The credit channel is alive at the zero lower bound but how does it operate? Firm level evidence on the asymmetric effects of U.S. monetary policy*

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Abstract

We calculate borrowing spreads for over 8,000 U.S. firms and investigate how these are related to the stance of monetary policy. After 2009, we observe, consistent with credit channel theory, a positive relationship between shadow federal funds rates and borrowing spreads for only firms with high borrowing spreads and low quality. Conversely, we find a negative relationship for firms (of high and low quality) with low borrowing spreads. These relationships are reversed for the period before 2008. Our results uncover the distortional effects of monetary policy. Loose monetary policy causes spreads to converge (diverge) across firms after 2009 (before 2008).

Keyword(s): credit channel; zero lower bound; firm-level data; shadow rates.

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I. Introduction

While most economists would agree that the monetary policy incentives provided in the immediate aftermath of the 2008 global financial crisis were helpful in restoring financial stability and preventing a more severe recession, the long-term stability implications of these incentives are not clear. It is, in particular, not clear what types of firms act as a conduit for the transmission of monetary policy shocks to the real economy at the zero lower bound. If this transmission works through highly leveraged, risky firms then one could project that a loose monetary policy, while keeping the economy buoyant, can make it inherently more volatile going forward.

In our paper, we use a large number of firm-level observations to classify borrowers according to their credit risk and quality and measure the strength of U.S. monetary policy transmission that operates through these borrowers. Guided by credit channel theory, we capture the strength of the transmission by measuring the impact of monetary policy on firms' borrowing spreads. According to this theory, the presence of asymmetric information and positive probability of default generates a wedge/spread between firms' borrowing rates and a risk-free rate, and monetary policy shocks are transmitted to the real economy through this wedge by altering borrowers' probability of default and banks' ability to lend. While our approach is conceptually straightforward, it faces a major practical obstacle. Borrowing spreads data are either not available or they are available for only a subset of debt instruments in credit markets. Firm-level borrowing spreads on bank loans are, in particular, very hard to find and they are only available for large, syndicated loans. This infamous problem in the credit channel literature has lead research to substitute lending data for borrowing spreads (as in Kashyap and Stein, 2000; Cetorelli and Goldberg, 2012) and approximate borrowers' probability of default by using macroeconomic indicators instead of using direct, firm-level measures (e.g. Ashcraft and Campello, 2007).

In this paper, we take a different direction. We infer borrowing spreads by following a methodology similar to that of Caballero et al. (2008) and compare firms' actual interest payments, as a share of their total debt, to what they would have paid if they borrowed at the lowest interest rates (hereafter, the risk-free rates) prevailing in the financial market. This allows us to incorporate all forms of external finance that firms use and to cover a large number of firms instead of restricting our dataset to only firms for which bond spread data are available. Although this methodology has been applied to various topics since 2008, some of which we discuss below, our approach is unique as it uses the methodology to investigate the credit channel of monetary policy transmission and to fill a conspicuous gap between theory and empirics.

The second obstacle that we face in our analysis is that the U.S. policy rates have been close to their zero lower bound since 2009. To measure the stance of monetary policy, given this constraint, we use the shadow federal funds rate of Krippner (2013) that is derived from Black (1995) type formulation that uses latent variables and risk factors to predict the values of nominal federal funds rate if it were to fall below zero. While we check the sensitivity of our results to other measures of the shadow rate, the Krippner (2013) measure gives us a robust and accurate way of capturing the stance of U.S. monetary policy in our baseline estimations. By combining this shadow rate with firm-level data, our analysis allows us to determine whether the credit channel is alive in the post-crisis era and provides a first look into how it operates at the firm level.

Our firm-level data, including only non-financial firms, are quarterly and they are obtained from the COMPUSTAT (North America) database for the time periods 2002Q1-2007Q4 and 2010Q1-2014Q4, where the former period is included to determine whether monetary transmission mechanism has changed since the 2008/09 financial crisis. In constructing our dataset, we classify the firms according to two criteria: borrowing spreads and quality rating. Borrowing spreads give us an indication of a firm's credit risk. Higher credit risk, however, does not, by itself, signal whether a firm has sound fundamentals or not. Just as a firm with poor fundamentals and higher probability of default would face higher spreads, a cash-strapped firm with good investment opportunities could also face higher spreads since it relies more heavily on external finance. Using the firms' quality rating, derived from the stability and growth of past earnings and dividends, here allows us to distinguish between the two types of firms and gives us a better perspective on how monetary policy operates. In each quarter we classify the firms into 6 types that are determined by 2 categories for quality rating (high or low) and 3 categories for borrowing spreads (high, low or negative). Consistent with the terminology in Caballero et al. (2008), we refer to the firms with a negative borrowing spread as zombies. Zombie firms in this paper and the others we mention below usually refer to Japanese firms that need loan restructuring to stay afloat. While our focus is on U.S. firms and credit markets, we include these firms as a separate group to determine the potential differences in the impact of monetary policy. For each of the types mentioned above, we form a dynamic panel model with firm-specific and macroeconomic variables and estimate the relationship between monetary stance and borrowing spreads by using the system general method of moments (GMM) methodology of Blundell and Bond (1998).

Our results provide unique insights that are, occasionally, at odds with the predictions of credit channel theory. For example, we find that firms' borrowing spreads are more closely related to macroeconomic variables, such as the shadow rate, output gap and the general profitability of the banking sector, compared to firm-specific variables such as financial leverage, return on assets and liquidity ratio. While we observe that the relationship between monetary policy stance and borrowing spreads is significant for some types of firms, implying that the credit channel is operational, the direction of the relationship varies across the different types and the two sample periods. After 2009, the positive policy rate - borrowing spread relationship predicted by theory is only observed for firms with high borrowing spreads and low quality. Conversely and contrary to theoretical predictions, we find a negative relationship for firms (of high and low quality) that face low borrowing spreads. These relationships are reversed when we investigate the period 2002 to 2007. These results uncover a distortional impact of monetary policy on credit markets. After 2009, while low quality, high borrowing spread firms benefit from a loose monetary policy, for example, high quality, low borrowing spread firms are hurt by the same policy; loose monetary policy causes borrowing spreads to converge across firms. This mechanism operates in the opposite direction before 2008 causing spreads to diverge. The results described so far are only observed when we consider specific types of firms. When we consider the whole sample of firms, by contrast, we do not find any link between monetary policy and borrowing spreads. This finding is critical since it implies that while U.S. monetary policy appears to be ineffective on the aggregate, it has a significant impact on a large number of firms' cost of funding. A battery of sensitivity analyses indicate that our results are robust to some, but not all, measures of the shadow federal funds rate, to alternative indicators of firms' financial condition and that the impact of monetary policy is more closely related to the firms' average borrowing spreads than their quality ratings.

Up to this point, our analysis captures the sensitivity to monetary policy given a snapshot of the firms' decomposition across the different types. We extend our analysis to a more dynamic setting and test whether monetary policy causes firms to transition between the different borrowing spread types by using a binomial fixed effects logistic estimation. We do this exercise for only the borrowing spread types since firms' quality rating is much less volatile compared to their borrowing spreads. Focusing on the quarterly transition between the two types, we observe that after 2009 loose monetary policy decreases the probability that a high borrowing spread firm becomes a low borrowing spread firm in the next period and increases the probability that low borrowing spread firms switch types. The predicted model suggests that for an average firm in the post-crisis sample that had a low borrowing spread in the previous quarter, the odds of having low borrowing spread fall by 7.5 percent if the shadow rate decreases by 25 basis points over the past 8 quarters. Before 2008, this mechanism is reversed and low spread firms stay as a low spread type with a greater probability (5.6 percent) under a looser monetary policy stance. Therefore, while a loose monetary policy can cause an immediate convergence (divergence) in borrowing spreads after 2009 (before 2008), dynamics governing the behavior of a subset of the firms, firms that switch types, imply that this policy also increases the odds that a firm becomes a high spread (low) type in the next period. We should, however, note that these results are qualified by the fact that a majority of the firms (79.1 and 74.3 percent in the post-crisis and pre-crisis periods, respectively) do not switch types in a given quarter.

