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Does Access to Credit Improve Labour Productivity?

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Abstract

If credit rationing justifies public intervention in credit markets, it should be the case that unconstrained firms should result in higher productivity. In this paper, we use a longitudinal SME dataset for the UK to empirically test whether this is true. Our findings are nuanced and show that SMEs subject to quantity rationing suffer from productivity declines of up to 40%, which is more important than full rationing in the determination of labour productivity. We suggest that partial rationing forces firms to undertake second-best investment projects that limits their ability to become more productive. This implies that the returns to capital would increase if small firms that are of sufficient quality to pass banks screening tests received all the funds they applied for. This suggests that loan guarantee schemes may play a fundamental role in removing quantity rationing barriers for SMEs. We also find that discouragement can have a positive effect on productivity, and this suggests that firms reconfigure their capital structure by retaining more cash to avoid engaging with debt markets.

1. Introduction

The productivity of labour is a fundamental determinant of economic growth which raises the incomes of workers, firms and the economies they reside within (Hornbeck and Moretti, 2018). Yet many firms operate below their minimum efficient scale of output and are constrained in investing to grow their firms to a more efficient level of output (Bencivenga and Smith, 1993), a clear violation of the Gibrat's law (Audretsch et al, 2004). For SMEs specifically, they often face access to finance barriers due to their information opaqueness (Jaffee and Stiglitz, 1990) and credit rationing has been found to be an important, and pervasive, feature of capital markets across time and countries (Casu et al, 2024). This is particularly important as most economies in the world are dominated numerically by SMEs hence addressing this particular access to finance problem should result in above average productivity gains.

Yet the phenomenon of credit rationing is not a simple binary issue of whether a firm applied for a loan and either received it or not. Indeed, it is far more nuanced as some firms apply for bank loans and receive less than the full amount they requested. This is termed partial (or quantity) rationing and has been found to be a non-trivial feature of SME loan contracting (Beyhaghi et al, 2020; Cole, Cowling, and Liu, 2024). Further, some firms who have an underlying need for external bank loans choose not to apply due to their perception of a low probability of success should they apply. These firms are called discouraged borrowers because they are reluctant to bear the costs of application and self-exclude from the loan market (Kon and Storey, 2003). A more recent subset of discouraged borrowers identified by Cowling, Liu, and Calabrese (2021) have been termed 'scarred borrowers' as they previously made bank loan applications but were unsuccessful and this rejection caused them to withdraw from the loan market. Recent empirical evidence has also shown that these phenomena can also be temporary as firms become rationed, discouraged, or scarred and others exit these states over time (Cowling and Sclip, 2023).

In this respect, it is likely that these positive changes in firm's and lenders behaviour in respect of the bank loan market should, if rationing is important enough to justify public intervention in the loan market, result in improved productivity at the firm level. This is a clear research gap that remains relatively unexplored despite evidence that credit constrained SMEs have lower growth rates in employment and sales (Cowling, Brown, Liu, and Rocha, 2024). One important study, Yu and Fu (2021) that examined labour productivity in Chinese SMEs, did, however, establish that both weak and strong credit rationing both acted to reduce labour productivity, with the magnitude of the strong credit rationing effect being larger than the weak rationing effect. However, this study focused on price based rationing and used the bank's interest rate offer as its focus for identifying credit rationing. This is consistent with the key feature of credit rationing theory which is the backward bending loan supply curve at high rates of interest (Shen, 2002), but ignores the underlying effects, for example, lack of collateral or track record.

In this paper we explore the important question of whether different elements of credit rationing act as a constraint on labour productivity growth in SMEs using a large longitudinal sample of SMEs in the UK between 2017 and 2023. Rather than inferring credit rationing, we have more explicit and direct measures of full credit rationing (applied for a loan and received a complete rejection), partial rationing (applied for a loan and received an offer for less than the full cash amount requested), and discouraged borrowers (had a need for external borrowing but did not make an application). Our baseline findings show that 2.73% of all UK SMEs were fully credit rationed, 2.06% partially credit rationed, and 2.56% were discouraged borrowers in 2017. Using the UK SME population data for employer businesses, these figures would equate to 38,220 fully rationed firms, 36,400

partially rationed SMEs, and 35,840 discouraged borrowers. In this sense, of the total of 110,460 credit rationed SMEs in the UK in 2017, 67.5% of credit rationed SMEs in the UK were constrained by banks and 32.5% self-constrained by their own volition.

The time-series variation in all three forms of credit rationing is particularly interesting and confirms that the dynamics of all aspects of credit rationing are key to understanding this phenomenon. We clearly observe some important changes during the Covid-19 period from 2020 until 2021 when credit rationing decreased in all its forms in the presence of two very large and generous public loan guarantee schemes that accounted for 92.1% of total UK SME loans issued (Calabrese, Cowling, and Liu, 2021). Subsequently, all forms of credit rationing have increased and partial credit rationing was found to be as prevalent as full credit rationing.

In respect to the dynamics of labour productivity, we also observe some important time-series variation. On this, the pre-pandemic period was characterised by fairly strong labour productivity growth, but this collapsed as the UK economy transitioned into the Covid-19 pandemic period and declined even further in the post-pandemic period. It follows that the UK economy is moribund currently with low labour productivity growth thus understanding the potential causal effect of different types of credit rationing on labour productivity is a fundamental building block in identifying the scale of the potential problem and establishing whether or not there is a role for public policy to intervene in SME loan markets to reduce any potential credit rationing gap.

Our econometric modelling shows that partial credit rationing is the most important element of credit rationing in respect of labour productivity. We also found that borrower discouragement was associated with higher labour productivity and this suggests that when firms self-exclude from debt markets, they do not do this passively and undertake strategic actions to counteract this constraint, such as retaining more free cash to support operations and investment without recourse to external borrowing. In contrast, full credit rationing is found to be less important. These latter findings suggest that both full credit rationing is more randomly distributed amongst good and bad quality firms. This is an issue of concern in its own right, but separate in this case from the labour productivity question. The findings relating to partial credit rationing are intriguing. Banks have taken the view that a firm is a low enough risk to offer a loan to. Yet they have also taken the view that they are not of sufficient quality to advance the full cash amount of loan they requested. The firm wants a station wagon, but the bank offers them a small family car. This gets to the heart of the issue in the sense that, when faced with partial credit rationing, a firm either invests at a suboptimal scale or chooses a second-best investment option. Both reduce the labour productivity enhancing effect of raising a bank loan. This effect can also be traced out through the classic long-run average cost curve facing the firm as a partially rationed firm is able to expand its output into a lower point on its cost curve, but not by as much as receiving all the loan they requested.

These findings suggest that the shift in the operating rules of the UK loan guarantee schemes since 2009 (the initiation of the Enterprise Finance Guarantee (EFG) scheme) that allowed for lenders to take firm and some forms of personal collateral directly addressed this specific group of partially credit rationed firms who had some collateral, but not enough to raise the full loan amounts they desired. This feature of UK loan guarantee schemes remained in place on the post-pandemic Recovery Loan Scheme (RLS) and in its currently active replacement, the Growth Guarantee Scheme (GGS).

