the effects of over- and under-branching on local firms' cost of debt, hence addressing the potential nonlinearity stemming from the 'too-much-branching' hypothesis. It

also allows us to investigate the effects of economic geography, which could have been one of the important factors in bank branch network redesign in Slovakia in recent years (Section 3).[3]

In our selection of fundamental variables affecting the optimal size of a local credit market, we draw upon the literature in Section 2.1.[4] In addition to the demand-size factors, we also incorporate a few measures of spatial distance. The unexplained part of the real credit market size should therefore reflect the reduction (or expansion) of the bank branch network that exceeds standard socio-economic considerations. In our interpretation, it captures the implicit belief of bank management about the significance and potential of a local market such that it is willing to engage in otherwise unfounded competition, often at the expense of loss of effectiveness. Alternatively, since our geographically based indices might provide just a limited view of spatial distance in bank networks, unexplained artefacts from the 1^{st} level equation will simply reflect other reasons why 'too-much-branching' might be present (Section 2.2).

4.1 Modelling the local credit market size

We model the optimal size of the local bank market by the following regression:

$$Branch_{j,t} = \beta_0 + \beta X_{j,t-1} + \tau_t + \epsilon_{j,t} \tag{1}$$

where $branch_{j,t}$ stands for the number of bank branches in region j at time t expressed in natural logarithms, $X_{j,t-1}$ vector of control variables characterizing region j at time $t-1$, and τ_t time dummies. $\hat{Branch}_{j,t}$ stands for the estimated optimal size of credit market j at time t derived as fitted values from [1].

The over-/under-branching index for a region j at time t is calculated as follows:

$$Index_{j,t} = Branch_{j,t} - \beta X_{j,t-1} \tag{2}$$

and measures the percentage deviation of the actual local credit market size from its equilibrium value. If positive (negative), the local credit market in region j at time t is larger (smaller) than fundamentally optimal. We split $Index_{j,t}$ into two parts, with $Index^{+}_{j,t}$ measuring the extent of over-branching in local market j at time t if positive and zero otherwise and $Index^{-}_{j,t}$ measuring the extent of under-branching in local market j at time t if negative and zero otherwise.

When estimating the two-stage regression with IVs, the choice of instrumental variable represents one of the key steps in this procedure. By assumption, the variable serving as the IV needs to be correlated with the instrumented variable, but its expected value conditional on the error term in the benchmark equation should be zero. In the context of our study, the instrumental variables X_{jt} must be correlated with the number of bank branches in the region $Branch_{jt}$ but should not be affected by the firm's cost of debt IR_{ijt}.

Given the literature review in Section 2.1, we hypothesize that the optimal number of bank branches

[3]Econometrically speaking, there are various ways to account for nonlinearity in empirical models (introduction of squared terms, quantile regression, regime-switching models, etc.). However, in all these cases, the turning point is derived empirically and without any a priori theoretical knowledge about the data-generating process. We decided to proceed differently, as we also need to understand the underlying conditions under which the turning point materializes in the data.

[4]In what follows, we refer to the credit market size as a measure of the total number of bank branches located in a defined geographical unit, i.e., one municipality. This term should not be confused with the credit market size used in different contexts and when defined as total bank credit or total bank assets in a given market.

will be driven by three groups of factors: (i) size and quality of market demand; (ii) economic characteristics of local markets; and (iii) spatial aspects. The size and quality of market demand is approximated by the total population in the region, share of young (20-29 years) and middle-aged (40-49 years) populations, and share of tertiary educated persons. Economic characteristics are captured by the unemployment rate. The rural or urban character of a region is approximated by a population density indicator.

The spatial element measures the distance of the NUTS 3 centre to the regional centre, i.e., NUTS2 regional centres, in minutes and is calculated as an inverse of squared distance, with eight NUTS2 regional centres in Slovakia attributed a value of one. This step is performed to capture the overall trend in centralization of bank networks to regional centres discussed in Section 3. The second spatial element measures the size of a population living in neighbouring regions. It is calculated as the weighted average of population size in all other regions with weights derived from the inverse of squared distance in kilometres between regions. Officially declared borders of municipalities often do not correspond to socio-economically defined regions (Hornak and Kraft, 2015). To account for this discrepancy, we include population in the nearest regions as a possible extension of the local market. Functional distance is accounted for by inclusion of the inverse distance between the LAU1 city centre and the capital city, Bratislava (Section 3). The inter-bank distance is approximated by the Herfindahl-Hirschman index (HHI) calculated at the local LAU1 level.

Aside from the unemployment rate and HHI, all explanatory variables can be considered strictly exogenous due to their either geographical or demographic nature. The possible endogeneity of the unemployment rate and HHI is addressed by introducing a time lag. Additionally, all other regressors enter the specification in [1] in lags.

We estimate equation [1] by a static panel model with random effects at the NUTS 3 level. This model is preferred over the fixed effect estimator due to the inclusion of time-invariant conditioning variables, such as distance to the regional centre and the quality of human capital. We use robust bootstrapped standard errors with 200 repetitions. If applicable, control variables enter the regressions in logarithmic form.

4.2 Determinants of cost of debt

The general construction of our baseline static panel model is illustrated by the following:

$$IR_{i,j,t} = \alpha_0 + \mu_0 \hat{Branch}_{j,t} + \mu^{+} Index^{+}_{j,t} + \mu^{-} Index^{-}_{j,t} + \gamma Z_{i,j,t-1} + \delta W_{j,t-1} + \rho_i + \tau_t + \epsilon_{j,t} \qquad (3)$$

where $IR_{i,j,t}$ stands for the effective interest rate paid on bank debt in firm i located in region j at time t, $\hat{Branch}_{j,t}$ estimates the optimal size of credit market j at time t, $Index^{+}_{j,t}$ is the index of over-branching in local market j at time t, $Index^{-}_{j,t}$ is the index of under-branching in local market j at time t, $Z_{i,j,t-1}$ is the vector of firm i characteristics located in region j at time $t-1$, $W_{j,t-1}$ is the vector of control variables characterizing region and local credit market j at time $t-1$, ρ_i are firm dummies, and τ_t are time dummies.

Due to their time-invariant nature, qualitative firm characteristics are expressed in the form of dummies and introduced in interaction with $Index^{-}_{j,t}$. A similar approach was used in Baxa and Paulus (2020).

Equation 3 is therefore adjusted in the following fashion:

$$IR_{i,j,t} = \alpha_0 + \mu_0 \hat{Branch}_{j,t} + \mu_k^{-(+)} \sum_{k=1}^{K} Q_{i,j,t}^{k} Index_{j,t}^{-(+)} + \alpha Z_{i,j,t-1} + \delta W_{j,t-1} + \rho_i + \tau_t + \epsilon_{j,t} \qquad (4)$$

where $Q_{i,j,t}^{k}$ stands for qualitative characteristic k of firm i located in region j at time t.

Models [3] and [4] are estimated by a static panel model with firm and time fixed effects. We use robust bootstrapped standard errors with 200 repetitions. To address potential endogeneity between firm characteristics, local conditions and measures of the cost of debt, we use lagged explanatory variables. If applicable, control variables enter regressions in logarithmic form.

The determinants of the cost of debt can be grouped into two categories: (i) firm-level characteristics; and (ii) regional characteristics. Given the relevant literature (Section 1), a list of control variables is summarized in Table A1. Qualitative firm indicators enter the regression [4] in the form of dummies with all categories represented by one individual dummy variable.

