The Manchester School

WILEY

The Manchester School

ORIGINAL ARTICLE OPEN ACCESS

The Fixed or Variable Rate Loan Decision: Which Small Businesses Prefer the Certainty of Fixed Rate Loans and Which Banks Offer Them?

Marc Cowling[1] | Kit Pong Wong[2]

[1]Oxford Brookes University, Oxford, UK | [2]Hong Kong University, Hong Kong, Hong Kong

Correspondence: Marc Cowling (mcowling@brookes.ac.uk)

Received: 7 May 2024 | **Revised:** 21 October 2024 | **Accepted:** 3 December 2024

Keywords: bank loans | fixed rate loans | loan guarantees | small business

ABSTRACT

If a small business expects that interest rates will rise in the future then it is rational to insure oneself against this by accepting a fixed rate loan. In addition, small firms may prefer the certainty of fixed interest payments throughout the term of a loan. However, banks may prefer to offer variable rate loans as this insures them against volatility and uncertainty of their funding cost and shifts risk to the borrower. In this paper we empirically analyse what types of lending institutions offer fixed rate loans and what types of small firms accept them using a large UK data set from 2009–2020 covering government guaranteed loans. We initially found that fixed rate loans are more expensive than variable rate loans on average, and that larger firms and those taking out longer maturity loans were more likely to take out fixed rate loans. In contrast, larger size loans were more likely to be issued on a variable interest rate and by a larger lending institution. As large banks made greater returns from fixed rate loans, they increased use of them over the decade to favoured borrowers suggesting that regret aversion also played a role in the bank's decision and also that macroeconomic conditions were improving after the Global Financial Crisis.

JEL Classification: D21, D81, D82, E43, E65

1 | Introduction

Banks use the choice of offering fixed or variable rate loans as a mechanism for managing their assets in the face of funding uncertainty. It follows that a risk-averse competitive bank that faces funding cost uncertainty will seek to share this risk with their borrowers by offering variable rate loans (Chang, Rhee, and Pong 1995). An important result of this desire to transfer risk to borrowers is that variable rate loans, on average, will attract a lower interest rate than fixed rate loans. Wong (2014) provided an important extension to this theory by including banks' regret aversion in its decision-making process. Regret-aversion, from selecting a sub-optimal mix of fixed and variable rate loans, adds to the bank *ex post* disutility.

The purpose of this paper is to augment these theories of the banks decision-making process for fixed and variable rate lending by considering this decision in the context of banks of different sizes and market power. This is important in the UK as there is a dominant group of global banks who have had a fairly stable market share of customer accounts and loans of around 80% for a number of decades. This theoretical extension allows for large banks to hedge risk arising from the uncertain market interest rate by trading interest rate futures. Small banks, in contrast, cannot hedge. The model then predicts that hedging allows big banks to issue a greater proportion of variable rate loans. As all banks derive utility from end of period profit, these ex ante choices of the mix of fixed and variable rate loans will determine the end period profit.

To provide a framework for analysing this decision, we develop a novel and bespoke theoretical model that considers the fixed or variable interest rate decision from the perspective of small and large banks. Having developed a theoretical model with clear predictions, we then test the model with a unique data set covering 30,000 loan contracts issued under a 75% UK government guarantee to SMEs over the period 2009–2020. The key features of the data are that we have detailed information on the loan contract and specifically whether the loan was issued under a fixed or variable interest, what the prevailing interest rate was, the cash value of the loan, loan maturity, and the size of the bank that issued the loan. We also have a set of firm level (borrower) variables that influence not only the bank's interest rate offer, but the firm's relative negotiating power and lending risk. Finally, we have key information on loan default which we use to identify the relative profitability of lending under fixed and variable interest rates for banks of different sizes.

2 | Related Literature

We discuss two related, but at present, separate literature here. The first relates to theoretical and empirical literature contextualising the fixed—variable interest rate loan decision and covers a variety of loan markets where this decision has featured from a supply (or bank) and demand (consumer or firm) perspective. The second literature deals explicitly with loan guarantee scheme lending in the context of small business credit rationing and lending.

2.1 | Fixed and Variable Interest Rate Loans

The bank's decision to offer fixed or variable rate loans has been the subject of a rich theoretical and empirical research in a variety of contexts including mortgage loans, business and commercial loans, agricultural loans, and consumer loans. A related strand of literature has also considered the decision from the borrower perspective. Equally, this literature has also considered this in the context of a competitive lending bank or a bank with a degree of market power. A key aspect that ties all these literature together is banks funding cost, and how this relates to the current state of the macroeconomy, and future states of the macroeconomy which also influence consumers and businesses income streams, the latter which are forecast with uncertainty and error.

As our study relates to (small) business loans, Athavale and Edmister (2003) note some key areas of distinction between business loans and mortgage loans and these differences mean that the determinants of either type of loan are different too. In particular, they argue that variable rate loans are not simply a response to higher, and volatile, interest rates, but also relate to loan size as larger firms and banks both have preferences for variable rate loans. However, Pintus, Wen, and Xing (2015) observe two features of (US) variable rate loans that are important in understanding the time-series volatility of interest rates, which may in turn influence the bank and borrower choice between variable and fixed rate loans. Firstly, the interest rate on variable rate loans moves in a counter-cyclical way. Secondly, it is an inverted, leading, indicator of future real economic activity, including interest rates per se, GDP growth, consumption, investment and employment. As we study a period that extended from the Global Financial Crisis (GFC) through to the onset of Covid-19, and in the UK also Brexit, these leading, current, and future states of the economy are important in understanding the banks fixed—variable rate loan choice.

On the borrower (for us a small business) side of the market, they face a choice of two types of loan. One with a fixed interest rate, and one with a variable interest rate. Carmichael and Handford (2015) posit that the 'usual wisdom and advice' is that a borrower will choose a fixed rate loan if it expects interest rates to rise in the future. Conversely, they choose a variable rate loan if interest rates are expected to fall in the future. However, they also argue that this is too simplistic a view, and that this decision depends upon the magnitude of the competing interest rates offered and how much market uncertainty exists. This latter aspect was also considered by Stutzer and Roberds (1988) who pointed out that demand for variable rate loans can also be a rational choice for borrowers with a desire to smooth their consumption in the presence of uncertain future incomes.

Cox, Ingersoll, and Ross (1980) provide an historical underpinning to the evolution of variable rate loans. They note that they existed in UK and Canadian mortgage markets since the 1930s, yet, due to regulatory constraints, only became a feature of US loan markets in the 1970s when rapid growth in inflation to exceptionally high rates led to high and volatile interest rates. Their introduction in the US was designed to stabilise the price and value of loan contracts, and mitigate against changes in underlying interest rates. However, Rubio (2011) developed a dynamic stochastic general equilibrium model for the housing market that contained a set of constrained borrowers who need housing collateral to obtain loans. We note that our study contains a similar set of constrained firms that use a UK government guarantee scheme in order to access loans. The Rubio model predicted that with a high share of variable rate loans, an exogenous interest rate shock will have a larger effect on borrowers than in a market where fixed rate loans dominate. It followed that for a given monetary policy, a higher proportion of fixed rate loans in the mortgage market would be welfare enhancing.

A more recent paper traced out the post-GFC evolution of European Central Bank (ECB) policy shifts in terms of how they influenced the fixed and variable rate loan decision through differences in the relative costs of a common loan under two interest rate regimes (Fischer and Kampl 2019). Following the March 2016 shift in the ECB main refinancing rate, down from 4% prior to the GFC in 2008 to a lower bound of 0%, the rate at which banks could borrow from the ECB reduced and this led to a low and stable interest rate environment. Housing loans, for example, prior to GFC were, on average, 5%, and prior to Covid-19 fell to an average of 2%. This period of low and stable interest rates in Europe posed an interesting dilemma for borrowers. Do they secure these low long-term interest rates with a fixed rate loan contract? Or do they seek to benefit from current negative short-term interest rates with a variable rate loan? More

importantly, what criteria do they use to make this decision? Fischer and Kampl (2019) argue that the decision is based on expectations of future interest rates and that the key criteria to consider are the effective interest rate (the annual percentage rate of charge, APRC) and the total repayments. Here the effective interest rate is the discount rate that equates the present value of payments to the present value of repayments to the bank.