Current beliefs about the real effects of monetary policy were influenced by a large number of empirical studies that came out during the mid to late 90s such as Gertler and Gilchrist (1994), Gilchrist and Himmelberg (1995, 1999), Oliner and Rudebusch (1995), and Bernanke et al. (1996). The common finding in these studies is that small firms are more sensitive to monetary policy because they rely more on external finance and the financial frictions, frictions that reinforce the effects of monetary policy shocks, apply more acutely to the credit market contracts of these firms. Most of these studies use aggregated loan volume data for different size categories and vector autoregressive analyses to find that while both large and small firms' reaction to monetary policy is consistent with credit channel theory, small firms' sensitivity is higher. Our firm-level analysis allows us to measure firms' credit risk, quality and the degree of financial frictions that they face more directly instead of using size as an indirect indicator and demonstrate that the actual transmission of monetary policy is not always consistent with theory. Specifically, we find that the transmission of monetary policy described by credit channel theory works only through a subset of U.S. firms and that it is significant only during certain time periods. One subset of firms that show a significant sensitivity to monetary policy, those with low quality and high borrowing spreads, are also the smallest firms in our sample. While this significance is consistent with the findings of the earlier research mentioned above, the sign of the sensitivity coefficients for the 2002-2007 period are different compared to earlier findings. The relative insignificance of firm-specific variables that we uncover in this paper, while also going against the theoretical description of borrowing costs, is consistent with various empirical findings. For example, Hubbard et al. (2002) generally find that firms' leverage does not have a significant effect on their borrowing spreads by estimating a model with bank and loan specific variables. Similarly, Chen and Chen (2012) show that liquidity or cash flow variables may no longer be a good measure of the financial constraints that firms face. Although the evidence is mixed in general, there are other examples (c.f. Strahan, 1999; Ashcraft and Santos, 2009).[1]

It is important to note here that by using borrowing spreads, instead of bank lending data, we are testing the significance of the broad credit channel. Given the scarcity of borrowing spread data, studies typically use bank lending data to measure the strength of different mechanisms that form the broad credit channel such as the balance sheet channel, lending channel and bank capital and risk taking channels, and they usually follow various strategies to shut down the effects of the other channels (e.g. Kashyap and Stein, 2000; Ashcraft and Campello, 2007; Cetorelli and Goldberg, 2012; Aysun and Hepp, 2013; Aysun, 2016; Ciccarelli et al., 2013; Buch et al., 2014; Dell'Ariccia et al., 2013). As suggested by Kashyap et al. (1996), however, these strategies are not fully sufficient to separate the different channels and firm level data are needed for more reliable inferences. In our analysis, the borrowing spread variable incorporates all the different mechanisms/channels such that it can increase or decrease depending on the strength of borrowers' balance sheets, banks' ability to raise loanable funds or their risk appetite. By combining our firm-level borrowing spreads with measures of monetary policy stance we, therefore, offer the most direct and comprehensive way of determining how the broad credit channel operates.

After 2009, the number of studies on the credit channel that use the conventional methodologies mentioned above naturally declined as the policy rate approached the zero lower bound. During this period, the focus shifted to the effects of unconventional monetary policies, such as large-scale assets purchases (LSAP), on asset prices. Studies such as, Gagnon et al. (2011), Hancock and Passmore (2011), Hamilton and Wu (2012), Gilchrist et al. (2015), Krishnamurthy and Vissing-Jorgensen (2011), Wright (2012), D'Amico and King (2013), Bauer and Rudebusch (2014), investigate the effect of these policies on a wide range of securities (including government and corporate bonds, mortgage-backed securities) with different term structures. The usual finding in this rapidly growing literature is that the unconventional policies have been successful in altering asset prices. This transmission, however, is found to be similar in strength for both corporate bonds and government bonds, leaving borrowing spreads unchanged.[2] Our findings indicate that while borrowing spreads are not sensitive to monetary policy for the whole sample of firms, this sensitivity is sig-

[1]In contrast to these findings, Campello et al. (2011), Lin et al. (2011), and Aslan and Kumar (2012) show that firm characteristics have significant effects. We should note that the types of firms, the sample period and the methodology in these studies, and the ones we mention above, are considerably different from those in our paper.

[2]The inability of monetary policy to alter borrowing spreads is consistent with the negligible effects of LSAP on macroeconomic variables found in studies such as Chen et al. (2012) and Wu and Xia (2016).

nificant for subsets of the firms. We should mention, though, that this is not a perfectly adequate comparison as our analysis uses firm-level data, considers all forms of funding and includes a larger number of firms while the studies mentioned above mostly use aggregate indicators of borrowing costs, consider large public firms that issue bonds and capture their cost of funding by using bond yields.

Our approach is different from the aforementioned studies in two other ways. We use a methodology similar to that in Caballero et al. (2008) to measure borrowing spreads and we use the shadow rate as an indicator of monetary policy stance. The former approach is usually followed to identify the zombie firms (e.g. Acharya et al., 2016; Giannetti and Simonov, 2013; Fukuda and Nakamura, 2011) and to determine the distortions they cause in credit markets, mostly focusing on the Japanese economy. In our paper, we instead use this approach to infer the borrowing spreads of a wide spectrum of U.S. firms, including those with positive borrowing spreads. There has been a recent surge in the practice of using shadow rates to approximate the stance of monetary policy as an alternative to using policy events (e.g. Wu and Xia, 2016; Lombardi and Zhu, 2014; Krippner, 2013; Bauer and Rudebusch, 2014; Bullard, 2012). While a majority of the studies investigate the macroeconomic effects of monetary policy by using this variable, our analysis offers a first look at the firm-level effects of monetary policy decisions captured by the changes in shadow rates.

II. Empricial Model

There are two main components of our methodology: constructing firm-level borrowing spreads and investigating the impact of monetary policy on these variables. To construct the borrowing spreads, we compare actual interest payments of firms, as a share of their total debt, at a given period to the level they would have paid if they borrowed at a low, risk-free interest rate. This methodology is complicated by the fact that every firm's debt has a different maturity structure. Choosing an appropriate risk-free asset for our analysis is, therefore, infeasible since the term of any risk-free asset is not a perfect match for every firm. If we use a simple average of the long-term and short-term interest rates, for example, our computations would generate a higher borrowing spread for a firm that mostly engages in long-term borrowing compared to an identical firm that engages in short-term borrowing. To minimize this risk, we match firms' short-term and long-term borrowing with the appropriate risk-free interest rates in our computations as follows: Let

$STB_{i,t-1}$ and denote $LTB_{i,t-1}$ the stock of short-term and long-term debt for firm i at time $t-1$, and $R^{f,s}_{t-1}$ and $R^{f,l}_{t-1}$ denote the short-term and long-term risk free interest rates, then we compute our borrowing spread variable, $RP_{i,t}$, as:

$$RP_{i,t} = \frac{IP_{i,t}}{B_{i,t}} - (STB_{i,t-1}R^{f,s}_{t-1} + LTB_{i,t-1}R^{f,l}_{min,t-1}) \quad (1)$$

where $IP_{i,t}$ and $B_{i,t}$ are the actual interest payments and the total debt of the firm in period t, respectively. We explain in detail the types of data that we use to measure $R^{f,l}_{min,t-1}$ in the next section. We should point out at this time, however, that when approximating long-term risk-free interest rates, we take a long-term perspective by using the minimum values of the long term risk-free rate over a broader time period. This approach is denoted by "min" in the subscript of $R^{f,l}_{min,t-1}$ in equation (1) and it is discussed in detail below.

After constructing the firm-specific borrowing spread variable, $RP_{i,t}$, we include it in the following dynamic panel model to study the impact of monetary policy.

$$RP_{i,t} = \sum_{k=1}^{4} \beta^{ld}_k RP_{i,t-k} + \sum_{k=1}^{8} \beta^{mp}_k MP_{t-k} + \sum_{k=1}^{4} \beta^{lev}_k LEV_{i,t-k} + \sum_{k=1}^{4} \beta^{yg}_k YG_{t-k} + \epsilon_{i,t} \quad (2)$$

In this model, our primary focus is on the stance of monetary policy, MP_t, and the firms' financial leverage, LEV_{it}. Here leverage takes the spotlight since the balance sheet channel theory describes a clear link between borrowers' leverage and probability of default and the external finance spreads they face (e.g. Bernanke et al., 1999; Carlstrom and Fuerst, 1997; Prescott and Townsend, 1984; Townsend, 1979). According to this theory, monetary policy interacts with the strength of borrowers' balance sheets and the lenders' sensitivity to these balance sheets and alters the borrowing spreads in the market. In addition to firms' leverage and monetary policy, we also include the output gap in the economy, YG_t, as another potential determinant of borrowing spreads.