Other important findings were that labour productivity was highest in firms located outside of urban locations, contradicting agglomeration theories, and amongst exporting firms, supporting learning theories of exporting (Delgado, Farina, and Ruano, 2002), and profitable firms. Wider regional effects were also apparent with firms in London and South East England being more productive than firms anywhere else in the UK. In terms of firm level effects, we find that older firms were, on average, more productive, and that firms with larger boards of directors were too. The former suggests that over time firms iterate towards more efficient means of production and that a greater accumulation of board level experience is a key human capital input to productivity. This latter effect was also observed in a previous study of productivity in SMEs in the UK which found that all senior level human capital (including the founding entrepreneur, board of directors and management team) was important in the determination of productivity across firms (Cowling, 2003). We also find that family firms are less productive, confirming the findings of Aiello, Mannarino, and Pupo (2020) in their study of European manufacturing firms who cited problems in translating investment into economic gains, and another European study by Aguilera et al (2024) who cite their inefficient labour-intensive

production processes. In general, we also found that primary industries, construction, and wholesale and retail sectors were the most productive in the UK.

The rest of the paper is set out as follows: In Section 2 we review the literature relating to credit rationing, with a specific focus on different types of credit rationing, and the channels through which it might impact on labour productivity. Section 3 presents the base data and sample characteristics alongside the time-series dynamics and evolution of credit rationing and labour productivity. In Section 4 we discuss the findings from our econometric models of labour productivity. We conclude in Section 5 by considering whether SME credit rationing does influence labour productivity and, if so, how and for whom.

2. Literature Review

We split our review into two parts. First, we consider credit rationing and its different types. Then we review the literature on labour productivity and its determinants with a view to identifying the channels through which credit rationing might subsequently impact on productivity. Here, we also review the empirical evidence that has linked credit rationing to SME growth and productivity.

2.1. Credit rationing

Credit rationing has its theoretical roots in seminal contributions by Stiglitz and Weiss (1981) Jaffe and Stiglitz (1990) and Jaffee and Modigliani (1969). In essence, due to imperfections in the credit market due to information asymmetries, there may exist an equilibrium where there remains excess demand for loans that banks are unwilling to meet. This is traced out in the backward bending loan supply curve that bends backwards as banks become increasingly less willing to lend to borrowers that would attract high risk adjusted loan interest rates even when there are some firms that are willing to accept such loans. This is connected to the bank's revenue-profit curve and banks choke off riskier loans that shift the bank to a position where their marginal profit from advancing one more loan is diminishing due a higher default risk. With perfect information, banks can offer separating contracts that distinguish between high- and low-quality borrowers. However, with imperfect information, if banks offer pooling contracts, then good quality borrowers face higher interest rates than they would be offered under a separating contract regime (Innes, 1991).

The empirical evidence for the existence of credit rationing is fairly compelling and it has been shown to be a non-trivial phenomenon in SME credit markets across the world and one that is persistent over time (Beck and Demirguc-Kunt, 2006), albeit to varying degrees depending on the state of the economy largely due to changes in banks' lending standards in crisis periods (Kremp and Sevestre, 2013). Yet, simply establishing that a significant number of firms in an economy are credit rationed is a necessary, but not sufficient, condition to justify public intervention in credit markets. Rather, this requires it to be the case that credit rationing must impact on firms with 'good' quality projects and a high probability of loan repayment.

A useful framework for considering the prima facie case for public intervention is outlined by Astrebro and Bernhardt (2003). The authors describe Type 1 and Type 2 errors in the loan market. A Type 1 error would occur if a bank made its original loan decision to reject the application in the absence of a loan guarantee scheme and was correct. A Type 2 error would occur if the bank rejected the original loan application which was then referred onto the loan guarantee scheme and was subsequently repaid in full. In this framework, if default increases as constrained firms become unconstrained via the loan guarantee scheme, then

banks are, under certain conditions and particularly under a low guaranteed coverage rate, better off without a scheme. This is because loan guarantee schemes raise the equilibrium price (via the government interest rate premium) and volume (number of loans and the total value of loans) offered in the loan market. This can lead to a situation where banks are lending at levels beyond their profit maximising point.

However, the phenomenon of credit rationing is more nuanced than is often considered and on the supply side encompasses full credit rationing (where a firm makes a loan application and receives an outright rejection), partial credit rationing (where a firm makes a loan application and receives and offer but not for the full cash amount requested). The presence of loan guarantee

schemes in more than one hundred countries across the world (Honohan, 2010) suggests that policy makers believe that credit rationing is both a numerically important phenomenon, and one that actively constrains firms from growing and becoming more productive. During the recent Covid-19 pandemic period, loan guarantee schemes were one of the most prevalent policy responses to support SMEs (Budnik et al, 2021).

On the demand side of the loan market there exists a pool of firms with a latent need for bank loans, but who do not formally make a loan application. This arises as they perceive that any application they put forward will be treated unfavourably by a bank in the sense that it will receive an outright rejection or the loan contract offer will be such that they would refuse it (e.g too high an interest rate offer, high fees, or excessive collateral etc). Firms that exhibit this behaviour are termed discouraged borrowers (Kon and Storey, 2002). A new and important subset of latent borrowers uncovered by Cowling, Liu, and Calabrese (2021) have been collectively termed 'scarred borrowers'. These firms previously engaged with the loan market, but after a rejection chose to self-exclude in the future for an extended period. In this respect the general pool of discouraged borrowers relates to firms with a perception of rejection should they apply for a bank loan, rightly or wrongly, whilst scarred borrowers have a real-life negative experience that influences their future behaviour with respect to the loan market.

So, what does empirical evidence tell us about the prevalence of these four different types of credit rationed firms? Continental European evidence provides estimates of discouraged borrowing over the last two decades of between 6% for lines of credit and 7% for term loans (Cowling and Sclip, 2023) and 22.1% (Beyhaghi et al, 2020), although Mac an Bhaird, Vidal, and Lucey (2016) in their analysis of nine European countries found discouraged borrower rates varying from as low as 5.5% in Finland to 44.0% in Ireland. UK studies report estimates of between 4.1% (Cowling, Brown, Liu, and Rocha, 2024) and, at a more fine-grained level, 10.0% for lines of credit and 7.0% for term loans (Cole, Cowling, and Liu, 2024). Evidence also shows that less developed countries tend to have more discouraged borrowers with Gama, Duarte, and Esperanca (2017) reporting an aggregate figure of 34%, which is higher than the US estimate of 27.6% of firms that needed credit (Cole and Sokolyk, 2016). The UK study that explicitly considered scarred borrowers reported that 6.5% of the business population had withdrawn from the loan market due to a previous negative experience from a loan application rejection (Cowling, Liu, and Calabrese, 2022). One of the most important features arising from the body of discouraged borrower research is that significant shares of discouraged borrowers have been predicted to have been offered a bank loan had they applied for one. These predictions range from in the UK study of Cowling, Liu, Minniti, and Zhang (2016), to 40% in the Ferrando and Mulier (2022) study, to 50% in the US study of Cole and Sokolyk (2016). This suggests that non-trivial shares of the discouraged borrower population may have erroneously self-excluded from the loan market.