In terms of the theoretical underpinnings that supported the development of our new model of the bank's fixed or variable rate loan decision, a series of theoretical models were important building blocks. In chronological order, Wong (1997), considered the optimal bank interest rate margin to be jointly determined by cost, regulation, credit risk, and interest rate risk. Importantly, Wong (1997) also allowed for banks market power. This latter consideration is important for us as the UK credit market, and particularly that relating to small businesses, is dominated by a small set of global and domestically powerful banking groups (DBIS 2016). Wong (2013) presented a theoretical model in which a competitive bank may optimally extend fewer loans than it should if it is forced to assume all interest rate risk by exclusively extending fixed rate loans. This is important in the context of our study as only credit rationed firms are able to access loan guarantee schemes and also because the lending bank, which assumes 25% of the lending risk, makes the choice to offer public guaranteed loans at a fixed or variable rate. The third theoretical model by Wong (2014) again considers a competitive bank, but here the optimal mix of fixed and variable rate loans is influenced by regret aversion. In this model, the competitive bank extends more variable rate loans per se, but extends more fixed rate loans if it faces a higher marginal cost of funds. This is relevant as we allow for differences in the marginal cost of funds for different sizes of bank.

2.2 | UK Loan Guarantee Schemes and Small Business Lending

As it stands today, loan guarantee schemes in the UK have experienced a zenith across their rich 41- year history from 1981. During the first two quarters of the Covid-19 crisis in the UK (from March 2020), 92.1% of total loans issued to small businesses were underwritten by a UK government guarantee (Calabrese, Cowling, and Liu 2022) either from the Bounce Back Loan scheme (BBL) or the Coronavirus Business Interruption Loan scheme (CBILS). These two public loan guarantee schemes replaced the Enterprise Finance Guarantee scheme (EFG) which ran from 2009 (the Global Financial Crisis) until the Covid-19 pandemic (March, 2020). The EFG scheme provides the empirical data for our current study.

The justification for a loan guarantee was rooted in the classic theories of credit rationing and the implied backward bending loan supply curve which predicts that banks willingness to supply loans to small, informationally opaque borrowers diminishes exponentially in loan interest rates once the banks profit from lending has passed it maximum point on its profit curve (Stiglitz and Weiss 1981). The incidence, channels, and consequences of credit rationing have been considered in a variety of contexts. For start-ups, Castaldo et al. (2023), using a sample of Italian start-ups considered whether access to bank loans improved survival rates during the GFC crisis and found that the effect was particularly large in less innovative industries. In short, firms that were credit rationed in their formative years, even when economic conditions were relatively favourable, had less resilience to subsequent economic shocks. Others have considered the impact of banking regulations on credit supply in the face of macroeconomic shocks, and found that the shift from Basel I to Basel II increased banks responsive to shocks in a negative way which implies more credit rationing in crises periods (Zicchino 2006). Research has also considered how monetary policy transmission is impacted by financial uncertainty and Baum, Caglayan, and Ozkan (2013) found that the severity of the contraction in loan supply over and above that required by banking regulations was particularly large for smaller and less liquid banks, which are also those most likely to serve smaller and younger businesses in local communities. Relating explicitly to the UK Small Firms Loan Guarantee Scheme during the 1980s, Cowling and Mitchell (1997) found that it had a positive effect on the time-series evolution of self-employment through removing capital constraints.

The first UK loan guarantee scheme, the Small Firms Loan Guarantee (SFLG) included a hard rule that firms could only apply for an SFLG loan once they had exhausted all their collateral and conventional loan capacity. Time-series analysis of SFLG showed that the scheme parameters were fundamental to the approved lending bank decision and also the firms to borrow under the scheme with an increase in the guarantee coverage rate having a particularly strong effect on loan issuance through de-risking lending for banks (Cowling and Clay 1995). Further, Ughetto, Scellato, and Cowling (2017) found that an increase in the guarantee coverage rate also lowered the average interest rate margin on SFLG loans, whilst Cowling, Ughetto, and Lee (2018) found that there was tremendous variation in loan rates for different 'types' of small firms and in different spatial contexts.

However, SFLG loan interest rates also influenced default probability in a positive way (Cowling and Mitchell 2003). As default is particularly important for us in understanding the relative outcomes of the bank's initial decision to offer a fixed or variable rate EFG loan, and the optimal mix of loan rate types, this is a key empirical finding. Overall, the evaluation strand of evidence for the SFLG and EFG suggests that they have produced a small, but positive, impact on UK small businesses, and in particularly those at an early stage in their life-cycle, but even in the presence of large, nationally available loan guarantee schemes, a residual degree of credit rationing persists as not all credit rationed small firms get guaranteed loans (Cowling 2010; Cowling, Robson, Stone, and Allinson 2018).

The key differences between the original SFLG scheme and its replacement, the EFG scheme, were that (a) a larger set of lenders were approved to issue loans under the scheme, (b) the maximum loan available was increased from £250,000 to £1.2 m, and, © that small firms did not have to be fully credit rationed and all collateral exhausted. These EFG changes provide us with a much richer set of loan contract data as we are able to consider small, medium, and large banks, loan contracts with and

without collateral, and loans across a much broader size range. In relation to smaller, local, lenders, some interesting US loan guarantee work has shown that local lenders can reduce default by extending their geographic and industry mix in their guaranteed loan portfolios to reduce default (Patel 2023), and further that learning-by-lending is negligible; however, learning-by-repaying is small but meaningful (Patel and Tsionas 2022: 906). Next, we present our theoretical model.

3 | The Model

To provide a framework for analysing this decision, we develop a novel and bespoke theoretical model that considers the fixed or variable interest rate decision from the perspective of small and large banks. A large bank is considered to be a bank that is of sufficient scale that it can actively engage in interest rate risk hedging, for example through derivatives trading such as forward rate agreements (FRAs), futures contracts, and interest rate swaps, and also one of sufficient size that it is under regulatory supervision by banking authorities in respect of financial stability of the banking system. The UK Prudential Regulation Authority (PRA) uses a size threshold of £20 billion in assets to regulate banks. In the UK, for example, Barclay's Bank had £1.2 trillion in assets on its balance sheet in 2024. Starling Bank had only £14.7bn in contrast in 2024.

Consider a competitive bank that makes decisions in a single period horizon. The bank possesses a von Neumann-Morgenstern utility function, $U(\Pi)$, defined over its end-of-period profit, Π. The bank is risk averse so that $U'(\Pi) > 0$ and $U''(\Pi) < 0$ for all $\Pi > 0$.

At the beginning of the period, the bank extends two types of loans, fixed rate loans and variable rate loans, which are financed by deposits. There is a government-funded deposit insurance scheme so that the supply of deposits is perfectly elastic at the fixed one-plus deposit rate, $R_d > 1$. The one-plus lending rate on variable rate loans, $\tilde{R}_v$, is tied to a one-plus market interest rate, $\tilde{R}$, by a fixed mark-up, $M > 0$, so that $\tilde{R}_v = \tilde{R} + M$, where a tilde (~) indicates a random variable. On the other hand, the one-plus lending rate on fixed rate loans, $R_f > 1$, is deterministic. The bank is competitive in the sense that its actions influence neither the one-plus loans rates nor the one-plus deposit rate.

Let $F(R)$ be the cumulative distribution function of $\tilde{R}$ over support $[\underline{R}, \bar{R}]$, where $1 < \underline{R} < \bar{R}$. We use $E(\cdot)$, $Cov(\cdot,\cdot)$ and to denote the expectation and covariance operators with respect to $F(R)$, respectively.

Both fixed rate loans and variable rate loans are subject to default. For the sake of tractability, we assume that a fraction, $\alpha(L_f)$, of the amount of fixed rate loans, L_f, will default at the end of the period, and the loss given default is normalized to unity. The default fraction, $\alpha(L_f)$, satisfies that $\alpha(0) = \alpha'(0) = 0$, and $\alpha'(L_f) > 0$ and $\alpha''(L_f) > 0$ for all $L_f > 0$, reflecting the fact that the more fixed rate loans the bank grants the lower the average quality of the fixed rate loans. Likewise, we assume that a fraction, $\beta(L_v)$, of the amount of variable rate loans, L_v, will default at the end of the period, and the loss given default is normalized to unity. The default fraction, $\beta(L_v)$, satisfies that $\beta(0) = \beta'(0) = 0$, and $\beta'(L_v) > 0$ and $\beta''(L_v) > 0$ for all $L_v > 0$.

