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Monetary policy expectations and risk-taking among U.S. banks

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Abstract

We investigate the role that monetary policy plays in influencing the riskiness of bank lending via the "risk-taking channel" of the transmission mechanism. This affects banks' perception of, and preference for, extending new relatively risky lending. Using data on the lending of US banks to different risk categories of borrowers, we show that unanticipated increases in expected future interest rates, as measured by the term spread, induce banks to increase the riskiness of their lending. They do this both on an intensive margin, decreasing their lending to less risky borrowers in favour of riskier borrowers, and on an extensive margin also. We show that a one percentage point increase in the term spread leads banks to increase the relative share of riskier lending by 12.6 percent. Our results are relevant for understanding the channels of the monetary policy transmission mechanism and for thinking about the linkages between monetary policy and financial stability.

JEL classification: E51, E52, E58, G21.

Keywords: Monetary Policy, Risk Taking, Bank Lending

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Non-Technical Summary

Central banks conduct monetary policy with the aim of achieving price stability in the economy. Central banks also monitor risks to financial stability, often arising in the banking sector, because these can have material negative effects on economic growth. Since the financial crisis, many central banks have also engaged in forms of macroprudential policy to mitigate these financial stability risks. Recent experience has also shown that monetary policy and financial stability do not operate in vacuums. Linkages exist between monetary policy and financial stability and these represent important areas of research for central banks in considering their policies. Central banks must consider which mixture of their tools they should use to achieve their monetary policy and financial stability aims.

Monetary policy affects the economy through a number of channels. Since the financial crisis, the risk-taking channel has become increasingly prominent. This refers to how monetary policy, and expectations of future monetary policy, can change how financial agents perceive the riskiness of their activities or change their appetites for taking on risk. In this paper, we use data on the lending of US banks to examine how they change the riskiness of their lending based on changes in expectations of monetary policy. Previous research has shown that the level of the monetary policy rate can affect risk-taking by financial agents. Our contribution is to show that expectations for the path of future monetary policy rates also affect risk-taking, independent of the level of the monetary policy rate.

We use the term spread, the difference between interest rates at long and short maturities, as a representation of the expected path of monetary policy. The term spread is important for banks for a number of reasons. An increase in the term spread (i) makes bank lending more profitable, (ii) causes banks to consider their lending less likely to make losses, and (iii) raises the value of the bank's equity, meaning they can bear more risk according to standard risk measures. The importance of these factors also leads banks to anticipate changes in the term spread when setting their lending policies. For this reason, in this paper, we focus on changes in the term spread not previously anticipated by banks to identify the causal link from the term spread to their risk-taking.

We find that an increase in the term spread causes US banks to increase the riskiness of their lending. They reduce their share of lending to less risky borrowers and increase their lending to riskier borrowers. They also increase the total volume of their risky lending and accept less collateral from borrowers. This paper highlights how monetary policy can induce changes in the riskiness of behaviour in the banking sector. It underscores the importance for monetary policymakers to consider the entire term structure of interest rates when setting short-term rates. For financial stability policy, it highlights the need to carefully consider the mix of lending done by banks and not just the aggregate amount of lending. It also emphasises the importance of the use of macroprudential policy to address the build-up of financial imbalances and mitigate financial stability risks.

1 Introduction

The post-global financial crisis period has seen a renewed debate on the link between monetary policy and financial stability. This has focused in particular on the ability of monetary policy to counteract the rise of financial stability risks, or "lean against the wind" (Woodford, 2010; Svensson, 2013; Gambacorta and Signoretti, 2014; Gali, 2014; Barnea et al., 2015; Herman et al., 2017) and on the increasing role of shadow banks in credit markets (?Adrian et al., 2018). This debate reflects, in part, the insufficient attention previously paid to the risk-taking channel of monetary policy, in which monetary policy can induce changes in the risk-taking perceptions and behaviour of financial agents (Borio and Zhu, 2012). Monetary policy rates have been at low levels, close to or below zero in many countries, for a prolonged period since the global financial crisis. This has caused the risk-taking channel to become increasingly important for understanding monetary transmission and the linkages between monetary policy and financial stability.

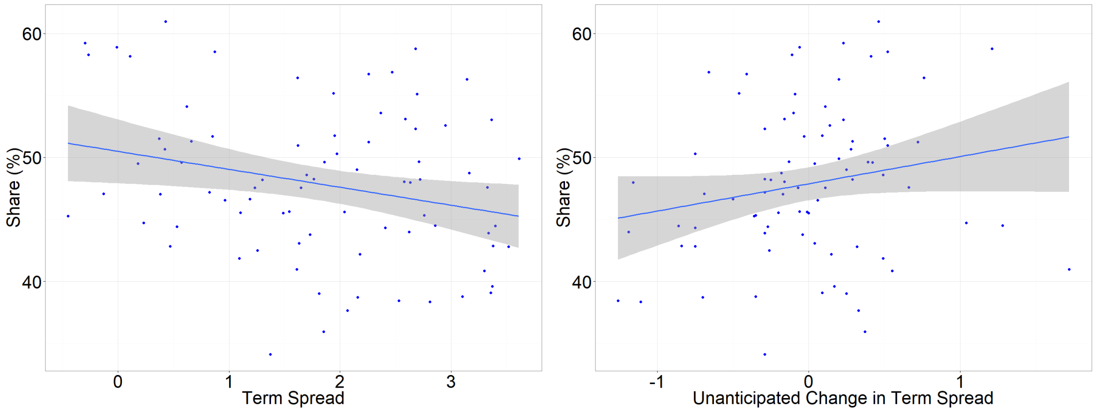
Notwithstanding the recent increase in interest in non-banks, banks remain an integral part of the monetary policy transmission mechanism and so remain of research interest to the monetary policy and financial stability fields. Financial intermediation remains the core business of banks: they fund themselves through short-term liabilities (e.g. deposits) but extend credit with considerably longer maturities. Managing this maturity mismatch between the horizons of their assets and liabilities is thus of primary importance. In this, banks must consider the term structure of interest rates because of how their interest expense and interest income relate to different portions of this set of interest rates.[1].

Balance sheet management by banks and the term structure of interest rates thus provide mechanisms by which monetary policy expectations and short-term policy rates can affect the supply of credit via banks. Adrian and Shin (2010) shows that when the term spread rises the profitability of new lending increases for banks. The value of bank equity also rises, allowing banks to bear additional risk given the improvement in their leverage or risk measures. Bruno and Shin (2015) further argue that the banking sector, and banks' balance sheets, has not received sufficient attention as an important piece in the transmission mechanism and in driving financial conditions and risk premia over the cycle.

Dell'Ariccia et al. (2017) show that changes in the perceptions of, and pricing of, risk by economic agents yield a negative relationship between short-run interest rates and the riskiness of banks' loan portfolios. The contribution of this paper is to focus on how the term spread can affect the risk-taking of the banking sector when controlling for the already-studied effects of the short-term interest rate. Identifying and quantifying the effect of the term spread is challenging,

[1] The term structure of interest rates, also known as the yield curve, represents a set of interest rates at different durations. It can be thought of as having a slope from the interest rates at lower maturities to those of longer maturities. Taking the difference in a short and long-term rate, typically the three-month and ten-year rates gives us the term spread. This paper shall use the label "term spread", but term premium and term structure are also used in the literature.

FIGURE 1. Share of Risky Loans issued by US Banks vs. Measures of Term Spread



(A) Term Spread (B) Unanticipated Changes in Term Spread

however. The term spread is itself partially determined by monetary policy actions which in turn reflect economic activity and the risk appetite of banks. This paper outlines a causal mechanism, through unanticipated increases in the term spread, to assess the impact of the term structure of interest rates on risk-taking by US banks.

An increase in the term spread affects banks' risk-taking in a number of ways. First, this signals a path for future interest rates which is consistent with strong economic growth, reducing the level of perceived credit risk. Second, an increase in the term spread increases bank profitability through maturity transformation. A steeper yield curve increases the difference between a bank's funding cost, which is related to the short end of the curve, and the marginal profitability of lending, which is related to interest rates at longer maturities. Finally, the greater profitability boosts forward-looking measure of bank capital, increasing the value of the bank's equity. A bank may take on more risk while maintaining a level of leverage or overall risk which is consistent with that before yield curve steepened. Adrian and Shin (2010) suggest that banks target a roughly-constant expected lending loss, as represented by Value-at-Risk, in times of both good and bad financial conditions. In better times, the increase in bank equity can be accompanied by greater credit extension to return the bank to its target level of Value-at-Risk. In worse times, when the Value-at-Risk measure is above the target, the bank can constrain the flow of lending and/or shed assets.

The above channels contribute to lowering the hurdle rate for investment in high risk/lower return projects. However, monetary policy will respond endogenously to raise rates if the current term structure induces agents to increase their risk appetite and fund a large number of such projects. This monetary policy reaction is the dominant factor in the relationship in a scatter plot of risk appetite and term structure, leading to a negative relationship (Figure 1a). This relationship runs contrary to that which we should expect from theory, based on the relationship between profitability and the term structure (Adrian and Shin, 2010). However, Figure 1b re-frames the relationship between risk and the term structure using forecast errors. These forecast errors represent when a steepening of the yield curve occurs in an unanticipated manner. Figure 1b thus depicts the positive relationship between risk appetite and an increase in the term spread, which should be expected given the maturity transformation role of banks and the importance of balance sheet management for financial intermediaries (Bruno and Shin, 2015; Adrian and Shin, 2013; Igan et al., 2017).