We now turn our attention to the empirical quantification of full and partial credit rationing. European studies have generated estimates of between 9% (Cowling and Sclip, 2023) and 12.0% for full rationing of low type borrowers (Beyhaghi et al, 2020). Comparable estimates for partial credit rationing are 9% for term loans and 11% for lines of credit (Cowling and Sclip, 2023) and 22.7% Beyhaghi et al, 2020). All forms of rationing in their study diminish in firm size and age. Casu et al (2024) in an atypical study of mid-corporate firms in Europe, report estimates of 6.5% for full rationing and 30.5% for partial rationing for renewal of lines of credit. UK studies report figures of full credit rationing of 14.3% (Cowling, Brown, Liu, and Rocha, 2024), and in Cole, Cowling, and Liu (2024) 15.0% for lines of credit and 34.0% for term loans.

2.2. Credit rationing and SME performance

Growth in firm level (and aggregate national) productivity is substantially linked to measures of worker skills and ability (human capital), the financial capital available to them, and also the state of technology (Castellacci and Zheng, 2010). Increases in the human and financial capital available to firms raises productivity growth rates as more talented and skilled workers (Anos-Casero and Udomsaph, 2009) and higher capital investment raises their output and lowers their average costs per unit of output (Esaku, 2022).

However, the effect of financial frictions on productivity growth is less well understood as the majority of firm level productivity research is conducted on samples of large corporate firms and/or manufacturing plants (Van Reenan, 2011; Bloom, Sadun, and Van Reenan, 2010) rather than SMEs where the presence of financial frictions and access to capital are most apparent (Stiglitz and Weiss, 1981). It follows that any link between capital markets and the real economy should mostly be observed for smaller

and younger firms who are most likely to face capital market constraints and particularly in periods of crisis (Casu, Chiaramonte, Croci, and Filomeni, 2024; Yu and Fu, 2021). Of the research that has considered firm level finance issues in the context of productivity, there is a broad level of concordance in terms of establishing that general financial frictions, or problems with access to specific forms of capital lower firm level productivity. For example, evidence on the negative effects of financial frictions is identified in a Euro area study by Ferrando and Ruggieri (2015), and confirmed in a European study by Levine and Warusawitharanawhilst (2021), a Bulgarian study by Gatti and Love (2008) found that credit access problems lowered future productivity growth a finding confirmed in an Italian study in respect of industry level finance constraints (Caggese, 2019). In the endogenous growth model reported by Bencivenga and Smith (1993), where investment is financed by credit markets, the issue of adverse selection in loan markets allows equilibrium credit rationing to occur endogenously such that equilibrium credit rationing and real growth rates are jointly determined. On specific types of finance, Chemmanur, Krisnan, and Nandy (2011), in a longitudinal study of private and public US firms, found that venture capital raised firms' growth rates and efficiency in production. Crisis period studies, for example Manaresi and Pierri (2024) found that broader contractions in credit supply during the Global Financial Crisis period reduced both the output and productivity of Italian firms.

In a UK small firm productivity study, Cowling (2003) found that the majority of small firms face increasing returns to scale and this implies that any barriers to firm investment in growth, including access to capital, but also including board and managerial level human capital, will prevent the firm from becoming more productive and moving into the lower region of their long-run average cost curves. More specialist and focused studies have also found that in Europe family firms tend to adopt more labour-intensive production techniques and have lower productivity (Aguilera et al, 2024) and that whilst they invest more in R&D, this does not translate into higher returns (Aiello, Mannarino, and Pupo, 2020). A Chinese SME study by Yu and Fu (2021), also found that both weak and strong credit rationing reduced firm productivity growth but the channel through which it occurred was through the innovation channel, although they also found that firms with low rates of fixed real estate investment or a lower general willingness to invest in growth had lower productivity growth rates.

Thus, there is an emerging body of research from which a consensus is building that financial issues that restrict firms' access to capital do have an impact on firm growth, but more importantly directly on productivity growth in a negative way. Importantly, as capital market frictions and rationing are most evident for younger and smaller firms (and often innovative firms of both types), it follows that this acts to reduce their growth potential, hence their ability to move down their long-run average cost curves at higher output levels, but also their productivity growth. In this sense linking capital market problems with SMEs is the most appropriate way to identify if financial frictions and credit rationing reduce firm level productivity growth.

3. Data and Method

In this section, we describe in detail the data set and the econometric methodologies we used in the empirical analyses.

3.1. Data and variables

The data for this study were drawn from the UK Longitudinal Small Business Surveys (LSBS) between 2016 and 2023, a dataset that has been extensively utilized in prior empirical research examining SME business outcomes (e.g., Liu, Liu, & Ko, 2022). Commissioned by the UK Department for Business, Energy and Industrial Strategy (BEIS), the LSBS is a large-scale, nationally representative survey of owners and managers of SMEs, defined as businesses with fewer than 250 employees. The survey provides comprehensive data on various aspects of business behaviour, including innovation activities, export participation, financing strategies, and workforce training. A distinctive feature of the LSBS, in contrast to other UK SME surveys used in earlier studies (e.g., Cowling et al., 2015; Wai et al., 2022), is its longitudinal design. This structure enables researchers to mitigate endogeneity concerns related to unobserved time-invariant effects within cross-sectional units.

The LSBS employed a stratified random sampling approach, ensuring representation across key dimensions such as industrial sectors (one-digit Standard Industrial Classification codes), firm size categories (based on employee counts), and geographic regions (England, Scotland, Wales, and Northern Ireland). Given the highly skewed distribution of the UK business population, dominated by micro-enterprises and non-employer businesses, the survey design intentionally oversampled firms with 5 to 249 employees while undersampling non-employer businesses. This approach was adopted to ensure robust subsamples for

analysis. The final dataset comprises 59,559 valid firm-year observations, with the following distribution: 60% micro-enterprises or non-employer businesses (0–9 employees), 27% small enterprises (10–49 employees), and 13% medium-sized enterprises (50–249 employees).

Our primary dependent variable is labour productivity, defined as real sales (sales adjusted for CPIH) per employee. Our key independent variables of interest concern the financial constraints faced by SMEs, capturing both supply-side quantity rationing and demand-side self-rationing. The former is measured by whether or not a firm was rejected all the external finance (full-ration), or only obtained some of the finance (part-ration) it applied for. Demand-side rationing is captured by borrower discouragement following Kon and Storey (2003), defined as firms reporting a demand for finance but did not apply for any because of (a) fear of rejection or (b) borrowing cost being too high. We further control for firm-level characteristics that are commonly found to be associated with business outcomes, including age, spatial measures (region, urban and deprived area indicator), sector, organisational/ownership structure (legal form, family-owned, female- or ethnic-minority-led and number of directors), profitability, and operational behaviours (export and innovation).

3.2. Methodology

Our data set consists of an unbalanced panel of 59,559 effective firm-year observations over eight years between 2016 and 2023, 14,948 of which will enter the final regression analyses with the inclusion of lagged variables. Specifically, we estimate the following linear dynamic panel data model:

$$Productivity_{it} = \alpha Productivity_{it-1} + \beta \sum_{j=0}^{2} FinancialConstraints_{it-j}$$

$$+\gamma \sum_{j=0}^{1} Controls_{it-j} + \tau_t + \zeta_i + \varepsilon_{it}$$

1

where τ_t represents the common year effect in the panel regression, ζ_t the unobserved firm-level fixed effects and ε_{it} the idiosyncratic error term. The contemporaneous and one- and two-year lagged values of financial constraints variables are included to capture both the short- and long-run effects. For all the control variables, contemporaneous and one-year lagged values are included so that their causality relations to the dependent variables are explicitly and temporally established, with the exception of time-invariant variables such as spatial variables, sector, legal form and organisational/ownership measures. To minimise the effect of outliers, all the continuous variables are winsorised at 1% level on both tails and enter the regressions in natural logarithms.