3.1 | The Case of Small Banks

We first consider the case that the bank is small and is unable to hedge against the interest rate risk arising from $\tilde{R}$. In this case, the bank's end-of-period profit is given by

$$\tilde{\Pi} = \left[1 - \alpha(L_f)\right] R_f L_f + \left[1 - \beta(L_v)\right] \tilde{R}_v L_v - R_d L - C(L), \quad (1)$$

where $L = L_f + L_v$, and $C(L)$ is the cost function of servicing loans such that $C(0) = C'(0) = 0$ and $C'(L) > 0$ and $C''(L) > 0$ for all $L > 0$. The bank's ex ante decision problem is to choose the amounts of fixed rate loans and variable rate loans, $L_f \geq 0$ and $L_v \geq 0$, so as to maximize the expected utility of its end-of-period profit:

$$max_{L_v \geq 0, L_v \geq 0} \quad E\left[U(\tilde{\Pi})\right], \quad (2)$$

where $\tilde{\Pi}$ is given by Equation (1).

The first-order conditions for Equation (2) are given by

$$E\left[U'(\tilde{\Pi}^*)\left\{\left[1 - \alpha\left(L_f^*\right) - \alpha'\left(L_f^*\right)L_f^*\right]R_f - R_d - C'(L^*)\right\}\right] = 0, \quad (3)$$

and

$$E\left[U'(\tilde{\Pi}^*)\left\{\left[1 - \beta(L_v^*) - \beta'(L_v^*)L_v^*\right]\tilde{R}_v - R_d - C'(L^*)\right\}\right] = 0, \quad (4)$$

where an asterisk $(*)$ signifies an optimal level. For Equations (3) and (4) to hold, it must be true that $\alpha\left(L_f^*\right) + \alpha'\left(L_f^*\right)L_f^* < 1$ and $\beta(L_v^*) + \beta'(L_v^*)L_v^* < 1$. The second-order conditions for programme (2) are satisfied given the assumed properties of $U(\Pi)$, $\alpha(L_f)$, $\beta(L_v)$, and $C(L)$.

Define the following function:

$$F^a(R) = \int_{\underline{R}}^{R} \frac{U'\left(\left[1 - \alpha\left(L_f^*\right)\right]R_f L_f^* + \left[1 - \beta\left(L_v^*\right)\right](x + M)L_v^* - R_d L^* - C(L^*)\right)}{E[U'(\tilde{\Pi}^*)]} dx, \quad (5)$$

for all $R \in [\underline{R}, \bar{R}]$. It is evident from Equation (5) that $F^a(\underline{R}) = 0, F^a(\bar{R}) = 1$, and $\partial F^a(R)/\partial R > 0$ for all $R \in [\underline{R}, \bar{R}]$. Hence, we can interpret $F^a(R)$ as the adjusted cumulative distribution function of $\tilde{R}$ taking the bank's risk preferences into account.

We write the left-hand side of Equation (4) as

$$E\left[U'(\tilde{\Pi}^*)\right] \times \left\{\left[1 - \beta(L_v^*) - \beta'(L_v^*)L_v^*\right]\left\{\frac{E\left[U'(\tilde{\Pi}^*)\,\tilde{R}\right]}{E\left[U'(\tilde{\Pi}^*)\right]} + M\right\} - R_d - C'(L^*)\right\}$$

$$= E\left[U'(\tilde{\Pi}^*)\right]\left\{\left[1 - \beta(L_v^*) - \beta'(L_v^*)L_v^*\right]\left\{E^a\left[\tilde{R}\right] + M\right\} - R_d - C'(L^*)\right\},$$

where the equality follows from Equation (5) and $E^a[\,\cdot\,]$ is the expectation operator with respect to $F^a(R)$.

Since $U'(\Pi) > 0$ for all $\Pi > 0$, we can equivalently write Equations (3) and (4) as

$$\left[1 - \alpha\left(L_f^*\right) - \alpha'\left(L_f^*\right)L_f^*\right]R_f - R_d - C'(L^*) = 0, \tag{6}$$

and

$$\left[1 - \beta\left(L_v^*\right) - \beta'\left(L_v^*\right)L_v^*\right]\left\{E^a\left[\tilde{R}\right] + M\right\} - R_d - C'(L^*) = 0. \tag{7}$$

Equation (6) states that the bank's optimal amount of fixed rate loans is the one that equates the marginal revenue of fixed rate loans to the marginal cost. Equation (7) states that the bank's optimal amount of variable rate loans is the one that equates the expected marginal revenue of variable rate loans to the marginal cost, where the expectation is taken with respect to $F^a(R)$.

3.2 | The Case of Large Banks

We now consider the case that the bank is large and can trade interest rate swaps to exchange the uncertain one-plus market interest rate, $\tilde{R}$, for a fixed interest rate. To focus on the bank's hedging motive, we set the fixed one-plus interest rate equal to $E\left[\tilde{R}\right]$. In this case, the bank's end-of-period profit becomes

$$\tilde{\Pi}_h = \tilde{\Pi} + \left\{E\left[\tilde{R}\right] - \tilde{R}\right\}H, \tag{8}$$

where H is the number of interest rate swaps. The bank's ex ante decision problem is to choose the amounts of fixed rate loans and variable rate loans, $L_f \geq 0$ and $L_v \geq 0$, and a hedge position, H, so as to maximize the expected utility of its end-of-period profit:

$$E\left[U\left(\tilde{\Pi}_h\right)\right], \tag{9}$$

where $\tilde{\Pi}_h$ is given by Equation (8).

The first-order conditions for Equation (9) are given by

$$E\left[U'\left(\tilde{\Pi}_h^\circ\right)\left\{\left[1 - \alpha\left(L_f^\circ\right) - \alpha'\left(L_f^\circ\right)L_f^\circ\right]R_f - R_d - C'(L^\circ)\right\}\right] = 0, \tag{10}$$

$$E\left[U'\left(\tilde{\Pi}_h^\circ\right)\left\{\left[1 - \beta\left(L_v^\circ\right) - \beta'\left(L_v^\circ\right)L_v^\circ\right]\tilde{R}_v - R_d - C'(L^\circ)\right\}\right] = 0, \tag{11}$$

and

$$E\left[U'\left(\tilde{\Pi}_h^\circ\right)\left\{E\left[\tilde{R}\right] - \tilde{R}\right\}\right] = 0, \tag{12}$$

where a nought ($\circ$) signifies an optimal level. For Equations (10) and (11) to hold, it must be true that $\alpha\left(L_f^\circ\right) + \alpha'\left(L_f^\circ\right)L_f^\circ < 1$ and $\beta\left(L_v^\circ\right) + \beta'\left(L_v^\circ\right)L_v^\circ < 1$. The second-order conditions for programme (2) are satisfied given the assumed properties of $U(\Pi)$, $\alpha\left(L_f\right)$, $\beta\left(L_v\right)$, and $C(L)$.

Substituting Equation (12) into Equation (11), we can equivalently write Equations (10) and (11) as

$$\left[1 - \alpha\left(L_f^\circ\right) - \alpha'\left(L_f^\circ\right)L_f^\circ\right]R_f - R_d - C'(L^\circ) = 0, \tag{13}$$

and

$$\left[1 - \beta\left(L_v^\circ\right) - \beta'\left(L_v^\circ\right)L_v^\circ\right]E\left\{\left[\tilde{R}\right] + M\right\} - R_d - C'(L^\circ) = 0. \tag{14}$$

since $U'(\Pi) > 0$ for all $\Pi > 0$. Equation (13) states that the bank's optimal amount of fixed rate loans is the one that equates the marginal revenue of fixed rate loans to the marginal cost. Equation (14) states that the bank's optimal amount of variable rate loans is the one that equates the marginal revenue of variable rate loans to the marginal cost.

