

PIN - Productivity Projects Fund

Pioneer Project Report

Financing productivity in the UK: Do sources of finance and geographical location matter?

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About PIN

The Productivity Insights Network (PIN) was established in January 2018 and is funded by the Economic and Social Research Council. As a multi-disciplinary network of social science researchers engaged with public, private, and third sector partners, our aim is to change the tone of the productivity debate in theory and practice. It is led by the University of Sheffield, with co-investigators at Cambridge Econometrics, Cardiff University, Durham University, University of Sunderland, SQW, University of Cambridge, University of Essex, University of Glasgow, University of Leeds and University of Stirling. The support of the funder is acknowledged. The views expressed in this report are those of the authors and do not necessarily represent those of the funders.

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1. Introduction

Financial factors have been identified as a “potential (major) source” behind the UK productivity puzzle (i.e. Harris, 2019). From a firm-level perspective, this potential link could arise from barriers to accessing finance that disrupt the efficient allocation of resources and the financing of productivity-enhancing investments (Beck et al., 2000; Wurgler, 2000; Fisman and Love, 2004). Despite this claim, only a few studies have evaluated the direct link between finance and firm productivity (e.g. Chen and Guariglia 2013; Levine and Warusawitharana, 2019). The majority of firm-level analysis have focused on examining the role of finance for specific real activities such as employment (e.g. Nickell and Nicolitsas, 1999); physical capital expenditure (e.g. Fazzari et. al. 1988; Chava and Roberts, 2008; Campello et al., 2010); inventory investments (e.g. Carpenter et. al. 1994); or R&D expenditure (e.g. Bates et al., 2009; Bond, et.al. 1999). In these studies, financial factors are likely to affect a firm’s output by altering the level of inputs (i.e. employment or capital) or by inducing technological improvements (i.e. via R&D). However, the productivity of a firm is shaped by the combination of a wide range of actions and investments (such as R&D expenditure, staff training, new product development, software upgradation, and the acquisition of know-how). These factors vary across several dimensions of the firm, including its size, and the sector in which it operates, among other aspects.¹ Considering the high level of heterogeneity in the set of actions made by firms to improve their productivity, it is important to quantify the direct link between finance and productivity, rather than just evaluating the role of financial factors for specific investments.

Given that productivity is a main driver of economic growth and a key factor explaining the differences in economic activity across regions and countries, understanding the direct link between finance and productivity is crucial to inform public policies aimed promoting growth and local development via productivity improvements, such as the UK leveling up agenda. Thus, this project contributes to the emerging finance-productivity literature by evaluating the direct link between finance and firms’ total factor productivity (TFP) in the United Kingdom (UK). In doing so, the efforts of this project contribute to the public policy and academic literature in two ways: first, by examining the role of diverse sources of finance for firms’ productivity; and second, by evaluating whether the geography of financial centers matters for financing productivity. Throughout our analysis we examine the role of firms’ size in shaping the dynamics of these relationships.

To date, the small literature on finance and productivity has largely focused on examining whether accessing external finance affects productivity (e.g. Gatti and Love, 2008; Chemmanur et al. 2011; Coricelli et. al., 2012; Ferrando and Ruggieri, 2015; Manaresi and Pierri, 2019; Caggese, 2019; Levine and Warusawitharana, 2019). Less is known about the role of internal finance for firm’s productivity, despite ample evidence that productivity-enhancing investments (such as R&D) are funded by internal sources of finance (Hall, 1992; Bates et al., 2009; Benfratello et al., 2008; Brown et. al., 2009; Chen and Guariglia 2013;). In this project we evaluate the role and availability of different sources of finance (both internal and external) in shaping firms productivity. Understanding which financing options are more conducive for productivity gains is of utmost importance for the formulation of appropriate access-to-finance public policies aimed at impacting growth through productivity improvements.

¹ This argument dates back at least to Pavitt (1984) who categorized firms according to their sectoral technological trajectories into “science-based sectors”, “specialised supplier equipment”, “scale intensive”, and “supplier dominated”. The more innovative firms, such as those suppliers of specialized equipment or those operating in the science-based sectors, typically find it difficult to access external finance for investing in R&D (Hall, 2002). Instead, firms in R&D intensive sectors tend to depend more on internal savings as most intangible investment cannot be used as collateral (Bates et al., 2009).

Moreover, this project evaluates whether the location of the firm (relative to the major financial centers) affects its ability to fund their productivity-enhancing activities. So far, the finance-productivity literature has paid limited attention to whether the role of finance for productivity varies spatially. This lacuna exists despite ample evidence of uneven spatial distributions of the financial system across national economies and the consequent existence of regional financial gaps (e.g. Alessandrini et al., 2009; 2010). This phenomenon is particularly acute for the UK, where in the past decades an increasing geographical concentration of equity (e.g. Wilson et al., 2019) and debt (Lee and Brown, 2017) finance has been reported. Evaluating whether such spatial variation in the availability of finance has implications for firms' productivity is relevant to understand the UK regional productivity puzzle given the widely documented evidence of variation in productivity performance across UK regions (Harris and Moffat, 2015), and yet the lack of a clear understanding of the geographical aspects of this puzzle (McCann, 2018). This project aims to contribute to the academic and policy research on finance and productivity by examining whether the distance of UK businesses to the main financial centers affects the extent to which access to internal and external sources of finance affects their productivity.

To evaluate the financing sources-productivity link and its regional variation we use a mixed-method study consisting of:

- i. A quantitative analysis using panel data econometric techniques to evaluate the relative importance of cash flow and debt finance for total factor productivity, and to examine whether the distance of firms to the main financial centres affects the finance-productivity link. To perform this analysis we use the FAME database over the period 2001-2018. Specifically, we define financial centres as the UK's top 10 financial sector contributors over our sample period measured by gross value added, these include, Belfast, Birmingham, Bournemouth, Bristol, Cardiff, Edinburgh, Manchester, Leeds, London and Reading. Using the above definition we measure the greater circle distance between firms' headquarters and the nearest financial centre and examine how geographical distance impacts the finance-productivity relationship.
- ii. A qualitative approach based on semi-structured interviews with Micro, Small and Medium Enterprises (MSMEs) in the Leeds City Region to better understand the range of financing sources used by firms (specially Micro, Small and Medium Enterprises – MSMEs-) to fund their diverse productivity-enhancing activities and the barriers they might face to do so.

The main results from the quantitative analysis indicate that although both cashflow and debt finance are positively related to firms' productivity, the sensitivity of productivity to cashflow is much higher than its sensitivity to debt. These results suggest that UK firms heavily rely on internal finance to undertake productivity-enhancing innovative investments, while external finance plays a less important role in supporting such activities. Moreover, our results show that the dependence on internal finance for productivity improvements is stronger the further away the firm is from the core financial centres in the UK. This strong dependence on internal finance is particularly acute for Small and Medium Enterprises (SMEs) in the peripheral areas of the UK, suggesting that firms in these areas are likely to be more financially constrained than their counterparts located near financial centers.

Our results also show that the positive effect of debt on firm's productivity decreases with their distance from the financial center, suggesting that debt-funded innovative projects of firms in closer proximity to the decisional financial centres in the UK are likely to be more productive (but potentially more riskier) than projects funded by debt in the peripheral areas. Perhaps peripheral

firms have more difficulty to provide funders in the center with relevant soft information about their more innovative projects. To fund their highly productive, but riskier innovations, peripheral firms might rely more on their internally generated resources than firms near financial centers. Thus, unless firms are already profitable and capable to generate internal resources, productive innovations are more likely to fail in peripheral than in central areas.

Overall, our quantitative findings suggest that a potential explanation for the observed differences in productivity across regions in the UK could be linked to the uneven spatial distribution of finance, as higher financial frictions (e.g. information asymmetry) associated to being located further away from the main financial centers are likely to make it harder for peripheral firms to realize their innovative potential.

Our econometric analysis is not without limitations. In particular, the FAME database tends to underrepresent the smallest firms in the UK (especially microenterprises), restricting our ability to understand how these firms fund their productivity-enhancing decisions. Moreover, like most secondary databases, FAME does not report the wide range of financing sources used by firms to fund their productive investments. This lack of detailed information on firms' funding alternatives is particularly problematic when trying to understand the importance of finance for smaller firms, as these firms tend to use non-conventional sources of finance more recurrently than their larger counterparts. Moreover, quantitative data is not informative about the specific barriers firms face when trying to access different sources of finance. To overcome these limitations, we complement our quantitative analysis with a qualitative analysis based on 10 semi-structured interviews with representatives from MSMEs across different sectors in the Leeds City Region. These interviews allow us to get a better mapping of the diverse financing sources used by firms to fund their various productivity-enhancing investments; identify potential mismatches between desired and actual types of financing; assess whether the geography of finance influences the funding of productive investments; inquire about the impact of Covid and Brexit on firms' access to finance; and identify specific solutions to inform firm strategy and public policy.