The formulation in equation (2), designed for our quarterly analysis, is mostly consistent with common practice. 8 lags of the monetary policy variable are included since evidence typically indicates that monetary policy shocks persist for up to 2 years. The lags of the output gap and borrowing spreads are included to account for the cyclical behavior of credit markets and to take account of the potential persistence in borrowing spreads. While our approach for investigating the credit channel and our measure of firms' probability of default is different, we include 4 lags of the dependent variable, output gap and our measure of the firms' balance sheet strength on the right hand side following Kashyap and Stein (2000), Ashcraft and Campello (2007) and Cetorelli and Goldberg (2012).[3]

Notice here that, by following the common practice, we are using a very parsimonious formulation in equation (2). Although it is possible to incorporate more firm-specific and macroeconomic variables into our analysis, the formulation in equation (2) is not unreasonable since firms' leverage is the most direct measure of their probability of default and the output gap is the most comprehensive measure of economic activity in the data. We should, however, note that we check the robustness of our results to using a model with a larger number of firm-specific and macroeconomic variables and that we use other firm-specific variables as instruments in our estimations.

III. Data, descriptive statistics and the estimation methodology

To conduct our analysis, we obtain quarterly firm level data, excluding observations for financial and government entities, from the COMPUSTAT (North America) database for two separate time periods: 2002Q1-2007Q4 and 2010Q1-2014Q4. Our main focus is on the latter period where U.S. monetary policy operates near the zero lower bound. We do, however, extend our analysis to the period before the 2008/09 crisis to compare how the credit channel operates when policy rates are not close to zero. We choose the year 2002 as our cutoff point for two reasons. First, by doing so we are able to exclude the 2001 recession. Second, we are able to compare periods of similar length. The latter reason is particularly crucial for our estimation methodology as we explain below.

Our main dependent variable is the firm-level borrowing spread described by equation (1). To compute this variable, we use the rates on 10-year constant maturity Treasury notes and 3 month Treasury bills (both expressed as quarterly averages) as our indicators of long-term and short-term risk-free interest rates. These data are obtained from the Federal Reserve Bank of St. Louis, FRED database. Given that the average maturity of long-term corporate bonds is much longer than a year, we use the minimum rate on 10 year Treasury notes that is observed in the past 5 years to measure the lower bound for long-term interest rates.[4] In equation (1), the firm-level short-term and long-term debt are

[3]We experimented with different number of lags. In these regressions macroeconomic variables were similarly a more important determinant of borrowing spreads and our main conclusions, discussed below, were similar.

[4]According to The Securities Industry and Financial Markets Association (SIFMA) average maturity for

measured as debt in current liabilities (DLCQ) and debt obligations due more than one year (DLTTQ), respectively. Firms' total debt, B_{it}, is then measured as the sum of these two variables. The total interest payments of firms are captured by the total interest and related expenses (XINTQ). Our main firm-level independent variable, the leverage ratio, is measured as the total-debt-to-total-assets ratio (B_{it}/ATQ_{it}). We use this variable instead of the total-debt-to-equity ratio since the latter ratio was very volatile and at times negative for a significant number of firms in our sample. In our estimations, we also incorporate other firm-level variables such as the return on assets (ROA), the liquidity ratio and debt composition (measured as the short-term-debt-to-total-debt ratio) as instruments. These variables, along with all the other variables in our estimations are listed and described in Appendix A.

In addition to the firm-level data described above, our dataset includes the output (real GDP) gap, a variable to account for the profitability of U.S. banks (net interest margin) and 3 well-known measures of the shadow rate: the measures constructed in Krippner (2013), Bauer and Rudebusch (2015), Wu and Xia (2016). The former sets of variables are also from the FRED database and the shadow rates are obtained from the authors' websites and they represent quarterly averages. All three measures of the shadow rate are obtained from dynamic term structure models that follow the formulation of Black (1995) where the short term interest rates are bounded below at either zero or a near-zero value and they are a function of a shadow rate that is not bounded by zero. This shadow rate in turn is a function of latent variables and risk factors (that evolve according to a VAR model), and they are helpful in predicting the term structure of interest rates and representing the stance of monetary policy. Despite their basic similarities, the three approaches are different and they produce significantly different measures of the shadow rate as illustrated in Figure 1. While the three rates are more correlated before 2008, they are very different in the post-crisis period. In addition, between 2002 and 2004, the Krippner (2013) and Wu and Xia (2016) measures exhibit different trends. To construct their stance of monetary policy, Wu and Xia (2016) use forward rates in a Kalman filter to approximate the latent factors and the shadow rate. In Krippner (2013) the input data are the sum of shadow forward rates and an option effect instead of the forward rates themselves. Unlike these two measures that only use yields, Bauer and Rudebusch (2015) also include macroeconomic variables such as measures of economic activity and inflation as the latent variables.

corporate bonds in the past 20 years (between 1996 and 2015) is 11.0 years. Their computations, however, exclude all corporate bond issues with maturity of 1 year or less and thus we expect the average maturity to be shorter than 11 years. We, therefore, use 5 years as the average maturity for corporate bonds. Using 11 years or any other value between 5 and 11 years does not change our results significantly.

Out of the three shadow rates, we use the Krippner (2013) variable in our baseline estimations for two reasons. First, the Krippner (2013) measure is specifically designed to capture the stance of monetary policy and it is robust and highly correlated with the unconventional policy developments observed in the post-crisis period.[5] Second and as indicated by Krippner (2015a), using two factors to generate the shadow rate has distinct advantages over using three and four factors as in Wu and Xia (2016) and the Bauer and Rudebusch (2015), respectively.[6] Given the lack of a consensus in the term structure literature, however, we use the Wu and Xia (2016) and the Bauer and Rudebusch (2015) shadow rates in our sensitivity analysis.

To analyze the asymmetric effects of monetary policy, we divide the firms into 6 groups. These groups are determined by two factors: firms' borrowing spreads and their S&P quality rating (hereafter, quality rating). A firm's quality rating is determined by the growth and the stability of its earnings and dividends in the past and how this performance compares with other firms (the rating ranges from A+ to D). Incorporating quality rating as an additional partitioning criterion here is a critical part of our analysis since it provides us with a way to infer why firms face high/low borrowing costs and partition the firms accordingly. Specifically, a firm can face a relatively high borrowing spreads, for example, for two reasons. First, the firm can be underperforming in terms of earnings growth and stability (i.e., becoming a low quality firm), which increases the probability of bankruptcy or prompts the firm to rely more heavily on debt finance. Conversely, an over-performing firm with lucrative investment prospects that is at the same time cash-strapped can also face high borrowing costs since it similarly requires higher amounts of external funding. Adding quality rating into our analysis, therefore, allows us to more accurately identify the types of firms that monetary policy operates through.

In our regression analyses, we partition the firms as follows: In each quarter, we measure the average borrowing spread across all the firms and classify firms that have a borrowing spread above the mean value as high borrowing spread firms. If a firm's borrowing spread is below the mean but positive we classify it as a low borrowing spread firm. If the firm's borrowing spread is negative, we classify it as a zombie following the

[5] Unlike Krippner, the focus of Bauer and Rudebusch (2015) is on forecasting the stance of monetary policy by approximating the expectations of monetary policy at the zero lower bound.

[6] Krippner (2015a) finds that Wu and Xia (2016) shadow rates are not robust because they are highly dependent on lower bound parameters, the confidence intervals for the shadow rate do not include zero and that their shadow rate shows low correlation with the evolution of unconventional monetary policy events. Conversely, Wu and Xia (2016) finds a tight link between QE events and their shadow rate and find that two-factor term structure models perform worse than three-factor models in terms of fitting the data. For a more thorough review on shadow rates refer to Krippner (2015b) and Wu and Xia (2016).

terminology of Caballero et al. (2008). Similarly in each quarter we classify firms as high quality if their rating is B or above. The remaining firms are classified as low quality. While high quality is often designated only to firms with a rating of A- or above in finance, our strategy renders a more even split between the firms across the different rating categories. We do, however, check the sensitivity of our results to this alternative classification.

Table I displays the composition of firms based on the partitioning criteria described above along with various summary statistics for each type of firm and the two sample periods that we use in our analysis. To summarize the number of firms by type, we add the number of firms that were classified under a specific type at any time during the whole sample period. The number of firms and observations is the largest for type 1 (firms with high borrowing spreads and low quality rating) before and after the crisis. These firms are also the most leveraged, least profitable and the smallest in our sample in terms of assets. The largest firms are of type 4 (low borrowing spread, high quality). These firms are relatively less leveraged, most profitable and have the lowest liquidity ratios. Comparing the two sample periods we find that the financial ratios and indicators are relatively similar. Though the number of zombies has decreased in the post-crisis period, their number is still not negligible. The number of firms and observation for types 1 and 3 also change significantly between the two periods (with the share of type 1 firms increasing and the share of type 3 firms decreasing in the post-crisis period) indicating that firms do transition between types. To better gauge this dynamic feature in our sample, we measure the percentage of firms that stay in their own type from one quarter to the other. These percentages, though high in both periods (and slightly higher in the post-crisis period), show that approximately a quarter of the firms transition between types in each period. We investigate whether monetary policy is related to this transition in Section IV.C.