Proposition 1. *The ability to trade interest rate swaps for hedging purposes induces the competitive bank to allocate a larger fraction of variable rate loans and a smaller fraction of fixed rate loans in its optimal loan portfolio.*

Proof. Since $U''(\Pi) < 0$ for all $\Pi > 0$, we have

$$Cov\left[U'(\tilde{\Pi}^*), \tilde{\Pi}^*\right] = Cov\left[U'(\tilde{\Pi}^*), \tilde{R}\right]\left[1 - \beta\left(L_v^*\right)\right]L_v^* < 0,$$

where the equality follows from Equation (1). Using Equation (5), we have

$$E^a\left[\tilde{R}\right] = \frac{E\left[U'(\tilde{\Pi}^*)\,\tilde{R}\right]}{E\left[U'(\tilde{\Pi}^*)\right]} = E\left[\tilde{R}\right] + \frac{Cov\left[U'(\tilde{\Pi}^*), \tilde{R}\right]}{E\left[U'(\tilde{\Pi}^*)\right]} < E(\tilde{R}).$$

Hence, Equation (7) implies that

$$\left[1 - \beta\left(L_v^*\right) - \beta'\left(L_v^*\right)L_v^*\right]\left\{E\left[\tilde{R}\right] + M\right\} - R_d - C'(L^*) > 0. \tag{15}$$

Suppose that $L_v^* \geq L_v^\circ$. Since $\beta'(L_v) + \beta''(L_v) > 0$, we have $\beta\left(L_v^*\right) + \beta'\left(L_v^*\right)L_v^* \geq \beta\left(L_v^\circ\right) + \beta'\left(L_v^\circ\right)L_v^\circ$. It then follows from Equations (14) and (15) that $C'(L^*) < C'(L^\circ)$ so that $L_f^* < L_f^\circ$. Since $\alpha'(L_f) + \alpha''(L_f) > 0$, we have $\alpha\left(L_f^*\right) + \alpha'\left(L_f^*\right)L_f^* < \alpha\left(L_f^\circ\right) + \alpha'\left(L_f^\circ\right)L_f^\circ$. It then follows from Equations (6) and (13) that $C'(L^*) > C'(L^\circ)$, a contradiction. Hence, it must be true that $L_v^* < L_v^\circ$.

Suppose now that $L_f^* \leq L_f^\circ$. Since $\alpha'(L_f) + \alpha''(L_f) > 0$, we have $\alpha\left(L_f^*\right) + \alpha'\left(L_f^*\right)L_f^* \leq \alpha\left(L_f^\circ\right) + \alpha'\left(L_f^\circ\right)L_f^\circ$. It then follows from Eqs. (6) and (13) that $C'(L^*) \geq C'(L^\circ)$ so that $L_v^* \geq L_v^\circ$, a contradiction to $L_v^* < L_v^\circ$. Hence, it must be true that $L_f^* > L_f^\circ$.

Finally, suppose that $L^* \geq L^\circ$. Since $C''(L) > 0$, we have $C'(L^*) \geq C'(L^\circ)$. It then follows from Equations (6) and (13) that $\alpha\left(L_f^*\right) + \alpha'\left(L_f^*\right)L_f^* \leq \alpha\left(L_f^\circ\right) + \alpha'\left(L_f^\circ\right)L_f^\circ$. Since $\alpha'(L_f) + \alpha''(L_f) > 0$, we have $L_f^* \leq L_f^\circ$, a contradiction to $L_f^* > L_f^\circ$. Hence, it must be true that $L^* < L^\circ$. We as such conclude that

$$L_v^\circ/L^\circ > L_v^*/L^* \text{ and } L_f^\circ/L^\circ < L_f^*/L^*. \qquad \square$$

The intuition for Proposition 1 is as follows. The ability to hedge reduces the interest rate risk associated with variable rate loans. The bank as such is willing to substitute fixed rate loans by variable rate loans, and the total amount of loans increases. As a result, the bank's optimal loan portfolio contains a larger fraction of variable rate loans and a smaller fraction of fixed rate loans.

Proposition 2. *The ability to trade interest rate swaps for hedging purposes makes the default fraction of variable rate loans increase and that of fixed rate loans decreases.*

Proof. Since $\alpha'(L_f) > 0$ and $L_f^* > L_f^\circ$, we have $\alpha\left(L_f^*\right) > \alpha\left(L_f^\circ\right)$. Likewise, since $\beta'(L_v) > 0$ and $L_v^* < L_v^\circ$, we have $\beta\left(L_v^\circ\right) > \beta\left(L_v^*\right)$. $\square$

Our presumption that large banks have the ability to hedge against interest rate risk and small banks do not leads to the following two testable hypotheses.

Hypothesis 1. *Large banks have a larger fraction of variable rate loans and a smaller fraction of fixed rate loans as compared to small banks.*

Hypothesis 2. *Large banks have a larger default fraction of variable rate loans and a smaller default fraction of fixed rate loans as compared to small banks.*

4 | The Data and Descriptive Statistics

We have the data for Enterprise Finance Guarantee (EFG) loans from its inception in 2009 up until the Covid-19 outbreak in early 2020. In total, this records the loan details for 32,747 individual loan contracts. The management information system at the British Business Bank records data relating to 27 key elements of the guaranteed lending facility that can be grouped into two categories:

- Business characteristics at loan origination—age, sales turnover, industry sector and geographic region
- Loan characteristics—bank interest rate, government interest premium, loan amount, loan term, fixed or variable rate loan, type of security, loan purpose, lending institution, type of loan facility, draw date, date lender considers loan is in default claim, date lender makes a guarantee claim to government, date government settles guarantee claim by bank and total outstanding balance.

The key variables in this paper relate to (i) whether the loan is issued at a fixed or variable rate of interest, (ii) the size of the lending institution, (iii) the loan interest rate, and (iv) whether or not the loan is repaid or ends in default.

The UK Enterprise Finance Guarantee (EFG) scheme replaced the original Small Firms Loan Guarantee (SFLG) scheme in 2009, in the immediate GFC period which was the deepest crisis the country faced since the 1930s. It had a much wider remit in terms of its scale and the breadth of coverage with an increase in the maximum loan amount available from £250,000 to £1.2 m. This key change was introduced to support lending to much larger SMEs who were capital constrained throughout the GFC induced credit crunch. An additional change to the EFG scheme (compared to the SFLG scheme) was that banks were allowed to secure lending against EFG loans for all types of collateral other than an individual's personal primary domestic residence. In return for a government guarantee of 75% on unrecovered outstanding balances, there was an additional interest premium of 2.0% paid to the government above the loan interest rate charged by the lending institution.

Figure 1 shows the dynamics of EFG loans over the lifetime of the scheme. The first 3 years of the EFG were the GFC period and lending under government guarantee was historically high as more small firms were rationed in the capital market than in business-as-usual years. Over the decade the use of EFG tailed off dramatically to around 1/3rd of its GFC level as capital markets became more willing to lend to smaller firms under their conventional loan processes. The onset of the Covid-19 crisis saw the closure of EFG and it was replaced by two new government guarantee schemes offering a 100% guarantee on small loans (up to £50,000) and an 80% on larger loans. Peak demand in 2020 on these schemes exceeded 1 million loans suggesting that government guarantee schemes are most effective in channelling credit to small firms in crisis periods.

Figure 2 shows that the share of EFG loans issued under a fixed interest rate rose significantly over the entire history of the scheme from a low of 8.1% in the GFC year of 2009 to a peak of 49.9% in the scheme's final year. This dramatic increase in fixed rate lending broadly mirrored the state of the macroeconomy in the UK as it emerged from the GFC years into a period of relative stability. This suggests that lenders were concerned about the level of uncertainty in the economy during the GFC years and were reluctant to offer fixed rate loans.

Figure 3 shows the time-series dynamics of interest rates on fixed and variable rate EFG loans issued to small businesses. It is apparent that from 2009 until 2017 average interest rates for loans issued under fixed rates were higher than those issued under floating rates. The margin of difference was non-trivial and ranged from 4.87 in 2009 to 0.94 in 2017. This means that the interest payments for fixed rate loans over this period would be significantly higher for small firms taking the fixed rate option than their peers on variable interest rate lending contracts.

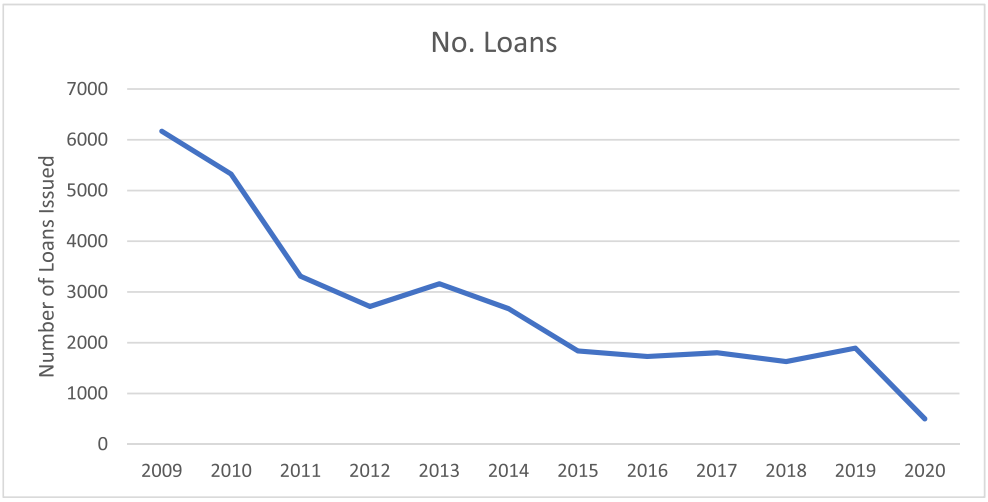

FIGURE 1 | Number of loans issued, 2009–2020. [Colour figure can be viewed at wileyonlinelibrary.com]