In line with the results from our econometrics analysis, we find that MSMEs in the Leeds City Region frequently rely on internal cash flow or personal income to fund productivity promoting investment expenditures. We also present some evidence that the type of financing acquired by firms depends on the nature of their expenditures. Overall, access to bank financing remains very difficult and limited to collateralized lending, either through physical objects such as buildings, cash-flow generating activities, or increasingly through the demand for personal guarantees which draw on entrepreneurs' own wealth in the case business failure. This difficulty is particularly marked for risky, innovative, and pre-revenue business ventures. According to our interviews, the difficulty to access bank financing has increased with the move from relationship banking to automated and standardized loan provision. Given the lack of bank financing, MSMEs draw on a wide range of different financing sources, ranging from personal credit cards, financing companies, angel investment networks, and public loans and grants. Given the dispersed and often ad-hoc nature of these financing sources, personal networks, contacts, and a significant amount of own initiative and knowledge of financial markets are necessary to secure the appropriate financing. Interestingly, Covid has removed cumbersome barriers to access financial support from the government, making access easier and friendly. Finally, our results confirm the key role spatial factors play in shaping the ability of locally-based firms to gain access to finance, with firms located in less favorable postcodes reporting higher difficulties in accessing finance.

The remainder of this report is structured as follows. Section 2 presents the literature review and our main hypotheses. The quantitative and qualitative analyses are presented in Sections 3 and 4 respectively. Section 5 concludes and presents some potential policy measures to address the spatial finance – productivity gap.

2. Literature and hypotheses

Empirical firm-level studies examining the direct effect of finance on productivity are scarce. Studies in this limited research field have largely examined whether external finance plays a role for firm's productivity, whereas only a few works have evaluated the role of internal finance. Even less is known about the relative productivity implications of diverse funding sources. This literature has also overlooked whether uneven geographies of finance across regions shape the finance-productivity link. This section briefly reviews the firm-level empirical research on the direct link between finance and productivity and sets out the main hypotheses of this report.

2.1. Do sources of finance matter for productivity?

2.1.1. External finance and firm productivity

The small literature on finance and productivity has mainly focused on examining whether external finance (mainly bank borrowing) affects firms' productivity. The results from this literature are mixed with some studies documenting positive effects (e.g. Levine and Warusawitharana, 2019); while others reporting a negative relationship between leverage and productivity (e.g. Nucci et al., 2005).

Although the theoretical literature remains silent on the direct relationship between leverage and productivity, some established theories have been invoked to rationalize these ambiguous results. On the one hand, the bankruptcy theory has been used to explain the positive relationship between leverage and productivity by arguing that, as higher levels of leverage increase the probability of bankruptcy, firms tend to use their debt to fund productivity-enhancing investments in order to reduce the chances of bankruptcy. On the other hand, the agency theory has been invoked to explain the negative effects of leverage on productivity, by claiming that, as banks tend to issue collateralized loans, productivity-enhancing investments are less likely to be funded by banks due to the lack of collaterals firms can offer to fund these investments (Chen and Guariglia 2013).

2.1.2. Internal finance and firm productivity

Very few studies (e.g. Chen and Guariglia, 2013; Girma and Vencappa, 2015) have evaluated the effect of internal finance on productivity. This gap exists despite ample evidence that productivity-enhancing investments are disproportionately financed by internal sources due to their inherent risk and the reluctance of banks to fund them. Overall, the results from this literature have found positive effects of cashflow on firms' productivity, suggesting that firms are financially constrained and that "in the presence of negative cash flow shocks, firms will be forced to reduce productivity-enhancing activities" (Chen and Guariglia, 2013).

2.2. Does the geographical distance of firms to the main financial centers affect the sensitivity of productivity to finance?

The concentration of the financial system in specific geographical areas has been widely documented (e.g. Pažitka, and Wójcik, 2019; Alessandrini, et al. 2009, 2010). Yet, the implications of such uneven geographical presence of finance on firms' productive activities has received limited attention in the literature. On the one hand, some scholars argue that the development of financial technologies has rendered the location of firms unimportant, as firms can access financing sources from any location (e.g. Petersen and Rajan, 2002). On the other hand, recent developments in the financial geography literature argue that the concentration of

finance in central areas harms the financing of firms, especially if small sized, in the periphery (e.g. Alessandrini, et al. 2009, 2010; Lee and Brown, 2017). According to this literature, the development of financial technologies and the increasing geographical concentration of financial activities in a few financial centers have made it harder for peripheral firms, especially for MSMEs, to access external finance to fund their innovative projects (e.g. Lee and Brown, 2017). The conjecture is that with the advancement of financial technologies, the funding decisions are now based on “hard information on the actual performance of the firm” rather than on soft information about the potential of the project to achieve growth, which was traditionally obtained by close communication between the firm and its potential local funder. Thus, in spatially-centralized financing systems, firms in close proximity to decisional financial centers can provide financial institutions with better and more reliable soft information about their innovative projects than firms in the peripheral areas, where financial institutions have less decision power to allocate funding (Alessandrini, et al. 2010).

Moreover, firms near financial centers are more likely to be part of social relationships and networks, from which they gather better information about specialized financial alternatives for their diverse projects. Also, apart from accessing finance more easily, firms in the center are more likely to benefit from a wider range of finance and other business services (e.g. consulting, accounting, law) than peripheral firms (Ioannou and Wojcik, 2021; Pažitka and Wójcik, 2019).

As indicated above, empirical research examining the relationship between the spatial structure of the financial system and firms’ productive investments is still limited. Some notable contributions to this area of research are the works of Alessandrini et. al. (2009, 2010) who show that Italian SMEs located in provinces where bank branches and their headquarters are distant are less likely to innovate. For the UK, Lee and Brown (2017) show that innovative SMEs located in financially peripheral areas (i.e. in areas far from the main financial centers) have more difficulties to access bank lending than those closed to London and secondary cities in the UK. However, to our knowledge, presently there is a lack of studies evaluating the implications of uneven financial distribution for the financing of productivity. In addition to focusing on the finance-productivity link, our analysis also differs from the aforementioned studies by introducing firm-specific variation in the geographical distance to the main financial center, rather than examining the role of aggregate financial conditions of the region in which the firm is located. Moreover, in addition to bank borrowing, we also examine spatial variations in the role of internal finance for productivity.

2.3. Hypotheses

Overall, above discussion has shown the need for more empirical work and theoretical development about the role of diverse sources of finance for firm’s productivity, as well as the firm-level productivity implications of the uneven distribution of finance across a country’s regions. Building on the existing literature, we identify several testable hypotheses:

- We expect internal finance to be positively associated to firm productivity in the UK. Due to the thin and centralized financial system in the UK, we expect UK firms (especially MSMEs) to use their internal resources to fund their productivity-enhancing investments, which by nature entail high uncertainty in outputs and returns.
- We expect peripheral firms, especially MSMEs, to be more dependent on internal finance to fund their productivity-enhancing activities, than similar firms near dynamic financial centers.

- Based on the theoretical predictions and mixed empirical results discussed above, we expect the effects of leverage on productivity to move in either direction. However, it is expected that firms in closer proximity to the main financial centers can use debt to fund more innovative projects than firms in the peripheral areas. We therefore expect the effects of debt on productivity to be more positive (or at least less negative) for centrally located firms.

We test these hypotheses using a mixed method using quantitative and qualitative analysis, as we will proceed to describe in sections 3 and 4.

3. Quantitative analysis

3.1. Data

To investigate the role of finance for productivity we use the Financial Analysis Made Easy (FAME) database for the period 2001 to 2018. We focus on manufacturing and service firms with unconsolidated accounts and 12-month accounting periods.² The FAME database provides comprehensive information on firms' internal and external sources of finances, such as bank loans and cashflow. It also contains information on turnover, employment, fixed capital and intermediate input expenditure, which allow us to construct measures of total factor productivity (TFP). The database also contains a strong set of firm characteristics considered as key determinants of TFP, as well as the location of the firm, which allows us to calculate the distance to the main financial centers in the UK.

3.2. Model and estimation strategy

We estimate the following equation to evaluate the role of finance on Total Factor Productivity (TFP):

$$\ln TFP_{it} = \beta_0 + \beta_1 CF_{it-1} + \beta_2 LEV_{it-1} + \alpha_1 X_{it-1} + \alpha_2 Z_{jt-1} + u_i + v_t + \varepsilon_{it}$$

Where:

$\ln TFP_{it}$ is the natural logarithm of firm i 's total factor productivity at time t , estimated using the generalized method of moments (GMM) production approach proposed by Wooldridge (2009).³ CF_{it-1} and LEV_{it-1} are the levels of cashflow and total debt at time $t-1$, both normalized by total assets. X_{it-1} is a vector of firm-specific determinants of total factor productivity, including a firm's age, size, export status, and market power. Z_{jt-1} is a set of regional indicators at NUTS2 level, including the regional GDP per capita, the size of the financial sector and the employment rate. We also included the average total factor productivity of other firms in the same industry located in the region in which firm i is established, to account for potential productivity peer effects. Finally, u_i , v_t and ε_{it} represents firm specific fixed effects, time effects, and an idiosyncratic

² This activity is to rule out the double inclusion of firms which belong to large groups and are technically included with consolidated accounts. Also, we exclude firms that have year-end accounting reference periods of more or less than 12 months to ensure consistently comparative productivity performance across firms and to exclude firms with relatively more or less benefits (e.g., firms that are in administration or subsidiaries) than others.