Due to the inclusion of lagged dependent variable which is by construction correlated with the unobserved panel-level effects, standard estimators such as OLS and static panel data models are no longer unbiased and consistent. To overcome this endogeneity problem by construction, we use the two-step robust Generalized Method of Moments (GMM)-system estimator proposed by Blundell and Bond (1998) where the level equation is instrumented by lagged differences of the dependent variable, in addition to the lagged instruments for the difference equation in the Arellano and Bond (1991) difference-GMM estimator. The correct specification of the model requires the absence of second-order serial correlation in residuals (and ideally, significant first-order serial correlation). Further, the Hansen test of over-identifying restrictions will be used to test the validity of instruments.

4. Results

In this section, we first report the summary statistics of the variables, followed by the coefficient estimates of the regression models and lastly, findings from additional and robustness analyses.

4.1. Sample descriptives

Table 1 reports the population-weighted summary statistics of the variables. All continuous variables (except for employment size) are winsorised at 1% level to minimise the effect of outliers. It is shown that the average real labour productivity and turnover are £112,144 and £306,043 with medians of £39,027 and £45,914, respectively so the distribution of both variables are right-skewed. The mean employee number is little short of three (2.9) with an average number of 1.6 directors or partners. On average and across the years, about one in twenty (5.2%) businesses have difficulties in accessing external finance to some degree, and amongst them, 39.3% were fully rationed, 17.0% were partially rationed and 43.6% were discouraged borrowers. There is no clear pattern on labour productivity across three types of credit rationing and compared to non-rationed firms[1], which implies that there may be a lagged effect between the two.

Table 1
Descriptive Statistics (N = 59,559)

Variable	Mean	se(mean)	Median	Min	Max	Mean (full ration)	Mean (partial ration)	Mean (discouraged)	Mean (non-ration)
Dependent variables									
Real labour productivity (£,000)	112.144	3.219	39.027	0.022	33,800	115.877	123.254	100.086	112.659
Independent variables									
Full ration (0, 1)	0.020	0.001	0	0	1	1			0
Partial ration (0, 1)	0.009	0.000	0	0	1		1		0
Discouraged (0, 1)	0.022	0.001	0	0	1			1	0
Control variables									
Real sales (£,000)	306.043	6.421	45.914	1.855	33,800	345.930	462.512	225.993	305.785
Employment	1.892	0.037	1	0	249	2.395	3.966	1.648	1.867
Firm age	20.122	0.062	16	1	78	15.335	15.945	16.129	20.335
Legal form (Base = Sole proprietorship)									
Company	0.476	0.002	0	0	1	0.580	0.563	0.483	0.473
Partnership	0.071	0.001	0	0	1	0.051	0.059	0.057	0.071
Number of directors	1.603	0.005	1	1	12	1.659	2.179	1.541	1.598
Ethnic minority led (0, 1)	0.048	0.001	0	0	1	0.097	0.102	0.119	0.045
Women led (0, 1)	0.193	0.002	0	0	1	0.184	0.242	0.243	0.191
Family own (0, 1)	0.901	0.001	1	0	1	0.862	0.784	0.921	0.902
Rural (0, 1)	0.314	0.002	0	0	1	0.275	0.336	0.298	0.315
Deprived (0, 1)	0.078	0.001	0	0	1	0.097	0.114	0.084	0.077
Profitability (0, 1)	0.765	0.002	1	0	1	0.621	0.595	0.547	0.774
Export (0, 1)	0.143	0.001	0	0	1	0.175	0.196	0.199	0.148
Product innovation (0, 1)	0.076	0.001	0	0	1	0.147	0.181	0.176	0.072
Sector (Base = Primary)									
Manufacturing	0.050	0.001	0	0	1	0.043	0.062	0.060	0.050
Construction	0.175	0.002	0	0	1	0.212	0.149	0.189	0.175
Wholesale/ Retail	0.098	0.001	0	0	1	0.094	0.093	0.130	0.098

Variable	Mean	se(mean)	Median	Min	Max	Mean (full ration)	Mean (partial ration)	Mean (discouraged)	Mean (non-ration)
Transport/ Storage	0.059	0.001	0	0	1	0.101	0.109	0.071	0.057
Accommodation/ Food	0.034	0.001	0	0	1	0.055	0.031	0.043	0.033
Information/ Communication	0.063	0.001	0	0	1	0.081	0.057	0.048	0.063
Financial/ Real Estate	0.038	0.001	0	0	1	0.042	0.053	0.026	0.039
Professional/ Scientific	0.151	0.001	0	0	1	0.103	0.069	0.107	0.154
Administrative/ Support	0.089	0.001	0	0	1	0.086	0.077	0.082	0.089
Education	0.051	0.001	0	0	1	0.020	0.041	0.038	0.052
Health/ Social Work	0.057	0.001	0	0	1	0.040	0.088	0.054	0.057
Arts/ Entertainment	0.047	0.001	0	0	1	0.058	0.055	0.071	0.047
S - Other service	0.054	0.001	0	0	1	0.040	0.068	0.058	0.054
Region (Base = East Midlands)									
East of England	0.102	0.001	0	0	1	0.103	0.081	0.087	0.102
London	0.105	0.001	0	0	1	0.123	0.130	0.144	0.103
North East	0.025	0.001	0	0	1	0.033	0.018	0.018	0.025
North West	0.085	0.001	0	0	1	0.093	0.077	0.092	0.084
South East	0.183	0.002	0	0	1	0.195	0.224	0.171	0.182
South West	0.145	0.001	0	0	1	0.105	0.121	0.097	0.147
West Midlands	0.087	0.001	0	0	1	0.118	0.068	0.080	0.087
Yorkshire & the Humber	0.072	0.001	0	0	1	0.065	0.069	0.049	0.073
Scotland	0.062	0.001	0	0	1	0.079	0.079	0.059	0.061
Wales	0.035	0.001	0	0	1	0.021	0.033	0.061	0.035
Northern Ireland	0.022	0.001	0	0	1	0.025	0.041	0.036	0.022

Regarding firm and owner characteristics, an ‘average’ firm is 20 years, family owned (90%) and run by a male (80.7%) and non-ethnic-minority (95.3%) owner manager. Most of the firms are either traded as sole proprietorships (42.8%) or limited companies (47.6) with the remaining as partnerships (7.1%) or other legal organisations (2.6%). Geographically, the majority of the firms are located in urban areas (69.6%), with around one in thirteen business (7.8%) in the 15% most deprived areas in the UK. Operationally, 14.3% of the firms exported goods/services overseas and 7.6% reported to have introduced market-level (radical) innovation on products and services, and over three quarters (76.5%) generated a profit during the previous financial year. Further analyses show that all types of credit rationing are associated with low profitability, young firm age and more aggressive

investment behaviours proxied by export and innovation, which is consistent with the existing knowledge. Compared to non-rationed firms, discouraged firms on average are smaller as measured by employment and sales, but exactly the opposite is true for other two types of credit rationing.