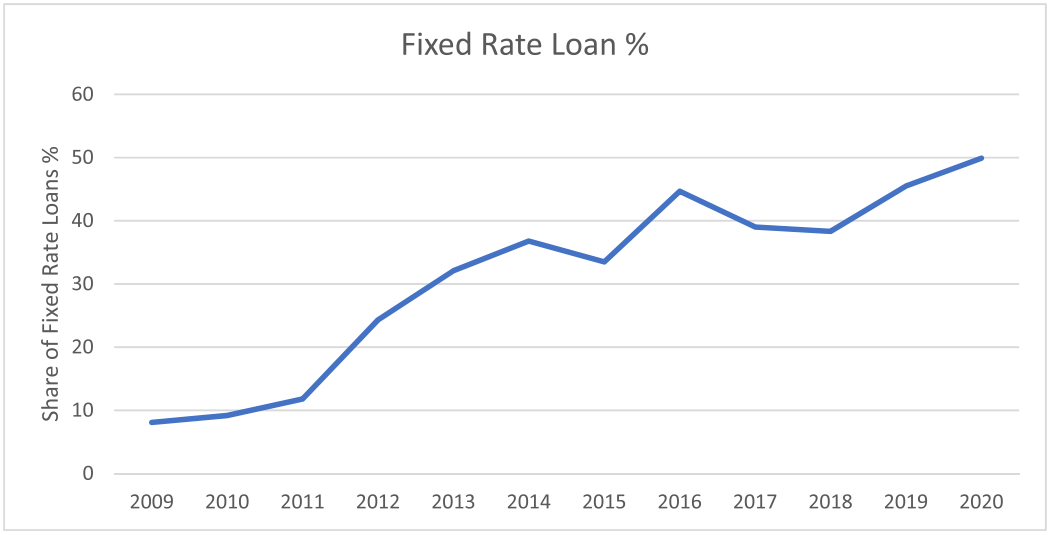

FIGURE 2 | The share of fixed rate loans, 2009–2020. [Colour figure can be viewed at wileyonlinelibrary.com]

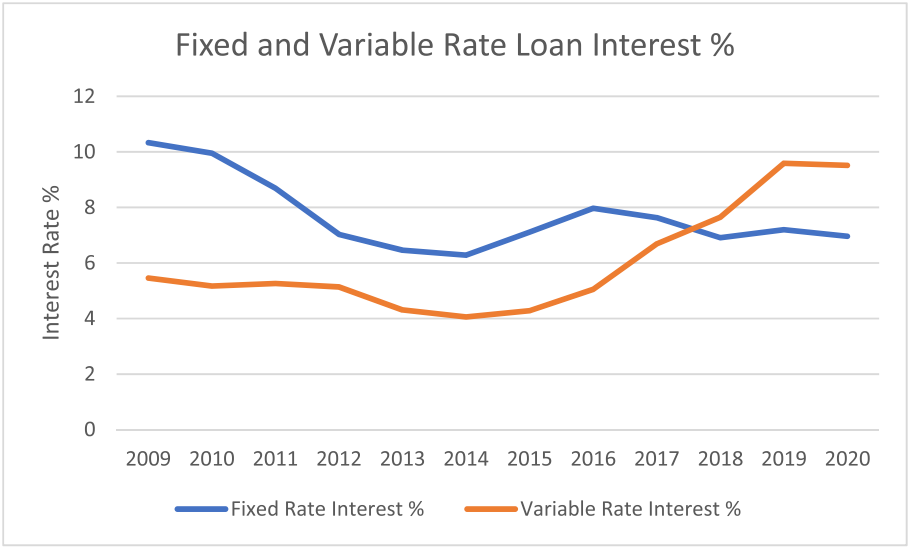

FIGURE 3 | Interest rates for fixed and variable rate loans, 2009–2020. [Colour figure can be viewed at wileyonlinelibrary.com]

However, after 2017 this interest rate difference was reversed with variable rate loans becoming, on average, more expensive than fixed rate loans. The difference in 2019 was 2.55 which again is a non-trivial borrowing cost.

Figure 4 shows that in aggregate the cash volume of EFG lending issued under fixed rates was fairly stable over the GFC period around £31 m and that there was a post-GFC expansion in fixed rate lending volumes to between £50 m and £92 m subsequently. More broadly there was a collapse in the cash volume of EFG variable interest rate lending over the scheme's life from £746m in £2009 to £114 m in 2019. In its final years, there was a degree of parity and equivalence between the cash volume of EFG loans under fixed and variable interest rates.

As our model considers bank size as a key determinant of the fixed and variable rate loan decision on the supply-side of the loan market, Figure 5 shows the time-series dynamics of the shares of fixed rate loans out of total loans issued for small, medium, and large lending institutions. We observe that there is significant time-series variation for all sizes of lender, but the most consistent pattern is for large banking groups to increasingly offer fixed rate loans. The large bank share of fixed rate loans rose from 6.3% of all EFG loans issued to 65.1% in Q1 of 2020. In 2016 this exceeded the fixed rate loan share of medium sized banks and in its final quarter of existence prior to Covid-19 it exceeded the fixed rate share of small banks who for the entire period leading up to 2020 had maintained a clear preference for issuing fixed rate loans.

Table 1 shows the core loan contracts offered by each size of bank under fixed and variable interest rates. We observe that small banks offer high interest rate loans of all types and large banks low interest rates for all loan types. The differences in interest rates across lenders of different sizes is substantial. Across fixed and variable rate loans, we find that fixed rate loans, on average, attract higher interest rates across all bank sizes. Loan maturity months varied quite considerably across bank sizes with small and medium banks offering loans of all interest rate types at shorter durations than big banks. For big banks, fixed rate loans, on average, were offered at longer maturities.

It was also the case that average loan size differed between fixed and variable rate loans and across banks of different sizes. In all bank types, fixed rate loans were smaller with the largest difference in loans issued by medium sized banks with an average difference of £68,041 which compares to small banks with an average difference of £48,069 and big banks £36,077. For loans of all interest rate types, big banks offered larger loans and small banks the smallest loans. As the underlying default rate is a primary determinant of the profitability of lending, we find that there was significant variation across loans issued by different size banks and across loan interest rate types. Big banks had the highest default rate of 24.85% on variable rate loans and small banks the lowest default at 16.19%. For fixed rate loans this was reversed with small banks having a default rate of 31.02% and big banks a default rate of only 19.02%. However, the default rate is only one characteristic that determines banks profitability from lending. Even for loans that ultimately end in default the timing of that default from loan origination is also important. The longer before a loan defaults, the greater the interest income and the lower the exposure to default as capital is repaid up until that point. For medium and big banks default months were virtually identical across loan interest rate types, but for small banks variable rate loans defaulted 6 months earlier than fixed rate loans. Overall, big banks loans that ended in default survived the longest period after loan origination before they defaulted.

5 | Modelling the Fixed Rate Loan Decision

The first issue we address is the bank's fixed or variable rate loan decision. As this is a binary decision we model it as a probit model with the dependent variable coded as one if the loan is issued at a fixed rate and a 0 if a loan is issued at a variable rate. Our vector of explanatory variables includes loan characteristics,

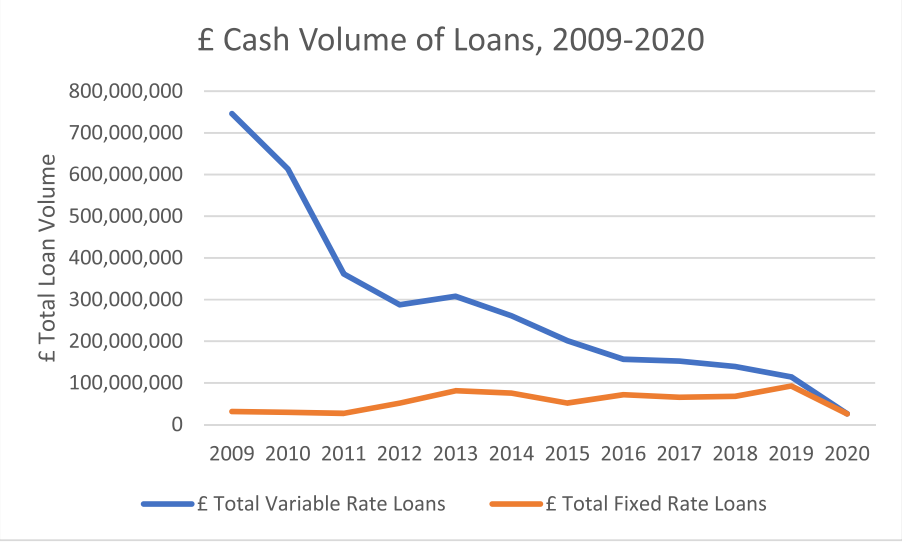

FIGURE 4 | Total cash volume of fixed and variable rate loans, 2009–2020. [Colour figure can be viewed at wileyonlinelibrary.com]