In this paper, we proceed by exploiting periods of unanticipated steepening in the yield curve, using forecast errors derived from expectations of the term spread taken from the Survey of Professional Forecasters for the US. To underscore the importance of exploiting **unanticipated** changes in the term spread for identification of the risk-taking channel, consider the Adrian and Shin (2010) argument that banks target a roughly constant Value-at-Risk in the face of differing financial conditions. If financial conditions turn out to be better than had been expected, with bank equity now higher and probabilities of default lower, a bank's Value-at-Risk measure lies below its target. The bank now has scope to take on additional risk merely to return this measure to its previous level. Banks do form ex-ante expectations of financial conditions when setting lending policy, however, and thus anticipate the term spread. This causes issues with identifying the timing and magnitude of effects on lending. An unanticipated change in the term spread, however, must have effects only after the change. This allows us to better identify the relationship between the term spread and lending. Using forecast errors to derive an instrumental variable has been used across economic fields (Barnichon and Brownlees, 2016; Jorda et al., 2015; Ramey, 2016; Ramey and Zubairy, 2018; Stock and Watson, 2018).

Our estimates show that an increase in the term spread causes US banks to reduce their share of new lending extended to relatively safe borrowers in favour of new lending to relatively risky borrowers. That is, on the intensive margin, banks reallocate lending making their portfolios riskier when the term spread rises. We also find extensive margin effects, with increased volumes of credit being extended. To facilitate this expansion of riskier lending in the face of likely collateral-constrained borrowers, collateralisation rates fall following an increase in term spread. This itself represents further risk-taking behaviour.

The yield curve is a well-studied topic. A significant literature has developed outlining the predictive power of the yield curve for economic activity (Estrella and Hardouvelis, 1991; Stock and Watson, 1993; Adrian and Estrella, 2008). Inversion of the yield curve, i.e., a negative term spread, is a good predictor of recessions and of increases in the unemployment rate. An inverted yield curve implies that long rates are lower than short rates, which is related to expectations of the monetary policy response to negative outcomes for economic activity in the future. Hence, the yield curve embeds information about the path of monetary policy. It can be considered to be a financial data-derived representation of monetary policy expectations.

The term spread is also closely related to financial intermediation by both banks and non-banks (Adrian et al., 2018). Banks (and other financial intermediaries) fund themselves over short-term horizons, and their funding cost is related to the front end of the yield curve. However, they tend to lend over longer maturities than the maturity of their liabilities, and so the term spread can be thought of as the marginal profitability of an additional dollar of lending. Adrian et al. (2018), focusing on *non-banks* in their paper, discuss the risk-taking channel of monetary policy.

They show that an increase in the term spread leads to an increase in the assets of non-banks, and thus an increase in the aggregate risk of the financial sector. Adrian and Shin (2013) show that banks manage their balance sheets in response to changing financial conditions, including the term spread, to keep their probability of loss constant. This results in meaningful macroeconomic effects, in this case, cross-border capital flows, arising from balance sheet considerations in the banking sector. Igan et al. (2017) also highlight the macro-level importance of private sector balance sheets in the transmission of US monetary policy, drawing distinctions between types of financial intermediaries.

A number of pieces of research have supported the existence of a risk-taking channel of the transmission mechanism. Maddaloni and Peydro (2011) show evidence of a risk-taking channel via bank credit standards. Using Taylor Rule residuals, they show that monetary policy being too low for too long can affect credit standards and thus their level of risk. Kurtzman et al. (2017) show that the Federal Reserve's Large-Scale Asset Purchases lowered credit standards on lending by US banks and increased loan risk characteristics. Detken et al. (2018) also contribute to the risk-taking channel literature by showing that overly-optimistic expectations of national income growth can increase credit-to-GDP ratios.

Buch et al. (2014) find evidence for the risk-taking channel among US banks. They find that expansionary monetary policy shocks lead to an increase in new lending to higher risk borrowers. They do not examine the impact of the term spread. Altunbas et al. (2014) examine a panel of listed US and EU banks and find that relatively low levels of monetary policy rates contribute to increased bank risk. Dell'Ariccia et al. (2017) use loan-level data for the US to show that risk-taking by US banks is negatively associated with increases in the short-term policy rate.

Bonfim and Soares (2018) similarly use loan-level data to find a negative relationship between the policy rate and credit quality for Portugal. Gaggl and Valderrama (2017) exploit variation in the synchronicity of Taylor Rules for Austria and for the euro area as a whole to examine risk-taking by Austrian banks. Using bank-firm data, they find that persistently low short-term policy rates pre-crisis caused Austrian banks to make riskier loans with higher probabilities of default. Ferrero et al. (2018), also using bank-firm level data, examine the impact of the yield curve on risk-taking by Italian banks, separate to the effect of the short rate. They find that that risk-taking is positively associated with the long end of the yield curve, controlling for the short end of the curve.

Another strand of the literature focuses on the role that corporate governance plays in determining risk-taking by banks. Andries and Brown (2017) find that the existence of a dedicated risk committee, with sole responsibility for monitoring and managing risk management efforts within a bank, is associated with more moderate pre-crisis credit growth and a smaller contraction of credit in the crisis. Buch and DeLong (2008) show that strong supervision can reduce the risk-taking of banks. De Haan and Vlahu (2016) provide a survey of this topic. They note mixed results in the literature, with no conclusive results on the relationship between different governance mechanisms on bank performance. They discuss the broad literature on banks' incentives for risk-taking and on banks being "too big to fail". They note that the systemic importance of banks for the financial system and wider economy can paradoxically encourage their risk-taking because of implicit government guarantees and deposit insurance.

Our contribution is to quantify the extent to which the term spread can induce changes in risk behaviour in the banking sector, separate to the effects already studied of the impact of the level of the short-term interest rate. We thus add to the body of evidence supporting the existence of a risk-taking channel of monetary policy. To the best of our knowledge, ours is the first paper to quantify aggregate effects of the term spread on the riskiness of bank lending. We show that the magnitude of the adjustments in the riskiness of the aggregate banking sector are large and economically meaningful. We thus contribute also to the literature on understanding the macroeconomic relationship between the yield curve and growth, providing evidence that macro outcomes can, at least in part, be traced back to the balance sheets of banks.

There are a number of policy implications from this work. For the conduct of monetary policy, our results argue that consideration should not only be given to the level of the short-term interest rate, but also to the term spread. We show that for a given level of the short-term rate, the transmission of monetary policy can differ based on the associated term spread. From a financial stability perspective, our work suggests that careful consideration should be given by banking supervisory authorities to the mix of risky lending done by banks and not just to the aggregate volume of credit extended or to simpler measures of bank leverage. In upswings, risk may be increasing, even though perceptions may not fully appreciate this. This is particularly true when bank equity increases following an increase in the term spread.

The rest of this paper is structured as follows: Section 2 outlines the sources of data we use to look at bank lending by risk and for our identification strategy. Section 3 outlines our empirical model and identification strategy. Section 4 presents our empirical results, underlines the importance of mitigating anticipation effects, and presents some robustness checks and extensions. Finally, Section 6 concludes and offers implications for policy.

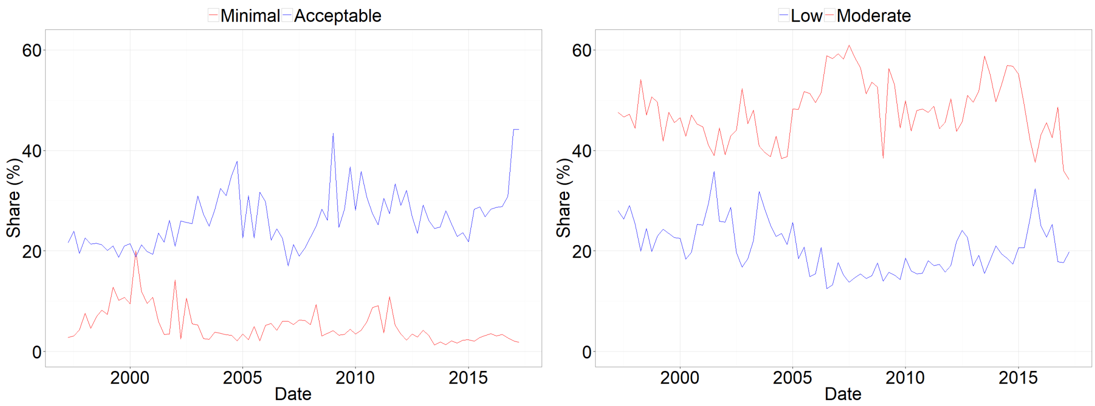
2 Data

We construct our dataset from three main Federal Reserve data sources: the Survey of Terms of Business Lending (STBL), the Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS) and the Survey of Professional Forecasters (SPF).

The STBL is a quarterly survey of loan extensions from a panel of domestically chartered US commercial banks and US branches and agencies of foreign banks[2]. As noted by Buch et al. (2014), a key benefit of the STBL is that it focuses on new loans and not on existing loans. It thus is suited to examining whether banks engage in ex-ante riskier lending, as per the Borio and Zhu (2012) definition of the risk-taking channel. Most previous studies have not distinguished between new risk on new lending and realised risk on existing lending.

[2]The STBL was discontinued in August 2017. At that point, the panel comprised 348 domestic banks and 50 US branches and agencies of foreign banks.