³ As robustness checks for our finance-productivity econometrics analysis we also estimate TFP using the Olley and Pakes (1996) and Levinsohn and Petrin (2003) methodologies. The results from these estimations are available upon request.

error term, respectively. A detailed definition of the variables is provided in Table A1 in the appendix.

To evaluate whether geography plays a role in the financing of productivity, we interact our financial indicators (cash flow and leverage) with a variable (D_i) measuring the distance (in logs) of the firm to its nearest financial center as follows:

$$\ln TFP_{it} = \beta_0 + \beta_1 CF_{it-1} + \beta_2 LEV_{it-1} + \beta_3 CF_{it-1} * D_i + \beta_4 LEV_{it-1} * D_i + \alpha_1 X_{it-1} + \alpha_2 Z_{jt-1} + w_{it}$$

$$w_{it} = u_i + v_t + \varepsilon_{it}$$

We consider the top 10 financial centers in the UK, defined as the NUTS3 level geographical areas with the highest average Gross Value Added values of the financial service sector during the period 2001-2018.⁴ We use firms' headquarters coordinates to define their location and calculate their distance to the geometric center of the city (centroid) in which the nearest financial center is located.⁵ For instance, the City of London area at the NUTS3 level has the highest average GVA of financial services sector in the London region. Accordingly, the coordinates of London financial centre are set at the geometric centre of the city of London.

To construct our primary measure of geographical distance between firms' and their nearest financial centre we use the haversine formula, which calculates the greater circle distance between the firm's location and its nearest financial centre:

$$Distance_{F,FC} = 2 \cdot R \cdot \arcsin(\min(1, \sqrt{z}))$$

$$z = \sin^2\left(\frac{Lat_F - Lat_{FC}}{2}\right) + \cos(Lat_F) \cdot \cos(Lat_{FC}) \cdot \sin^2\left(\frac{Lon_F - Lon_{FC}}{2}\right)$$

where R is an approximation to the earth radius of 3,963 miles. Lat and Lon denote latitude and longitude coordinates in decimal degrees, respectively, of a particular firm (F) and its nearest financial centre (FC). The geographical coordinates of firms are provided by FAME, while the formation of a financial centre's coordinates is derived from the geometric centre of the city (centroid) in which the financial centre is located.

In addition to our core measure of greater circle distance, we also approximate geographic distance by travel distance (in miles) and travel duration (minutes). By adopting such additional measures it allows us to incorporate elements of both regional density and local infrastructure into our measures of distance, with travel routes and travel time providing more acute measures of market frictions, such as asymmetric information. We use the STATA routine to calculate our travel distance and travel time indicators.

⁴ If the ranking falls into a neighboring town or city of those that have been ranked, the next position in the ranking is given to the next city or town on the list. For example, the top 4 NUTS-3 regions with the higher financial service sector are : 1) Camden and City of London, 2) Tower Hamlets, 3) Westminster, 4) City of Edinburgh. However, given the geographical proximity of Tower Hamlets and Westminster to Camden to City of London, we consider these 3 as a the single largest financial center and assign the second place in our ranking to the City of Edinburgh. See table A2 in the appendix for a full description of the ranking of the areas. As shown in table A2, the top-ten financial centers used in this report are London, Edinburgh, Cardiff, Belfast, Birmingham, Leeds, Manchester, Reading, Bristol, Bournemouth.

⁵ Although some firms operate across multiple regions, empirical evidence has largely confirmed that financial connections and the impact of regional shocks primarily occur through firms' headquarters (e.g., John, 2011 and Dougal et. al. 2015).

3.3. Descriptive statistics

Before performing our empirical analysis we applied several data cleaning procedures as is standard in the literature. First, we dropped firms with missing records on productivity inputs, and those with less than 3 years of continuous observations. Second, we winsorized the top and bottom 1% tails of financial variables. These cut-offs enable us to rule out the possibility of extraordinary financial demands, firm shocks, to control for the potential impact of outliers and to eradicate coding errors (See Greenaway, Guariglia, and Kneller, 2007; Guariglia, 2008). These data restrictions left us with an unbalanced panel dataset of 15,049 firms over the period 2001-2018 (132,808 firm-year observations) to perform our econometric analysis. See Table A3 for the panel structure of the dataset.

The descriptive statistics of the main variables of interest are presented in Table 1. This table shows that the average firm in our sample is geographically located 25 miles from the nearest financial centre and within 15-mile and 27-minute driving radius. However, there is substantial geographical heterogeneity in the distribution of firms in relation to their nearest financial centre. As Figure 1 shows, firms in our sample are mostly clustered in close proximity to or in regions that host major financial markets and institutions, whereas areas further away from such financial centres have much lower concentration of firms. In our sample, a large fraction of firms (40%) are concentrated around the London financial center, which hosts almost three times the number of firms located near Birmingham and Leeds financial centers. In the top-ten financial center list (shown in Figure 1), there are also other important centres in which leading businesses in financial and related professional services are regionally clustered: Edinburgh in Scotland, Cardiff in Wales, and Belfast in Northern Ireland. Although these financial centres host a modest number of firms in our sample, they play an important role to the economy of each country and regional businesses.

In terms of productivity, Figure 2 shows the average total factor productivity by region at the NUTS3 level by quintile group. The figure suggests that regions in close proximity to major financial centres—particularly London, Reading, Yorkshire and the Humber, Belfast, Manchester, Greater Manchester, Edinburgh, Belfast and Cardiff—have higher productivity, on average.

Table 1: Summary statistics

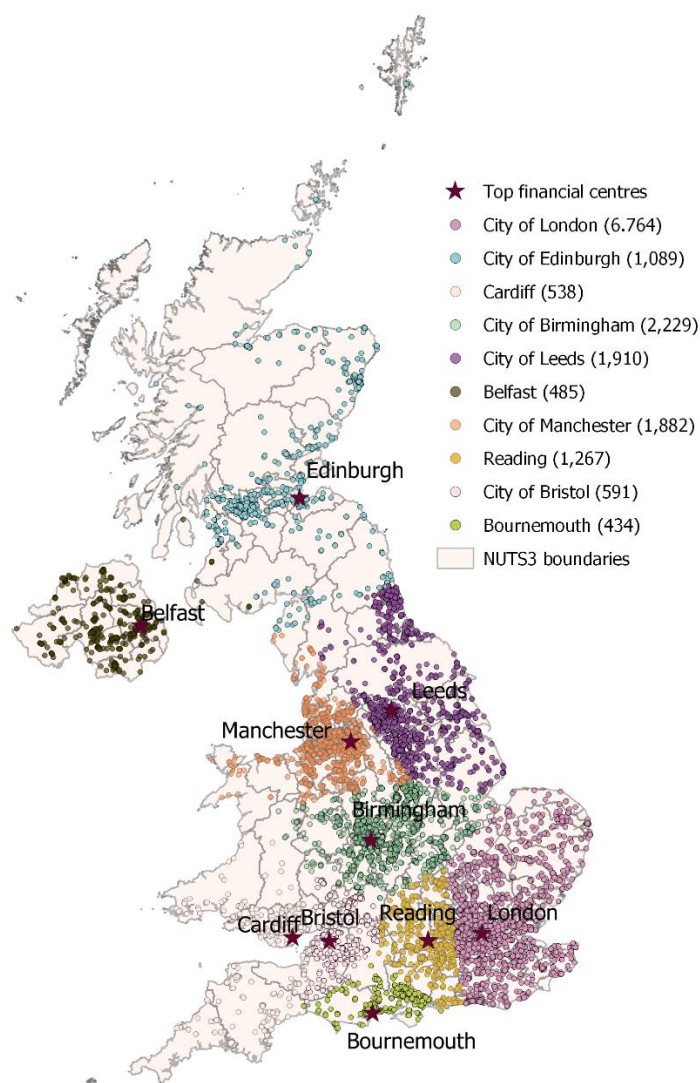
	Mean	Median	SD	Min	Pct.5	Pct.95	Max
TFP	5.346	5.300	0.665	-1.870	4.451	6.412	12.550
Cashflow	0.088	0.079	0.141	-0.546	-0.091	0.302	0.584
Leverage	0.663	0.624	0.433	0.069	0.167	1.203	3.167
Geographical							
Distance (in miles) *	24.786	18.385	22.776	1.185	1.518	73.039	105.219
Travel distance (in miles)*	15.422	9.331	23.085	1.000	1.246	41.379	603.326
Travel time (in minutes) *	26.957	22.083	23.783	1.217	2.317	62.433	154.167
<u>Firm-level controls</u>							
Age (log)	2.980	3.045	0.762	0.000	1.609	4.190	4.990
Size (log)	8.916	8.850	1.299	2.435	6.861	11.099	13.541
Export	0.287	0.000	0.452	0.000	0.000	1.000	1.000
HHI	0.086	0.051	0.106	0.006	0.013	0.287	0.996
<u>Region-level controls</u>							
GDP	3.487	3.265	0.601	2.343	3.008	5.018	5.131
GVA financial sector	-2.945	-3.015	0.404	-3.923	-3.480	-2.243	-1.509
Employment	0.850	0.687	0.470	0.401	0.584	2.122	2.342
TFP peers	5.345	5.366	0.264	1.751	4.914	5.712	8.200
Number of observations	132,808						

Notes:

*Distance, Travel_distance (in miles) and Travel_time (in minutes) are measured from the firm's location to the nearest financial centre.