After categorizing the firms, we estimate our model separately for each type. In doing so, we use the dynamic panel, system GMM estimation methodology of Blundell and Bond (1998). This methodology offers several advantages. First, consistent with the common practice in the credit channel literature, our model includes lagged values of the dependent variable on the right-hand side to account for the persistence in borrowing spreads. The Blundell-Bond estimator accounts for the potential endogeneity generated by this practice. Second, the estimator is specifically designed for panels like ours that have a much larger cross-sectional dimension. In our sample periods, we have an average of 7,664 firms and only 22 quarters.[7] In addition, the methodology allows us to consider the endogeneity of the

[7] The instruments that we use, for example, become invalid according to the Hansen test when we extend our sample period to more than 6 years.

other independent variables, unobserved panel-level fixed and random effects and the potential non-stationarity of the dependent variable, and allows us to obtain heteroskedasticity-consistent standard errors. In our estimations we use the lags (lags 5 to 7) of firm-specific variables including the return on assets and liquidity ratios as instruments.[8] It is important to note here that by using two periods of similar length we are able to also use the same instruments (with the same lag structure). This allows for a more adequate comparison of the inferences drawn from the two estimations.[9]

IV. Results

In this section, we present our baseline results and compare these with those obtained by using the 2002-2007 sample period, and we report the results from various sensitivity tests.

A. *Baseline results*

Our baseline results are reported in Table II. To obtain these results we use the scheme described above to classify the firms and we use the period after 2009. The central finding in this table is that monetary policy transmission operates only through types 1, 3 and 4. The borrowing spreads of the remaining firms, firms classified as zombies and firms with a high quality rating but also a high borrowing spread, are not sensitive to the changes in the stance of monetary policy during the post-2009 period. While the relationship between the stance of monetary policy and borrowing spreads of types 1, 3 and 4 are significant, the direction of these relationship are different. The positive policy stance coefficient for type 1 firms, firms with a low quality rating and a high borrowing spread, for example, implies that if monetary policy is tightened (if the shadow policy rate increases), the firms' borrowing spreads increase. This positive relationship is consistent with the standard interest rate channel and the predictions of credit channel theory described in Bernanke and Gertler (1995) and Bernanke et al. (1999). Conversely, the negative coefficients for types 3 (low quality rating and low borrowing spread) and 4 (high quality rating and low borrow-

[8]We experimented with a number of other firm-specific variables and different lags of the instruments and obtained similar results. Our baseline instruments is the most parsimonious specification that does not violate the instrument validity tests for any of the types.

[9]The comparison becomes confounded if we extend the pre-crisis period by adding pre-2002 observations since we are forced to use different instruments for the two sample periods.

ing spread), contrary to usual theoretical predictions, imply that these firms face a lower borrowing spread when monetary policy is tightened.

The monetary stance coefficient value reported in the first column (0.2650) implies that type 1 firms face a 6.625 percentage increase in their borrowing spreads if the shadow rate increases by 25 basis point in each quarter of the past 2 years (a total of 2 percent increase). A similar computation for types 3 and 4 reveals that the magnitudes of the coefficients are comparable. It is important, however, to note that both the mean and the standard deviation of the borrowing spreads are significantly higher for type 1.[10] The coefficient values for types 3 and 4, therefore, reveal a much larger sensitivity of these firms' borrowing costs to monetary policy.

Turning to the other right-hand side variables, we find that borrowing spreads are mostly countercyclical as the output gap coefficients are negative for 3 of the 4 significant coefficients. Theoretical frameworks with costly state verification (e.g. Bernanke et al., 1999) usually identify two conflicting effects of output on borrowing spreads. On the one hand, firms' higher demand for investment and external finance during an expansion causes an increase in borrowing spreads. On the other hand, higher asset prices and net worth that are also typically observed during an expansion have a negative effect on borrowing spreads. Our results indicate that the latter countercylicality of borrowing spreads is observed for types 1, 3 and 6, and that the borrowing spreads are procyclical for type 4. We do, however, find that the firms' financial leverage is not significantly related to their borrowing spreads in the post-2009 period.

The relationships between borrowing spreads and monetary stance that are mentioned above are reversed when we consider the period before the crisis (between 2002 and 2007). The results corresponding to this time period are displayed in Table III. While types 1 and 3, as before, are sensitive to the changes in monetary policy stance, type 1 firms' borrowing spreads are negatively related to the shadow rate and the corresponding relationship is positive for type 3 firms. Unlike our baseline results, we find that the borrowing spreads of type 5 firms, firms with low quality rating and negative borrowing spreads, are also positively related to the shadow rate and that the leverage-borrowing spread relationship is positive and significant for types 2 and 4. It is important to notice the composition impact of monetary policy in these results. In the post-2009 period, loose monetary policy causes borrowing spreads to converge as high borrowing spread firms face lower borrowing costs,

[10] In the post-2009 sample, the mean and the standard deviation of the borrowing spread variable for type 1 firms are 3.8% and 6.0% respectively. The corresponding values are 0.64% and 0.27% for type 3 firms and they are 0.62% and 0.26% for type 4 firms.

for example, as the monetary stance loosens while low spread firms face higher borrowing costs. This mechanism operates in the opposite direction before 2008 and monetary policy causes borrowing spreads to diverge.

B. Sensitivity Analyses

In this section we check the sensitivity of our results to alternative definitions of quality ratings, borrowing spreads and the shadow rate, and we use two alternative model specifications to measure the sensitivity to monetary policy. We report our results in Table IV. In so doing, we only include the monetary policy coefficients to focus on our main question. We should note, however, that the significance of the other coefficients were similar in these estimations.[11] In Table IV, we also include our baseline estimates to make the comparison more convenient.

B.1. Alternative quality and borrowing spread classifications

Our baseline quality and borrowing spread classification scheme is based on an even split between the different quality categories and borrowing spreads (with firms rated B and above classified as high quality and firms with a positive borrowing in the top 50 percent of the borrowing spread distribution classified as high borrowing spread). In our first two sets of tests we follow a narrower definition of these categories to check the sensitivity of our results. First, we classify firms with a rating of A- and above as high quality and the rest as low quality. This definition is also more consistent with the usual designation of quality in finance. Second, we classify firms in the top 10 percent of the borrowing spread distribution as high borrowing spread firms and those in the bottom 10 percent as low borrowing spread firms.

The coefficient estimates and their significance reported in rows 5 through 9 of Table IV, are mostly similar to our baseline results. We do, however, find that for the pre-crisis period, firms with a rating of A- and above that have a low borrowing spread (type 4 firms) demonstrate a negative sensitivity to the stance of monetary policy. This relationship is not significant for the said firms in the post-crisis period. Together with our baseline results, these findings suggest that monetary stance is negatively related to borrowing spreads of type 4 firms rated A- and above before the crisis, and type 4 firms rated B+, B and B- after the crisis. Turning to the results corresponding to the alternative classification of borrowing

[11] The full results are available if requested.

spreads, we similarly find that low quality firms with high borrowing spreads (spreads in the top 10 percent) demonstrate a positive and a negative sensitivity to monetary stance in the post-crisis and pre-crisis periods, respectively. The remaining coefficient values, however, are insignificant suggesting that the significant coefficients for types 3 and 4 in our baseline regressions are not determined by the firms with the lowest borrowing spreads (firms in the bottom 10 percent).[12]

B.2. Single classification criterion and inferences from the whole sample

In our baseline tests we used both quality ratings and borrowing spreads to compare and classify the firms. Here we use these variables one at a time to form the different groups. First, we compare the quality ratings of the firms to classify them as high and low quality. The results indicate a significant negative sensitivity to the shadow rate for low quality firms in both the post-crisis and pre-crisis periods. High quality firms' sensitivity, by contrast, is not significant in either period. For the second classification criterion we use only the firms' borrowing spreads. The results are consistent with the general conclusions that we draw from our baseline regressions. High spread firms have significant positive and negative sensitivities to the shadow rate in the post-crisis and pre-crisis periods, respectively. Low spread firms, conversely, demonstrate a negative and a positive sensitivity during the two periods, respectively. These results suggest that a monetary tightening prompts a decrease in the borrowing spread of low quality firms; but this is true only if these firms have a low borrowing spread in the post-crisis period and a high borrowing spread in the pre-crisis period. While high quality firms as a whole do not display a significant sensitivity to monetary policy, they do so in the post-crisis period if they have high borrowing spreads.