FIGURE 2. Shares of US Bank Lending by Risk Category, 1997 - 2017



(A) Minimal and High Risk Shares

(B) Low and Moderate Risk Shares

The STBL provides weighted-average loan rates for commercial and industrial lending, in addition to collateralisation rates, loan volumes, and weighted-average maturities, among other series, separating lending by fixation/repricing interval. Crucially for our research question, from the second quarter of 1997, the survey also split lending by the categories of risk. Respondents to the STBL assign their lending to four categories according to a matrix of qualitative criteria provided by the Federal Reserve. The risk categories are, from least risky to riskiest, "minimal", "low", "moderate" and "acceptable"[3]. Table A1 presents an abridged example of the criteria by which they are sorted. For example, a minimal risk customer should have a public debt rating of AA or better, while the moderate and high-risk customers are assumed only to have limited access to capital markets.[4]

Almost half of credit advanced per quarter is at moderate risk. A further 26 percent of lending is accounted for by the high-risk category, resulting in an almost three-fourths share for the two higher risk categories. Low-risk lending comprises 21 percent of quarterly lending on average, while minimal risk lending contributes just 5 percent on average (Table A2). Figures 2a and 2b show the evolution of risk shares. The main substitution is between low and moderate categories, with a clear retrenchment towards low risk during the financial crisis. There is more stability in the highest and lowest risk categories, with the exception of the last couple of quarters, where the highest increased by more than 10 percentage points. This is consistent with the reach for yield in the prolonged period of low rates.

One potential concern is this measure focuses on the riskiness of the borrower but risk-taking can also be possible through loosening loan characteristics of borrowers for low-risk categories. This is partially captured through information on the collateral coverage also available in the STBL. Further, Dell'Ariccia et al. (2017) show that loan characteristics explain a very small portion of the variation in loan risk ratings, implying that the most relevant component is the riskiness of the borrower.

[3]For the sake of clarity, we will refer to the highest risk "acceptable" category as "high" risk.

[4]The full set of STBL criteria are available from the Federal Reserve here.

The SLOOS examines the views of senior loan officers at a panel of US banks[5]. The survey has undergone a number of revisions in design and in its participation since its inception in 1964, but its questions have remained consistent since 1997. We have matched the post-1997 sample to the STBL. In the survey, banks report qualitative responses to questions examining the demand for credit they have perceived over the previous quarter and changes in their credit standards on lending. Their credit standards refer to internal guidelines which determine to which customers credit should be supplied. A "tightening" of credit standards refers to a bank being less likely to extend credit, all else equal than it had been previously. The responses from individual banks are aggregated to express a net measure of changes in credit demand and credit supply for the banking system. The aggregated demand and credit standards series may be interpreted as shifters of the demand and supply curves for credit in the banking system, and so should help to explain patterns of lending. To match the STBL, we focus on the SLOOS responses to questions covering Commercial and Industrial Lending. Table A2 shows that the average credit standards response over the sample was a small net tightening. The average credit demand respond was a marginal increase of 0.24 percent. In both cases, however, the standard deviation of the series is much higher, reflecting the volatile credit cycle.

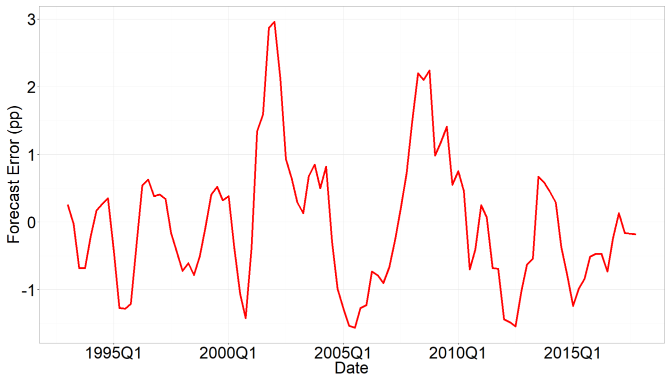
The Philadelphia Fed's Survey of Professional Forecasters is used to calculate measures of term structure. This survey began in the fourth quarter of 1968 and has been administered by the Philadelphia Fed since 1990. It is a survey of macroeconomic forecasts by a panel of forecasters[6]. Among other forecasted variables, the survey examines the expected three-month Treasury bill rate and the 10-year Treasury bond rate over a range of quarterly forecast horizons. From this, it is possible to calculate the forecast term structure, i.e., the spread between the 10-year and 3-month rates. Furthermore, we are able to generate forecast errors of the term spread by netting off the forecast for a point in time from the realisation of the term spread at that point. Figure 3 shows the forecast error between 1992 and 2017. It has a mean of approximately zero and a standard deviation of one percent, with some individual errors close to three per cent[7].

[5]As with the STBL, the SLOOS panel includes both domestically chartered commercial banks (80) and branches and agencies of foreign banks (24).

[6]See here for more information including methodology and forecast evaluation. Some panellists are named while others remain anonymous.

[7]The forecast error is also stationary: we use an Augmented Dickey-Fuller test with four lagged differences of the forecast error and find a MacKinnon p-value of 0.03. We are thus able to reject the null hypothesis of a unit root.

FIGURE 3. Forecast Error of Term Spread, 1992 - 2017



The analysis also includes a range of macroeconomic variables such as unemployment, inflation and credit growth, outlined in Table A3.

3 Empirical Model and Identification Strategy

When investigating the role that the term spread plays in bank lending, the term spread can be thought of as a representation of the future path of interest rates. Given that banks are forward-looking agents, we need to be cautious in how the relationship between lending and the term spread is estimated to avoid potential endogeneity in the relationship. Banks' expectations of the term spread are likely to affect their lending decisions and thereby lead to violations of lead/lag exogeneity (Stock and Watson, 2018). In other words, anticipation effects by banks can result in endogeneity bias. This form of endogeneity is commonly encountered with trade liberalisation or estimating fiscal policy multipliers, e.g., in Auerbach and Gorodnichenko (2012).

To proceed, we need to exploit the exogenous, un-forecasted element of the term spread. Unanticipated movements in the term spread, by their nature, will not have been expected by banks and thus provide us with a source of variation from which we can identify the impact of the term spread on a variety of lending outcomes. We take the SPF forecasts of the term spread from four quarters previously and net them off from the presently realised term spread (equation 1). The remaining forecast error represents the unanticipated element of the term spread at each point in time. We choose to calculate the forecast error on the basis of a four-quarter difference between expected and realised term premia to reflect the fact that banks adjust their lending patterns only after some delay. However, in Section 5 we repeat our estimations using a forecast error calculated from a single quarter difference.

$$forecasterror_t = termspread_t - E_{t-4}\left(termspread_t | I_{t-4}\right) \tag{1}$$

We use the local projection method of Jorda (2005) to estimate the relationship between lending and the term spread in a single equation. We are able to generate structural impulse responses through estimation of (2) by Two-Stage Least Squares, such as in Barnichon and

Brownlees (2016); Jorda et al. (2015); Ramey (2016); Ramey and Zubairy (2018); Stock and Watson (2018); Lane and Stracca (2018). We follow Auerbach and Gorodnichenko (2012, 2013); Crowe (2010); Detken et al. (2018); Ramey and Zubairy (2018); Thapar (2008) in exploiting forecast errors for identification, in several cases as an instrumental variable. In our case, we use them as instruments for the term spread. Using the instrumental variable approach for identification allows us to mitigate the risk of endogeneity bias, while a single equation is of benefit due to economy in the number of parameters to be estimated. The local projection approach is also more robust to misspecification than Vector Autoregression (VAR) approaches as it does not impose the dynamic restrictions implicit in a VAR (Tenreyro and Thwaites, 2016).

$$y_{t+h} = \alpha_h + \beta_h termspread_t + \sum_{l=1}^{L} \delta_{1,h} y_{t-l} + \sum_{l=0}^{L} \delta_{2,h} X_{t-l} + \epsilon_{t+h}; h = \{0, ..., H\} \quad (2)$$

$$IRF = \{\beta_h\}_{h=0}^{H} \quad (3)$$

We estimate the relationship between a number of bank lending variables y_t and the term spread. Table A3 describes the set of outcome variables we examine, with the shares of lending done at low risk, moderate risk, and the difference of the two shares, being chiefly of interest to us in examining whether banks adjust the riskiness of their lending along the intensive margin.

We separately estimate the parameter on the term spread at each time point between a contemporaneous effect and the effect at lead H. The impulse response function is generated from the sequence of β parameters that are estimated, as given by (3). Following Ramey (2016), we also include lags of the dependent variable to account for persistence, include a vector of controls, X, to reduce the residual variance, and use heteroskedasticity and autocorrelation consistent (HAC) standard errors throughout.

The controls in equation (3) include the level of the short-term interest rate, credit standards and credit demand, the unemployment rate, inflation, the interest rate margin on lending, and aggregate credit growth. We include the level of the short-term interest rate to control for the direct impact this has on bank lending, via both the risk-taking and traditional bank lending channels. This means that the impact we find of the term spread on lending should be interpreted purely as the effect which comes from the banks' balance sheet concerns such as profitability and lower expected losses. Our estimates are conditional on the distribution of short-term rates which can be consistent with any given term spread. Our motivation for the other controls comes from theory on the determinants of financial intermediation by banks, including how this affected by macroeconomic variables, private sector demand for credit and banks' willingness to lend.

4 Results

4.1 First stage regression

Table 1 reports the results of the Two-Stage Least Squares first stage regression for the term spread, in which we instrument the term spread with the contemporaneous forecast error. This is our preferred specification which we use throughout. The forecast error is highly significant, with a percentage point increase in this component representing a 54.4 basis point increase in term spread. The F-statistic for the first stage regression very comfortably exceeds the standard benchmark value of 10, indicating that the forecast error is a strong instrument.

TABLE 1. First stage regression

	(1)	(2)	(3)	(4)
$ForecastError_t$	0.544***	0.544***	0.578***	0.583***
	(0.066)	(0.114)	(0.102)	(0.092)
$ForecastError_{t-1}$		0.000	-0.080	0.080
		(0.130)	(0.119)	(0.119)
$ForecastError_{t-2}$			0.077	-0.245**
			(0.097)	(0.113)
$ForecastError_{t-3}$				0.316***
				(0.081)
Observations	79	79	79	79
R-squared	0.521	0.521	0.528	0.600
F-statistic	68.44	36.28	25.97	26.96
J-statistic		0.766	0.053	0.12

Notes: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. HAC standard errors in parentheses.