*lnDistance, lnTravel_distance and lnTravel_time are measured as the logarithm of one plus distance in miles or minutes to the nearest financial centre in top-ten financial centres. To control for potential outliers, we scale the firm's distance by the median of the distribution at particular year and industry sector.

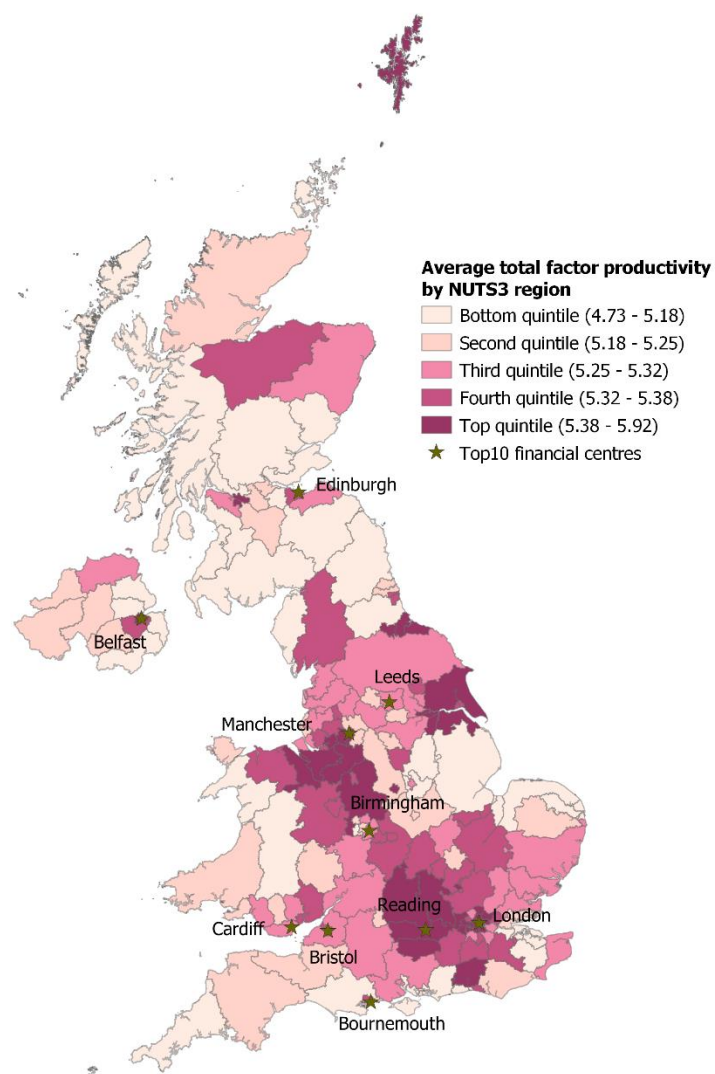
Figure 1.
Distribution of firms and the top 10 financial centers in the UK



Boundaries shown are for UK local authority districts (level 3). Office for National Statistics licensed under the Open Government Licence v.3.0. Contains OS data © Crown copyright [2021]

Source: Authors' own calculations based on FAME database.

Figure 2
Average total factor productivity across UK regions
2001-2018



Boundaries shown are for UK local authority districts (level 3). Office for National Statistics licensed under the Open Government Licence v.3.0. Contains OS data © Crown copyright [2021]

Source: Authors' own calculations based on FAME database.

3.4. Econometric results

3.4.1. Internal and external sources of finance and firm's productivity

We use the fixed effect estimator to estimate the relationship between finance and productivity. Our baseline estimates reported in column (1) of Table 2 show a positive relationship between firm's leverage and productivity. Concretely, keeping everything else constant, a 1 percentage point increase in the leverage ratio increases total factor productivity by 0.07% on average. This positive relationship between leverage and productivity can be explained by the bankruptcy theory, which states that managers of firms with high level of leverage have more incentives to improve productivity to avoid bankruptcy.

Regarding the role of internal finance for firm's productivity, our results are in line with those reported by Chen and Guariglia (2013) who found a positive effect of cashflow on firm's productivity in China. For the UK, our results show that, everything else constant, a 1 percentage point increase in the cashflow-to-total assets ratio increases total factor productivity by 0.5% on average. The high dependence of productivity on internal finance suggests that British firms are also financially constrained: they highly rely on internal finance to fund their productivity-enhancing investments. It is worth noticing that the sensitivity of productivity to cashflow is higher than its sensitivity to leverage, suggesting that although access to external finance can help firms to increase their productivity, external finance is still limited to fund productivity-enhancing investments amongst UK firms.

3.4.2. Geography of finance and the finance-productivity link

In order to evaluate whether the geographical variation in the availability of finance affects the sensitivity of productivity to finance, we interact our firm-level financial indicators with a set of variables measuring the distance of the firm to its nearest financial center. The results from this exercise, reported in columns (2) to (4) of Table 2, indicate that firms further away from core financial centers are more dependent on their cashflow to fund their productivity-enhancing investments than firms in close proximity to a financial center. This finding is aligned with recent empirical research showing that uneven geographical distributions of financial systems have important implications for firms' real investments (e.g. Alessandrini et. al., 2009, 2010; Lee and Brown, 2017).

The interaction term between firms' leverage and the distance of the firm to its closest financial center is negative, although only significant when we use the geographical distance indicator. To check whether the effects of leverage are affected by the presence of firm-year observations with zero values of debt, we dropped these observations and performed our estimations on the subsample of firms with positive values of debt, which account for about 90% of the total observations. The estimations on this subsample, reported in columns (5) to (7) of Table 2, confirm the positive effects of leverage on firm's productivity. More interestingly, using this subsample of firms we find that the effects of leverage on firm's productivity decrease with the distance of the firm to its nearest financial center. As discussed in Section 2, a theoretical explanation for this view is that in spatially-centralized financing systems, like the UK, firms in close proximity to decisional financial centers can provide financial institutions with better and more reliable soft information about their innovative projects than firms in the peripheral areas (Alessandrini, et al. 2010). Thus, it might be plausible that the type of investments funded by external bodies in central areas are more innovative (and therefore more conducive to productivity improvements) than the projects of firms in the periphery, as the soft information associated to their projects is more difficult to be assessed by local institutions with low power

in the funding decision process. As also discussed in Section 2, firms near dynamic financial centers are likely to benefit from a wider range of financial and other business services, which might enhance the positive effects of external funding.

**Table 2. The effects of internal and external finance on total factor productivity:
does geography matters?**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Financial indicators							
Cashflow	0.508*** (0.014)	0.518*** (0.014)	0.524*** (0.011)	0.475*** (0.018)	0.474*** (0.015)	0.488*** (0.011)	0.433*** (0.018)
Leverage	0.056*** (0.003)	0.072*** (0.007)	0.061*** (0.005)	0.060*** (0.008)	0.084*** (0.007)	0.073*** (0.005)	0.078*** (0.008)
Does distance matter?							
Cashflow* Geographical distance		0.033** (0.014)			0.053*** (0.015)		
Leverage* Geographical distance		-0.019*** (0.007)			-0.028*** (0.007)		
Cashflow* Travel distance			0.023*** (0.009)			0.031*** (0.009)	
Leverage* Travel distance			-0.005 (0.004)			-0.012*** (0.004)	
Cashflow* Travel time				0.078*** (0.018)			0.094*** (0.018)
Leverage* Travel time				-0.004 (0.008)			-0.020** (0.008)
Geographical distance		0.005 (0.020)			-0.011 (0.020)		
Travel distance			-0.003 (0.008)			-0.001 (0.008)	
Travel time				-0.011 (0.024)			-0.006 (0.025)
Firm-level controls							
Export	0.016*** (0.003)	0.016*** (0.003)	0.016*** (0.003)	0.016*** (0.003)	0.015*** (0.003)	0.015*** (0.003)	0.015*** (0.003)
Age	0.199*** (0.015)	0.198*** (0.015)	0.198*** (0.015)	0.198*** (0.015)	0.174*** (0.015)	0.174*** (0.015)	0.174*** (0.015)
Size	0.304*** (0.009)	0.304*** (0.009)	0.304*** (0.009)	0.304*** (0.009)	0.395*** (0.010)	0.393*** (0.010)	0.394*** (0.010)
Age ²	-0.049*** (0.005)	-0.049*** (0.005)	-0.049*** (0.005)	-0.049*** (0.005)	-0.042*** (0.005)	-0.042*** (0.005)	-0.042*** (0.005)
Size ²	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.008*** (0.001)	-0.008*** (0.001)	-0.008*** (0.001)
HH index	-0.013 (0.017)	-0.012 (0.017)	-0.013 (0.017)	-0.013 (0.017)	-0.024 (0.018)	-0.024 (0.018)	-0.024 (0.018)
Regional-level controls							
TFP local peers	0.057*** (0.006)	0.056*** (0.006)	0.056*** (0.006)	0.057*** (0.006)	0.047*** (0.006)	0.047*** (0.006)	0.047*** (0.006)
GVA financial sector	0.044** (0.020)	0.043** (0.020)	0.044** (0.020)	0.044** (0.020)	0.054*** (0.020)	0.056*** (0.020)	0.056*** (0.020)
GDP	0.020 (0.029)	0.020 (0.029)	0.019 (0.029)	0.019 (0.029)	0.029 (0.030)	0.028 (0.030)	0.029 (0.030)
Employment	-0.022 (0.020)	-0.020 (0.020)	-0.021 (0.020)	-0.021 (0.020)	0.034* (0.020)	0.032 (0.020)	0.033 (0.020)
Constant	2.471***	2.450***	2.465***	2.470***	2.048***	2.055***	2.056***