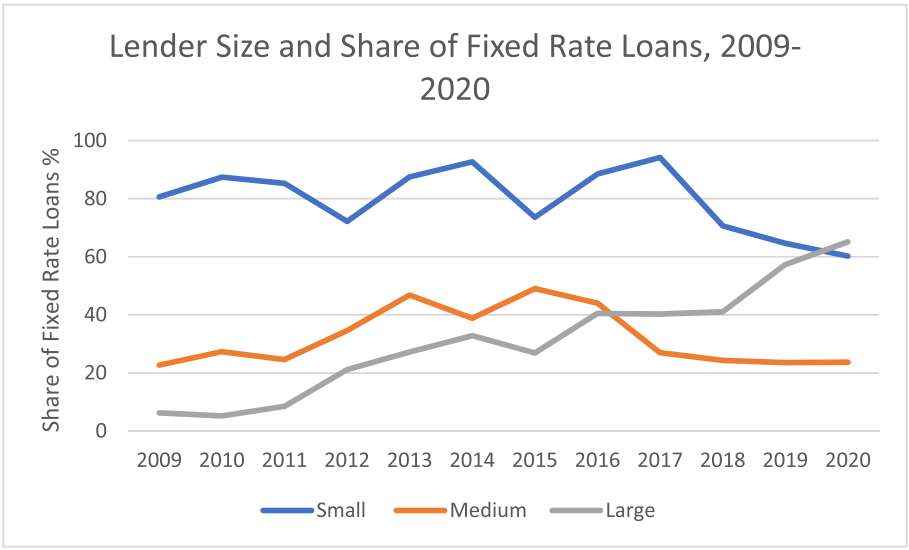

FIGURE 5 | Lender size and share of fixed rate loans offered %, 2009–2020. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 1 | Loan contracts and outcomes by lender type.

	Small bank		Medium bank		Large bank	
	VR	FR	VR	FR	VR	FR
Interest rate %	10.294	11.399	8.01	10.579	4.915	5.502
Loan term months	53.86	52.6	55.38	51.08	73.43	81.56
Real loan amount £	92,207.12	44,138.06	146,630.9	78,589.86	133,915.6	97,839.04
Default %	0.1619	0.3108	0.2039	0.2656	0.2475	0.1902
Number loans	350	1229	3620	1672	20,912	4964
Repaid number	293	847	2882	1228	15,736	4020
Default number	57	382	738	444	5176	944
Months to default || default	16	22	22	22	29	30

bank size, firm characteristics, and indicators of the state of the macroeconomy such as real GDP growth and the Bank of England base interest rate. In the probit model, the inverse standard normal distribution of the probability as a linear combination of the predictors. The model specification is as follows:

$$\Pr(Y = 1|X_1, X_2, \cdots, X_k) = \Phi(\beta_0 + \beta_1 + X_1 + \beta_2 X_2 + \cdots + \beta_k X_k)$$

here, $\Phi(\cdot)$ is the cumulative standard normal distribution function, and the β's are the changes in our independent variables that are associated with a one unit change in the X's.

Table 2 reports the fixed rate interest loan models. The results from the all bank model (Model 1) show that there are significant effects on the fixed-variable interest rate decision by loan contract terms, by firm characteristics, the state of the macroeconomy and the size of the loan issuing bank. On loan contract terms, we find that there is a negative relationship between real loan amounts and fixed rate lending suggesting that the greater the bank's capital exposure the more variable rate lending that is offered. Where no collateral is present to secure a loan against, the more likely a loan is offered at a fixed interest rate suggesting that preferred borrowers receive more favourable contract terms and more certainty to their repayment schedules. Loan maturity months were positively associated with fixed term lending and this might suggest that short-term interest rate is smoothed out over a longer period of time. Finally, loan interest rates were positively associated with fixed term lending which attract, on average, higher rates.

At the firm level, we find that firm size (measured by real total sales) is negatively associated with the issuance of fixed rate loans as are loans issued for working capital. Further, we find that there is a positive relationship between firm age and fixed rate lending. This suggests that safer, more stable firms, with an extended track record benefit from being offered fixed rate loans. Firms borrowing to fund new growth are also more likely to be offered fixed rate loans. The age finding is consistent with banks offering less risky firms fixed rate loans, but the general firm size effect is not supportive of this if size is a proxy for lower risk. Firms that are facing liquidity problems that have to borrow to bolster their working capital are offered variable rate loans and this is consistent with default risk.

The state of the general macroeconomy, captured by real GDP, is important in the bank's loan rate decision and the stronger the macroeconomy, the greater probability that banks offer fixed rate loans. In contrast, when there is an increase in the

TABLE 2 | The fixed-variable loan interest rate decision.

	Modelling the fixed—variable interest rate decision							
	[1] All banks		[2] Small banks		[3] Medium banks		[4] Big banks	
	Coeff	S.E	Coeff	S.E	Coeff	S.E	Coeff	S.E
Loan contract variables								
ln Real_Loan_Amount	−0.1736***	0.013	−0.3325***	0.058	−0.2325***	0.027	−0.1686***	0.017
No_Collateral	0.0923***	0.023	0.0329	0.097	0.0391	0.048	−0.03	0.030
full_term_days	0.0001***	0.000	−0.0001	0.000	−0.0001***	0.000	0.0001***	0.000
ln Interest rate	0.4129***	0.022	0.3071***	0.069	0.2756***	0.036	1.0950***	0.037
Bank size								
Small								
Medium	−0.8545***	0.044						
Large	−0.7211***	0.045						
Purpose of loan								
Asset finance								
Growth	0.15581***	0.038	0.4015***	0.147	0.2209**	0.089	0.071	0.046
Other	−0.1806	0.113	−0.6724	0.636	0.1569	0.183	−0.4280***	0.160
Start-up	0.0572	0.048	0.4157**	0.207	−0.0363	0.125	−0.1493***	0.057
Working capital	−0.1676***	0.038	−0.4686***	0.138	0.0328	0.082	−0.0945**	0.047
Macroeconomic variables								
ln RGDP	5.8374***	0.172	−3.9526***	0.799	−4.2143***	0.371	11.5628***	0.234
BOE_Rate	−0.4334***	0.030	−0.7748***	0.184	−0.6557***	0.078	−0.3276***	0.036
Firm variables								
Age_at_Loan	0.0000***	0.000	0	0.000	0	0.000	0.0000***	0.000
ln Real sales	−0.0724***	0.009	−0.0585*	0.031	−0.0446**	0.019	−0.0836***	0.012
Plus industry								
Constant	−73.5372***	2.242	55.9974***	10.395	56.9583***	4.866	−149.4935***	3.032
N obs	29,151		1254		4826		23,062	
Pseudo R2	0.1688		0.1582		0.1037		0.2209	

underlying cost of borrowing via the Bank of England base rate banks switch to variable rate lending to protect themselves against increases in their underlying cost of capital. This suggests that in a business-as-usual economic environment, with low base interest rates, banks shift towards fixed rate lending. In the current macroeconomic environment in the UK, with increasing base interest rates and real GDP falling, we would expect that banks shift quickly to variable rate lending and away from fixed rate lending.