The subsequent columns of Table 1 add the first, second and third lags of the forecast error as instruments. In each case, the contemporaneous effect remains positive and highly significant, while the F-statistics reported remain comfortably in excess of the standard benchmark of 10. The forecast error appears to be a strong instrument and this remains true when adding lags of the forecast error. In addition, for the specifications which are over-identified, we report the results of the Hansen test of over-identifying restrictions. The reported J-statistics for these specifications indicate that we cannot reject the null hypothesis of instrument validity, i.e., that the instruments are uncorrelated with the error term, in any case. Table A4 reports unabridged first stage regression results, showing the first stage parameter estimates for the second stage controls from our baseline results.

4.2 Baseline results

Our baseline results focus on the intensive margin between lending at low risk and at moderate risk. As discussed above, these are the middle two of four categories of risk, with moderate being the largest category and low being the only quantitatively meaningful lower risk category. As such, this is likely the margin along which we would observe shifting shares of lending.

TABLE 2. Second stage regression

Dep. Variable		(1) Quarter 0	(2) Quarter 1	(3) Quarter 2	(4) Quarter 3	(5) Quarter 4
Low Risk	Term Spread	-0.016	-0.037**	-0.051**	-0.061***	-0.053***
		(0.012)	(0.019)	(0.021)	(0.019)	(0.017)
	N	79	78	77	76	75
	R-Squared	0.541	0.354	0.379	0.382	0.446
Moderate Risk	Term Spread	0.007	-0.009	0.028	0.062***	0.046**
		(0.012)	(0.010)	(0.019)	(0.024)	(0.021)
	N	79	78	77	76	75
	R-Squared	0.636	0.606	0.592	0.498	0.604
Moderate - Low	Term Spread	0.020	0.030	0.080**	0.126***	0.104***
		(0.019)	(0.026)	(0.035)	(0.039)	(0.034)
	N	79	78	77	76	75
	R-Squared	0.673	0.520	0.510	0.451	0.540
High Risk	Term Spread	-0.001	0.006	-0.007	-0.038*	-0.006
		(0.014)	(0.011)	(0.017)	(0.020)	(0.014)
	N	79	78	77	76	75
	R-Squared	0.637	0.641	0.671	0.596	0.702
High - Low	Term Spread	0.013	0.036	0.041	0.015	0.036
		(0.020)	(0.022)	(0.032)	(0.031)	(0.029)
	N	79	78	77	76	75
	R-Squared	0.536	0.488	0.514	0.505	0.558

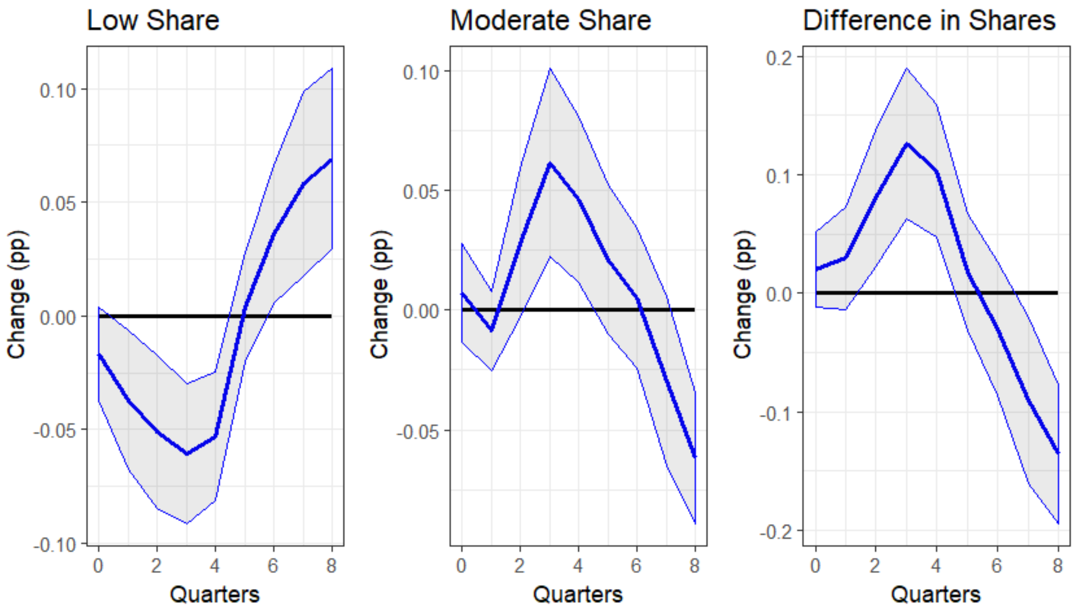
Notes: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$. HAC standard errors in parentheses.

Table 2 shows the estimated effects of the term spread on the lending shares of the low and moderate risk categories, and the difference in these shares. This is based on the first stage shown in the first column of Table 1. The first column of Table 2 shows the contemporaneous response of these shares to an increase in the term spread, with the subsequent columns showing the projections from one to four quarters ahead. The effect on the share of the low-risk lending is negative throughout, and significant from the first quarter ahead onwards. The peak effect is a 6.1 percentage point decrease in this share. Similarly, the share of the moderate risk category increases, with significant effects for between two and four quarters after the shock. The peak increase in share is 6.2 percentage points. The lags we observe in the effect of the term spread on the flow of credit are economically plausible.

In Table 2, we also include the responses of the high-risk share and the premium of the high-risk share over the low-risk share. The share of high-risk lending is largely unresponsive to the term spread, with the exception of a marginally significant decrease of 3.8 percentage points in the third quarter after the shock. The difference between the high and low shares never shows a significant response over the horizon in Table 2. The coefficients are positive, however, in keeping with there being a substitution toward higher risk. The results for the high-risk share support that the main margin of adjustment is between low and moderate risk shares.

In Figure 4 we report the impulse response functions of the shares of the two categories to a one percentage point increase in the term spread. The error bars represent the 90 percent

FIGURE 4. Impulse Response Functions of the Low and Moderate Risk Shares, and their Difference



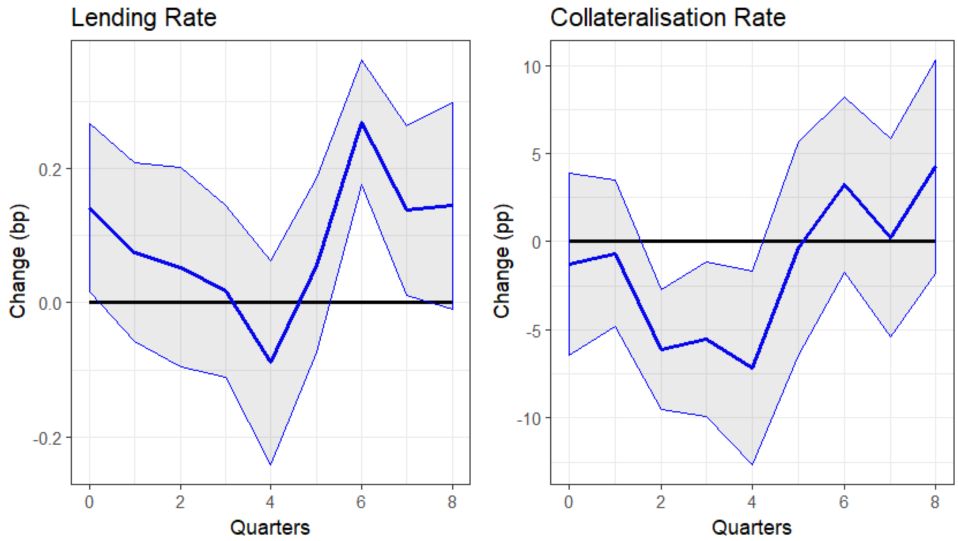
Notes: Impulse Response Functions generated from local projections of shares of lending on the term spread. The term spread is instrumented with the forecast error. The lending shares are for the low-risk category, the moderate risk category, and the share premium of moderate risk over low risk.

confidence interval. Our main result is given by the right-most panel of Figure 4, which shows the response of the difference in lending shares of moderate and low risks. The adjustment in shares on the intensive margin between these categories is statistically significant. The peak effect is reached after three quarters, with a 12.6 percent increase in the share premium of the riskier category. These effects are also highly economically significant. The average shares in all lending of these two categories are 21 percent and 48 percent, respectively. They represent, on average, \$9 billion and \$20 billion of quarterly lending. A 12.6 percent redistribution in the shares of lending between these two categories represents a sizeable and economically significant adjustment in the pattern of lending by the US banking sector.

One consideration which follows these results is what constraints banks may face in trying to expand their lending to riskier borrowers. As Table A1 indicates, one way in which these two groups differ is in whether collateral is required and in its quality. The low-risk group may or may not have collateral requirements, and if they do, it is generally of good quality and recovery is very likely. The moderate risk group usually does face collateral requirements, with their collateral considered generally sufficiently liquid to make recovery likely. The collateral requirements for the moderate group can thus be considered more onerous than for the low-risk group.

Borrowers may be no less collateral constrained after the increase in the term spread than they were before, but banks' willingness to lend has increased via the risk-taking channel. What happens to a bank which, for risk appetite or perception reasons, wants to expand its riskier lending but finds its customers collateral constrained? In the right-hand panel of Figure 5 we find evidence for a decrease in the collateralisation rate of the higher risk group, relative to the

FIGURE 5. Impulse Response Functions of Interest Rate and Collateralisation Rate Premia: Moderate vs. Low Risk



Notes: Impulse Response Functions generated from local projections of lending rate and collateralisation rate premia on the term spread. The term spread is instrumented with the forecast error. The premia are the differences in lending and collateralisation rates for moderate and low-risk categories.