Figures 1 further shows the time-series of labour productivity and the percentage of businesses being credit rationed. Not surprisingly, the levels of all three alternative measures of credit rationing, especially that directly induced by the banking sector (full and partial rationing) dropped significantly during the COVID pandemic, a likely result of the public financial support during the period, whereas there appears to be a lagged effect of COVID on self-imposed rationing (discouragement). However, the percentage of fully rationed firms immediately returned to the pre-pandemic level, an indicator of the existence of zombie firms incapable of servicing their existing debt, which would represent a severe lending risk to the banks. Turning to productivity dynamics, if they are indeed negatively related to financial constraints, the effect may take time to manifest as shown in the figure.

4.2. Regression results

Table 2 reports the coefficient estimates of Eq. (1) using the GMM estimator. For all the specifications, the first-order serial correlation in residuals (AR(1)) is significant at 1% level and the second-order serial correlation in residuals (AR(2)) is statistically insignificant. Both the Sargan and Hansen statistics show a general lack of significance, so the null that all overidentifying restrictions are valid cannot be rejected. Jointly, we are confident that the GMM model is correctly specified and the level and difference IVs are valid. When the dependent variable enters the regression in logarithm form, the coefficient estimates can be approximately interpreted as the marginal effect given a one-unit change in the explanatory variables.

Table 2
Dynamic panel data (DPD) regression results: Real labour productivity (RLP)

	Model I	Model II	Model III	Model IV	Model V	Model VI
	Ln (RLP $_t$)	*Ln (RLP $_t$)*	*Ln (RLP $_t$)*	*Ln (RLP $_t$)*	*Ln (RLP $_t$)*	*DRLP/RLP$_{t-1}$*
Dependent variable $_{t-1}$	0.407***	0.417***	0.402***	0.417***	0.397***	-0.127***
	(0.034)	(0.034)	(0.033)	(0.033)	(0.033)	(0.016)
Dependent variable $_{t-2}$	0.010	0.065**	0.039	0.062**	0.034	
	(0.033)	(0.030)	(0.032)	(0.030)	(0.032)	
Full ration $_t$	-0.091	0.042			-0.086	-0.144
	(0.106)	(0.084)			(0.104)	(0.179)
Full ration $_{t-1}$	-0.017	0.015			-0.072	-0.022
	(0.089)	(0.072)			(0.089)	(0.163)
Full ration $_{t-2}$	0.065	0.081			0.079	0.151
	(0.068)	(0.053)			(0.067)	(0.130)
Partial ration $_t$	-0.274***		-0.253***		-0.260***	-0.108
	(0.097)		(0.089)		(0.088)	(0.104)
Partial ration $_{t-1}$	-0.114		-0.120		-0.124	-0.134
	(0.080)		(0.078)		(0.076)	(0.096)
Partial ration $_{t-2}$	-0.102		-0.134**		-0.127**	-0.086
	(0.067)		(0.064)		(0.064)	(0.107)
Discouraged $_t$	0.066			0.040	0.107	0.307**
	(0.084)			(0.069)	(0.078)	(0.140)
Discouraged $_{t-1}$	0.129			0.059	0.154**	0.322**
	(0.082)			(0.067)	(0.076)	(0.148)
Discouraged $_{t-2}$	0.098*			0.069	0.103*	0.053
	(0.057)			(0.049)	(0.055)	(0.080)
Ln(Employment $_t$)		-0.032***	-0.029***	-0.031***	-0.028***	-0.083***
		(0.008)	(0.008)	(0.008)	(0.008)	(0.010)
Ln(Firm age $_t$)		0.026*	0.029**	0.029**	0.031**	-0.014
		(0.014)	(0.015)	(0.014)	(0.015)	(0.018)
Company $_t$		0.265***	0.283***	0.268***	0.285***	0.111***
		(0.036)	(0.036)	(0.035)	(0.036)	(0.030)
Partnership $_t$		0.238***	0.256***	0.239***	0.254***	0.025

Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Model I	Model II	Model III	Model IV	Model V	Model VI
	Ln (RLP $_t$)	*Ln (RLP $_t$)*	*Ln (RLP $_t$)*	*Ln (RLP $_t$)*	*Ln (RLP $_t$)*	*DRLP/RLP$_{t-1}$*
		(0.042)	(0.044)	(0.042)	(0.044)	(0.037)
Ln(Number of directors $_t$)		0.098***	0.112***	0.099***	0.114***	0.076***
		(0.018)	(0.019)	(0.018)	(0.020)	(0.020)
Family own $_t$		-0.116***	-0.123***	-0.119***	-0.128***	0.028
		(0.024)	(0.026)	(0.024)	(0.026)	(0.025)
Ethnic-minority-led $_t$		-0.047	-0.040	-0.048	-0.045	0.001
		(0.042)	(0.044)	(0.041)	(0.045)	(0.054)
Women-led $_t$		-0.067***	-0.072***	-0.068***	-0.072***	0.055*
		(0.023)	(0.025)	(0.023)	(0.025)	(0.028)
Profitability $_t$		0.291***	0.269***	0.289***	0.272***	0.216***
		(0.034)	(0.035)	(0.034)	(0.034)	(0.054)
Profitability $_{t-1}$		0.024	-0.004	0.020	-0.006	-0.169***
		(0.028)	(0.032)	(0.028)	(0.031)	(0.063)
Export $_t$		0.152***	0.112*	0.130**	0.123**	0.164*
		(0.057)	(0.062)	(0.057)	(0.060)	(0.089)
Export $_{t-1}$		0.014	0.002	0.005	0.008	-0.042
		(0.043)	(0.049)	(0.043)	(0.048)	(0.085)
Product innovation $_t$		0.088**	0.080*	0.084**	0.078*	0.074
		(0.041)	(0.044)	(0.041)	(0.044)	(0.066)
Product innovation $_{t-1}$		0.068**	0.083**	0.074**	0.077**	0.068
		(0.035)	(0.040)	(0.035)	(0.039)	(0.061)
Rural $_t$		0.033*	0.041**	0.035*	0.043**	0.000
		(0.019)	(0.020)	(0.019)	(0.020)	(0.021)
Deprived $_t$		-0.004	-0.001	-0.006	0.002	0.031
		(0.026)	(0.028)	(0.026)	(0.028)	(0.031)
Constant	6.403***	5.340***	5.836***	5.385***	5.938***	0.215*
	(0.659)	(0.626)	(0.634)	(0.621)	(0.624)	(0.122)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Model I	Model II	Model III	Model IV	Model V	Model VI
	Ln (RLP $_t$)	*Ln (RLP $_t$)*	*Ln (RLP $_t$)*	*Ln (RLP $_t$)*	*Ln (RLP $_t$)*	*DRLP/RLP$_{t-1}$*
Region	Yes	Yes	Yes	Yes	Yes	Yes
N	14,948	14,948	14,948	14,948	14,948	14,948
P-value: Wald χ^2	0.000	0.000	0.000	0.000	0.000	0.000
P-value: AR(1)	0.000	0.000	0.000	0.000	0.000	0.000
P-value: AR(2)	0.370	0.627	0.878	0.694	0.816	0.256
P-value: Sargan test	0.276	0.536	0.216	0.503	0.369	0.557
P-value: Hansen test	0.473	0.141	0.115	0.134	0.204	0.242
Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.						