The more general inference here is that the monetary policy effectiveness, or accurately designating it as such, depends on the type of firms the policy is operating through. While monetary policy may appear to work in one way when we consider a category of firms, it may work in a different way for the subcategories of the same group of firms. We find a similar evidence when we estimate our model by using the observations for all the firms in our sample. The results show that in neither period do the borrowing spreads exhibit a significant sensitivity to monetary policy. This is a stark contrast to the significant sensitivity to monetary policy that we observe when we use smaller groups. This

[12]Alternatively, we classified the firms that are not in the top 10 percent of the borrowing spread distribution as low borrowing spread firms. The signs and the significance of the monetary stance coefficients were identical to those in our baseline results.

observation is consistent with the weak link between monetary policy and firms' borrowing spreads uncovered by the studies mentioned above that use aggregated borrowing spread data (e.g. Gilchrist et al., 2015).

B.3. Alternative indicators of financial constraints and monetary stance

In our baseline model, we used leverage as a firm-level determinant of borrowing costs following the predictions of theoretical models with costly state verification that leverage is related to the degree of asymmetric information that lenders face and their probability of recovering their loans. There is also, however, theory and evidence linking borrowing costs to other firm-specific variables. In the financial constraints literature, for example, firms with high investment and sales growth that have low levels of liquidity rely more heavily on external finance and thus they face higher borrowing spreads (see for example, Brown and Petersen, 2011; Kashyap et al., 1994). In this section, we incorporate these alternative explanations by including firms' sales growth, measured as the growth of net sales over the previous period, and firms' liquidity ratio, measured as the ratio of cash and short-term investments to total assets. In addition to these alternative variables, we include a measure of banking profitability by adding the net interest margin, measured as the ratio of tax-adjusted income to average earning assets of all U.S. banks. We do this to control for supply side determinants of credit spreads. In our baseline specification, we did not follow this strategy since monetary policy stance and output gap variables are strongly related to the condition of banks. Here we, therefore, investigate whether there are any bank-specific effects on the firms' borrowing spreads that are independent of monetary policy and the business cycle.

While the signs and significance of the monetary policy coefficients, also displayed in Table IV, are similar to those from our baseline estimation, the coefficient estimates for the pre-crisis period are significant for all types. Unlike our baseline results, type 2 firms (high quality, high borrowing spread) and type 6 firms (zombie, high borrowing spread) display a positive and a negative sensitivity to monetary policy, respectively during this period. The signs and the significance of the remaining monetary stance coefficients are similar. We also find that sales growth and liquidity are insignificant for each type and that bank profitability is mostly positively related to borrowing spreads.[13]

To gauge the sensitivity of our results to alternative measures of monetary policy

[13]These results are displayed in Appendix B.

stance, we use the shadow rates of Wu and Xia (2016) and Bauer and Rudebusch (2015). As mentioned above and displayed in Figure 1, the two measures have a low and high correlation with the Krippner (2013) shadow rate, respectively. Consistent with this observation, the monetary stance coefficient estimates corresponding to the regressions with the Bauer and Rudebusch (2015) shadow rate are mostly similar to those in our baseline findings. The post-crisis coefficients of the type 4 firms is no longer significant and the pre-crisis coefficient estimate for the type 6 firms become significant with this alternative measure. The estimations with the Wu and Xia (2016) shadow rate, by contrast, produce coefficients with opposite signs.

B.4. Monetary policy and the within-group variation of borrowing spreads

So far, our analysis focuses on the relationship between monetary policy stance and the average borrowing spreads in each group. In this section, we instead investigate whether the changes in the stance of monetary policy causes a dispersion/convergence in the borrowing spreads within each group. To do so, we measure our interest rate spread and the leverage variable as the absolute value of the percent deviations from type-specific averages in each quarter. We then replace the baseline measures of interest spreads and leverage in our model with these alternative variables.

The estimation results reported in Table V show that in the post-crisis period there is a significant negative relationship between the shadow rate and the dispersion of borrowing spreads for types 3 to 6. In other words, borrowing spreads within these types converge and diverge in response to tight and loose monetary policy, respectively. Combined with our earlier findings, we can infer from Table V that a loose monetary policy not only increases the borrowing spreads for types 3 and 4 but it also causes these spreads to diverge within each group. In the pre-crisis period, monetary stance coefficients are significant only for types 1, 3 and 5. The signs of these coefficients, too, are the same as their baseline counterparts implying that monetary policy has a similar effect on borrowing spreads and their dispersion. Type 1 firms, for example, face lower borrowing spreads in response to a monetary tightening, and these spreads converge to the type-specific mean.

C. Dynamic compositional effects of monetary policy

How does monetary policy affect the composition of firms across the different types over time? The descriptive statistics that we reported earlier, indicated that while a majority of the firms remain within their own type, there is a considerable degree of transition between types as well. In this section, our goal is to determine whether the changes in monetary policy stance are related to this transition.

We begin our analysis by eliminating zombie firms to construct a binary dependent variable that takes a value of 1 if the firm has a low positive borrowing spread and 0 if the firm has high positive borrowing spread. We then partition the firms into two groups based on their borrowing spreads in the previous quarter and estimate our model separately for each group. The focal point of the analysis is the borrowing spread only because there is a much lower degree of transition between the different quality ratings across time compared the transition between the borrowing spread types.

In this section, we follow the more general model that we used in our sensitivity analysis since, to the best of our knowledge, there is no widely-documented theoretical description of why firms transition between the different types in our analysis. In this model, we include the shadow rate, leverage, liquidity (LQ_i, t), return on assets ($ROA_{i,t}$), banks net interest margin (IB_t) and output gap on the right-hand side. In so doing, we use the first lag of all variables except the shadow rate. Similar to our earlier analysis, we use 8 lags of the shadow rate. Note that in our baseline analysis 4 lags of the firm-specific and banking profitability variables are included to account for the longer-term perspective that creditors take in formulating terms of credit. This is consistent with the usual practice in empirical studies of the credit channel that we mentioned above. In this section, however, our focus is on the quarter-to-quarter transition between types which is in turn more directly related to the most immediate condition of the firms, the banks and the economy. Given the lags in monetary policy transmission, however, earlier changes in policy stance would still be expected to affect the current degree of transition between types.

Our model is represented as follows:

$$P(LP_{i,t}|LP_{i,t-1}=1) = F\Bigg[\sum_{k=1}^{8}\beta_k^{mp}MP_{t-k} + \beta^{lev}LEV_{i,t-1} + \beta^{lq}LQ_{i,t-1} + \beta^{roa}ROA_{i,t-1} + \beta^{ib}IB_{t-1} + \beta^{yg}YG_{t-1} + \mu_i + \epsilon_{i,t}\Bigg] \quad (3)$$

where $LP_{i,t}$ denotes the binary dependent variable for firm i at time t and $F(x) = \frac{e^x}{1+e^x}$. In addition to the variables described above, we also include firm fixed effects in our model, denoted by μ_i, that may be related to the firms' propensity to switch types. Our goal here is to use our panel dataset and identify the effect of shadow rates on a firm's odds of either staying with the same type or switching types conditional on its type in the previous quarter. For this reason, the binary outcome for the borrowing spread type is estimated by using a fixed effects population-averaged logit model. We prefer this approach over a probit estimation given the advantages that a logistic estimation has in terms of generating unbiased coefficient estimates when there are fixed effects.

Table VI shows our estimation results. We find that regardless of the borrowing spreads that firms have in the previous period, a looser monetary policy is positively (negatively) related to the log odds of being a low spread type in the pre-crisis (post-crisis) period. These relationships are both statistically and economically significant. In the post-crisis period, the odds of staying as a low borrowing spread firm, for example, falls by 7.5 percent if the shadow rate is reduced by 25 basis points over the past 8 quarters. The corresponding computation for the pre-crisis period produces a 5.6 percent increase in the odds of remaining in the low spread group. The results also show that a loose monetary policy in the post-crisis period decreases (increases) the odds that high (low) borrowing spread firms switch types. These results are reversed in the pre-crisis period. If we combine the inferences that were drawn from our earlier analysis with the ones in this section, we can predict that while loose monetary policies cause borrowing spreads to converge (diverge) across the different types in the post-crisis (pre-crisis) period, they also increase the odds that a firm becomes a high (low) spread type in the next period. As we mention above, however, the dynamic compositional effects of monetary policy that we uncover in this section are qualified by the fact that a majority of the firms do not switch types from quarter to quarter.

The results in Table VI also demonstrate a large difference in the magnitude of the monetary stance coefficients. Specifically, monetary policy has a larger impact on the odds of becoming/remaining a low spread type in the post-crisis period and it has a larger impact of switching to a high spread type in the pre-crisis period. Turning to the firm-specific variables we find that leverage, return on assets and liquidity are, in general, significant determinants of the dependent variable in the pre-crisis period. In the post-crisis period, by contrast, only the coefficient of leverage is significant. The signs of the significant coefficients indicate that firms with higher leverage, higher liquidity and lower returns on assets are more likely to remain as a low spread type and less likely to switch to a high spread type. The more general inference here is that firm-specific variables play a more important role in the transition of firms between types compared to their role in determining borrowing spreads. We find that the coefficients of the two other macroeconomic variables, output gap and banking sector profitability, are more significant and larger in magnitude in the post-crisis period. The signs of the coefficients for this period suggest that the odds of being a low spread type is countercyclical and the odds of remaining a low spread type is positively related to banking profitability.