To control for regional characteristics, we include the unemployment rate.[5] In the Slovak Republic, economic conditions characterized by strong regional disparity resulting from, among other factors, the structural unemployment and aggregate socio-economic characteristics of a region can be embodied by this indicator. A similar approach was used in Hasan et al. (2017) in a Polish environment. However, as part of the robustness checks, we either add or replace this indicator with other relevant economic variables.

Finally, we investigate the effect of the qualitative properties of local credit markets by introducing the interaction between the measure of under-/over-branching and the financial conditions of banks operating in a region. The baseline equation [3] is adjusted in the following fashion:

$$IR_{i,j,t} = \alpha_0 + \mu_0 \hat{Branch}_{j,t} + \mu_l^{-(+)} \sum_{l=1}^{L} C_{j,t}^{l} Index_{d}^{-(+)}{}_{j,t} + \alpha Z_{i,j,t-1} + \delta W_{j,t-1} + \rho_i + \tau_t + \epsilon_{j,t} \qquad (5)$$

where $C_{j,t}^{l}$ stands for qualitative characteristic l of a local credit market j at time t, $Index_{d}^{+}{}_{j,t}$ stands for a dummy based on the index of over-branching in local market j at time t (1=over-branching, zero otherwise), and $Index_{j,t}^{-}$ stands for a dummy based on the index of under-branching in local market j at time t (1=under-branching, zero otherwise).

A list of qualitative local credit market properties is drawn from the relevant literature (Section 2).[6] We use simple averages constructed by averaging over indicators calculated for banking groups present in the local credit market.[7] We introduce qualitative measures in a step-by-step fashion due to their mutual interconnectedness, especially in the Slovak banking environment (Subova and Kocisova, 2019).

[5] The remaining regional characteristics are used to derive the equilibrium level of the local credit market size.

[6] In the Slovak banking environment, all banks adopt a multi-regional strategy and compete across regional borders. For this reason, we do not distinguish between smaller and larger banks, as suggested in the relevant literature (Agarwal and Hauswald, 2010; Cohen and Mazzeo, 2010; Galardo et al., 2021; Chen and Strathearn, 2020).

[7] As a robustness check, we also use weighted averages of respective indicators with weights derived from shares of bank brands calculated by the total number of bank branches in a given region.

4.3 Dataset description

For our analysis, we combine a few datasets from different sources. Data are collected on a yearly basis and cover the 2013-2019 period. A detailed description of the variables is provided in Table A1. The classification of firms using the NACE classification based on technology-demanding industries is presented in Tables A2 and A3.

The information regarding the number of bank branches operating in specific regions is obtained from the official database published by the National Bank of Slovakia, and the data are transformed from quarterly to annual frequency by averaging them over the respective year. The information regarding the localization of units of bank branches that do not operate as foreign subsidiaries in Slovakia is omitted from the database.[8]

In our dataset, we observe only one acquisition (Sberbank). As no new unit is created, but the existing bank network is taken over by the new owner, this event does not need to be specifically addressed in our sample. Altogether, we identify ten (nine after acquisition) individual bank groups operating in Slovakia during the period analysed.

The dependent variable, the effective interest rate IR reflecting the cost of bank debt, is calculated as follows:

$$IR_{t+1} = interest_{t+1}/loans_t \tag{6}$$

where IR_{t+1} stands for the effective interest rate, $interest_t$ is the total interest payments over t, and $loans_t$ is the stock of bank debt at the end of the year t. We omit the firm-region subscripts for the sake of brevity. In line with previous studies (Bauwhede et al., 2015), the effective interest rate is computed as the one-year-ahead interest expenses divided by the end-year stock of bank debt.

Firm-level data are gathered from the private FINSTAT database, which collects information from the publicly available Register of Financial Statements operated by Ministry of Finance of the Slovak Republic. Regional characteristics were collected from the Statistical Office of the Slovak Republic.

The FINSTAT database covering 2013-2019 contains data for more than 166,000 enterprises. However, the quality of the data varies from year to year since several indicators for individual enterprises were not available due to the lack of submitted financial statements. Our representative sample of small and medium enterprises from the FINSTAT database was selected by the following process that closely follows that used in Bauwhede et al. (2015).

1. We select enterprises that report data for all relevant variables during the entire monitored period;
2. We select only firms that fulfil all of the following conditions valid for small and medium enterprises during the entire monitored period:
   - total assets are less than EUR 43 million;
   - total gross sales are less than EUR 50 million;
   - total number of employees is less than 250;

[8] Units of bank branches that do not operate as foreign subsidiaries are located almost exclusively in the two largest cities in Slovakia: Bratislava and Kosice. The exclusion of these bank branches affects the estimates of optimal local credit market size predominantly in the case of Bratislava when we constantly report an under-branching situation. As a point of interest, we consider this fact to be a positive feature of our model because it is able to identify missing elements that would explain the, at first sight, counter-intuitive findings. The entire Bratislava region is excluded from the second step regression.

3. We include only joint stock and limited liability companies;
4. We exclude enterprises:
   - with officially declared numbers of employees less than three;
   - with total amounts of assets that increased more than 3 times over the period of 6 years;
   - that report zero or negative value of employee costs, equity or total assets or negative value of fixed assets any year during the period monitored;
   - that report greater value of debt than total assets;
5. We exclude enterprises with official headquarters located in Bratislava and Kosice[9];
6. We use trimming at three standard deviations and exclude companies that report abnormal values for employee costs.

As pointed out by Bauwhede et al. (2015), the measure of the effective interest rate calculated from firm-level data, as in [6], is prone to outliers. To mitigate their impact, we exclude firms that report observations beyond the 5^{th} and 95^{th} percentiles. Finally, we select only firm/year observations when we observe an increase in the annual growth rate of the stock of bank loans. We considered this increase to be an indication of a new loan received during the observed time period. Hence, the calculated effective interest rate should reflect the most recent or updated information regarding relevant control variables.

After performing these steps, we ended with a representative sample of a total of 2047 enterprises, for which we recorded 4127 observations.[10] From the point of view of spatial distribution, we have at least one SME represented in each of the 72 LAU1 regions. The minimum number of observations per LAU1 region is seven, with an average value of 59 observations per county. The distribution of our observations at the LAU1 level strongly resembles the population distribution in Slovakia (correlation coefficient is 0.82). The distribution of firms in our sample according to their qualitative characteristics is summarized in Table A4. Descriptive characteristics of our sample are provided in Table A5.

5 Results

5.1 Modelling the determinants of local credit market size

Table 3 summarizes the regression results used to model the optimal size of the local credit market. All of the specifications include basic fundamental determinants of credit market size as specified in the relevant literature. The second to fifth columns report the results from specifications with at least one spatial element included. The overall general trend in the decrease in the number of bank branches is captured by yearly time dummies (not reported), which are statistically significant in all cases.

As hypothesized, the size of a credit market is fundamentally driven by the size of the local population, creating demand for financial services (POP variable). Positive and statistically significant signs associated

[9]Papers studying regional differences in Slovakia often exclude the Bratislava region from the sample due to its very unique socio-economic environment. For further discussion, see, e.g., Nemethova et al. (2019). We decided to exclude the city of Kosice, which fulfils a role very similar to Bratislava for the eastern and southeastern parts of Slovakia. Our sample thus includes only regions that are more homogeneous in terms of their socio-economic characteristics.