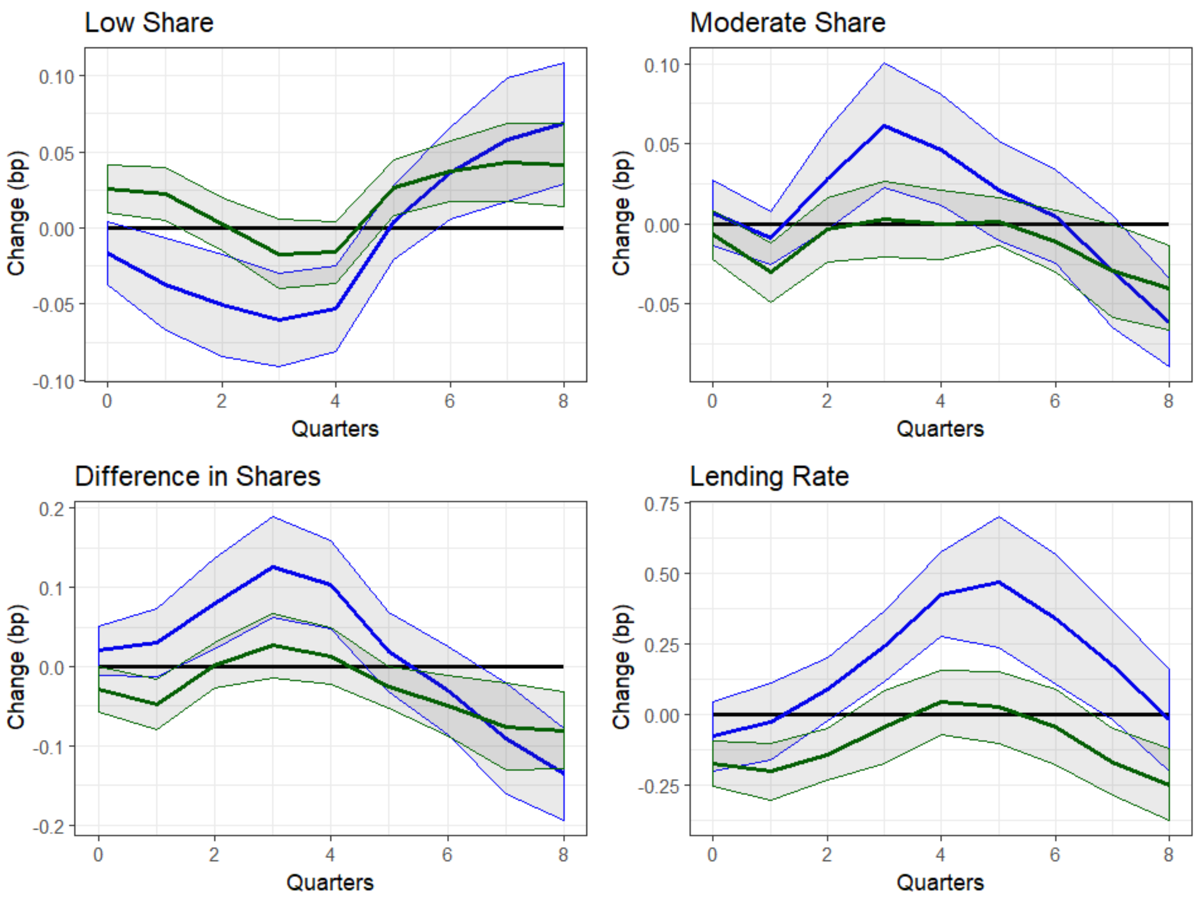
lower risk one, of approximately six percentage points following the steepening of the yield curve. The duration of the effect closely matches the duration of the adjustment in the lending shares premium seen in Figure 4. Banks thus appear to lower their collateral requirements to facilitate their desired expansion of lending in the face of collateral-constrained borrowers. In the left-hand panel of Figure 5, we also find some evidence for an increase in lending rate premia for the moderate risk group, likely reflecting the decrease in collateral pledged against the new lending.

4.3 Comparing Ordinary Least Squares and Instrumental Variable estimates

In this section, we aim to provide some evidence on the importance of using the instrumental variable approach. We have argued that anticipation effects may result in endogeneity bias in OLS estimates. But how meaningful in magnitude and for interpretation is this endogeneity bias? The panels of Figure 6 provide the impulse responses for the shares of low and moderate risk lending once more, their difference, and the interest on bank lending. The set of impulse responses in blue are the structural impulse responses identified via external instruments. Also included are a set of reduced form impulse responses, in green, that are generated from Ordinary Least Squares regressions using the term spread.

Figure 6 shows that the response of low-risk lending to an increase in the term spread is significantly positive on impact, which runs counter to what we expect. Although the impulse response becomes negative after a number of quarters, it is never statistically significantly so. For the moderate risk lending, we find little responsiveness to the slope of the yield curve at any point. The share premium of the riskier lending has a positive but insignificant effect, and its peak magnitude is six times smaller than that found using the Instrumental Variable approach.

FIGURE 6. Comparison of Structural and Reduced Form Impulse Response Functions



Notes: Impulse Response Functions generated from local projections of shares of lending, and the lending rate, on the term spread. For the IRFs shaded in blue, the term spread is instrumented with the forecast error. The IRFs shaded in green are reduced form. The lending shares are for the low-risk category, the moderate risk category, and the share premium of moderate risk over low risk. The lending rate is the interest rate on C&I loans on floating rates or for up to one year of fixation.

Similarly, we can examine the responsiveness of the margin of the interest rate on new lending over the monetary policy rate (bottom right panel of Figure 6). We expect to find a positive relationship here given that we are examining an increase in term spread, controlling for the short-term interest rate. As argued by Adrian and Shin (2010), among others, the term spread represents the marginal profitability of lending. An increase in the term spread should thus make the marginal dollar of lending more profitable, at higher lending rates. Looking at the IV estimates, we find a positive relationship with a peak effect of approximately 50 basis points. The OLS estimates, by contrast, are initially significantly negative and the peak positive effect is 10 times smaller in magnitude and not statistically significant.

Based on this evidence, we conclude that the IV approach is important for correct inference and for understanding the size of effects. The IV approach allows us to gain some intuition into risk-taking by banks, while the OLS approach produces effects that are economically implausible due to endogeneity bias.

5 Robustness checks

Our main specifications rely upon a four-quarter difference between the forecasted term spread and the realisation. We have two reasons for this. The first relates to reasonable expectations of how quickly a bank might change its lending practices in response to a change in the term spread. Second, it is also reasonable to expect a lag between change in lending practices and the observation of extension of credit to firms. Typically, the draw-down of funds extended to a counterparty by a bank takes some time, for legal and administrative reasons among others. However, as a robustness check, we use the one-quarter difference in forecast and realisation to generate a forecast error.

TABLE 3. First stage regression: one-quarter forecast error

	(1)
$ForecastError_t$	0.549***
	(0.116)
N	79
R-squared	0.228
F-statistic	22.53

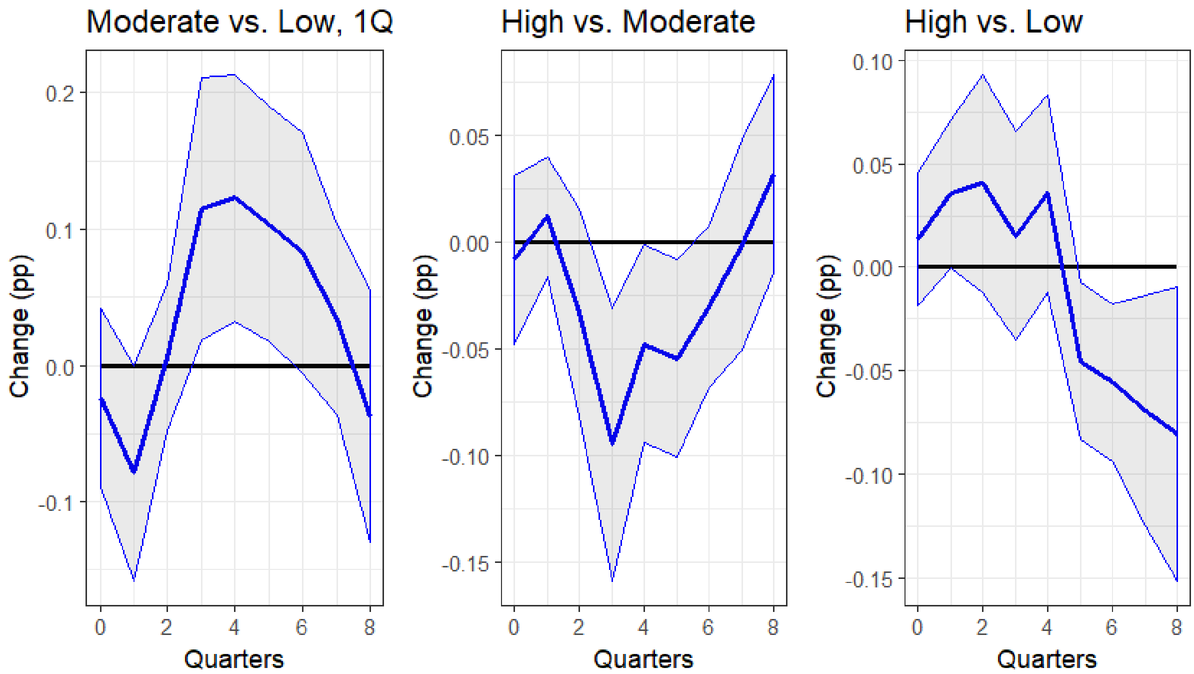
Notes: $^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$. HAC standard errors in parentheses. All second stage controls in equation.