	(0.115)	(0.115)	(0.114)	(0.116)	(0.119)	(0.118)	(0.120)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	132,808	132,808	132,808	132,808	117,434	117,434	117,434

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors are displayed in parentheses. The dependent variable is the natural logarithm of TFP.

3.4.3. Does firm size matter?

As mentioned in Section 2, recent studies have documented that SMEs, especially in peripheral areas, are disproportionately disadvantaged at accessing external finance because of their distance from the main financial centers. Following this line of enquiry, we evaluate whether the effect of the distance to the main financial centers in the UK affects the sensitivity of productivity to finance more strongly for smaller than for larger firms. To perform this analysis we consider triple interaction terms between our financial variables (cash flow and leverage), the distance of the firm to the nearest financial center and a dummy variable (SME) equal to 1 if the firm is a small or medium enterprise. The results from these specifications, reported in Table 3, indicate that compared to larger firms, SMEs further away from financial centers rely more on internal sources of finance to fund their productivity-enhancing investments, suggesting that SMEs are indeed disproportionately affected by their distance to financial centers. For example, looking at column (6), which reports estimation results based on the shortest geographical distances (D_i) as defined in Section 3.2, we can obtain the elasticity of productivity (tfp_{it}) to cashflow (cf_{it}) as:

$$\frac{\partial tfp_{it}}{cf_{it}} = 0.515 - 0.047 * D_i + 0.095 * D_i * SME$$

Thus, for a given geographical distance the sensitivity of productivity to cashflow for MSMEs and large firms are:

$$\frac{\partial tfp_{it}}{cf_{it}} = \begin{cases} 0.515 + 0.048 * D_i & \text{if } SME = 1 \\ 0.515 - 0.047 * D_i & \text{if } SME = 0 \end{cases}$$

Our findings show that the greater dependence on internal finance of peripheral firms to fund their productivity improvements is a phenomena of smaller sized firms.

3.4.4. Control variables

Looking at the effects of our control variables, our results indicate that, in line with the extensive literature on exporting and productivity, exporting firms are more productive than their non-exporting counterparts (e.g. Wagner, 2007). Similarly, larger and older firms tend to be more productive than smaller and younger firms. However, these effects are not linear, but rather decreasing with size and age. From a theoretical perspective, it can be argued that as a firm grows in size its scope for economies of scale arising from investing in productivity-enhancing activities increases, which translates in higher productivity. However, such productivity gains are likely to be diminished due to the increasing monitoring costs and difficulty to adjust capital and

labour associated with a larger size. Similarly, a potential explanation for the non-linear relationship between productivity and age is that as a firm gets older its accumulation of learning experience are likely to result in productivity improvements. However, the strong forces of inertia and the use of outdated technology typically associated to older firms (Burki & Terrell, 1998) can eventually diminish the productivity advantage gained by experience.

Interestingly, our results show that a firm's productivity is positively associated with the size of the financial sector of the region in which the firm is located. Moreover, it correlates positively with the average productivity of other firms operating in same region and industry, suggesting that there might be some productivity peer effects, whereby firms imitate the productivity-enhancing behavior of their local counterparts (i.e. by adopting similar technologies, etc.) For example, Machokoto et. al. (2021) have recently documented the existence of significant positive peer effects on firm's innovation activities. However, presently there is a lack of studies examining potential productivity peer effects.

**Table 3. The effects of internal and external finance on total factor productivity:
does firm's size matters?**

	(1)	(2)	(3)
Financial indicators			
Cashflow	0.515*** (0.014)	0.520*** (0.011)	0.471*** (0.018)
Cashflow* Geographical distance	-0.047** (0.021)		
Cashflow* Geographical distance*SME	0.095*** (0.018)		
Leverage	0.070*** (0.007)	0.059*** (0.005)	0.059*** (0.008)
Leverage* Geographical distance	-0.020** (0.009)		
Leverage* Geographical distance*SME	0.000 (0.008)		
Cashflow* Travel distance		-0.043*** (0.015)	
Cashflow* Travel distance*SME		0.077*** (0.014)	
Leverage* Travel distance		-0.003 (0.007)	
Leverage* Travel distance*SME		-0.004 (0.006)	
Cashflow* Travel time			-0.021 (0.023)
Cashflow* Travel time*SME			0.117*** (0.018)
Leverage* Travel time			-0.013 (0.011)
Leverage* Travel time*SME			0.008 (0.008)
Geographical distance	-0.018 (0.021)		
Geographical distance*SME	0.031*** (0.010)		
Travel distance		-0.014 (0.010)	
Travel distance*SME		0.015** (0.007)	
Travel time			-0.021 (0.026)
Travel time*SME			0.019* (0.011)
MSME	-0.173*** (0.008)	-0.157*** (0.006)	-0.170*** (0.010)
Firm-level controls			
Export	0.016*** (0.003)	0.016*** (0.003)	0.016*** (0.003)
Age	0.198*** (0.015)	0.199*** (0.015)	0.198*** (0.015)
Size	0.352*** (0.009)	0.350*** (0.009)	0.351*** (0.009)
Age ²	-0.050*** (0.005)	-0.050*** (0.005)	-0.050*** (0.005)
Size ²	-0.007*** (0.001)	-0.007*** (0.001)	-0.007*** (0.001)
HH index	-0.012 (0.017)	-0.013 (0.017)	-0.013 (0.017)
Regional-level controls			
TFP local peers	0.055*** (0.006)	0.055*** (0.006)	0.055*** (0.006)

GVA financial sector	0.041** (0.020)	0.041** (0.020)	0.040** (0.020)
GDP	0.022 (0.029)	0.023 (0.029)	0.022 (0.029)
Employment	-0.026 (0.019)	-0.026 (0.019)	-0.026 (0.019)
Constant	2.497*** (0.115)	2.492** (0.114)	2.506*** (0.116)
Year effects	Yes	Yes	Yes
Individual effects	Yes	Yes	Yes
Number of observations	132,808	132,808	132,808

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors are displayed in parentheses. The dependent variable is the natural logarithm of TFP.

4. Qualitative approach

4.1. Method: Development of interview guide, data collection and analysis

As mentioned in the Introduction, a major limitation of the FAME database is that it underrepresents the smallest firms in the UK (in particular microenterprises). Also, FAME does not report the wide range of financing sources used by firms to fund their productivity-enhancing investments. To overcome these limitations, we complemented our econometric studies with 10 semi-structured interviews with representatives from micro, small and medium-sized enterprises (MSMEs) in the Leeds area. The MSMEs covered a range of industrial activities, including marketing services, medical technologies, civil engineering, food services, short term accommodation, electronic manufacturing services, sport facilities, rental activities, and repair of machinery. Most interviews were conducted with either the owners, or if appropriate the finance manager. Companies were approached through email.

The interviews were conducted in a semi-structured manner, meaning that a structured set of questions were followed; however, deviations from the exact order of questions and indeed sometimes from the exact wording of questions were tolerated. A main set of questions was asked to all interviewees. More detailed or follow-up questions were asked depending on the time available and the interviewees' prior response. Given that the focus was on the expertise of our interview partners, all questions were open ended. All interviews were conducted virtually on zoom and lasted between 45-60 minutes approximately. Interviews were transcribed, coded, and analysed using Nvivo.

Three main areas were covered in the interviews: First, firms' recent investment decisions and how they financed them. Here, particular emphasis was placed on whether different types of investments (e.g. highly innovative projects) were financed in different ways. Second, the specific barriers to access different financing sources and whether the Covid pandemic and Brexit have had an impact on the investment-finance nexus. Third, whether the location of firms matters for accessing finance.

4.2. Qualitative findings

4.2.1. Investment decisions and financing sources

Our interview results clearly indicate that the type of productivity-enhancing activities undertaken by a firm highly depends on the nature of its business. For example, for an innovative medical diagnostics and testing firm the type of investments most highly associated to efficiency gains are expenditures in R&D and staff training; whereas a rental working space firm benefits most from refurbishing their buildings. Similarly, accessing knowledge and expertise through

acquisitions is a fundamental strategy to increase productivity in a market research agency; while hiring research organizations is the key strategy for an electronic and electrical engineering company.