[10]One can consider our cleaning algorithm to be rather strict. Similarly, an uncompromising elimination procedure was applied in Bauwhede et al. (2015) for Belgian SMEs. The authors report a final representative sample including 2692 Belgian SMEs which is similar to our number of SMEs even though Belgium is twice the size of Slovakia in terms of population.

with population size confirm this theoretical assumption. As a point of interest, the estimated elasticity is close to unity, with a 1% increase in the size of the local population leading to an almost 1% increase in the number of bank branches serving the needs of local customers.

Table 3: Determinants of local credit market size

Dependent = ln(BRANCH)	(1)	(2)	(3)	(4)	(5)
Ln(POP)	0.937***	0.914***	0.912***	0.945***	0.838***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
YOUNG	-9.152***	-9.266***	-9.466***	-9.210***	-9.360***
	(0.002)	(0.001)	(0.002)	(0.003)	(0.000)
EXPERT	-0.462	-0.254	-0.433	-0.082	0.049
	(0.897)	(0.933)	(0.901)	(0.980)	(0.987)
TERT	3.304***	2.405*	2.718**	2.446*	2.150*
	(0.005)	(0.059)	(0.050)	(0.053)	(0.091)
ln(DENS)	0.053	-0.013	0.001	-0.008	0.094
	(0.592)	(0.898)	(0.995)	(0.935)	(0.39)
UR	-0.005	-0.005	-0.005	-0.007	-0.007
	(0.308)	(0.309)	(0.313)	(0.170)	(0.217)
R.MIN		0.369***	0.355**	0.339***	0.368***
		(0.007)	(0.012)	(0.008)	(0.007)
BA.MIN			-0.187		
			(0.906)		
HHI				0.441	
				(0.343)	
Ln(POP) spatial					-0.226**
					(0.037)
Constant	-7.396***	-6.822***	-6.840***	-7.284***	-3.320
	(0.000)	(0.000)	(0.000)	(0.000)	(0.144)
Time dummies	YES	YES	YES	YES	YES
N	432	432	432	432	432
R within	0.341	0.342	0.342	0.367	0.342
R between	0.914	0.923	0.924	0.914	0.930
R overall	0.907	0.916	0.916	0.908	0.923

Notes: * denotes significance at 10-percent, ** denotes significance at 5-percent, *** denotes significance at 1-percent. P-values in parentheses. All time-varying explanatory variables are lagged by one year.

Additionally, a larger share of the young population (YOUNG) results in a smaller number of bank branches, while the share of the population at the peak of their economic activity (EXPERT) does not.[11] There are three main lines of thoughts here. First, the young population is usually more prone to utilizing the newest technological advancements and online bank applications notwithstanding, hence leading to a lower need for bank physical presence. Second, under Slovak conditions, the share of the young population is higher among the Roma population due to their higher level of fertility, which, once associated with a lower level of education and total income, results in a lower likelihood of locating a bank branch in the particular municipality. Third, from a demographic point of view, a higher level of childbirth is empirically observed among families with a more conservative background and lower levels of income. Since these characteristics also tend to often be correlated with the rural nature of the environment, they can result in a predicted smaller credit market size. As part of the robustness checks, we address these hypotheses, confirming that in the Slovak case hypotheses, two and three are more likely to play a decisive role in explaining the size of the local credit market.

As expected, a larger share of people with tertiary educations positively influences the decision of

[11] We also alternate among the use of different age groups (people older than 65+, middle-aged population, etc.), but the findings for other age groups were not significant.

a bank to locate a branch in their vicinity. Given its overall higher level of income, prevalence in major economic centres or greater proclivity to start its own businesses, this population group tends to play a significant role in bank branch localization. Two other regional characteristics (density and unemployment rate) are reported to not have any statistically significant effect on the size of the local credit market. This finding could indicate that banks aim to service the general population, regardless of the economic situation in a region. However, once the local presence of a bank is established, the *individual* socio-economic situation is likely to be considered when negotiating the contract conditions.

The effect of the spatial dimension on the localization of bank branches is investigated by introducing the functional distance to local regional centres (R. MIN) and to bank headquarters (BA.MIN). While the distance to headquarters does not bear any additional information regarding the size of the local credit market, NUTS 3 regional centres can be characterized by a greater presence of bank branches. Consequently, the more distant that the region is, the smaller that the local credit market is. This factor has gained importance over the last few years and reflects the ongoing transformation of bank network structures, characterized by the concentration of activities in regional centres.[12] The difference between official administrative borders of regions and the concept of economic space is analysed by the introduction of distance-weighted population living in neighbouring regions (Ln(POP) spatial). Contrary to our expectations, rather than expanding the supply of customers, closeness to more populated regions places local markets into a larger disadvantage. As a complement, this factor thus shows that one local credit market might suffer from two types of geographical curse at once – by being located further away from the regional centre *and* by being surrounded by more populated neighbours.

From a spatial perspective, bank branches and other financial services are often concentrated in cities and urban environments due to agglomeration effects. Lee and Luca (2019) found strong evidence that firms in larger cities are less likely to perceive credit constraints due to the benefits of being in a 'larger' city. Large cities can allow competition between financial providers, the development of specialist finance, better availability and measurement of collateral and the sharing of specialized information (Storper and Venables, 2004). A combination of these factors makes it easier for firms in large cities to access finance than those elsewhere. However, the large city bias in access to finance should decline as economies develop.

The measure of local competition (HHI) among different bank brands, i.e., operational distance, does not affect the overall size of a local credit market. Under Slovak conditions, we therefore cannot confirm the findings of other studies showing that operational distance can affect the decisions of banks to expand or reduce their bank network (Gobbi and Lotti, 2004; Galardo et al., 2021). The reconstruction of bank networks in Slovakia tended to follow a simpler pattern by selecting the local regional centres (NUTS3 level centres or LAU1 centres with socio-economic potential), where bank branches were concentrated and drawn from other neighbouring regions. Hence, geographical aspects might have dominated the question of local competition, creating stronger spatial auto-correlation, as predicted in Qi et al. (2018).

Figures 4 and 5 depict values of the over-/under-branching index at the beginning (2014) and end (2019) of our sample, respectively. As illustrated, no apparent pattern in deviations from local credit market equilibrium is observed. If anything, seven of the eight regional centres (with the exception of Zilina) can be characterized as local markets with smaller than optimal levels of credit market saturation. In contrast, three regions (Poprad, Prievidza and Dunajska Streda) report the highest levels of over-branching while not

[12] By reducing the sample to pre-2017 years, the results show that the factor (R. MIN) loses its statistical significance.