Table 3 reports results which are qualitatively similar to those of our preferred first stage regression in Table 1. The F-statistic associated with the one-quarter forecast error is smaller but remains more than double the standard benchmark of 10. We conclude that the one-quarter forecast error is also a strong instrument. The left-hand panel of Figure 7 shows the impulse response function of the share premium of moderate risk lending over low-risk lending, based on using the one-quarter forecast error as the instrumental variable. We observe results that are similar to those shown in Figure 4, with adjustment on the intensive margin away from lower risk lending to higher risk lending. The peak effect is a 12.3 percent increase in the share premium, which is only marginally smaller than the 12.6 percent effect we find in our main specification.

Figure 7 also shows other potential margins of adjustment for the risk-taking channel. The centre panel shows the change in the share of the high-risk borrowers relative to the moderate risk borrowers. We find some evidence for a small growth in the moderate group at the expense of the high-risk borrowers, but this change is short-lived and marginally significant. The right-hand panel of Figure 7 shows that the sign of the change in high-risk share, relative to the low-risk share, is positive but not statistically significant. These charts indicate that the margin between low and moderate risk is the main margin of adjustment.

One question we wish to address is whether we have truly found an effect of banks adjusting the riskiness of their lending on the intensive margin. Adjustment on the intensive margin is not necessary to find evidence of a risk-taking channel. If monetary policy induces banks to lend their marginal dollar to a borrower that is riskier than the average, the aggregate risk of their

FIGURE 7. Additional Impulse Response Functions of Lending Shares

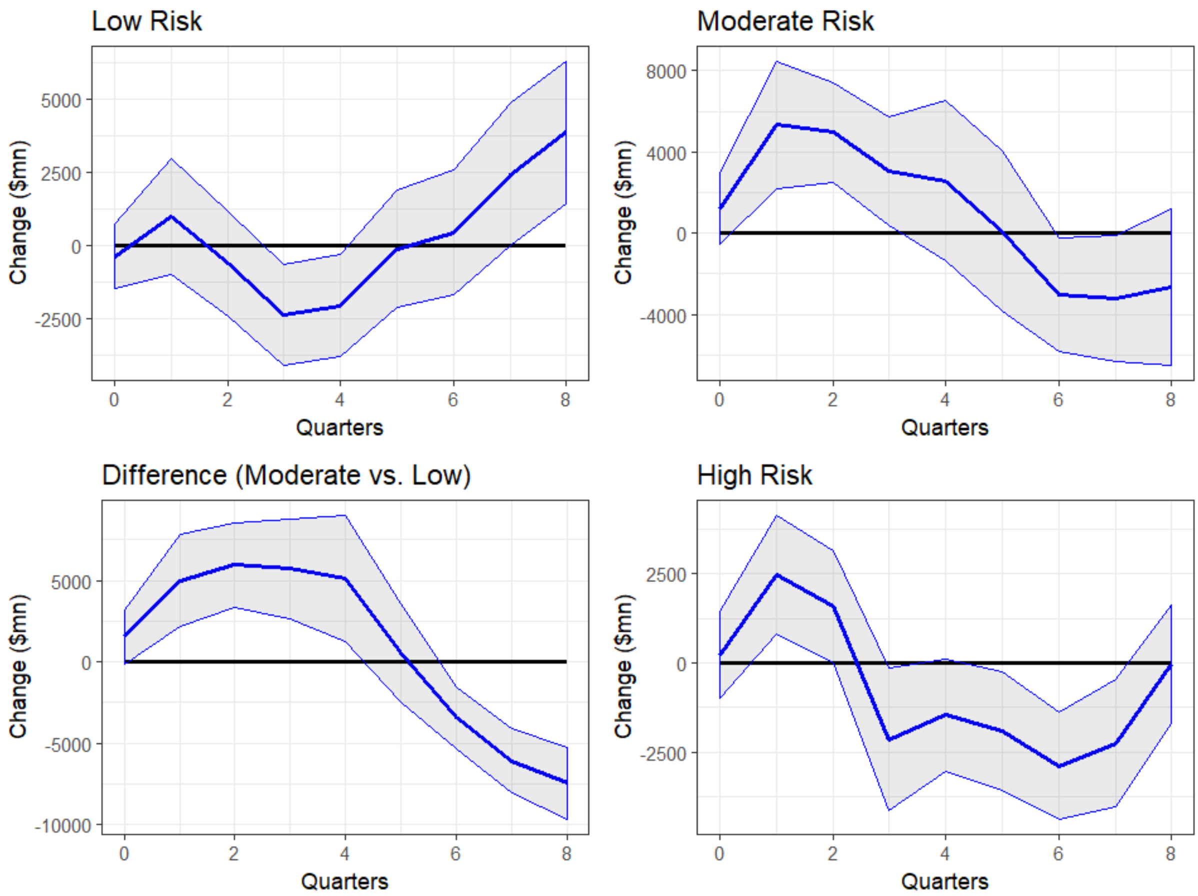


Notes: Impulse Response Functions generated from local projections of shares of lending on the term spread. The term spread is instrumented with the forecast error. The first panel shows the share premium of moderate risk over low risk, using a forecast error calculated over one quarter. The second panel shows the share premium of high risk over moderate risk. The third panel shows the share premium of high risk over low risk.

lending increases. Hence, if there were an extensive margin adjustment where banks did new lending solely to moderate risk borrowers, with no effect on low-risk lending volumes, that would represent a form of increased risk-taking and would result in a lower *share* of lower risk lending. An intensive margin effect is sufficient to show evidence of the risk-taking channel, however, and we view it as a stronger result. It would imply more engaged activity by banks to increase their risk because of their new expectations for the path of interest rates.

Figure 8 shows, however, that there is statistically significant evidence for a reduction in the dollar volume of lending to the low-risk category. The peak effect, after 3 quarters, is a reduction of $2.5 billion dollars in the flow of lending. The top-right panel of Figure 8 shows the associated increase in lending to moderate risk borrowers. The overall difference can be seen in the bottom-left panel of Figure 8. The difference in flows of lending between riskier and less risky borrowers is approximately $5 billion dollars per quarter for four quarters. This always exceeds the peak increase in the flow of lending to riskier borrowers and is a longer-lasting effect. As a result, the decrease in the *share* of low-risk lending cannot solely be driven by an increase in riskier lending on the extensive margin, with lending to lower risk borrowers unaffected. We conclude that the intensive margin effect is active. Regardless, both margins can be interpreted as contributing to the risk-taking channel.

FIGURE 8. Impulse Response Functions of Lending Volumes by Risk Category

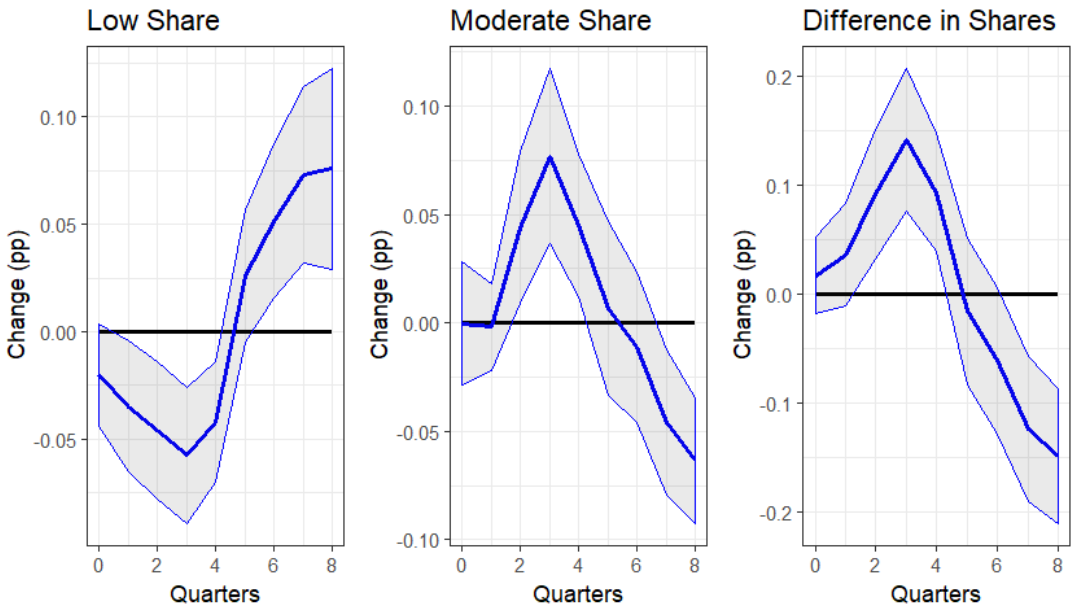


Notes: Impulse Response Functions generated from local projections of volumes of lending on the term spread. The term spread is instrumented with the forecast error. The volumes of lending are for the low, moderate and high-risk category, and the difference in volumes of the moderate and low-risk categories.

The bottom-right panel of Figure 8 also shows a short-lived but statistically significant increase in lending volumes for the riskiest borrowers. The fact that this increases, but by less than the volume for the moderate risk category, is consistent with a negative change in the relative share of the moderate versus the high-risk category seen in Figure 7. The change in lending to the riskiest group of borrowers is an extensive margin effect, increasing the total dollar amount of risky lending, and so amplifies the risk-taking effect of the term spread through that channel.