Model I is the baseline model that includes only the credit rationing measures without any control variables. Models II to IV look at the effect of each individual type of credit rationing along with all the control variables, and Model V is the full specifications including all the independent and control variables. Given that the coefficient estimates are reasonably consistent across all specifications, the discussion will be based on Model V. Our headline finding is the substantial variation regarding the effect of alternative forms of credit rationing. Whilst there is no consequence on labour productivity if a firm was denied all the finance applied for (full-ration), firms whose financing needs were only partly satisfied suffered the highest productivity loss and the negative impact is long-lasting. On average and in marginal terms, the labour productivity is 25 percent lower for a business subject to partial rationing in the most recent year, or approximately £28,000 below the mean. A partial rationing incident two years before will still reduce the current labour productivity by 13 percent, or approximately £15,000 below the mean. Jointly, the labour productivity of a firm suffered from continuous partial rationing can be more than a third lower than an equivalent, non-rationed firm. However, exactly the opposite is observed for borrower discouragement. Firms that self-selected out of the loan market would see a subsequent improvement in productivity, and the effect is significant with both one- and two-year lag. The marginal effect is 15 percent for more recent (£17,000 above mean labour productivity), or 10 percent (£11,000 above mean) for more distant discouragement incidents. There is a significant decrease in labour productivity since 2020, suggesting the long-lasting impact of the COVID pandemic, but COVID does not change the sensitivity of credit rationing measures on productivity in any significant manner (by interacting a COVID time indicator with the rationing measures)[2]. In Model VI, we replace the dependent variable as the growth rate of productivity and we find that the positive effect of discouragement still holds, but it appears that productivity growth is not influenced by market-induced rationing.

Regarding the control variables, labour productivity is negatively associated with employment size (β = -0.03, p < .01) and positively associated with firm age (β = 0.03, p < .05) and number of directors (β = 0.11, p < .01). Sole proprietorships, family-owned (β = -0.13, p < .01) and women-led (β = -0.09, p < .01) businesses on average have lower productivity. Regarding the effect of operating behaviours and outcomes, (current) profitability (β = 0.25, p < .01), (current) export (β = 0.13, p < .05) and (lagged) innovation (β = 0.07, p < .1) are all significant drivers of productivity. Sector-wise, construction and wholesale/retail are two worst performing industries. There are also significant variations in productivity across UK regions, with East of England, London, North West and South East see the highest levels of productivity. We also find a significant rural – urban difference in productivity, where the productivity of firms located in rural areas are on average 5 percent higher than their urban counterparts. However, productivity is unaffected by whether or not a firm is located in a deprived area.

4.3. Additional analyses

In this section, we undertake further analyses in an attempt to examine the mechanisms through which alternative credit rationing metrics influence a firm's labour productivity. Here we look at both the direct effect of credit rationing on the key elements of productivity, namely employment and sales, as well as its indirect effect through operational or strategic behaviours including innovation and export. Table 3 reports the GMM coefficient estimates of the afore-mentioned four specifications.

Table 3
Further DPD regressions: Determinants of productivity

	Model I	Model II	Model III	Model IV
	Ln(Employment $_t$)	***Ln (Real sales $_t$)***	***Product innovation***	***Export***
Dependent variable $_{t-1}$	0.603***	0.360***	0.073***	0.173***
	(0.038)	(0.044)	(0.027)	(0.042)
Dependent variable $_{t-2}$	0.153***	-0.034	0.024	0.066**
	(0.026)	(0.038)	(0.019)	(0.026)
Full ration $_t$	0.006	-0.036	0.025	0.003
	(0.060)	(0.097)	(0.036)	(0.028)
Full ration $_{t-1}$	0.003	-0.024	0.039	-0.024
	(0.049)	(0.083)	(0.026)	(0.019)
Full ration $_{t-2}$	-0.024	0.081		
	(0.036)	(0.061)		
Partial ration $_t$	0.139**	-0.180**	0.020	0.055*
	(0.059)	(0.090)	(0.031)	(0.032)
Partial ration $_{t-1}$	0.099**	-0.058	0.016	0.030
	(0.041)	(0.074)	(0.026)	(0.022)
Partial ration $_{t-2}$	0.056	-0.066		
	(0.039)	(0.060)		
Discouraged $_t$	0.025	0.114	-0.064*	-0.012
	(0.048)	(0.074)	(0.035)	(0.017)
Discouraged $_{t-1}$	0.033	0.164**	-0.059**	-0.005
	(0.045)	(0.068)	(0.030)	(0.016)
Discouraged $_{t-2}$	0.028	0.107**		
	(0.033)	(0.052)		
Constant	-1.318***	6.947***	0.114***	0.038
	(0.248)	(0.777)	(0.029)	(0.039)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes	Yes

Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Model I	Model II	Model III	Model IV
	Ln(Employment $_t$)	*Ln (Real sales $_t$)*	*Product innovation*	*Export*
N	14,948	14,948	14,948	14,948
P-value: Wald χ^2	0.000	0.000	0.000	0.000
P-value: AR(1)	0.000	0.000	0.000	0.000
P-value: AR(2)	0.711	0.666	0.054	0.722
P-value: Sargan test	0.398	0.143	0.874	0.540
P-value: Hansen test	0.032	0.281	0.784	0.150
Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.				

Using employment as the dependent variable (Model I), it is shown that businesses subject to partial credit rationing on average are more likely to growth their employment by 10 to 14 percent. Turning to sales (Model II), the signs of the coefficient estimates of credit rationing variables are highly consistent with those of the primary regression of labour productivity. Here (current) partial rationing is negatively ($\beta = 0.18$, $p < .05$) and (lagged) discouragement is positively ($\beta = 0.16$ and 0.11 for one- and two-year lag respectively, $p < .05$) associated with sales. Overall, it suggests that partial rationing lowers labour productivity through a joint effect of increased employment size and decreased sales, and the higher productivity growth induced by discouragement is a result of increased sales and relatively stable employment.

Regarding the potential indirect channels that relate credit rationing and productivity, there is mixed evidence according to our analyses on innovation (Model III) and export (Model IV). Model III shows that self-rationing induced by discouragement is negatively associated with the firm's decision to introduce new products, a likely behaviour given discouraged borrowers' aversion to operational or strategic risk-taking. On the other hand, there is a general lack of statistical inference between credit rationing and the decision on market expansion through export. The only exception is when a firm experienced recent partial rationing ($\beta = -0.06$, $p < .1$). However, the potential positive output effect of export is 'overshadowed' by the poor performance in sales and the expansion of employment when a firm had some but not all the financial resources required, jointly leading to lower output efficiency.

[Insert Table 3 Here]

5. Discussion and Conclusion

We set out to test whether issues with access to debt finance acted to reduce labour productivity by constraining firms investment and growth and leaving them stuck in a high average cost - low output region of output. Our focus was on smaller firms who are the most likely to suffer from access to finance problems and also tend to operate below the minimum efficient scale of output. If credit rationing is an economically important feature of capital markets, then it should be the case that rationed firms have lower productivity than unrationed firms. Evidence of this would support public policy interventions in capital markets to unlock firms productive potential.

Our research is set within a broader economic context in which the UK has suffered from low productivity growth for a number of decades and this has largely been attributed to a long tail of unproductive small firms and a more general lack of investment capital and investment. Our approach is nuanced and considers three potential sources of rationing including full credit rationing (the firm receives no loan offer), partial credit rationing (the firm receives a loan, but for less than it requested), and borrower discouragement (the firm self-excludes from the loan market as it fears rejection). This approach allows us to clearly identify what the implications of different sources of rationing have on labour productivity.