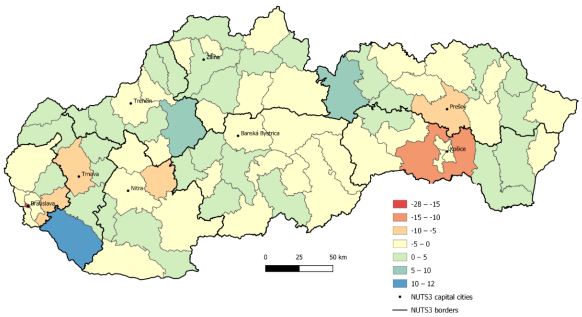


Figure 4: Deviations from optimal local market size across regions in 2014

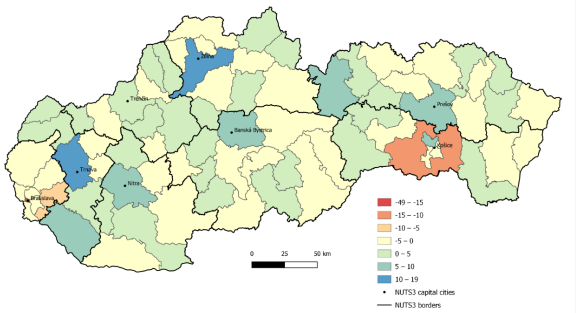


Figure 5: Deviations from optimal local market size across regions in 2019

Note: Deviations are calculated as difference between actual number of bank branches and fitted value, as formulated in [2].

serving as NUTS 3 regional centres at all. Division between the rural south and urban north, or the more economically developed west and the less developed east, is also not apparent since the conglomerations of more regions with over- or under-branched local credit markets are distributed all across Slovakia. Finally, most of the NUTS 3 regional centres are surrounded by regions reporting both negative and positive INDEX values, hence not yet showing a tendency to concentrate bank branches at the NUTS 3 regional level.

Quite the opposite picture is depicted for 2019. Six regional centres (Kosice, Presov, Banska Bystrica, Zilina, Nitra, Trnava) increased their bank branch saturation substantially, having achieved the highest levels of over-branching in the sample. One other local centre (Trencin) shifted from an under- to over-branching situation in local credit markets. At least in two cases (Zilina, Trnava), this increase in saturation has negatively affected some of the neighbouring regions. It is necessary to point out that over-saturation in local credit markets of major regional cities is observed *even after* controlling for further unspecified benefits of serving as the geographical regional centre (factor R. MIN in Table 3). Hence, the concentration of banking activities in local regional centres over the last few years is likely to have been driven, aside from other socio-economic factors, by further unspecified optimization policies for individual bank brands.

However, as was valid for 2014, there is no straight division observed between west and east or between north and south, and the location of under- or over-branching local markets is distributed relatively evenly across Slovakia.

5.2 Determinants of cost of debt

In Table 4, we provide results from the benchmark regression as defined in equation [3]. After controlling for firm-level and regional characteristics, the role of local bank market saturation, e.g., access to finance, is investigated in a step-by-step fashion.

The estimated optimal credit market size is not associated with any change in the effective interest rate. As argued, the local markets already operate optimally; hence, the current access to finance is sufficient to cover all past and future needs of economic agents in the region, and we should not observe any significant difference even if moving along the optimal trajectory following it over time. Stated differently, it is simply not possible to be more or less optimal. A similar finding is reported by Rafaj and Siranova (2020), with

the authors noting no statistically significant effect of credit market saturation on regional economic output in Slovakia.

Table 4: Determinants of effective interest rate

Dependent = IR	(1)	(2)	(3)	(4)	(5)
ln(BRANCH) predicted	-0.024	-0.023	-0.024	-0.017	-0.023
	(0.667)	(0.712)	(0.668)	(0.760)	(0.693)
INDEX negative	-0.045***	-0.043***	-0.045***		-0.044***
	(0.003)	(0.005)	(0.001)		(0.005)
INDEX positive		-0.003		-0.017	-0.005
		(0.804)		(0.182)	(0.696)
INDEX negative spatial			-0.001		0.000
			(0.888)		(0.956)
INDEX positive spatial				-0.001	-0.001
				(0.620)	(0.562)
l.UR	-0.025	-0.023	-0.027	-0.021	-0.027
	(0.738)	(0.796)	(0.743)	(0.788)	(0.748)
l.LIAB	0.001*	0.001*	0.001*	0.001*	0.001
	(0.083)	(0.095)	(0.063)	(0.075)	(0.124)
l.LEV	0.015	0.015	0.015	0.015	0.015
	(0.160)	(0.211)	(0.140)	(0.153)	(0.140)
l.EMP.PR	-0.003	-0.003	-0.003	-0.004	-0.003
	(0.472)	(0.489)	(0.456)	(0.400)	(0.469)
l.FIX	0.008	0.008	0.008	0.008	0.008
	(0.446)	(0.451)	(0.431)	(0.344)	(0.439)
l.ln(TA)	-0.093**	-0.093**	-0.093*	-0.098**	-0.093**
	(0.022)	(0.035)	(0.056)	(0.025)	(0.033)
l.ln(TA) sq.	0.003*	0.003*	0.003	0.003*	0.003*
	(0.053)	(0.082)	(0.110)	(0.061)	(0.079)
l.ROE	-0.007	-0.006	-0.007	-0.006	-0.006
	(0.901)	(0.931)	(0.929)	(0.937)	(0.922)
l.ln(AGE)	-0.027	-0.027	-0.027	-0.027	-0.027
	(0.157)	(0.198)	(0.13)	(0.126)	(0.165)
Constant	0.943***	0.943***	0.944***	0.966***	0.948***
	(0.004)	(0.007)	(0.009)	(0.005)	(0.006)
Time dummies	YES	YES	YES	YES	YES
N	4127	4127	4127	4127	4127
N firms	2047	2047	2047	2047	2047
R within	0.091	0.091	0.091	0.089	0.091
R between	0.059	0.06	0.059	0.066	0.06
R overall	0.077	0.078	0.077	0.087	0.078

Notes: * denotes significance at 10-percent, ** denotes significance at 5-percent, *** denotes significance at 1-percent. P-values in parentheses. Firm and region specific control variables enter regressions with one-year lag. BRANCH predicted stands for fitted values of credit market size from specification [1]. Index measures difference between actual and equilibrium size of local credit market expressed in log of number of bank branches. Negative (positive) index assigns negative values of INDEX to regions with existence of under-branching (over-branching) and zero otherwise. Spatial INDEX is calculated as weighted average of INDEX values in neighboring regions with weights calculated as inverse of distance between regional centers in km.

However, a completely different picture is observed when focusing on deviations from the estimated optimum. While under-branching (INDEX negative) brings about an additional markup for firms located in affected regions, the opposite situation does not (INDEX positive). As it turns out, simple 'too-much-branching', while present, bears no additional costs or benefits in terms of the effective interest rate level. A similar result is also true for the spatial element when the effective interest rate does not seem to respond to the credit market situation in the nearest neighbouring regions (INDEX spatial).

The size of the negative markup is distributed rather unevenly. The calculated markup for the average under-branched local market amounts to 0.25 b.p., whilst up to 70% of firms face a markup of only 0.10

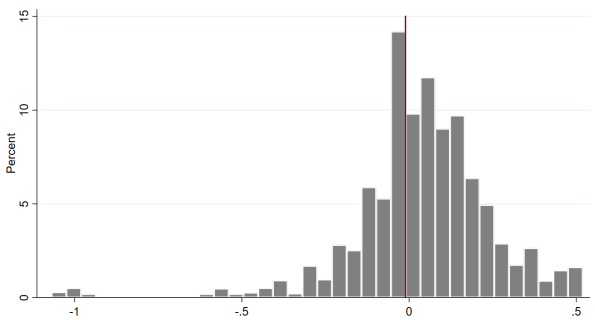


Figure 6: Histogram of deviations of local credit market size from its estimated optimal level (INDEX)

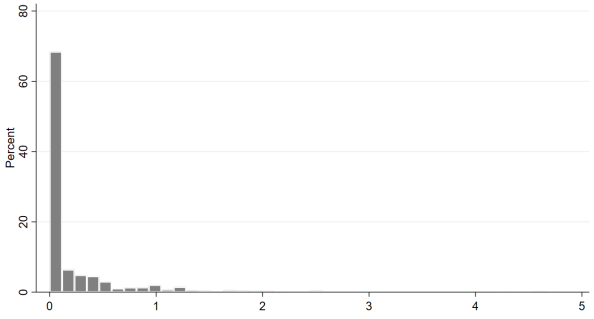


Figure 7: Histogram of estimated regional markups in regions with under-branched local credit markets (INDEX negative), in percent

b.p. (Figure 7). This finding simply reflects the empirical pattern observed in the data (Figure 6), in which most of the regions with lower credit market saturation are still located relatively close to their optimum. However, for firms located in regions with the smallest bank branch saturation, additional costs could accrue up to 2% (Kysucke Nove Mesto), 2.5% (Senec), or even an extreme value of 4.5% (Kosice-okolie). The estimated results are stable since the economic effect of under-branching (μ coefficient of -0.044) remains practically unaffected, even after removing observations of the top three under-branched regions from the sample.