V. Conclusion

In this paper, we demonstrated the asymmetric effects of U.S. monetary policy on the borrowing spreads of a large number of nonfinancial firms before and after the 2008-09 crisis. Firms' borrowing spreads were derived by comparing their actual interest payments with what they would have paid if they borrowed at the risk-free rate. This allowed us to incorporate all forms of external finance that firms use, include a large number of firms, and focus on the broad credit channel instead of only the balance sheet, lending channel, risk-taking, bank balance sheet channels of monetary transmission. In identifying the credit channel, we approached the problem from the perspective of the firms in contrast to the majority of the empirical research that focus on commercial bank lending.

Using the shadow rate of Krippner (2013) to approximate the stance of monetary policy and classifying the firms based on their quality and borrowing spreads, we obtained several unique insights. First, we found that a loose monetary policy causes borrowing spreads to converge (diverge) across the firms in the post-crisis (pre-crisis) period. The sensitivity to monetary policy in the whole sample, however, was insignificant implying that while monetary policy appears ineffective on the aggregate, it does affect the borrowing spreads of a large number of firms and it has substantial distortionary effects in credit markets. Second, by investigating the transition of firms between the high and low borrowing spread categories, we found that a loose monetary policy increases the tendency to become a high spread firm in the post-crisis period and decreases this tendency in the pre-crisis period. Third, our results indicated that macroeconomic variables such as the output gap and overall banking profitability are more closely related to firms' borrowing spreads compared to firm-specific variables. Our conclusions were mostly similar when we used alternative classification strategies, model specifications and the Bauer and Rudebusch (2015) shadow rate as our measure of the monetary policy stance.

There are several ways to branch out from the analysis in this paper. It would be insightful, for example, to track the future investment behavior and the financial structure of the firms that benefit from a loose monetary policy and determine whether these policies make the economy more volatile and fundamentally fragile or whether they enhance economic stability. A second natural extension would be to compare the borrowing spreads that we generate in this paper with the bond spread data that are available for a subset of the firms in our sample. If this analysis reveals a large disparity between the two measures of borrowing costs then this would imply that any assessment of monetary policy based on its ability to alter corporate bond spreads is inaccurate. Comparing the two spreads would also inform researchers about the disparity between the degree of asymmetric information in direct and indirect finance. Finally, it would be interesting to incorporate the sectoral breakdown of the firms into our analysis to determine if there are any differences in the sensitivity to monetary policy across different sectors. Determining the sensitivity of the firms in the housing sector would be particularly interesting given the renewed scrutiny of incorporating the condition of this sector into monetary policy formulation.

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Appendix A. Data definitions

Variable	Acronym	Description
Liquidity ratio	LQ	Defined as cash and short-term investments (CHEQ) divided by total assets (ATQ)
Short-term debt	STB	Debt in current liabilities (DLCQ)
Long-term debt	LTB	Long-term debt- Total (DLTTQ)
Return on assets	ROA	Defined as net income (NIQ) divided by total assets (ATQ)
Maturity		Defined as short-term debt (DLCQ) as a share of total debt (DLCQ + DLTTQ)
Leverage	LEV	Defined as total debt (DLCQ + DLTTQ) divided by total assets (ATQ)
Sales growth		Defined as net sales in current period ($SALEQ$) minus net sales in previous period ($SALEQ_{-1}$) divided by net sales in the previous period ($SALEQ_{-1}$)
Total debt	B	Defined as the sum of lagged short-term debt (DLCQ) and lagged long-term debt (DLTTQ)
Actual interest payment	IP	Interest and related expense-Total (XINTQ)
Quality rating		S&P quality rating- Current (SPCSRC)
Long-term risk-free interest rate	R^{fl}	Using quarterly averages of 10-year Treasury constant maturity rate from FRED, we find the lowest rate in the previous 5 years.
Short-term risk-free interest-rate	R^{fs}	Quarterly average of 3 month Treasury bill rate obtained from FRED database
Output gap	YG	Defined as real GDP minus real potential GDP divided by real potential GDP. All series are at quarterly frequency and obtained from FRED database
Banks' net interest margin	IB	Defined as tax-adjusted income divided by average earning assets of all U.S. banks
Monetary policy stance (Shadow rate)	MP	Obtained from Krippner (2013), Wu and Xia (2016) or Bauer and Rudebusch (2015)

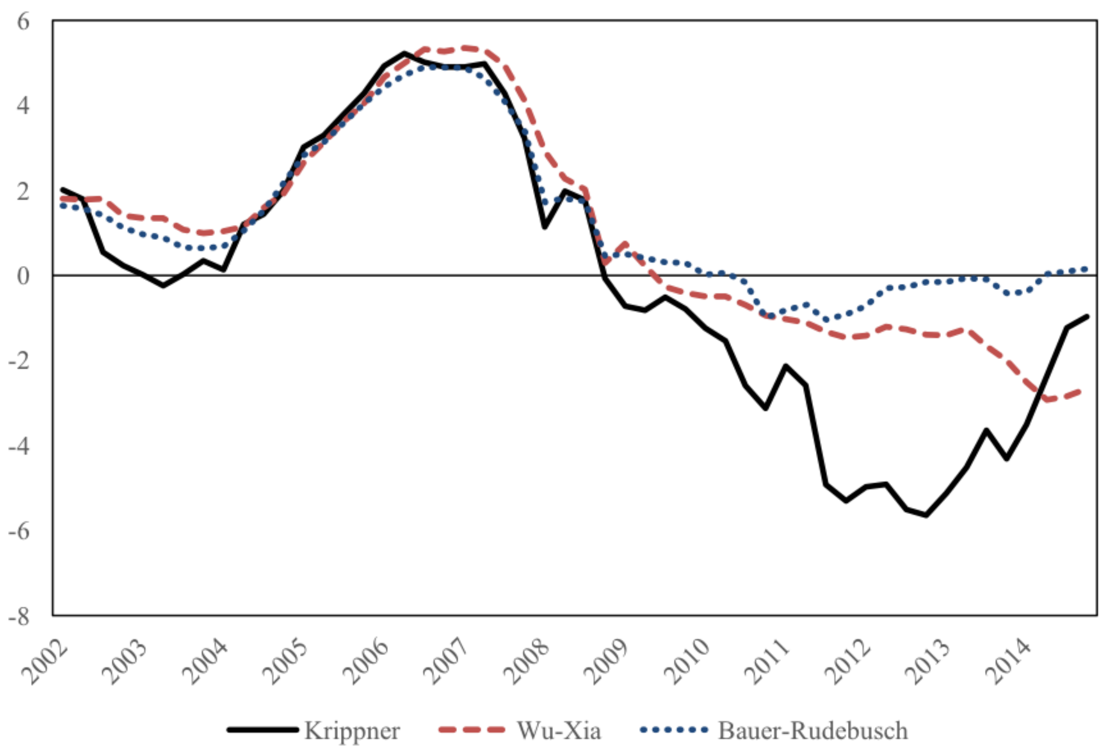
Notes: All variables except the bottom 5 are obtained from the COMPUSTAT (North America) database. The shadow rates and the remaining macroeconomic variables are obtained from the authors websites and the Federal Reserve Bank of St. Louis, FRED database.