Our results are supportive of this nuanced approach to credit rationing and show that partial rationing is more important in the determination of labour productivity than full rationing. This is an intriguing finding that suggests that fully rationed firms productivity would remain as was whether they got a loan or not which would be characteristic of a low quality firm. However, partial rationing reduces labour productivity and this tends to suggest that whilst the firm was of sufficient quality to be offered a loan, but not of sufficient quality to receive the full amount requested, they were forced to defer to second-best investment options which were less productive. From an industrial organization perspective, partially rationed firms remain active in the market but are prevented from reaching efficient operating scale to achieve growth (Capasso and Cefis, 2012). This finding was identified in the original UK loan guarantee scheme where the majority of beneficiary firms had other conventional loans which sat alongside the public guaranteed loan and acted as a bundle of loans that collectively allowed small firms to choose their first-best investment options. In relation to discouraged borrowers, we find that this had a productivity enhancing effect which is consistent with firms choosing to self-exclude from the loan market, but in doing so they appear to have adopted a proactive strategic stance to mitigate this problem. This is consistent with firms retaining more free cash within the business to fund operational cash requirements and also new investment.

In terms of how this might shape future public policy interventions aimed at reducing small firms credit rationing, our results suggest a nuanced policy response would be supported if the overarching policy goal is to increase small firms productivity. A rebalancing of loan guarantee schemes away from fully rationed firms towards partially rationed firms would be justified so that public loan guarantee schemes act as a top-up to allow small firms to invest at an appropriate scale in their first-best options. In respect of discouraged borrowers, there is little evidence to suggest that facilitating their access to the loan market through changing perceptions would induce positive productivity gains.

Declarations

Author Contribution

Both authors contribute equally to the manuscript.

Data Availability

The data used in this study, the UK Longitudinal Small Business Surveys, is publicly available from the UK Data Service under study number 7973 and can be accessed by subscribed users at the following URL: https://datacatalogue.ukdataservice.ac.uk/studies/study/7973#details.

References

1. Aguilera, R. V., Crespi-Cladera, R., Martín-Oliver, A., & Pascual-Fuster, B. (2025). Ownership, control, and productivity: family firms in comparative perspective. *Journal of Management*, *51*(8), 3321-3351.
2. Aiello, F., Mannarino, L., & Pupo, V. (2020). Innovation and productivity in family firms: evidence from a sample of European firms. *Economics of Innovation and New Technology*, *29*(4), 394-416.
3. Anos Casero, P., & Udomsaph, C. (2009). What drives firm productivity growth?. *World Bank Policy Research Working Paper*, (4841).
4. Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The review of economic studies*, *58*(2), 277-297.
5. Åstebro, T., & Bernhardt, I. (2003). Start-up financing, owner characteristics, and survival. *Journal of Economics and Business*, *55*(4), 303-319.
6. Audretsch, D. B., Klomp, L., Santarelli, E., & Thurik, A. R. (2004). Gibrat's Law: Are the services different?. *Review of Industrial Organization*, *24*(3), 301-324.
7. Beck, T., & Demirguc-Kunt, A. (2006). Small and medium-size enterprises: Access to finance as a growth constraint. *Journal of Banking & Finance*, *30*(11), 2931-2943.

8. Bencivenga, V. R., & Smith, B. D. (1993). Some consequences of credit rationing in an endogenous growth model. *Journal of Economic Dynamics and Control*, *17*(1-2), 97-122.
9. Beyhaghi, M., Firoozi, F., Jalilvand, A., & Samarbakhsh, L. (2020). Components of credit rationing. *Journal of Financial Stability*, *50*, 100762.
10. Bloom, N., Sadun, R., & Van Reenen, J. (2010). Recent advances in the empirics of organizational economics. *Annu. Rev. Econ.*, *2*(1), 105-137.
11. Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics*, *87*(1), 115-143.
12. Budnik, K. B., Dimitrov, I., Groß, J., Jancoková, M., Lampe, M., Sorvillo, B., ... & Volk, M. (2021). Policies in support of lending following the coronavirus (COVID-19) pandemic. *ECB Occasional Paper*, (2021/257).
13. Caggese, A. (2019). Financing constraints, radical versus incremental innovation, and aggregate productivity. *American Economic Journal: Macroeconomics*, *11*(2), 275-309.
14. Calabrese, R., Cowling, M., & Liu, W. (2022). Understanding the dynamics of UK Covid-19 SME financing. *British Journal of Management*, *33*(2), 657-677.
15. Capasso, M., & Cefis, E. (2012). Firm size and growth rate variance: The effects of data truncation. *Review of Industrial Organization*, *41*(3), 193-205.
16. Castellacci, F., & Zheng, J. (2010). Technological regimes, Schumpeterian patterns of innovation and firm-level productivity growth. *Industrial and Corporate Change*, *19*(6), 1829-1865.
17. Casu, B., Chiaramonte, L., Croci, E., & Filomeni, S. (2024). Access to credit in a market downturn. *Journal of Financial Services Research*, *66*(2), 143-169.
18. Chemmanur, T. J., Krishnan, K., & Nandy, D. K. (2011). How does venture capital financing improve efficiency in private firms? A look beneath the surface. *The Review of Financial Studies*, *24*(12), 4037-4090.
19. Cole, R. A., Cowling, M., & Liu, W. (2024). The effect of collateral on small business rationing of term loans and lines of credit. *Journal of Financial Stability*, *74*, 101320.
20. Cole, R., & Sokolyk, T. (2016). Who needs credit and who gets credit? Evidence from the surveys of small business finances. *Journal of Financial Stability*, *24*, 40-60.
21. Cowling, M. (2003). Productivity and corporate governance in smaller firms. *Small Business Economics*, *20*, 335-344.
22. Cowling, M., Brown, R., Liu, W., & Rocha, A. (2024). Getting left behind? The localised consequences of exclusion from the credit market for UK SMEs. *Cambridge Journal of Regions, Economy and Society*, *17*(1), 181-200.
23. Cowling, M., Liu, W., & Calabrese, R. (2021). Has previous loan rejection scarred firms from applying for loans during Covid-19?. *Small Business Economics*, 1-24.
24. Cowling, M., Liu, W., Ledger, A., & Zhang, N. (2015). What really happens to small and medium-sized enterprises in a global economic recession? UK evidence on sales and job dynamics. *International Small Business Journal*, *33*(5), 488-513.
25. Cowling, M., Liu, W., Minniti, M., & Zhang, N. (2016). UK credit and discouragement during the GFC. *Small Business Economics*, *47*, 1049-1074.
26. Cowling, M., & Sclip, A. (2023). Dynamic discouraged borrowers. *British Journal of Management*, *34*(4), 1774-1790.
27. Cowling, M., & Siepel, J. (2013). Public intervention in UK small firm credit markets: Value-for-money or waste of scarce resources?. *Technovation*, *33*(8-9), 265-275.
28. Esaku, S. (2022). Exports, investment and productivity growth in small firms: A firm-level analysis from Tanzania and Ghana. *Journal of African Business*, *23*(2), 400-421.
29. Ferrando, A., & Mulier, K. (2022). The real effects of credit constraints: Evidence from discouraged borrowers. *Journal of Corporate Finance*, *73*, 102171.
30. Ferrando, A., & Ruggieri, A. (2018). Financial constraints and productivity: Evidence from euro area companies. *International Journal of Finance & Economics*, *23*(3), 257-282.