The coefficient associated with non-bank liabilities indicates that a larger number of liabilities implies a higher effective interest rate. As discussed, we control for the size of non-bank liabilities because the interest payments entering equation [5] do not distinguish between interest paid on bank loans and other types of liabilities. For this reason, a positive association between non-bank liabilities and effective interest payments is expected and likely reflects interest payments related to loans other than bank loans. With respect to the remaining significant control variables, the size of SMEs measured by total assets is associated with a lower cost of bank debt, in line with Bonini et al. (2016) or Hasan et al. (2021). A negative sign, albeit statistically non-significant, associated with the age of a firm implies a smaller effective interest rate for more mature SMEs, as observed in Bonini et al. (2016). Our measure of leverage, the share of equity on total assets, shows a positive, yet again not statistically significant, effect on the costs of bank debt. A similar finding was reported in Hasan et al. (2021) and Bauwhede et al. (2015).[13]

Time dummies (not reported) show a steady decrease in the effective interest rate over time, which reflects the overall loose policy of the ECB during the monitored period. As indirect evidence, this finding confirms that the accommodative stance of monetary policy has been transmitted to firm loan rates, as also reported in other studies, e.g., Horvath et al. (2018).

All other control variables are highly statistically insignificant. Because we use a fixed effect estimator as in Bonini et al. (2016), contrary to the random effect estimator employed in Hasan et al. (2017), we hypothesize that the introduction of firm fixed effects renders many of the firm-specific variables statistically insignificant. This hypothesis might simply reflect the observation that unrevealed highly specific firm-level characteristics might be more important for the pricing decisions of bank institutions than adherence

[13]Hasan et al. (2021) and Bauwhede et al. (2015) calculated leverage as the ratio of debt to total assets and reported a negative coefficient. Our measure represents an inverse of their approach since we calculate leverage as the ratio of equity to total assets. Hence, our paper reports a positive coefficient.

to a more general group of firms. A similar observation is made by Agarwal and Hauswald (2010), who argue that credit to small businesses crucially relies on firm-specific subjective intelligence collected by loan officers during the origination process and, especially, on long-term lending relationships between banks and customers.

Next, we proceed by estimating the impact of time-invariant firm characteristics on price markup in regions with credit market sizes lower than the optimal level. As reported in Table 4, being located in a region with a less-than-optimal number of bank branches might impose an additional risk premium on the interest rate paid by a local firm, which is not the case for firms located in over-saturated regions. In Table 5, we present the results from specifications with interacted time-invariant firms while controlling for time dummies and firm and region characteristics.

Table 5: Determinants of effective interest rate - qualitative firm characteristics

Dependent = IR	(1)	(2)	(3)	(4)
INDEX neg * MICRO	-0.063***			
	(0.007)			
INDEX neg * SMALL	-0.004			
	(0.843)			
INDEX neg * MEDIUM	-0.075***			
	(0.000)			
INDEX neg * NACE1		-0.040**		
		(0.027)		
INDEX neg * NACE2		-0.076		
		(0.102)		
INDEX neg * NACE3		-0.046		
		(0.226)		
INDEX neg * NACE45		-0.048		
		(0.360)		
INDEX neg * OWN1			-0.048***	
			(0.001)	
INDEX neg * OWN23			-0.027	
			(0.449)	
INDEX neg * ALT1				-0.042**
				(0.017)
INDEX neg * ALT2				-0.039**
				(0.018)
INDEX neg * ALT3				-0.055**
				(0.012)
ln(BRANCH) predicted	-0.024	-0.023	-0.024	-0.023
	(0.728)	(0.686)	(0.689)	(0.681)
Constant	0.916***	0.941***	0.940***	0.936***
	(0.008)	(0.003)	(0.008)	(0.007)
Time dummies	YES	YES	YES	YES
Firm characteristics	YES	YES	YES	YES
Region characteristics	YES	YES	YES	YES
N	4127	4127	4127	4124
N firms	2047	2047	2047	2047
R within	0.094	0.091	0.091	0.091
R between	0.061	0.059	0.059	0.059
R overall	0.079	0.078	0.077	0.077

Notes: * denotes significance at 10-percent, ** denotes significance at 5-percent, *** denotes significance at 1-percent. P-values in parentheses. Firm and region specific control variables enter regressions with one-year lag. BRANCH predicted stands for fitted values of credit market size from specification [1]. INDEX measures difference between actual and equilibrium size of local credit market expressed in log of number of bank branches. Negative index assigns negative values of INDEX to regions with existence of under-branching (over-branching) and zero otherwise.

A positive yet nonlinear effect of firm size on the effective interest rate measured by the volume of

total assets was already confirmed in the baseline specification in Table 4. The size of a firm is thus an important factor influencing the cost of debt in regions with lower bank market saturation. Among the three distinct firm groups distinguished by the total number of employees, only the micro- and medium-sized enterprises seem to be influenced by their location, with medium-sized firms being affected economically to a greater extent than the others. In our sample, since medium-sized enterprises tend to rely on bank credit to the highest extent among all firms (average loans-to-assets ratio), limited access to finance might transform into a higher markup the most easily.

In terms of economic activity, a more sophisticated subject of production seems to protect against the adverse effects of under-branching in local credit markets (NACE2, NACE3, NACE45). In the presence of a local shortage of funds, the type of activity (low versus high tech) might serve as a signalling property informing the client about perceived creditworthiness. Naturally, banks would prefer extending their credit to clients with a lower likelihood of default and a higher expected yield. As a consequence, when credit is limited, SMEs operating in traditional industries characterized by lower value added will be forced to pay additional rents compared to markets with an abundance of bank funding. Alternatively, firms operating in medium- to high-technology industries that are often forced to work with and adopt the newest technological inventions often hire highly trained personnel. Thus, technologically skilled staff is more than able to compensate for local shortages of funds by being willing to try alternative sources of funding, thus forcing local banks to compete for this type of customer in the same way as in markets without limited access to finance. Finally, forward-looking banks that orient themselves towards searching for the highest yield within the scope of accepted risk could consider high-tech firms to be a worthy endeavour, therefore attempting to attract them by advantageous offers that overlook possible local regional bias.

We test the effect of foreign ownership on the cost of debt without any a priori expectations regarding its hypothesized impact. The statistically nonsignificant coefficient associated with the foreign ownership dummy might suggest that foreign ownership is likely to serve as yet another signalling factor for banking institutions, informing them about the potential credibility of a customer. As a consequence, SMEs with foreign ownership (OWN23) do not seem to suffer from higher interest costs, even in regions with limited access to credit funding. Conversely, domestic firms face additional risk premiums imposed by bank institutions operating in local markets with limited access to finance.