Appendix B. Bank profitability and alternative indicators of firm condition

Post-crisis	Type 1 Low quality rating High borrowing spread	Type 2 High quality rating High borrowing spread	Type 3 Low quality rating Low borrowing spread	Type 4 High quality rating Low borrowing spread	Type 5 Low quality rating Zombie	Type 6 High quality rating Zombie
sales growth	−0.0007	−0.0046	0.0012	0.0043	−0.0027	0.0010
	(0.946)	(0.823)	(0.326)	(0.725)	(0.818)	(0.989)
liquidity	0.7660	1.3600	−1.4800	0.7100	−0.4870	−0.8110
	(0.525)	(0.597)	(0.572)	(0.360)	(0.456)	(0.992)
banks' net interest margin	−9.2000	−11.7000	−1.8700	−6.2700	6.2400	19.9000
	(0.0755)*	(0.382)	(0.344)	(0.0708)*	(0.668)	(0.830)
monetary stance	0.2050	0.5110	−0.4550	−0.2080	−0.1300	−0.1530
	(0.0105)**	(0.104)	(0.000)***	(0.0032)***	(0.801)	(0.903)
output gap	1.1520	−0.8510	−0.7110	−0.1480	−0.1740	1.0690
	(0.115)	(0.115)	(0.0033)***	(0.0501)*	(0.515)	(0.894)
interest gap, lags	0.660	1.482	−0.255	0.153	0.0241	−0.183
	(0.0152)**	(0.000)***	(0.0304)**	(0.851)	(0.943)	(0.221)
Hansen test p-value	0.787	0.943	0.181	0.896	0.563	1.000
AR2 test, z-value	0.454	0.552	0.853	0.928	0.263	0.696
No. of observations	24,792	5,594	14,198	10,170	1,116	503
Pre-crisis	Type 1 Low quality rating High borrowing spread	Type 2 High quality rating High borrowing spread	Type 3 Low quality rating Low borrowing spread	Type 4 High quality rating Low borrowing spread	Type 5 Low quality rating Zombie	Type 6 High quality rating Zombie
sales growth	−0.0017	−0.0478	0.0003	0.0084	−0.0033	−0.0136
	(0.827)	(0.380)	(0.910)	(0.356)	(0.618)	(0.838)
liquidity	−1.3500	3.3500	0.6780	−0.0890	1.4200	1.2900
	(0.553)	(0.257)	(0.756)	(0.714)	(0.115)	(0.173)
banks' net interest margin	34.9000	−76.9000	4.2400	−1.0900	72.2000	22.9000
	(0.0336)**	(0.107)	(0.0055)**	(0.0027)***	(0.0008)***	(0.107)
monetary stance	−1.4700	1.3900	0.7460	0.5660	0.3020	−0.4800
	(0.0483)**	(0.0174)**	(0.000)***	(0.000)***	(0.0014)***	(0.903)*
output gap	3.7560	−2.7370	−1.6560	−1.0250	−0.8540	1.2970
	(0.0275)**	(0.178)	(0.0588)*	(0.247)	(0.105)	(0.211)
interest gap, lags	0.877	0.179	−0.0696	−0.0946	0.350	0.256
	(0.000)**	(0.338)	(0.401)	(0.0940)*	(0.0376)**	(0.0018)***
Hansen test p-value	0.589	0.565	0.495	0.351	0.742	0.906
AR2 test, z-value	0.750	0.289	0.122	0.489	0.598	0.143
No. of observations	27,731	5,801	21,238	14,054	2,942	1,501

Notes: This table shows the estimation results from our general model with alternative firm-specific and macroeconomic variables. *,**,*** significant at 10%, 5%, 1%, respectively.

Figure 1. Shadow Rates



Notes: The figure shows the shadow rates in Krippner (2013), Wu and Xia (2016) and Bauer and Rudebusch (2015). All rates represent quarterly averages. The Bauer and Rudebusch (2015) measure in the figure is their shadow rate derived by using macroeconomic factors.

Table I. Descriptive Statistics

	Whole Sample	Type 1 Low quality rating High quality spread	Type 2 High quality rating High quality spread	Type 3 Low quality rating Low borrowing spread	Type 4 High quality rating Low borrowing spread	Type 5 Low quality rating Zombie	Type 6 High quality rating Zombie
Post-crisis							
Number of firms	7,002	5,122	785	3,699	982	1,164	189
Number of observations	83,598	42,280	6,269	23,261	11,788	3,546	694
Borrowing spread	2.32	3.80	2.30	0.52	0.57	−0.15	−0.19
Leverage	41.18	51.00	28.07	34.29	26.53	41.98	16.30
ROA	−0.05	−0.09	0.01	−0.01	0.02	−0.14	0.02
Liquidity	14.30	16.07	11.29	14.20	9.74	26.40	16.96
Assets, 2009 USD	5,520	2,413	7,162	6,920	13,031	9,214	6,170
Total Debt, 2009 USD	1,716	863	2,343	2,160	3,565	3,022	999
% of firms that do not change type	80.57	83.45	80.90	75.16	86.80	58.56	64.44

	Whole Sample	Type 1 Low quality rating High borrowing spread	Type 2 High quality rating High borrowing spread	Type 3 Low quality rating Low borrowing spread	Type 4 High quality rating Low borrowing spread	Type 5 Low quality rating Zombie	Type 6 High quality rating Zombie
Pre-crisis							
Number of firms	8,327	6,005	1,030	5,211	1,260	2,221	471
Number of observations	112,070	48,598	7,317	38,089	18,066	7,413	2,145
Borrowing spread	2.12	3.99	2.58	0.42	0.49	−0.33	−0.26
Leverage	40.79	51.90	25.35	36.14	26.91	37.07	20.91
ROA	−0.04	−0.08	0.01	−0.01	0.01	−0.07	0.02
Liquidity	13.30	14.80	10.36	14.28	8.41	24.45	16.34
Assets, 2009 USD	3,313	1,241	4,012	3,512	8,186	4,144	6,868
Total Debt, 2009 USD	898	395	959	997	2,021	1,079	1,214
% of firms that do not change type	75.64	78.14	68.82	73.36	84.09	58.96	68.09

Notes: All of the statistics above, except the number of firms and observations, represent sample averages. The number of firms by type reflect the number of firms that were classified under a specific type during any quarter of the sample period. When computing average assets and total debt, we convert assets and debt to 2009 U.S. dollars by using the GDP deflator.

Table II. Baseline Results

	Type 1 Low quality rating High borrowing spread	Type 2 High quality rating High borrowing spread	Type 3 Low quality rating Low borrowing spread	Type 4 High quality rating Low borrowing spread	Type 5 Low quality rating Zombie	Type 6 High quality rating Zombie
monetary stance	0.2650	0.1860	−0.2550	−0.1710	−0.8250	−0.7340
	(0.0014)***	(0.912)	(0.0127)**	(0.032)**	(0.262)	(0.286)
output gap	−0.8750	0.3220	−0.0180	0.4270	−0.0203	−2.7230
	(0.000)***	(0.855)	(0.0028)***	(0.0032)***	(0.167)	(0.0533)*
leverage	−0.0039	−0.0195	−0.0051	0.0025	−0.0047	0.0358
	(0.969)	(0.911)	(0.0079)***	(0.573)	(0.872)	(0.969)
interest gap, lags	0.8480	1.5720	0.1710	0.1430	−0.1030	−0.3750
	(0.186)	(0.000)***	(0.262)	(0.896)	(0.961)	(0.0328)**
Hansen test p-value	0.808	0.976	0.219	0.941	0.484	1.000
AR2 test, z-value	0.958	0.718	0.866	0.904	0.668	0.343
No. of observations	26,406	5,595	14,480	10,175	1,373	503

Notes: The results are obtained by estimating equation (2) with data for the sample period 2010Q1 to 2014Q4. The numbers in the parentheses are the chi-square statistics that test the joint significance of the coefficients. The results in the columns are obtained by using observations for the corresponding type only. *, **, *** significant at 10%, 5%, 1%, respectively.

Table III. Pre-crisis Sensitivity to Monetary Policy

	Type 1 Low quality rating High borrowing spread	Type 2 High quality rating High borrowing spread	Type 3 Low quality rating Low borrowing spread	Type 4 High quality rating Low borrowing spread	Type 5 Low quality rating Zombie	Type 6 High quality rating Zombie
monetary stance	−1.0100	0.0743	0.2900	0.2100	0.9510	0.3920
	(0.000)***	(0.778)	(0.0001)***	(0.400)	(0.0454)**	(0.391)
output gap	2.7570	0.6260	−1.2410	−0.3630	−3.1230	−1.0180
	(0.0006)***	(0.708)	(0.000)***	(0.216)	(0.0297)**	(0.166)
leverage	−0.0047	0.0203	−0.0067	0.0077	0.0021	−0.0084
	(0.400)	(0.0875)*	(0.918)	(0.0652)*	(0.496)	(0.310)
interest gap, lags	0.9600	0.9290	0.2510	0.1410	−0.0638	0.2220
	(0.000)***	(0.0577)*	(0.426)	(0.376)	(0.640)	(0.530)
Hansen test p-value	0.379	0.138	0.272	0.181	0.346	0.611
AR2 test, z-value	0.272	0.144	0.894	0.719	0.248	0.391
No. of observations	29,158	5,822	21,761	14,101	3,193	1,501

Notes: The results are obtained by estimating equation (2) with data for the sample period 2002Q1 to 2007Q4. The numbers in the parentheses are the chi-square statistics that test the joint significance of the coefficients. The results in the columns are obtained by using observations for the corresponding type only. *, **, *** significant at 10%, 5%, 1%, respectively.