A separate concern one may have for our identification of the term spread affect on risk-taking is the fact that banks may be surprised by changes in the slope of the yield curve because of movement in the short-term interest rate, not just in the long rate. We focus on the long rate because of the interpretation that an increase in the US long-term yield reflects greater expected future growth and an associated monetary policy response with greater future short-term rates. However, the term spread may increase because of an unexpected movement at the front end of the curve, for instance, due to a decrease in the policy rate or a failure to meet the expectations of an increase in the policy rate. To mitigate this, we control for the short-term interest rate

FIGURE 9. Impulse Response Functions of Lending Shares by Risk Category (Long Term Rate Forecast Errors Only)



Notes: Impulse Response Functions generated from local projections of lending rate and collateralisation rate premia on the term spread. The term spread is instrumented with the forecast error solely based on the long-term rate. The lending shares are for the low-risk category, the moderate risk category, and the share premium of moderate risk over low risk.

throughout our specifications in this paper. We also do this to isolate the effect of the term spread on the risk-taking channel, acknowledging the impact of the short-term rate, as studied by Dell'Ariccia et al. (2017) among others.

To further address this concern, however, we decompose the forecast error of the term spread into the contributions from the forecast error from the short rate and long rate. We then re-estimate our risk share equations using the forecast error of the long-term rate as our instrument. We run these estimations with and without the short rate forecast error as a control. In all cases we find that our results are robust: the share of low-risk lending decreases while the share of higher risk lending increases. The impulse responses for the low-risk share, the moderate risk share and their difference, reported in Figure 9 are qualitatively very similar to those derived from our main specification (Figure 4).

Table A2 shows that the forecast error is approximately mean zero. To test this more formally, we take the fitted value for the term spread from the first-stage 2SLS regression. We regress this on the actual term spread and a constant and perform a t-test on the residuals of this equation, with the null hypothesis that they have a mean of zero. We cannot reject this hypothesis and thus conclude that the forecast error is unbiased.

Figure 10 shows the impulse responses derived from a structural VAR estimation of the impact of the term spread on the riskiness of lending. For robustness, we show that the results for the impact of an increase in the term spread are qualitatively similar when estimated as part of a system of equations, compared with the single equation local projection approach. One of our motivations for using local projections is the ease with which external instruments are incorporated (Stock and Watson, 2018). By comparison, in the structural VAR, we include the forecast error itself as a variable rather using it as an instrument.

We use a recursive identification scheme to generate structural impulse response functions and use two lags. We use the survey variables (credit standards and credit demand) the lending variables (share premium of moderate risk over low risk, lending volume growth, lending margin) and the monetary policy variables (the short-term interest rate and the forecast error). The results are also not sensitive to including inflation and unemployment. The panels of Figure 10 show alternative orderings for the Choleski decomposition. The first panel puts the lending variables first, followed by the survey variables and monetary policy. The second panel puts the lending variables last and survey variables first. The third panel puts the monetary policy variables first and lending last.

Figure 10 shows that the results are not sensitive to the ordering in the structural VAR and support our baseline results. An unanticipated increase in the term spread leads to an increase in the lending share of moderate risk over low risk. Our SVAR results hold for the moderate and low-risk shares also.

Figure 11 shows the impact of controlling for aggregate measures of corporate sector riskiness. We use the yield spreads, over the 10 year Treasury yield, of firms with a Moody's credit rating of Aaa or of Baa. Credit ratings are one criterion for the STBL risk classification (Table A1). These credit ratings may be pro-cyclical, with the same firm receiving different ratings at different points in the economic cycle. We can proxy for this effect by using the corporate bond premia, which are themselves pro-cyclical. These premia should capture the extent to which the perceived riskiness of firms can change depending on economic conditions. We find that our results are robust to controlling for these premia. This supports our argument that an increase in the term spread causes substitution of risk by banks.

6 Conclusion

The use of macro-prudential policy has increased significantly since the global financial crisis. These policy actions are aimed at financial imbalances, which previously were thought to be captured by monetary policy "leaning against the wind". This is part of a renewed debate on the links between monetary policy and financial stability, in particular, the previously under-examined risk-taking channel of monetary policy. This channel describes how not only price but also the risk perception and appetite of bank changes with monetary policy action. While there is a considerable body of work examining the role of short rates on risk-taking, the role played by the longer rates, especially relative to the shorter end (i.e., the term spread) is relatively under-examined. This paper outlines the likely transmission channels and a causal mechanism to estimate the impact of the term spread on the risk-taking of US banks.

Independent of the level of the short rate, a steepening in the term structure affects the risk appetite of banks in a number of ways. It is consistent with a change in monetary policy expectations caused by a positive view on future economic growth and expected higher future policy rates. This also reduces the perceived level of credit risk. Given a key source of bank profit is maturity transformation, funding at the shorter end and lending at longer maturities, a steeper curve increases profitability. Finally, this increased profitability boosts forward-looking measures of bank capital and hence increases the value of the bank's equity. It is common for a bank to make lending decisions based on economic profit - profit adjusted for the cost of capital. This is achieved through targeting a constant level of risk using a metric such as Value-at-Risk, and a steeper curve will induce the bank to rebalance lending toward riskier loans to keep such metrics constant.

The above channels contribute to lowering the hurdle rate for investment in high risk/lower return projects. However, monetary policy will respond endogenously to raise rates if the current term structure induces agents to increase their risk appetite and fund a large number of such projects. This presents a challenge when measuring the impact of these risk-taking channels. In fact, there is a negative correlation between the change in share of riskier loans and term structure – i.e. the monetary policy effect dominates risk-taking. However, if the relationship is re-framed in terms of unanticipated changes in the term structure, the relationship inverts and becomes positive. Therefore, following an approach used in other economic fields, we exploiting periods of unanticipated steepening using forecast errors with expectations taken from the Survey of Professional Forecasters. The forecast errors provide an instrumental variable to assess the impact of the risk-taking.

Using an instrumented local projection approach, estimates show that banks reduce their share of new lending extended to relatively safe borrowers in favour of new lending to relatively risky borrowers. That is, on the intensive margin, banks reallocate lending to making their portfolios riskier when the term structure rises. We also find extensive margin effects, with increased volumes of credit being extended, which increase the riskiness of lending also. We show that to facilitate this expansion of riskier lending in the face of likely collateral-constrained borrowers, collateralisation rates fall following an increase in term spread. This provides insight into the debate on the relative substitution towards riskier borrowers and the loosening of loan requirements. Further, we show the results are robust to estimating the effect on unanticipated shocks driven only by the long end of the curve.

Our contribution is to quantify the extent to which monetary policy can induce changes in risk behaviour in the banking sector. It underscores the importance of the entire yield curve and efforts to ensure the long rates remain anchored as moves vis-à-vis the front end of the curve have a material impact on risk-taking. Furthermore, it informs the link to financial stability where, for policymakers, careful consideration should be given to the mix of lending done by banks and not just to the aggregate volume of lending or bank leverage. This is particularly true in the expansionary phase of the cycle, when there is a steeper yield curve and the riskiness of banks' portfolios is likely to be rising, the true impact of which only being realised later.

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7 Appendix

TABLE A1. Definitions of risk categories

	Risk Category			
	Minimal	Low	Moderate	Acceptable
Credit History	Excellent	Excellent	Good	Fair
Cash Flow to Repayment	Well in excess	Comfortably in excess	Adequate	May not be adequate in adverse times
Debt rating	AA or above	BBB or above	Limited access	Limited access
Alternative sources: access	Excellent	Good	Some	Limited
Alternative sources: terms	Favourable	Favourable	Reasonable	Possibly unfavourable
Management quality/character	High	High	Good	Some weakness
Collateral required?	Maybe	Maybe	Usually	Generally
Collateral quality	Cash or equivalent	Sufficient, liquid	Sufficient, liquid	Sufficient, but may be illiquid
Recoverability of debt	Collateral exceeds loan	Very likely	Likely	Likely, might be expensive

Complete descriptions of risk categories are available here.