The standard Altman Z-score calculated by the FINSTAT company integrates various information from balance sheet and income statements to measure the extent of possible financial distress of a firm. In the case of firms located in regions with credit markets of less than optimal size, we report that even the lowest default probability will not protect against an increase in the cost of bank debt. If anything, the best-performing firms (i.e., with the highest Altman Z-score, ALT3) might even face the greatest markup; nevertheless, the difference in the calculated effective interest rate is rather negligible. Thus, considering the financial or economic situation, the impact of lower credit market saturation is relatively uniform across firms.

In the finally step, we introduce a few qualitative measures of the local credit market structure based on the financial conditions of banks operating in a region (specification [5]).

Local credit markets, populated by more efficient banks (ROA) with higher employee costs (UEC) that focus on the core business of extending loans (LTA) but often compensate for the decrease in interest rate by higher non-interest income (FTI), benefit firms by lowering their costs of debt. However, the positive

Table 6: Determinants of effective interest rate - bank brand characteristics

Dependent = IR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ln(BRANCH) predicted	-0.016	-0.017	-0.017	-0.016	-0.017	-0.013	-0.011	-0.01	-0.008	-0.009
	(0.743)	(0.760)	(0.779)	(0.790)	(0.756)	(0.808)	(0.856)	(0.850)	(0.880)	(0.870)
INDEX neg	-0.031*	-0.034**	-0.033**	-0.031*	-0.033**					
	(0.052)	(0.032)	(0.041)	(0.052)	(0.04)					
INDEX pos						-0.001	-0.001	0.000	0.001	0.000
						(0.962)	(0.963)	(0.994)	(0.951)	(0.987)
INDEX dummy * HHI	0.027					-0.041**				
	(0.123)					(0.021)				
INDEX dummy * ROA		0.003					-0.005**			
		(0.286)					(0.044)			
INDEX dummy * LTA			0.004					-0.008**		
			(0.258)					(0.037)		
INDEX dummy * FTI				0.010					-0.017**	
				(0.232)					(0.039)	
INDEX dummy * UEC					0.010					-0.018*
					(0.272)					(0.054)
Constant	0.935***	0.936**	0.936***	0.936***	0.936***	0.956***	0.950***	0.949***	0.942***	0.947***
	(0.005)	(0.012)	(0.004)	(0.009)	(0.007)	(0.002)	(0.009)	(0.008)	(0.004)	(0.005)
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm characteristics	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Region characteristics	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	4127	4127	4127	4127	4127	4127	4127	4127	4127	4127
N firms	2047	2047	2047	2047	2047	2047	2047	2047	2047	2047
R within	0.092	0.091	0.091	0.091	0.091	0.091	0.09	0.09	0.091	0.09
R between	0.064	0.064	0.065	0.065	0.065	0.069	0.07	0.07	0.071	0.07
R overall	0.085	0.085	0.086	0.086	0.086	0.092	0.093	0.094	0.096	0.094

Notes: * denotes significance at 10-percent, ** denotes significance at 5-percent, *** denotes significance at 1-percent. P-values in parentheses. Firm and region specific control variables enter regressions with one-year lag. BRANCH predicted stands for fitted values of credit market size from specification [1]. INDEX measures difference between actual and equilibrium size of local credit market expressed in log of number of bank branches. INDEX dummy characterizes region by the value of its INDEX (1=non-zero value of INDEX, otherwise).

side of competition in quality is seen only in markets with a sufficiently high level of credit market saturation (Table 6, columns 6-10). In the presence of limited access to bank credit funding (Table 6, columns 1-5), banking characteristics do not tend to play a decisive role, except for their sheer presence. In this sense, *any* bank that would enter the local credit market would experience a decrease in the costs of bank debt.

This hypothesis is further extended by the intriguing role played by market competition captured by a change in the associated coefficient (HHI). While a positive relationship between a lower degree of competition and a higher cost of debt is reported for less saturated markets (Table 6, column 1), even if statistically insignificant at the margins, stronger competition apparently brings about an additional increase in the effective interest rate in over-branched regions (Table 6, column 6). We can hypothesize that the structural shift from a quantitative to a qualitative type of competition, which occurs in 'overcrowded' markets, forces banks to pass on the incurred costs to customers. In other words, by operating at the level of zero markup, each unit of additional costs imposed by the entry of a new competitor is to be ultimately compensated for by an increase in the marginal interest rate if not covered by additional sources (e.g., non-interest income, increase in total credit).

Additionally, even though a few studies have suggested that banks tend to avoid over-saturated markets Chen and Strathearn (2020); Galardo et al. (2021), an increase in network size beyond the effective threshold can sometimes be used as a competitive tool to prevent the entry or induce the exit of a competitor (Cohen and Mazzeo, 2010). In this case, the costs of keeping the oversized branch network in highly saturated markets might be passed on to customers.

As an alternative, our measure of competition in local markets is based on the physical presence of

a bank in a region but does not observe banks' success in attracting the customers reflected in local market shares measured by total credit extended to local customers. In some sense, we only observe the necessary condition for an increase in competitiveness, i.e., entry of a competitor, but we are not able to measure the final outcome. Thus, while some of the markets could be populated by a larger number of competitors, the level of concentration in assets might be higher than in the case of a smaller number of competitors who face more forceful competition among them. As a result, greater market dominance in terms of the share of total credit extended in a market could translate into a higher interest rate than that in markets with more evenly distributed market share, even with a smaller number of competitors.

Column (9) in Table 6 indicates that a lower interest rate tends to be observed in banks with a higher fees-to-interest-income' ratio, thus pinpointing a possible substitution policy between interest rates and the costs of additional financial services. The combination of lower costs of debt and lower probability of credit extension (Agarwal and Hauswald, 2010) and the expansion of the provision of financial services where soft information is less needed (Gobbi and Lotti, 2004) should be observed in markets populated by multi-market banks. In Slovakia, where practically no domestically owned local banks exist, the effects of multi-market bank management are likely to be apparent, especially in over-branched regions.

5.3 Discussion and Policy Implications

Our results reveal several interesting findings that could become troubling news deepening the already significant regional differences in Slovakia.

Our *first* important finding shows that bank branch network size impacts the costs of firms' debt unequally, depending on the level of credit market saturation. Hence, the 'too-much-branching' phenomenon is likely to materialize. Firms located in less saturated markets face an additional price markup due to potentially limited access to bank credit. Economically, however, the size of this markup is not a life-threatening issue since it amounts to only 0.10 b.p. in 70% of cases. In contrast, firms located in over-branched regions do not benefit from additional bank branch openings by lowering their interest costs beyond the level of full local market saturation.

Second, SMEs, mostly affected by lower access to finance, are usually micro- or medium-sized firms located outside regional centres with domestic ownership and operating in low-tech industries. Interestingly, the level of firm creditworthiness assessed according to their economic profiles does not matter very much since all firms tend to be affected equally, which could indicate an important role for soft information based on the 'know-your-customer' policy.

The changing role of bank characteristics is highlighted in our *third* finding. Only in the over-branched regions does the presence of more efficient banks that focus on traditional banking activities (i.e., extending loans) lead to the lowering of loan rates. However, these banks are likely to compensate for the decrease in the offered loan rate with higher non-interest income. As a feature of markets populated by multi-market banks (Agarwal and Hauswald, 2010; Gobbi and Lotti, 2004), we observe a combination of lower costs of debt and expansion of the provision of financial services where soft information is less needed.