While we did not find a perfect one-to-one relationship between financing sources and types of investments, we found clear association between them. For example, bank lending is suitable for the acquisition of physical capital and low risk investments, as long as the credit is backed with adequate guarantees. However, banks do not support riskier investments such as innovative activities, new ventures, and start-ups. To fund these investments, business use their internal sources of finance; their personal wealth; and/or alternative financing options.

Bank finance: overall, interviews made very clear that bank financing was very limited and hard to come by for MSME. This trend has become worse over recent decades with the move from relationship banking to automated and standardized loan provision. Whereas in relationship banking, bank managers assessed the risk of MSME lending based on long-standing contacts and knowledge of the business, these sources of “soft” information have disappeared in the age of digitalized and standardized credit assessment. Moreover, the disappearance of relationship banking has meant a reduction in capability and knowledge transfer about appropriate financing from the banks to the companies. In general, bank financing was found to be limited to cases where companies were able to provide securities, either in the form of collateral (houses, cars) or in the form of (expected) cash flow. The latter referred, in particular, to commercial financing that is the provision of loans against the security of accounts receivables. In case these securities were not available, interviewees mentioned the tendency of banks to ask for personal guarantees from entrepreneurs to secure their lending. Indeed, the rising tendencies of banks to ask for personal guarantees, and the immense risks these brought for MSME entrepreneurs, was echoed in nearly all of the interviews. One interviewee noted that *banks don't know how to lend money to pre-revenue business*, like theirs. One interviewee said that banks really only lend to *those that don't need it*. Though not consistently discussed across interviews, the same interviewee also thought that the lack of bank lending was partly due to banks' ability to make sufficient profits on their own financial investments. Overall, the lack of bank financing was particularly acute for companies with highly innovative, risky ventures, and start-ups.

Alternative financing sources: given the declining importance of bank lending, the companies interviewed accessed a range of different funding sources. Partly, these funding sources depend on the type of business and type of expenditure undertaking. In particular, MSMEs with some track record and cash flow history reported a range of different financing options which they had sought on an ad-hoc basis. These included, among others, non-bank financial companies, specialist asset-based lenders, crowdfunding, venture capital, private equity, mezzanine finance. One interviewee also mentioned the cashing in of pensions and the use of several personal credit cards to max out credit limits.

Innovative and pre-revenue companies largely rely on different types of equity capital by investors prepared to assume the additional risk for the potentially high reward in case the investment bears fruit. Examples mentioned by the interviewees included: 1. Private networks and individual investors with some money to spare. Funding in up to £5,000,000 could be obtained that way. Some of the companies interviewed used the Enterprise Investment Scheme (EIS) and/or the Small Enterprise Investment Scheme (SEIS) to raise up to £5 million each year. Under these schemes, the investors of the company can claim tax reliefs relating to their shares. 2. Angel investment networks, which are a more institutionalized form of private funding networks, were considered appropriate for larger amounts.

Other (semi) equity types of funding mentioned by the interviewees included venture capitalists and mezzanine finance. However, both of them were considered quite expensive sources of finance. Moreover, one interviewee mentioned the pressure of venture capitalists to also influence the day-to-day operations of the business and hence loss of control. Mezzanine finance, on the other hand, though in principle also a source of equity capital, has been increasingly treated like loans (which limited risk participation of the funder), and some of them have even moved to the requirement to post personal guarantees.

Government support: Another important source of funding for many of the companies interviewed (in particular those with highly innovative products and/or those with a social purpose) are national and local grants, from Innovate UK, and the Access Innovation Program from the Leeds Enterprise Partnership, among others. Several of these grants are linked to Universities. Though an important source of funding for some companies, interviewees also commented that these grants were quite time intensive to apply for and might not always provide the flexible financing needs required by companies. In particular, some grants required the companies to undertake the investment first, which would then be reimbursement; a modality which was not considered suitable for cash-strapped MSMEs. One interviewee pointed out that when it came to grants, one would either seek to apply for very small grants with little paperwork involved, or medium-sized/large ones where the pay-off could justify the cumbersome application process.

Most companies interviewed have also used government loans, especially during the current pandemic crisis (e.g. the Covid bounce back loans; the Coronavirus Business Interruption Loan Scheme; and Innovative UK innovation loans). In some instances, these loans were used to invest in essential operations (e.g. acquisition of a new software, machinery, and the improvement of the business). In others they were considered a good way to improve the company's liquid situation to (a) buffer against shocks and (b) acquire other sources of finance, though they were not needed at that point in time.

4.2.2. Barriers to accessing finance

Access to bank lending: overall, the above discussion has shown the limited role of bank lending for MSMEs and the range of alternative sources those companies had to turn to. This shows the potentially severe funding banking gap for MSMEs, a gap which seems to have increased further over recent years with the continued digitalization and financialisation of the UK financial sector. As previously noted, this gap is particularly severe for riskier (innovative), uncollateralized, and pre-revenue investments. However, it is exactly those investments, which are key to increasing productivity. In addition, when it comes to the actual amounts borrowed, the gap seems to be particularly severe for amounts between £50,000 to £500,000/£1,000,000.

Access to alternative (private) sources of finance: many interviewees concur that currently there is plenty of private cash ready to be invested in different types of business in the UK. For example, there is a wide network of angels and venture capital that offer entry level funding, as well as wealthy individual investors willing to take advantage of the tax relief schemes available in the UK (e.g. EIS and SEIS). However, accessing these sources of finance not only requires a strong business plan, but also confident and well-connected owners/ managers willing to dedicate a lot of their time and energy into raising money. One interviewee mentioned that there is finance available, but *“you have to work hard to get it. But, it does affect productivity because you have to put a lot of effort and you might not be successful”*. Similarly, another interviewee

mentioned that raising their early stages rounds of private finance (up to £1 million) was “*the most stressful thing (they) have ever done in (their) entire life*”. According to this interviewee, raising up to £5 million, represents a “weird” financial gap as you need to convince many individual investors, who make their investments decisions very carefully. The same interviewee pointed out that there might be pretty good projects out there that are unfunded because of the stress of the process to raise money. This in turn, creates social (i.e. gender and race) unbalances, as certain segments of the population do not have the required confidence, networks and/or time to raise funding. Another interviewee mentioned that this problem might be more severe in the north, where people are likely to be less confident than their counterparts in London and the South East.

Access to government finance: impressions of interviewees about accessing government finance were mixed; applications for small funding appear to be straightforward whereas approaching medium and large loans and grants is a cumbersome process, which involves filling long and tedious forms, and going through torturous interviews. And, if successful, public funding (both grants and loans) comes with an endless series of reports, meetings, and monitoring mechanisms, which are time consuming for the businesses. While interviewees acknowledge the benefits of having to write a business plan to apply for public funding, they also concur that applications for public funding should be simplified. They acknowledge, however, that the recent financial support that the Government has put in place to deal with Covid has been the most efficient, easier, quicker, and friendly they have ever had. For example, the recent Government loans have come with favourable terms and conditions. Not only they are offered at a relatively low interest rate, but they also come with a high flexibility to be used according to the business’ needs and opportunities. However, one interviewee raised the issue that, at a macro level, loans could create problems for the taxpayer as there is a risk that some businesses do not repay their loans.

Impact of Brexit: in our interviews we asked whether Brexit has affected or is expected to affect the ability of firms to access finance for their investments. Some of the interviewees mentioned that Brexit has indeed affected the investments into their companies, as well as the investors’ perception about the UK economy. For example, one interviewee mentioned that uncertainty around has been a factor that heavily impacts evergreen funds, because they rely on high-net-worth individuals who are more likely to keep their money out for the moment waiting for conditions to improve. Another interviewee mentioned that Brexit has negatively affected investor’s perception about doing business in the country. With regards to public funding, one interviewee mentioned that several of the grants they applied for were supported by European funds, which might not be available anymore post-Brexit.

4.2.3. Geographical location and access to finance

There was a certain degree of variability in terms of finance and geography. Firms whose main activities are locally based, with local clients, tend to get mostly local financing. Several of those firms noted, that the availability of finance was strongly influenced by their location. This referred both to being located in the North of England, and the location within Leeds specifically. Here, being located in less advantageous part of the city was identified as a key determinant of the availability of finance. One interviewee mentioned what they call as a “postcode lottery”. This refers to the situation in which finance companies look mostly at the postcode of a company (whether or not it is in a high risk area, with crime) rather than the actual numbers and financial condition of the firm they are lending to. According to one interviewee, this lottery had more to do with culture, rather than actual conditions in those neighbourhoods. At the same time, one

interviewee also mentioned that finance companies themselves don't tend to be located in Leeds, but rather in the South of England.

Cases with branches across England and/or who sell their products to international clients did not mention specific problems in terms of their location. Neither did those cases in which the firm provided a service with high technological content. The development of personal networks was also mentioned as something that helps improving access to finance despite the specific location of the business.