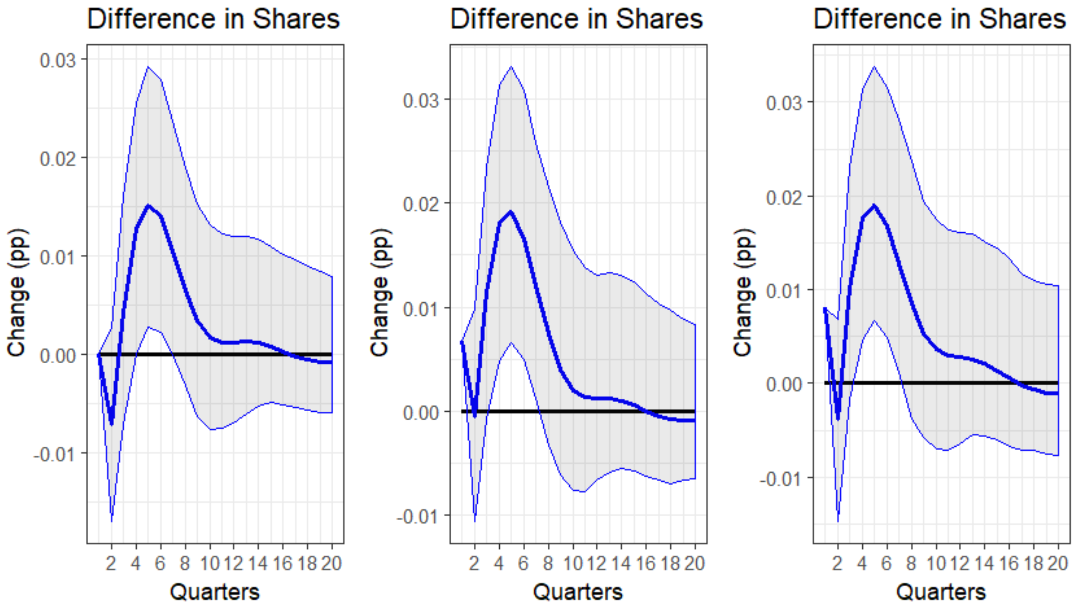
TABLE A2. Summary Statistics

Variable	Obs.	Mean	St. Dev.	Min	Max
Share: minimal risk (%)	81	0.05	0.03	0.01	0.2
Share: low risk (%)	81	0.21	0.05	0.12	0.36
Share: moderate risk(%)	81	0.48	0.06	0.34	0.61
Share: high risk (%)	81	0.26	0.06	0.17	0.44
Share premium: moderate over low (%)	81	0.27	0.1	0.03	0.47
Lending growth (%)	94	0.03	0.26	-0.45	0.9
Lending margin (%)	98	2.44	0.49	1.22	3.79
Credit standards (pp)	104	4.03	18.59	-18.98	65.2
Credit demand (pp)	102	0.24	21.02	-51.05	34.61
Unemployment (%)	104	5.96	1.6	3.9	9.9
Inflation (%)	104	2.29	1.09	-1.6	5.3
3 month yield (%)	104	2.47	2.1	0.01	6.02
10 year yield (%)	104	4.38	1.69	1.56	7.84
Term spread (%)	104	1.91	1.08	-0.45	3.69
Forecast error (%)	100	-0.03	0.98	-1.56	2.96
Forecast error (short sample) (%)	81	0.005	1.05	-1.56	2.96
Collateral premium: moderate over low (%)	81	9.06	12.17	-16.04	37.19
Corporate bond premium (Aaa, %)	81	1.57	0.43	0.68	2.56
Corporate bond premium (Baa, %)	81	2.59	0.76	1.49	5.58

TABLE A3. Data Description

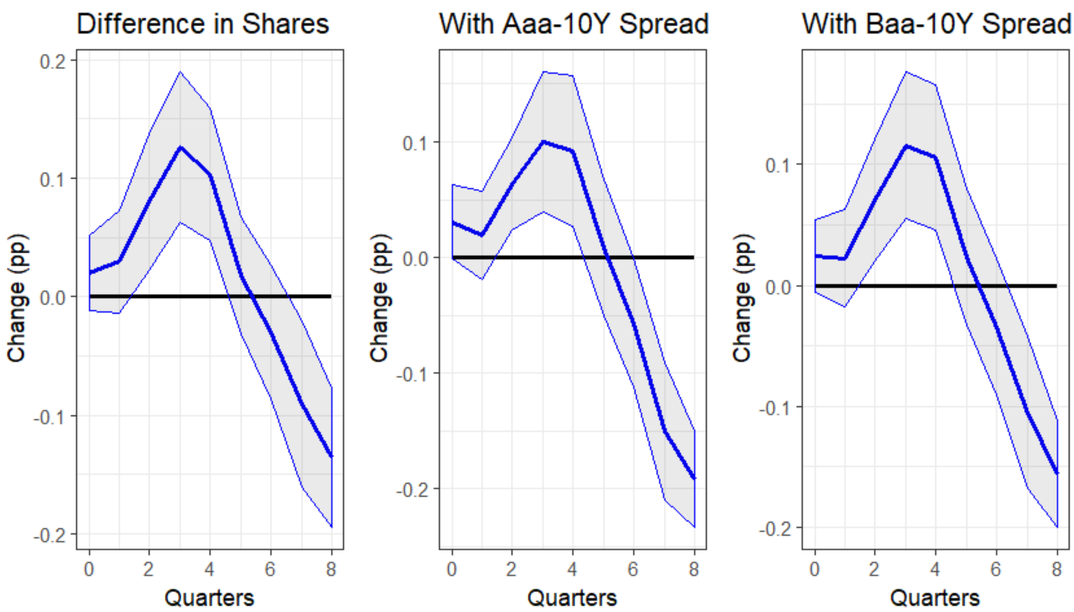
Variables	Symbols	Description
Dependent variables	y	Interest rate on commercial and industrial loans on floating rates or rates of up to 1 year in fixation Share of low risk lending Share of moderate risk lending Share of high risk lending Share premium of moderate risk over low risk Share premium of high risk over low risk Share premium of high risk over moderate risk Volume of low risk lending Volume of moderate risk lending Volume of high risk lending Volume premium of moderate risk over low risk Collateral premium of moderate risk over low risk Lending rate premium of moderate risk over low risk (All from Federal Reserve STBL)
Explanatory variables	X	3 month yield (FRED) 10 year yield (FRED) Term spread: 10 year - 3 month spread (FRED) Unemployment rate (Bureau of Labor Statistics) Inflation rate (Bureau of Labour Statistics) Credit standards (Federal Reserve SLOOS) Credit demand (Federal Reserve SLOOS) Lending growth (Federal Reserve STBL) Lending margin (Federal Reserve STBL) Term spread forecast errors (Constructed from Philadelphia Fed SPF) Aaa corporate bond premium (FRED) Baa corporate bond premium (FRED)

FIGURE 10. Impulse Response Functions of Lending Shares by Risk Category (Structural VAR)



Notes: Impulse Response Functions generated from structural VAR models for the shares of lending on the forecast error. The variables are as in the baseline and identification comes from a Choleski decomposition. Each panel shows the lending share premium of moderate risk over low risk, based upon alternative orderings of the variables in the VAR.

FIGURE 11. Impulse Response Functions of Lending Shares by Risk Category (Impact of Corporate Risk Premia)



Notes: Impulse Response Functions generated from local projections of the share premium of moderate risk over low risk on the term spread. The term spread is instrumented with the forecast error. The second panel controls for Moody's Aaa Corporate Bond Yield premium ove the 10-Year Treasury Yield. The third panel controls for the spread for Baa rated corporates.

TABLE A4. First stage regression (full)

	(1)	(2)	(3)	(4)
$ForecastError_t$	0.544***	0.544***	0.578***	0.583***
	(0.066)	(0.114)	(0.102)	(0.092)
$ForecastError_{t-1}$		0.000	-0.080	0.080
		(0.130)	(0.119)	(0.119)
$ForecastError_{t-2}$			0.077	-0.245**
			(0.097)	(0.113)
$ForecastError_{t-3}$				0.316***
				(0.081)
$Volumegrowth_t$	-0.318**	-0.317**	-0.325**	-0.090
	(0.142)	(0.144)	(0.144)	(0.161)
$Volumegrowth_{t-1}$	-0.166	-0.166	-0.161	-0.186
	(0.120)	(0.124)	(0.122)	(0.114)
$Volumegrowth_{t-2}$	0.151	0.151	0.132	0.127
	(0.148)	(0.151)	(0.153)	(0.110)
$Margin_t$	-0.336**	-0.336*	-0.327*	-0.286
	(0.166)	(0.168)	(0.172)	(0.174)
$Margin_{t-1}$	-0.124	-0.124	-0.119	-0.111
	(0.187)	(0.189)	(0.186)	(0.173)
$Margin_{t-2}$	-0.132	-0.132	-0.152	-0.018
	(0.128)	(0.171)	(0.166)	(0.142)
$CreditStandards_t$	-0.002	-0.002	-0.002	-0.008***
	(0.004)	(0.003)	(0.003)	(0.003)
$CreditStandards_{t-1}$	-0.001	-0.001	-0.001	0.005
	(0.005)	(0.005)	(0.005)	(0.004)
$CreditStandards_{t-2}$	0.007*	0.007*	0.006*	0.004
	(0.003)	(0.003)	(0.003)	(0.003)
$CreditDemand_t$	0.007***	0.007***	0.007***	0.006**
	(0.002)	(0.002)	(0.002)	(0.002)
$CreditDemand_{t-1}$	0.001	0.001	0.001	-0.001
	(0.004)	(0.004)	(0.004)	(0.003)
$CreditDemand_{t-2}$	-0.005**	-0.005**	-0.005**	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)
$Unemployment_t$	-0.026	-0.026	-0.046	0.156
	(0.244)	(0.246)	(0.244)	(0.235)
$Unemployment_{t-1}$	0.138	0.138	0.116	-0.192
	(0.276)	(0.260)	(0.264)	(0.265)
$Unemployment_{t-2}$	0.071	0.071	0.120	0.177
	(0.190)	(0.167)	(0.175)	(0.166)
$Inflation_t$	0.058	0.058	0.057	0.053
	(0.052)	(0.052)	(0.052)	(0.051)
$Inflation_{t-1}$	-0.116**	-0.116**	-0.107**	-0.080*
	(0.050)	(0.050)	(0.048)	(0.046)
$Inflation_{t-2}$	0.100**	0.100**	0.092**	0.085
	(0.044)	(0.045)	(0.045)	(0.052)
$3Month_t$	-0.408***	-0.408***	-0.373***	-0.519***
	(0.126)	(0.149)	(0.126)	(0.135)
$3Month_{t-1}$	0.242	0.242	0.159	0.373*
	(0.197)	(0.231)	(0.239)	(0.215)
$3Month_{t-2}$	-0.147	-0.147	-0.096	-0.166
	(0.189)	(0.191)	(0.218)	(0.190)
$Constant$	2.943***	2.943***	2.928***	3.036***
	(0.477)	(0.477)	(0.457)	(0.406)
Observations	79	79	79	79
R-squared	0.521	0.521	0.528	0.600
F-statistic	68.44	36.28	25.97	26.96
J-statistic		0.766	0.053	0.12

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