Finally, we show that while the spatial structure of the bank branch network in Slovakia reflects standard socio-economic factors, it is also significantly shaped by geographical considerations. The recently observed concentration of bank branches in selected LAU1 regional centres could therefore be attributed

more to considerations related to operational distance, while it has not responded to the existing level of local market competition, i.e., inter-bank distance.

The lower level of local credit market saturation is likely to affect business activities that are important for the Slovak industry yet whose location in regions farther away from regional centres might limit their future economic potential or even reduce their business activity and employment, as pointed out by (Nguyen, 2019). We believe that the relocation of bank branches from these regions to regional centres could further disrupt relationship-based banking between firms and banks, which is troubling news, especially for less innovative businesses. As indirectly implied by our findings and supported by the relevant literature (Agarwal and Hauswald, 2010), accumulated soft information often enters the bank pricing decision process as one of the crucial determinants. With a decrease in the volume and quality of soft information, the negative consequences of limited access to finance could materialize. As pointed out by Flogel (2018), the presence of local banks with accumulated soft information is the crucial factor in the case of financially distressed SMEs.

It is necessary to remind banks in less economically developed regions to be important institutions that strengthen the social capital of the population and companies (Calcagnini et al., 2019). To advance our argument slightly further, if firms decide to follow finance rather than the other way around, increasing the spatial concentration of bank networks might even result in further widening of regional disparities, which in the case of Slovakia are among the greatest in the OECD and longest lasting (ERDB, 2017; Commission, 2020). From the political perspective, long-term unresolved economic disparities between regions tend to lead to social tensions and discontent, which in worst-case scenarios can result in 'the revenge of places that don't matter' (Rodriguez-Pose, 2018; Dijkstra et al., 2020). This effect has already been observed in the case of Slovakia (Rehak et al., 2021).

From the opposite perspective, in regions with over-saturated markets, a reduction in bank branch network size should not be associated with the previously discussed adverse consequences. This point is especially valid in the case of banks that are less efficient and less oriented towards credit provisioning. Counter-intuitively, a reduction in the saturation of over-branched markets could even lead to improvement in loan conditions, especially in terms of the price of other associated financial services.

5.4 Robustness checks

We perform several robustness checks. All results are available upon request.

As the first robustness check, we exclude the estimated equilibrium values (BRANCH predicted) from the specifications. The results remain practically unchanged, with one exception. In Table 5, the interaction with the NACE2 firm group passes the 10% confidence threshold, indicating that firms in medium technology-demanding industries are also negatively affected by lower than optimal bank branch saturation.

Second, we exclude two spatially driven variables (R. MIN, ln(POP) spatial) from equation [1] to downplay the role of economic geography. Our reported results for firm-level characteristics are robust to this change in terms of statistical significance (Table 5). However, in the case of firm size (MEDIUM), ownership (OWN1) and creditworthiness (ALT3), the difference in reported coefficients is sizeable, implying that the adverse effects of under-branching might be more serious if not allowing for compensation due to the possibility of commuting to the closest regional centre. Recall that according to the findings in Table 6, regions treated as regional centres enjoy better access to finance because of a greater concentration

of bank branches, and conversely, the regions neighbouring regional centres do not necessarily require as large a number of bank branches (i.e., optimal size) since the customers are expected to commute. If this aspect is not considered, the extent of under-branching is estimated to be harsher for firms located in under-branched regions. In the case of local bank market characteristics, while the results for under-branched regions remain unaffected with the reported statistically significant negative effect of lower bank market saturation (Table 6, columns 1-5), the significance of bank characteristics in over-saturated markets disappears completely. Apparently, the effect of bank competition on costs of firm debt discussed previously comes into play only *after* accounting for the presence of local regional centres due to a simple mismatch between the administrative and natural definitions of local market borders, a special role played by regional financial centres, or both.

Next, we remove time dummies in the specification [1], which models the number of bank branches in a region. While time dummies control for an empirically observed downward trend in the extent of bank branching regardless of fundamentals, specifications without time dummies force this trend to be distributed across fundamental determinants or absorbed by individual random effects and error terms. The newly estimated results in Table 4 confirm the statistical significance of under-branching (INDEX negative), albeit at a lower confidence level, but they also deliver a statistically significant negative effect of over-branching. In the case of firm-level characteristics (Table 5), size (MEDIUM), domestic ownership (OWN1) and creditworthiness (ALT3) are confirmed to negatively affect the cost of debt in less saturated markets. After the introduction of bank market characteristics (Table 6), only the negative effect of under-branching is reported (columns 1-5), and all other variables turn out to be insignificant.

Since our interest predominantly lies in investigating the effects of three types of spatial distance (Papi et al., 2015), we calculate average local bank characteristics at the bank level with weights reflecting the presence of an individual bank brand. However, our data allow us to also proceed differently by calculating weights that consider the number of branches belonging to an individual bank. This approach carries additional information about possible within-bank competition, with more branches belonging to the same bank brand competing for the same customer. We re-estimate the models reported in Table 6 using the newly calculated bank market characteristics (HHI, ROA, LTA, FTI, UEC). In all but one case, the results remain unaffected by this change. However, the measure of competition (HHI), which now incorporates both the 'within' bank group and 'between' bank group competition, turns out to be insignificant. We interpret this result as an indirect confirmation that while in the over-branched regions, the inter-bank distance tends to matter, we find no signs of heterogeneous policies adopted at the bank branch levels belonging to the same bank group.

To address the concern that the unemployment rate might not fully capture the economic conditions in local markets, we extend the list of control variables in equations [1], [3], [4] and [5] by average wage per capita and annual economic growth of economic activity calculated at the regional level.[14] The results for all specifications remain robust and practically unchanged.

From the reporting point of view, the interest payments in the nominator of equation [6] do not distinguish among interest payments paid for bank loans or other liabilities incurred due to intra-company relations, loans included. We address this issue by controlling for the size of liabilities other than bank loans

[14] In the absence of official estimations for regional GDP, we create a 'quasi' measure of economic activity at the regional level by totalling the gross volume of nominal wages and the gross profits of all firms before cleaning the dataset, as reported in our database.

(LIAB). To exclude the possible hypothesis that inter-company liabilities are less costly than external sources, we also exclude companies with a non-zero value of liabilities towards other firms in the inter-company group as a robustness check. All the results remain stable.

Finally, we replace the measures of population and population living in neighbouring regions (POP, POP spatial) in specification [1] with the number of firms located in a region and neighbouring regions to test the hypothesis that banks pay attention to local business activity when deciding the locations of their branches. We replace the aforementioned variables rather than adding them to the list of explanatory variables due to their relatively strong mutual correlation. All results remain robust to this change, with the exception of NACE3 firms turning out to also become adversely affected by the under-branching phenomenon.

6 Conclusions

We investigate the nonlinear effects of access to finance via 'the 'brick-and-mortar' bank branch network in Slovakia over the period of 2013-2019. We observe that after breaching the optimal level of local market bank saturation, any additional increase in access to finance could have zero to negative effects on local economic conditions due to the 'too-much-branching' phenomenon. We adopt the two-step approach by first constructing an empirical model of bank branch localization and then analysing the effects of positive and negative deviations from the optimal level of market saturation (under- and over-branching) on the costs of firms' bank debt. In addition, we analyse the specific features of SMEs associated with the most severe effects of limited access to finance and the qualitative characteristics of banks that could potentially mitigate the consequences of the "too-much-branching' phenomenon. From an econometric point of view, we use a panel model with random effects in the first step and a panel model with fixed effects in the second step with bootstrapped standard errors. This approach helps to mitigate the effect of potential endogeneity in the presence of the changing nature of the underlying bank network structure.