Finally, we observe that the size of a lending bank, once all firm and loan characteristics have been taken account of, does influence the probability of an SME loan being issued at a fixed or variable interest rate. Here we find that big banks and medium-sized lenders have a lower probability of issuing fixed rate loans than small lenders. This is consistent with our theoretical model as larger banks that can hedge issue a larger fraction of variable rate loans than small banks. The inability of small banks to hedge against future uncertainty puts them at a potential disadvantage in adverse economic conditions. Thus, we find empirical support for hypothesis 1: *Large banks have a larger fraction of variable rate loans and a smaller fraction of fixed rate loans as compared to small banks.*

5.1 | The Fixed- Variable Rate Loan Decision by Size of Bank

Next, we estimate the same model for fixed and variable interest rate loans, but for each size of bank individually to understand what the key determinants of the bank's loan interest rate decision are, and whether this varies across banks of different sizes. These results are reported in Table 2 Models 2,3 and 4. We find that there are significant differences in the magnitude of the effects on some variables, and in specific cases the sign (or direction of the effect) is different. Real loan amount is negatively associated with the probability of fixed rate loans, but the magnitude of the effect diminishes as we move from small, to medium, to big banks. Firm size is important, and exerts a negative effect on fixed rate lending, but only for medium and big banks. Loan maturity months are not important in the small bank fixed - variable rate decision, but it is for medium and big banks, albeit in opposing ways. For medium

banks, longer loan maturity is associated with a lower fixed rate probability and for big banks the opposite. The purpose for which the funds are borrowed also influences the bank's decision. Small and medium banks prefer to offer fixed rate loans for growth investments, and big banks prefer variable rate loans to provide working capital to the firm. If a loan attracts a high interest rate, then all banks prefer to offer such loans at fixed interest rates. But the magnitude of the effect diminishes in lending bank size. We also observe that big banks are more likely to offer their established firms fixed rate loans and their younger firms variable rate loans.

Finally, we observe that the prevailing state of the macroeconomy mattered for all bank types but in quite different ways. Higher real GDP reduced the probability of fixed rate lending for small and medium banks suggesting that in economic boom periods these sizes of banks shifted towards variable rate lending. The opposite was true for large banks who shifted to fixed rate lending when the economy was strong. The magnitude of the real GDP effect for big banks was of the order of 2–3 times that of small and medium banks. The underlying Bank of England base rate was important in the fixed - variable rate loan decision for all banks and acted to reduce the probability of fixed rate lending as predicted in our theoretical model as rising base rates feed through into banks' underlying cost of funds for lending. However, we also find that the base rate effect was diminishing in bank size suggesting that small banks are more concerned about the underlying cost of funds.

5.2 | Default and Banks Optimal Mix of Fixed and Variable Rate Loans

We have observed that there is a significant degree of variation in the share of fixed and variable rate loans issued by banks of different sizes over time, and that the state of the macroeconomy is important in understanding these shifts in the mix of these two types of loans. Our model, and those of Chang, Rhee, and Wong (1995), and Wong (2014) which highlighted the importance of uncertainty in the cost of banks funds and the potential for regret aversion to influence the choice of fixed and variable rates, all consider that this lending interest rate type decision is ultimately designed to maximise the banks profit from lending. It follows that the default rate on lending is a primary determinant of banks profitability from lending.

We address the question of whether banks *ex post* default rate on lending, given their ex ante choice of fixed and variable rate lending is optimal by estimating a loan default model with a key augmentation from the models estimated previously for the banks initial fixed—variable loan rate decision. To understand this, we create an interaction term that combines bank size and the loan interest rate decision. From this set of interaction terms (e.g. small bank × fixed interest rate loan, medium bank × fixed interest rate loan, big bank × fixed interest rate loan) we can observe whether each size of lending bank had achieved the optimal mix or whether their actual loan interest rate type choices could be improved in respect of reducing subsequent default. Broadly, if the interaction term is insignificant in terms of explaining loan default then the bank has achieved an optimal mix of fixed and variable rate loans. If the interaction term is negative then it implies that a bank of that size could reduce default if it increased the share of fixed rate loans issued, and if the interaction term is positive then it could reduce default if it reduced the share of fixed rate loans issued.

From Table 3, Model 1, the key finding is that medium sized banks could improve their loan mix by offering more fixed rate loans and reducing their share of variable rate loans. In this respect they were improving their relative mix of fixed rate loans up until 2015 and then reversed this behaviour and offered too many variable rate loans in the period 2016 to 2020 until the EFG scheme closed for new lending. Big banks had iterated over the decade to an optimal mix of fixed rate loans with a significant expansion in their absolute use and the relative share which peaked in 2020 at over 60% of total loans issued.

In general, real loan size was positively associated with default, as were loan interest rates. Loans issued for the purposes of growth and working capital also had higher default rates than loans targeted at other uses. Where no firm collateral was present in a loan contract, default was reduced which is consistent with higher risk firms being required to place security against borrowing. Larger size firms defaulted less, but age of firm did not play a significant role in default determination. Macroeconomic effects were clearly evident, and a buoyant economy was associated with lower average default rates. The BoE base rate was positively associated with default suggesting that the underlying cost of borrowing played an important role.

As a further check, we can use the default model to predict default (see Table 4), taking account of the lending bank size but also a rich array of loan and firm characteristics. In this sense we are allowing for different loan portfolios and focussing explicitly on the relative default rates of fixed and variable rate loans by lending banks of different sizes. This is an explicit test of hypothesis 2: *Large banks have a larger default fraction of variable rate loans and a smaller default fraction of fixed rate loans as compared to small banks*.

5.3 | Robustness Test

As a robustness test, we also estimated the default model using a Heckman type probit selection model where the first stage is the fixed-variable interest rate decision and the inverse mills ratio is calculated and enters the second default equation. These results are presented in Table 3 model 2. It is reassuring to note that the basic results remain in terms of the coefficients being of a similar magnitude and of the same direction. Specifically, our key bank size—fixed rate loan interaction terms hold, although the magnitude of the medium-sized bank coefficient is slightly less than in model 1.

6 | Conclusion

We set out to understand more about the lending banks decision to offer fixed and variable rate loans in the unique context of the UK debt market where there is a small and dominant group of

TABLE 3 | Modelling default for fixed and variable rate loans by lender size.

	[1] Default model		[2] Default model With selection	
	Coeff	**S.E**	**Coeff**	**S.E**
Fixed rate × lender size				
FR × Small bank				
FR × Medium bank	−0.31018**	0.127	−0.2650**	0.131
FR × Big bank	−0.1497	0.121	−0.1735	0.124
Loan contract variables				
ln Real_Loan_Amount	0.3073***	0.015	0.2658***	0.017
No_Collateral	−0.2140***	0.027	−0.1925***	0.028
full_term_days	−0.0013***	0.000	−0.0013***	0.000
ln Interest rate	0.6757***	0.029	0.8567***	0.044
Purpose of loan				
Asset finance				
Capital investment	−0.3447**	0.147		
Growth	0.2966***	0.045	0.3485***	0.046
Other	0.1291	0.141	0.0955	0.142
Start-up	0.3854***	0.058	0.4074***	0.059
Working capital	−0.01143	0.044	−0.0456	0.045
Macroeconomic variables				
ln RGDP	−4.1653***	0.240	−1.7939***	0.528
BOE_Rate	0.2248***	0.029	0.1321***	0.034
Firm variables				
Age_at_Loan	5.68E-07	0.000	2.28E-06	0.000
ln Real sales	−0.2333***	0.010	−0.2587***	0.011
Plus industry				
Constant	52.8577***	3.132	23.2014***	6.627
N obs	29,408		29,151	
Pseudo R2	0.3905		0.3900	

TABLE 4 | Predicted default rates by bank size and fixed—variable interest rate.

	Predicted default rates		
Bank size	**Variable rate %**	**Fixed rate %**	***t*-test**
Small	0.1539	0.2777	***
Medium	0.2010	0.2862	***
Large	0.2382	0.1799	***

big global banks and a fringe of medium sized and small, local banks. An additional and very unique feature is that we also set our empirical work in the context of a flagship UK government loan guarantee scheme, the EFG, from its inception in the Global Financial Crisis of 2009 until its demise in 2020 with the onset of Covid-19. By augmenting existing theories of banks decision-making processes regarding the setting of fixed or variable interest rates on small business loans to allow for differences in the uncertainty of cost of bank funds by size of lending bank, we were able to derive testable predictions about each types of banks choices about fixed and variable rate lending that we could test against our data set which covered in excess of 30,000 loan contracts. This theoretical extension allows for large banks to hedge risk arising from the uncertain market interest rate by trading interest rate futures in a way that small banks cannot. The model then predicts that the ability to hedge allows big banks to issue a greater proportion of variable rate loans. As all banks derive utility from end of period profit, these ex ante choices of the mix of fixed and variable rate loans will determine the end period profit.