Table IV. Sensitivity Analyses

		Type 1 Low quality rating High borrowing spread	Type 2 High quality rating High borrowing spread	Type 3 Low quality rating Low borrowing spread	Type 4 High quality rating Low borrowing spread	Type 5 Low quality rating Zombie	Type 6 High quality rating Zombie
Baseline	Post-crisis	0.2620	0.1860	−0.2550	−0.1710	−0.8250	−0.7340
		(0.0014)***	(0.912)	(0.0127)**	(0.032)***	(0.262)	(0.286)
	Pre-crisis	−1.010	0.074	0.290	0.210	0.951	0.392
		(0.000)***	(0.778)	(0.0001)***	(0.400)	(0.0454)**	(0.391)
A different quality classification	Post-crisis	0.3800	0.6210	−0.2530	0.0000	−1.0300	
		(0.0031)***	(0.555)	(0.0187)**	(0.288)	(0.216)	
	Pre-crisis	−0.9280	0.4950	0.3320	−0.4390	0.6410	−0.6600
		(0.000)***	(0.356)	(0.000)***	(0.031)**	(0.0679)*	(0.752)
A different borrowing spread classification	Post-crisis	0.1210	2.2600	−0.2710	−0.1180		
		(0.0009)***	(0.796)	(0.729)	(0.549)		
	Pre-crisis	−3.1300	−2.0000	0.0754	0.2020		
		(0.0002)***	(0.497)	(0.425)	(0.347)		
Low/high quality only	Post-crisis	−0.1780	0.0573				
		(0.0847)*	(0.947)				
	Pre-crisis	−0.2500	−0.0466				
		(0.060)*	(0.340)				
High/low borrowing spread only	Post-crisis		0.3700	−0.2540			
			(0.0039)***	(0.0054)***			
	Pre-crisis		−0.8820	0.3470			
			(0.000)***	(0.000)***			
Whole sample of firms	Post-crisis	−0.1110					
		(0.145)					
	Pre-crisis	−0.1200					
		(0.672)					
Banking profitability and alternative indicators of firm condition	Post-crisis	0.2050	0.5110	−0.4550	−0.2080	−0.1300	−0.1530
		(0.0105)**	(0.104)	(0.000)***	(0.0032)***	(0.801)	(0.903)
	Pre-crisis	−1.4700	1.3900	0.7460	0.5660	0.3020	−0.4800
		(0.0483)**	(0.0174)**	(0.000)***	(0.000)	(0.0014)***	(0.0582)*
Rudebusch-Bauer	Post-crisis	4.4200	1.4900	−1.3500	−1.3200	−7.4600	−0.5910
		(0.0025)***	(0.846)	(0.0003)***	(0.475)	(0.119)	(0.636)
	Pre-crisis	−0.5860	0.1080	0.2630	0.0817	0.2210	−0.2800
		(0.0001)***	(0.849)	(0.0015)***	(0.119)	(0.0014)***	(0.0089)***
Wu-Xia	Post-crisis	−3.750	−5.070	2.970	−0.561	38.300	−1.440
		(0.0002)***	(0.975)	(0.0004)***	(0.789)	(0.0683)*	(0.923)
	Pre-crisis	0.954	0.816	−0.508	−0.214	−1.570	−0.371
		(0.0001)***	(0.569)	(0.0045)***	(0.119)	(0.0006)***	(0.0169)**

Notes: The table reports the magnitude and the significance of only the monetary policy stance coefficients obtained from various sensitivity analyses. The numbers in the parentheses are the chi-square statistics that test the joint significance of the coefficients. The results in the columns are obtained by using observations for the corresponding type only. The results reported under the two columns for the sensitivity analysis entitled high/low quality rating only are obtained by using quality rating as the only partitioning criterion. Similarly, we use borrowing spreads only to partition the firms to obtain the results for the sensitivity analysis entitled high/low borrowing spread only. *, **, *** significant at 10%, 5%, 1%, respectively.

Table V. Monetary policy and the within group dispersion of borrowing spreads

Post-crisis	Type 1 Low quality rating High borrowing spread	Type 2 High quality rating High borrowing spread	Type 3 Low quality rating Low borrowing spread	Type 4 High quality rating Low borrowing spread	Type 5 Low quality rating Zombie	Type 6 High quality rating Zombie
monetary stance	−4.0400	0.7480	−10.2000	−10.4000	−25.2000	−33.3000
	(0.112)	(0.997)	(0.000)***	(0.0531)*	(0.0003)***	(0.0031)***
output gap	12.3800	−31.6600	14.6900	41.1600	164.6000	168.9000
	(0.0006)***	(0.795)	(0.000)***	(0.102)	(0.0024)***	(0.087)*
leverage	−0.0556	−0.1990	0.0065	0.0756	0.0571	0.1020
	(0.675)	(0.981)	(0.0147)	(0.93)	(0.848)	(0.675)
interest gap, lags	0.4260	1.9780	0.1960	−0.0078	−0.0559	−0.7910
	(0.828)	(0.000)***	(0.102)	(0.930)	(0.0106)**	(0.309)
Hansen test p-value	0.855	0.781	0.250	0.963	0.677	1.000
AR2 test, z-value	0.303	0.337	0.228	0.791	0.668	0.318
No. of observations	26, 406	5, 595	14, 480	10, 175	1, 373	503
Pre-crisis	Type 1 Low quality rating High borrowing spread	Type 2 High quality rating High borrowing spread	Type 3 Low quality rating Low borrowing spread	Type 4 High quality rating Low borrowing spread	Type 5 Low quality rating Zombie	Type 6 High quality rating Zombie
monetary stance	−0.1850	0.0110	0.0537	0.0527	0.1580	0.2120
	(0.0002)***	(0.611)	(0.000)***	(0.903)	(0.0911)*	(0.344)
output gap	45.73000	8.6310	−26.5700	−2.0750	−19.4500	−6.5770
	(0.0014)***	(0.684)	(0.0009)***	(0.146)	(0.552)	(0.224)
leverage	−0.0670	0.2190	−0.0273	0.1650	0.1390	0.1550
	(0.480)	(0.776)	(0.741)	(0.586)	(0.675)	(0.435)
interest gap, lags	0.9250	0.8550	0.4580	0.4660	0.1330	0.6880
	(0.0017)***	(0.0231)**	(0.163)	(0.153)	(0.007)***	(0.0002)***
Hansen test p-value	0.574	0.275	0.327	0.914	0.506	0.415
AR2 test, z-value	0.146	0.132	0.870	0.679	0.174	0.634
No. of observations	29, 158	5, 822	21, 761	14, 101	3, 193	1, 501

Notes: The results are obtained by estimating equation (2) where borrowing spreads and leverage variables are measured as the absolute deviations from type-specific averages in each quarter. The numbers in the parentheses are the chi-square statistics that test the joint significance of the coefficients. The results in the columns are obtained by using observations for the corresponding type only. *, **, *** significant at 10%, 5%, 1%, respectively.

Table VI. The dynamic compositional effects of monetary policy

	Post-crisis			Pre-crisis		
	P(low spread in t| low spread in t-1)	P(low spread in t| high spread in t-1)	P(high spread in t| low spread in t-1)	P(low spread in t| low spread in t-1)	P(low spread in t| high spread in t-1)	P(high spread in t| low spread in t-1)
monetary stance	0.3000	0.2390	−0.0440	−0.2300	−0.0985	0.1440
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.001)***	(0.000)***
output gap	−0.5031	−0.0193	0.1012	0.1113	0.1536	−0.1157
	(0.000)***	(0.816)	(0.059)*	(0.227)	(0.127)	(0.201)
leverage	2.0540	0.0943	−2.0220	2.0530	0.1500	−2.0530
	(0.000)***	(0.205)	(0.000)***	(0.000)***	(0.015)**	(0.000)***
liquidity	−0.4500	0.6830	0.3960	1.5620	1.1180	−1.5640
	(0.411)	(0.11)	(0.472)	(0.000)***	(0.002)***	(0.000)***
ROA	0.0044	0.1520	−0.0387	−0.4750	0.0216	0.4790
	(0.989)	(0.102)	(0.901)	(0.017)**	(0.735)	(0.016)**
Banks'net	5.3160	−1.3450	−1.3790	0.7070	0.6700	0.4690
interest margin	(0.000)***	(0.078)*	(0.001)***	(0.659)	(0.709)	(0.103)
No. of observations	12,819	12,768	12,832	14,348	10,154	14,369

Notes: The results are obtained by estimating equation (3). The numbers in the parentheses in the second row are the chi-square statistics that test the joint significance of the monetary stance coefficients. The results in the columns are obtained by using observations for the corresponding type only. *, **, *** significant at 10%, 5%, 1%, respectively.