Our results reveal several important findings. First, we find that bank branch network size impacts the costs of firms' debt unequally depending on the level of credit market saturation. Firms mostly affected by such a nonlinear relationship, located in under-branched regions, are usually medium sized, with domestic ownership and operations in low-tech industries. Conversely, in over-saturated markets, bank characteristics gain importance as the source of competition in quality, rather than sheer expansion of the bank network. Finally, we show that while the spatial structure of the bank branch network in Slovakia reflects standard socio-economic factors, the role of geographical elements remains unsubstitutable.

The combination of worsened access to finance in regions populated with firms from the most affected group, loss of soft information collected by local banks, lower levels of financial literacy and increasing levels of private debt could potentially create a dangerous mixture for policy making in Slovakia. In contrast, reduction and redesign of bank branch networks in saturated markets could result in increasing efficiency of individual banks without adverse impacts on local economic conditions. Thus, the final impact of the recently observed trend in bank branch network reduction remains to be determined.

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Appendix

Table A1: Variables and their definitions

Panel A	**Quantitative SME characteristics**
LIAB	Total liabilities net of bank loans
LEV	Leverage - ratio of equity over total assets
EMP.PR	Employee productivity - Ratio of total sales over employee costs
FIX	Ratio of fixed assets to total assets
TA	Total assets
ROE	Ratio of EBT to total equity
AGE	Age of company (years)
Panel B	**Qualitative SME characteristics**
NACE	High-tech industries (1 low-tech, 2 middle tech, 3 lower high tech, 45 high-tech)
ALT	Altman z-score (-1 underperforming, 0 average, 1 overperforming)
OWN	Type of ownership (1 domestic, 23 international and foreign)
SIZE	Size of firm by number of emplyees (1 micro, 2 small, 3 medium)
Panel C	**Regional characteristics**
UR	Unemployment rate
POP	Total population
YOUNG	Ratio of population between 20-29 years on total population
EXPERT	Ratio of population between 40-49 years on total population
DENS	Density of population
TERT	Tertiary educated people in total population
R.MIN	Inverse of distance between regional center and NUTS3 center (in minutes), regional center=1
Panel D	**Bank branch market structure**
HHI	Hirsch-Herfindahl index for bank branch concentration
ROA	Net income before taxes over total assets, weighted average for region
LTA	Loans to total assets - loans to customers over total assets, weighted average for region
FTI	Fees to interest income - Gross fees and commissions income over gross interest income, weighted average for region
UEC	Unit employee costs - Total personal costs over number of employees, weighted average for region

Table A2: Aggregations of manufacturing based on NACE Rev. 2

NACE Rev. 2 codes - 2-digit level	Description	Codes in smaple
01 to 03	Agriculture, forestry and fishing	NACE_1
05 to 09	Mining and quarrying	
35	Electricity, gas, steam and air-conditioning supply	
36 to 39	Water supply, sewerage, waste management and remediation	
41 to 43	Construction	
45 to 47	Wholesale and retail trade, repair of motor vehicles and motorcycles	
49 to 53	Transportation and storage	
55 + 56	Accommodation and food service activities	
58 to 60	Publishing, audiovisual and broadcasting activities	
61	Telecommunications	
62 + 63	IT and other information services	
64 to 66	Financial and insurance activities	
68	Real estate activities	
69 to 71	Legal, accounting, management, architecture, engineering, technical testing and analysis activities	
72	Scientific research and development	
73 to 75	Other professional, scientific and technical activities	
77 to 82	Administrative and support service activities	
84	Public administration and defence, compulsory social security	
85	Education	
86	Human health services	
87 + 88	Residential care and social work activities	
90 to 93	Arts, entertainment and recreation	
94 to 96	Other services	
97 + 98	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	
99	Activities of extra-territorial organisations and bodies	

Table A3: Aggregations of manufacturing based on NACE Rev. 2 (cont'd)

Manufacturing industries	NACE Rev. 2 codes - 2-digit level	Description	Codes in smaple
High-technology	21	Manufacture of basic pharmaceutical products and pharmaceutical preparations;	NACE_5
	26	Manufacture of computer, electronic and optical products	
Medium-high-technology	20	Manufacture of chemicals and chemical products;	NACE_4
	27 to 30	Manufacture of electrical equipment; Manufacture of machinery and equipment n.e.c. ; Manufacture of motor vehicles, trailers and semi-trailers; Manufacture of other transport equipment	
Medium-low-technology	19	Manufacture of coke and refined petroleum products;	NACE_3
	22 to 25	Manufacture of rubber and plastic products; Manufacture of other non-metallic mineral products; Manufacture of basic metals; Manufacture of fabricated metals products, excepts machinery and equipment;	
	33	Repair and installation of machinery and equipment	
Low-technology	10 to 18	Manufacture of food products, beverages, tobacco products, textile, wearing apparel, leather and related products, wood and of products of wood, paper and paper products, printing and reproduction of recorded media;	NACE_2
	31 to 32	Manufacture of furniture; Other manufacturing	

Table A4: Distribution of sample SMEs according to business activity, ownership and creditworthiness

	MICRO		SMALL		MEDIUM		Total
	count	%	count	%	count	%	sum
NACE_1	673	87%	664	71%	192	45%	1,529
NACE_2	35	5%	99	11%	84	20%	218
NACE_3	48	6%	128	14%	95	22%	271
NACE_45	14	2%	49	5%	56	13%	119
by NACE	**770**	**100%**	**940**	**100%**	**427**	**100%**	**2,137**
OWN1	717	93%	820	87%	305	72%	1,842
OWN23	53	7%	119	13%	121	28%	293
by Ownership	**770**	**100%**	**939**	**100%**	**426**	**100%**	**2,135**
ALT1	252	19%	348	19%	141	15%	741
ALT2	584	43%	939	51%	534	58%	2,057
ALT3	507	38%	568	31%	249	27%	1,324
by Observ.	**1,343**	**100%**	**1,855**	**100%**	**924**	**100%**	**4,122**

Notes: Number of observations in columns and rows does not correspond to total number of firms in our sample (2047). This is due to the fact that some firms may have changed their qualitative characteristics over the course of our monitored period, thus enter the relevant data multiple times.

Table A5: Sample descriptive characteristics

	Mean	**St. Dev**	**Min**	**Max**	**Obs**
AGE	2.63	0.48	0.69	4.14	4127
EIR	0.06	0.05	0.00	0.41	4127
UR	9.93	5.32	1.98	31.24	4127
LIAB	10.06	2.90	0.00	17.28	4127
PAKA	0.39	0.22	0.00	0.99	4127
EMP.PR	11.94	25.79	0.00	851.34	4127
TA	39.75	24.73	0.00	99.16	4127
LTA	13.90	1.44	9.68	18.35	4127
LTA_sq	195.40	40.15	93.68	336.84	4127
ROE	0.09	3.61	-207.90	33.42	4127
ALT1	0.18	0.38	0.00	1.00	4122
ALT2	0.50	0.50	0.00	1.00	4122
ALT3	0.32	0.47	0.00	1.00	4122