Our empirical evidence provides support for our two hypotheses derived from our theoretical model. Firstly, our fixed - variable interest rate model shows that large banks do indeed offer a greater share of variable rate loans and this is consistent with their ability to mitigate against future adverse states of the economy by hedging. Secondly, we also find strong support for our second hypothesis which relates to the relative default rates on fixed and variable rate loans by banks of different sizes. Here we found that large banks were the only size of bank that had a higher default

fraction on variable rate loans. More generally, we found that there was substantial time-series variation in the relative shares of fixed and variable rate loans for all types of banks. This suggests that banks are always seeking to find their optimal mix of fixed and variable rate loans within their small business loan portfolios and this optimal mix is responsive to changes in underlying economic conditions, although larger banks, due to their hedging ability, can smooth out some of these risks.

To sum up, we have used a unique and rich small business loan data set to establish some unique features of small business lending and how a key loan contract feature, the fixed or variable interest rate decision, varies across banks of different sizes. To frame our empirical work, we developed a new theoretical framework that allowed us to predict how and why banks of different sizes make their small business lending decisions, and how this impacted loan outcomes. We believe that our theoretical and empirical extensions will allow future research to evolve that considers the bank - small business lending decision in a novel way.

The implications for firms are that the size of the lending bank they approach for a loan, and the state of the economy at that time, will both result in a different loan offer in respect of whether it is more likely to be fixed rate or variable rate, and the interest rate offer. To take the example of the two main UK Covid-19 public loan guarantee schemes, the Bounce Back Loan scheme (BBL) and the Coronavirus Business Interruption Loan Scheme (CBILS), the BBL offered a fixed interest rate loan and the CBILS allowed banks to set their own interest rate according to their normal lending practices. The BBL issued nearly 1 million fixed rate loans and was favoured by large banks compared to CBILS that issued only 70,000 loans, but was favoured by smaller banks. This has important implications for public policy in respect of how public support for smaller firms in particular is delivered in crisis periods. This arises due to differences in loan default across interest rate types by large, medium, and small banks which represents a claim on the UK Treasury.

References

Athavale, M., and R. O. Edmister. 2003. "Fixed or Variable Rate Choice in the Commercial Bank Business Loan Market." *Journal of Applied Business Research* 19, no. 4. https://doi.org/10.19030/jabr.v19i4.2184.

Baum, C., M. Caglayan, and N. Ozkan. 2013. "The Role of Uncertainty in the Transmission of Monetary Policy Effects on Bank Lending." *Manchester School* 81, no. 2: 202–225. https://doi.org/10.1111/j.1467-9957.2011.02274.x.

Calabrese, R., M. Cowling, and W. Liu. 2022. "Understanding the Dynamics of UK Covid-19 SME Financing." *British Journal of Management* 33, no. 2: 657–677. https://doi.org/10.1111/1467-8551.12576.

Carmichael, D. G., and L. B. Handford. 2015. "A Note on Equivalent Fixed Rate and Variable Rate Loans; Borrower's Perspective." *Engineering Economist* 60, no. 2: 155–162. https://doi.org/10.1080/0013791x.2014.973985.

Castaldo, A., R. Pittiglio, F. Reganati, and D. Sarno. 2023. "Access to Bank Financing and Start-Up Resilience: A Survival Analysis Across Business Sectors in a Time of Crisis." *Manchester School* 91, no. 3: 141–170. https://doi.org/10.1111/manc.12433.

Chang, E. C., M. W. Rhee, and W. K. Pong. 1995. "A Note on the Spread Between the Rates of Fixed and Variable Rate Loans." *Journal of Banking & Finance* 19, no. 8: 1479–1487. https://doi.org/10.1016/0378-4266(94)00113-h.

Cowling, M. 2010. "The Role of Loan Guarantee Schemes in Alleviating Credit Rationing in the UK." *Journal of Financial Stability* 6, no. 1: 36–44. https://doi.org/10.1016/j.jfs.2009.05.007.

Cowling, M., and N. Clay. 1995. "Factors Influencing Take-Up Rates on the Loan Guarantee Scheme." *Small Business Economics* 7, no. 2: 141–152. https://doi.org/10.1007/bf01108687.

Cowling, M., and P. Mitchell. 1997. "The Evolution of UK Self-Employment: A Study of Government Policy and the Role of the Macroeconomy." *Manchester School* 65, no. 4: 427–442. https://doi.org/10.1111/1467-9957.00073.

Cowling, M., and P. Mitchell. 2003. "Is the Small Firm's Loan Guarantee Scheme Hazardous for Banks or Helpful to Small Business?" *Small Business Economics* 21, no. 1: 63–71. https://doi.org/10.1023/a:1024408932156.

Cowling, M., P. Robson, I. Stone, and G. Allinson. 2018a. "Loan Guarantee Schemes in the UK: The Natural Experiment of the Enterprise Finance Guarantee and the 5 Year Rule." *Applied Economics* 50, no. 20: 2210–2218. https://doi.org/10.1080/00036846.2017.1392004.

Cowling, M., E. Ughetto, and N. Lee. 2018b. "The Innovation Debt Penalty: Cost of Debt, Loan Default, and the Effects of a Public Loan Guarantee on High-Tech Firms." *Technological Forecasting and Social Change* 127: 166–176. https://doi.org/10.1016/j.techfore.2017.06.016.

Cox, J. C., J. E. Ingersoll, and S. A. Ross. 1980. "An Analysis of Variable Rate Loan Contracts." *Journal of Finance* 35, no. 2: 389–403. https://doi.org/10.2307/2327398.

Department for Business and Industrial Strategy. 2016. SME Lending: An International Comparison of Markets. DBIS Research Paper No.270 prepared by Cowling, M and Deloitte Economy Strategy Group. London: Department for Business and Industrial Strategy.

Fischer, E. O., and L. M. Kampl. 2019. "How to Choose Between Fixed-And Variable-Rate Loans." *Journal of Banking and Financial Research (BankArchiv)* 67, no. 2: 125–135. https://doi.org/10.47782/oeba201902012501.

Patel, P. C. 2023. "Requisite Variety Theory and Third-Party Guarantee Loans: How Local Bank Branches Can Reduce Loan Defaults." *Managerial and Decision Economics* 45, no. 1: 226–246. https://doi.org/10.1002/mde.3993.

Patel, P. C., and M. G. Tsionas. 2022. "Learning-By-Lending and Learning-By-Repaying: A Two-Sided Learning Model for Defaults on Small Business Administration Loans." *Managerial and Decision Economics* 43, no. 4: 906–919. https://doi.org/10.1002/mde.3426.

Pintus, P., Y. Wen, and X. Xing. 2015. Interest Rate Dynamics, Variable-Rate Loan Contracts, and the Business Cycle. FRB St. Louis Working Paper, (2015-32). United States: Federal Reserve Bank of St. Louis.

Rubio, M. 2011. "Fixed-and Variable-Rate Mortgages, Business Cycles, and Monetary Policy." *Journal of Money, Credit, and Banking* 43, no. 4: 657–688. https://doi.org/10.1111/j.1538-4616.2011.00391.x.

Stiglitz, J. E., and A. Weiss. 1981. "Credit Rationing in Markets With Imperfect Information." *American Economic Review* 71, no. 3: 393–410.

Stutzer, M. J., and W. Roberds. 1988. "Variable Rate Loans and Financed Activities: The Case of Adjustable Rate Mortgages." *Journal of Urban Economics* 24, no. 1: 27–37. https://doi.org/10.1016/0094-1190(88)90044-7.

Ughetto, E., G. Scellato, and M. Cowling. 2017. "Cost of Capital and Public Loan Guarantees to Small Firms." *Small Business Economics* 49, no. 2: 319–337. https://doi.org/10.1007/s11187-017-9845-y.

Wong, K. P. 1997. "On the Determinants of Bank Interest Margins Under Credit and Interest Rate Risks." *Journal of Banking & Finance* 21, no. 2: 251–271. https://doi.org/10.1016/s0378-4266(96)00037-4.

Wong, K. P. 2013. "Fixed Versus Variable Rate Loans Under State-Dependent Preferences." *Economic Modelling* 31: 659–663. https://doi.org/10.1016/j.econmod.2013.01.006.

Wong, K. P. 2014. "Fixed versus Variable Rate Loans under Regret Aversion." *Economic Modelling* 42: 140–145. https://doi.org/10.1016/j.econmod.2014.06.005.

Zicchino, L. 2006. "A Model of Bank Capital, Lending and the Macroeconomy: Basel I versus Basel II." *Manchester School* 74, no. s1: 50–77. https://doi.org/10.1111/j.1467-9957.2006.00517.x.

Supporting Information

Additional supporting information can be found online in the Supporting Information section.