5. Conclusions and Policy Recommendations

5.1. Summary of our findings

In this report, we sought to address two policy-relevant questions: (i) *What is the role of diverse sources of finance for firm's productivity?* (ii) *Does the geography of finance matter for financing productivity?* To do so, we pursued a mix-method approach by employing econometric techniques using the FAME dataset and by analysing qualitatively interviews we conducted with MSMEs in the Leeds City Region. Here, we provide a summary of our findings, and draw the relevant policy implications.

First, regarding the sources of finance that boost productivity, the results of the econometric analysis indicate that firms in the UK predominately mobilise *internal sources of finance* for productivity enhancing innovative investments. The role of bank finance is rather limited. This is especially the case when it comes to MSMEs, which appear to be more financially constrained. In the same vein, the findings of the qualitative analysis of the interviews with owners/managers offer an insight into the tensions they encounter when they seek external finance for innovation enhancing productive investments. The case of bank finance is notable, whereby a collateral borrowing is the norm and the increased use of automated banking imposes further constraints to MSMEs. Moreover, the disappearance of relationship banking has meant a reduction in capability and knowledge transfer about appropriate financing from the banks to the companies.

Given the decline of bank lending, knowledge of financial markets and networks have become increasingly important for MSMEs to access affordable and stable sources of private finance. In other words, there is no lack of private money out there but (a) SMEs need to invest much more time and energy into finding out about these sources; and (b) the terms at which this financing is provided (i.e. the rates and maturity) might be quite disadvantageous for them. The dispersed and ad-hoc nature of financing sources, also makes personal networks a key channel to know and access these sources.

Second, with regards to the relation between the geography of finance and productivity, the results of the quantitative analysis point out that the dependence on internal finance for productivity-enhancing investments is more profound for firms in the periphery. The further away the firms are from the core financial centers in the UK, the less they rely on external finance to boost their productivity. Again, this effect is more acute for MSMEs. Equally, the findings of the qualitative analysis enrich our understanding of why geography plays a role when firms seek to finance productive investments. For instance, owners/managers of locally-based business reported that lenders base partly their risk assessment of loans on the postcode of a company. As a result, firms located in less favourable postcodes faced higher difficulties in accessing finance. These results might partly explain the observed differences in productivity across regions in the UK. Acknowledging the existence of the UK's regional inequality of financial access and its impact on productivity, especially for peripheral firms, is pivotal for policy decisions geared towards regional development, such as the UK levelling up agenda.

5.2. Policy Recommendations

The results of our project suggests that part of the regional productivity puzzle in the UK can be explained by the uneven geographical distribution of the business finance provided by the financial system. In order to address the regional financial gap in funding of productivity-enhancing investments and to contribute toward the challenge of leveling up the UK economy and building back economic growth, *direct public support to SME's* as well as the *repurposing of the UK financial system* are necessary. Two key policy recommendations that emerge from our analysis are:

1. Simplify the processes of accessing all forms of government support and ensure that public funding reaches the less advantageous geographical areas of the UK.

Given the high barriers to access private external sources of finance, government grants and loans are a suitable alternative source of finance for business to fund their productive-enhancing investments. Our interviews evidenced that accessing public funding helps firms to access private finance, so government support has a multiplier effect in the ability of firms to raise funding. It is important to simplify not only the application process, but also streamline the monitoring procedures during the execution of the project. The disbursements of the funding should also be flexible according to the firm's needs. The Covid-19 crisis has proven that government support can be provided in a timely, advantageous, and flexible way. It is therefore important to adapt and maintain these supporting mechanisms beyond the pandemic, ensuring that funds are spread across the less advantaged geographies of the UK.

2. Supporting and establishing regional and local banks to fill regional and local financial gaps.

Our results showed that a highly concentrated financial system disadvantages peripheral firms and could lead to a further concentration of productive activities in a small number of over-represented regions of the country, with the consequence of increased spatial inequality. Supporting and establishing regional and local banks is therefore important to cater to less advantageous regions. Specifically, in relation to the recent emergence of UK challenger banks and the governments "leveling up" agenda, we propose a close collaboration between the existing regional government agencies (e.g. the Local Enterprise Partnerships LEPs-) and regional challenger banks - such as Birmingham Bank - as a means of addressing the current misallocation of funds. It is our opinion that small to medium size financial intermediaries are pivotal in addressing the shortage of available funds for SME's since not only are these institutions regional in nature, but also have mission statements and objectives aligned towards local development.

Accordingly, the possible collaboration between regional authorities and regional financial institutions can be made to encourage local community development and mutually beneficial local lending strategies, whereby local authorities can i) assist in the alleviation of poor information dissemination by providing funding information to local business (for example, through programs such as the Investment Readiness Program provided by the Leeds City Region Enterprise Partnership) and ii) by further sharing part of the lending risk burden via a potential government-backed lending scheme similar to that witnessed in the recent pandemic.

5.3. Limitations and further research

One of the main limitations of this report is that the qualitative analysis was performed on a specific region of the UK, namely the Leeds City Region. Expanding this research to other locations would allow us to gain a better understanding of the financing needs of businesses across the UK. Also, in the context of the covid-19 pandemic, not only many firms were not able to dedicate time to be interviewed, but also those who effectively gave some of their time could mostly be seen as “successful” firms. Hence our qualitative analysis is likely to be biased towards successful business. Therefore, it is very likely that the barriers business face to access finance are more severe than what our interviews suggest. Nevertheless, the sectoral and technological variance of the business interviewed, along with their financial challenges were extremely useful inputs.

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Appendix

Table A1: Variable definition and data sources

Variable	Definition	Source
TFP	Log (total factor productivity) using Wooldridge (2009)'s GMM approach. In estimating the production function we measured output as turnover; capital stock as physical assets; labour as number of employees; and intermediate inputs as cost of sales net of staff remuneration, as in Harris and Li (2008). We estimate the parameter factor inputs on a industry-year basis to allow for time-varying parameters.	FAME
Cashflow (CF)	All monetary variables were measured at constant prices of 2015. Income before extraordinary items plus depreciation and amortization normalized by total assets.	FAME
Leverage (LEV)	Ratio of total debt to total assets	FAME
Geographical Distance	Log (1+ distance in miles to nearest financial centre) scaled by median in distribution by year and industry sector	FAME, HERE
Travel distance	Log (1+ travel distance in miles to nearest financial centre) scaled by median in distribution by year and industry sector	REST API, Stata
Travel time	Log (1+ travel time in minutes to nearest financial centre) scaled by median in distribution by year and industry sector	FAME, HERE
<u>Firm-level controls</u>		
Age	Log (Years since establishment)	FAME
Size	Log (Total assets in real values)	FAME
Export	=1 if firms are reported with positive overseas turnover	
HHI	Herfindahl-Hirschman Index at the two-digit SIC code industry level for sectoral competition	FAME
<u>Region-level controls</u>		
TFP local peers	Average total factor productivity of other firms (excluding the firm itself) located in the same industry and geographical (NUTS2) area.	FAME
GDP	Log (Regional GDP at NUTS2 level per 1000 capita), yearly measures	ONS
GVA financial sector	Log (Regional GVA at NUTS2 level of financial services sector per 1000 capita), yearly measures	ONS
GVA financial sector	Ratio of total employment to population aged 16-64, yearly measures	Nomis

Notes: Regional gross value added (GVA) has been measured by balancing the income and production approaches and inflation-adjusted by using UK consumer price index.

NUTS2 boundaries are classified as [Nomenclature of Territorial Units for Statistics](#) (NUTS) level 2 areas.

The broad industry sector is grouped by two-digit SIC industry as defined in UK 2007 Standard Industrial Classification (SIC) system provided by the Office for National Statistics (ONS).