31. Gama, A. P. M., Duarte, F. D., & Esperança, J. P. (2017). Why discouraged borrowers exist? An empirical (re) examination from less developed countries. *Emerging Markets Review*, *33*, 19-41.
32. Gatti, R., & Love, I. (2008). Does access to credit improve productivity? Evidence from Bulgaria 1. *Economics of Transition*, *16*(3), 445-465.
33. Honohan, P. (2010). Partial credit guarantees: Principles and practice. *Journal of financial stability*, *6*(1), 1-9.
34. Hornbeck, R., & Moretti, E. (2018). *Who benefits from productivity growth? Direct and indirect effects of local TFP growth on wages, rents, and inequality* (No. w24661). National Bureau of Economic Research.
35. Innes, R. (1991). Investment and government intervention in credit markets when there is asymmetric information. *Journal of Public Economics*, *46*(3), 347-381.
36. Jaffee, D., & Stiglitz, J. (1990). Credit rationing. *Handbook of monetary economics*, *2*, 837-888.
37. Kon, Y., & Storey, D. J. (2003). A theory of discouraged borrowers. *Small business economics*, *21*, 37-49.
38. Kremp, E., & Sevestre, P. (2013). Did the crisis induce credit rationing for French SMEs? *Journal of Banking & Finance*, *37*(10), 3757-3772.
39. Levine, O., & Warusawitharana, M. (2021). Finance and productivity growth: Firm-level evidence. *Journal of Monetary Economics*, *117*, 91-107.
40. Liu, G., Liu, W., & Ko, W. W. (2022). Organisational capabilities and small and medium sized firms' attainment of innovation outcomes: the moderating roles of exports and formal business networks. *International Journal of Operations & Production Management*, *42*(7), 1022-1060.
41. Mac an Bhaird, C., Vidal, J. S., & Lucey, B. (2016). Discouraged borrowers: evidence for Eurozone SMEs. *Journal of International Financial Markets, Institutions and Money*, *44*, 46-55.
42. Manaresi, F., & Pierri, N. (2024). The Asymmetric Effect of Credit Supply on Firm-Level Productivity Growth. *Journal of Money, Credit and Banking*, *56*(4), 677-704.
43. Martin, S. (2012). Market structure and market performance. *Review of Industrial Organization*, *40*(2), 87-108.
44. Shen, C. H. (2002). Credit rationing for bad companies in bad years: evidence from bank loan transaction data. *International Journal of Finance & Economics*, *7*(3), 261-278.
45. Stiglitz, J. E., & Weiss, A. (1981). Credit rationing in markets with imperfect information. *The American economic review*, *71*(3), 393-410.
46. Van Reenen, J. (2011). Does competition raise productivity through improving management quality?. *International journal of industrial organization*, *29*(3), 306-316.
47. Wai, K. W., Liston-Heyes, C., Liu, W., Liu, G., & Cowling, M. (2022). Organizational capabilities and SME exports: the moderating role of external funding intentions and managerial capacity. *Small Business Economics*, *58*(1), 247-261.
48. Yu, J., & Fu, J. (2021). Credit rationing, innovation, and productivity: Evidence from small-and medium-sized enterprises in China. *Economic Modelling*, *97*, 220-230.

Footnotes

1. The correlations between productivity and credit rationing measures are all insignificant.
2. Results on year, sector and regional effects are not reported to save space but are available on request.

Figures

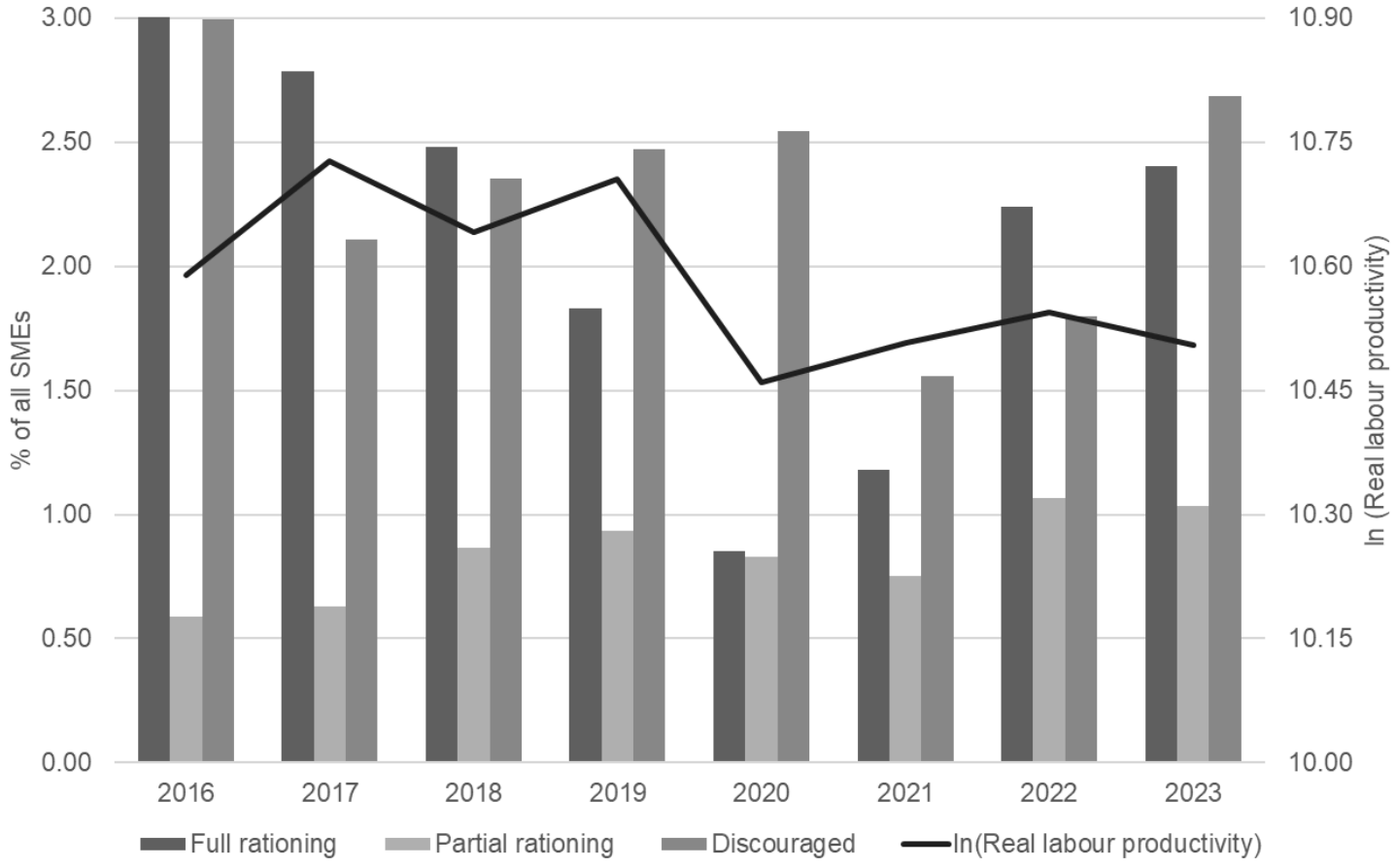


Figure 1

Distribution of productivity and different forms credit rationing by time