Table A2: Ranking of the UK NUTS3 regions according to the size of their financial sector

NUTS3 code	NUTS3 region name	Regional GVA of financial services sector	Top 10 financial centres
UKI31	Camden and City of London	27035.611	Yes
UKI42	Tower Hamlets	12019.389	No
UKI32	Westminster	5266.111	No
UKM75	City of Edinburgh	4344.000	Yes
UKE42	Leeds	2457.111	Yes
UKG31	Birmingham	2275.333	Yes
UKJ26	East Surrey	2237.000	No
UKD33	Manchester	1901.500	Yes
UKM82	Glasgow City	1734.556	No
UKH23	Hertfordshire	1373.722	No
UKI43	Haringey and Islington	1301.556	No
UKD63	Cheshire West and Chester	1226.944	No
UKJ11	Berkshire	1206.000	Yes
UKK11	Bristol, City of	1203.667	Yes
UKK21	Bournemouth and Poole	1137.278	Yes
UKL22	Cardiff and Vale of Glamorgan	1123.444	Yes
UKI62	Croydon	1007.889	No
UKK13	Gloucestershire	967.444	No
UKN06	Belfast	956.722	Yes
UKK12	Bath and North East Somerset, North Somerset and South Gloucestershire	955.111	No
UKD34	Greater Manchester South West	945.167	No
UKJ32	Southampton	918.833	No
UKI44	Lewisham and Southwark	905.167	No
UKJ46	West Kent	896.556	No
UKE32	Sheffield	843.556	No
UKD72	Liverpool	830.500	No
UKJ12	Milton Keynes	816.056	No
UKH14	Suffolk	758.000	No
UKF24	West Northamptonshire	747.556	No
UKJ25	West Surrey	743.444	No
UKJ21	Brighton and Hove	731.000	No
UKC22	Tyneside	725.889	No
UKJ37	North Hampshire	678.556	No
UKH15	Norwich and East Norfolk	662.167	No
UKG33	Coventry	652.667	No
UKH36	Heart of Essex	627.000	No
UKE44	Calderdale and Kirklees	612.056	No
UKG12	Worcestershire	596.000	No
UKJ13	Buckinghamshire CC	592.333	No
UKK14	Swindon	576.778	No
UKI75	Hounslow and Richmond upon Thames	560.944	No

UKF11	Derby	548.111	No
UKC23	Sunderland	497.444	No
UKH11	Peterborough	468.833	No
UKL18	Swansea	436.833	No
UKJ28	West Sussex (North East)	428.389	No
UKM77	Perth and Kinross and Stirling	422.278	No
UKK43	Devon CC	412.444	No
UKE21	York	403.333	No
UKG24	Staffordshire CC	401.222	No
UKK15	Wiltshire	395.333	No
UKD45	Mid Lancashire	385.889	No
UKI74	Harrow and Hillingdon	366.278	No
UKF21	Leicester	354.944	No
UKH34	Essex Haven Gateway	346.000	No
UKH35	West Essex	342.556	No
UKE22	North Yorkshire CC	340.222	No
UKH12	Cambridgeshire CC	332.889	No
UKI61	Bromley	331.611	No
UKF22	Leicestershire CC and Rutland	328.722	No
UKJ36	Central Hampshire	326.833	No
UKE41	Bradford	315.111	No
UKD71	East Merseyside	288.500	No
UKD62	Cheshire East	279.056	No
UKI52	Barking & Dagenham and Havering	274.778	No
UKD35	Greater Manchester South East	274.778	No
UKD36	Greater Manchester North West	274.444	No
UKC11	Hartlepool and Stockton-on-Tees	273.833	No
UKI41	Hackney and Newham	261.500	No
UKF14	Nottingham	259.333	No
UKJ35	South Hampshire	243.444	No
UKG13	Warwickshire	241.167	No
UKJ27	West Sussex (South West)	241.056	No
UKM95	South Lanarkshire	238.167	No
UKM50	Aberdeen City and Aberdeenshire	225.000	No
UKG21	Telford and Wrekin	218.000	No
UKI51	Bexley and Greenwich	213.222	No
UKJ44	East Kent	212.611	No
UKG32	Solihull	205.611	No
UKI53	Redbridge and Waltham Forest	203.333	No
UKC14	Durham CC	198.611	No
UKF30	Lincolnshire	192.778	No
UKI71	Barnet	188.000	No
UKD73	Sefton	185.389	No
UKD37	Greater Manchester North East	185.222	No
UKI54	Enfield	183.778	No
UKE31	Barnsley, Doncaster and Rotherham	177.944	No

UKI73	Ealing	171.778	No
UKK30	Cornwall and Isles of Scilly	159.111	No
UKJ14	Oxfordshire	155.722	No
UKI63	Merton, Kingston upon Thames and Sutton	153.667	No
UKI72	Brent	144.889	No
UKL21	Monmouthshire and Newport	140.111	No
UKH31	Southend-on-Sea	136.389	No
UKH37	Essex Thames Gateway	135.111	No
UKH21	Luton	130.056	No
UKD12	East Cumbria	126.556	No
UKJ43	Kent Thames Gateway	124.556	No
UKJ41	Medway	123.722	No
UKE13	North and North East Lincolnshire	123.056	No
UKK23	Somerset	120.611	No
UKG22	Shropshire CC	118.333	No
UKG39	Wolverhampton	116.833	No
UKJ45	Mid Kent	116.500	No
UKL15	Central Valleys	115.000	No
UKG23	Stoke-on-Trent	112.556	No
UKF16	South Nottinghamshire	109.722	No
UKE12	East Riding of Yorkshire	107.111	No
UKC12	South Teesside	106.222	No
UKD44	Lancaster and Wyre	97.667	No
UKL23	Flintshire and Wrexham	95.944	No
UKN10	Derry City and Strabane	93.944	No
UKG38	Walsall	93.000	No
UKC13	Darlington	89.444	No
UKJ22	East Sussex CC	87.611	No
UKI33	Kensington & Chelsea and Hammersmith & Fulham	81.056	No
UKD46	East Lancashire	80.222	No
UKM72	Clackmannanshire and Fife	78.611	No
UKF25	North Northamptonshire	76.611	No
UKD47	Chorley and West Lancashire	75.722	No
UKM81	East Dunbartonshire, West Dunbartonshire and Helensburgh and Lomond	73.944	No
UKE11	Kingston upon Hull, City of Inverness and Nairn and Moray, Badenoch and Strathspey	73.833	No
UKM62		73.056	No
UKD74	Wirral	70.222	No
UKM84	North Lanarkshire	69.333	No
UKM71	Angus and Dundee City	68.833	No
UKE45	Wakefield	62.000	No
UKL16	Gwent Valleys	61.000	No
UKC21	Northumberland	60.833	No
UKG36	Dudley	58.444	No
UKL14	South West Wales	56.556	No

UKK41	Plymouth	55.444	No
UKD11	West Cumbria	54.167	No
UKJ31	Portsmouth	53.667	No
UKH16	North and West Norfolk	52.056	No
UKH17	Breckland and South Norfolk	49.833	No
UKG37	Sandwell	48.889	No
UKM93	East Ayrshire and North Ayrshire mainland	45.222	No
UKL17	Bridgend and Neath Port Talbot	43.389	No
UKN16	Fermanagh and Omagh	43.333	No
UKH25	Central Bedfordshire	42.833	No
UKD41	Blackburn with Darwen	42.556	No
UKF15	North Nottinghamshire	37.833	No
UKD42	Blackpool	37.278	No
UKK22	Dorset CC	36.500	No
UKL24	Powys	35.722	No
UKG11	Herefordshire, County of	34.778	No
UKD61	Warrington	34.278	No
UKL13	Conwy and Denbighshire	32.611	No
UKF13	South and West Derbyshire	32.556	No
UKM83	Inverclyde, East Renfrewshire and Renfrewshire	32.167	No
UKM94	South Ayrshire	31.389	No
UKH24	Bedford	31.278	No
UKH32	Thurrock	30.500	No
UKL12	Gwynedd	26.444	No
UKI45	Lambeth	26.056	No
UKF12	East Derbyshire	25.389	No
UKM61	Caithness and Sutherland and Ross and Cromarty	22.111	No
UKM78	West Lothian	21.889	No
UKK42	Torbay	20.944	No
UKI34	Wandsworth	20.611	No
UKN09	Ards and North Down	19.611	No
UKM63	Lochaber, Skye and Lochalsh, Arran and Cumbrae and Argyll and Bute	19.333	No
UKJ34	Isle of Wight	15.278	No
UKM92	Dumfries and Galloway	13.556	No
UKN07	Armagh City, Banbridge and Craigavon	13.389	No
UKN08	Newry, Mourne and Down	9.778	No
UKM64	Na h-Eileanan Siar	8.556	No
UKL11	Isle of Anglesey	8.389	No
UKN12	Causeway Coast and Glens	8.167	No
UKN15	Mid and East Antrim	7.667	No
UKN14	Lisburn and Castlereagh	7.389	No
UKM91	Scottish Borders	7.111	No
UKN11	Mid Ulster	5.944	No
UKM73	East Lothian and Midlothian	5.778	No

UKM76	Falkirk	5.389	No
UKN13	Antrim and Newtownabbey	5.222	No
UKM66	Shetland Islands	5.000	No
UKM65	Orkney Islands	4.611	No

Table A3: Panel structure of the dataset

Year	No. obs	Percentage	No. of years per firms	No. firms	No. firm- year obs
2001	3,649	2.75	3	1,466	4,398
2002	4,025	3.03	4	1,498	5,992
2003	4,374	3.29	5	1,383	6,915
2004	4,162	3.13	6	1,283	7,698
2005	4,133	3.11	7	1,224	8,568
2006	4,351	3.28	8	1,251	10,008
2007	4,574	3.44	9	1,235	11,115
2008	4,947	3.72	10	1,153	11,530
2009	6,930	5.22	11	712	7,832
2010	8,186	6.16	12	566	6,792
2011	8,987	6.77	13	477	6,201
2012	9,706	7.31	14	449	6,286
2013	10,345	7.79	15	466	6,990
2014	10,891	8.20	16	464	7,424
2015	11,345	8.54	17	537	9,129
2016	11,527	8.68	18	885	15,930
2017	10,627	8.00	Total	15,049	132,808
2018	10,049	7.57			
Total	132,808	100.00			