The Effect of Unconventional Monetary Policy on Credit Flows*

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Abstract

This paper evaluates the quantitative effects of unconventional monetary policy in the late 2000s and early 2010s when the federal funds rate hit the zero lower bound (ZLB). We compute credit flows using Compustat data and employ a factor augmented vector autoregression to analyze unconventional monetary policy's impact on the allocation of credit among firms. We show that the impact of unconventional monetary policy on credit reallocation was substantial, especially for long-term credit. We then inquire what groups of firms accounted for this increased credit reallocation finding that, during the ZLB, unconventional monetary policy reshuffled credit towards firms typically viewed as financially constrained: small, young, high-default and highly leveraged firms. We also show that, during the ZLB, unconventional monetary policy brought about higher credit creation for firms of relatively high investment efficiency, suggesting this policy was key to fueling future economic growth.

Key words: Unconventional Monetary Policy, Credit Reallocation, Business Cycles

JEL codes: E44, E51, E52, E58

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1 Introduction

In December 2008, the Federal Open Market Committee (FOMC) established a target range for the federal funds rate of 0 to 0.25%. In the following years, with this rate effectively at the zero lower bound (ZLB), the Federal Reserve (Fed) resorted to unconventional policy methods to provide monetary accommodation. By November 2014, the Federal Reserve had purchased nearly $4 trillion of mortgage-backed securities, agency debt, and long-term U.S. Treasuries. Moreover, throughout the ZLB, Federal Reserve officials engaged in forward guidance to shape expectations of the course of future monetary policy. These unprecedented actions were intended to stabilize the financial system, which was hampering economic growth due to tight credit standards. Monetary policy accommodation was achieved, in part, through artificially boosting asset prices. This improved the availability of credit to borrowers who pledge these assets as collateral for external financing. Further, through forward guidance and rounds of quantitative easing, the Fed managed to lower market expectations. This decrease in long-term yields – once the ZLB was reached – eased financial conditions for households and firms.[1]

The objective of this paper is to assess the impact of unconventional monetary policy on the reallocation of credit among firms. To do this we first compute quarterly measures of inter-firm credit flows starting from the balance sheets and income statements of all publicly traded U.S. firms reported in the Standard and Poor's Full-Coverage Compustat tapes. Then, we estimate the effect of monetary policy shocks on credit flows using a factor vector autoregressive (FAVAR) model similar to that of Bernanke, Bovin and Eliasz (2005). In addition, to study the effect of unconventional monetary policy during the ZLB, we follow Wu and Xia (2016). That is, we replace the effective federal funds rate with Wu and Xia's shadow rate and analyze two alternative counterfactuals. First, we explore the effect of shutting down the monetary policy shocks during the ZLB, which amounts to the Fed following a traditional monetary policy rule. Second, we inquire about the effect of unconventional monetary policy during the ZLB by forcing the monetary policy instrument to be constrained by the ZLB.

Our first key empirical result is that monetary policy easing increases both total credit creation and destruction, thus leading to increased fluidity in total credit reallocation. This increase in credit reallocation peaks three quarters after the shock and slowly declines over the following year or so. Our baseline estimates suggest credit creation is more responsive than credit destruction, which is consistent with the increase in aggregate net credit found in the literature. We estimate that -25 basis-point shock on monetary policy causes total net credit to rise 2.5% over the steady state level and credit creation to nearly 5%.

We also provide empirical evidence that unconventional monetary policy had a heterogeneous impact on credit flows during the ZLB for groups of firms facing different financial constraints. Specifically, the boost provided by the Fed to credit creation was markedly larger for financially constrained firms. This was most evident for the short- and long-term credit of small firms, highly leveraged firms, and young firms, as well as long-term credit of high default probability firms. We provide two additional pieces of evidence, which suggest this heterogeneity was driven by firms' response to unconventional monetary policy measures and not by the response to unexpected monetary policy shocks. First, differences in credit flow counterfactuals among groups of firms are negligible when the monetary policy shock is shut down during the rounds of quantitative easing (QE) and operation twist. Only during QE3 did the monetary policy shock contribute to a substantial increase in credit reallocation, specifically for long-term credit of small, young, and highly leveraged firms and those having high default probabilities. Second, the fluidity of credit markets would have been considerably lower had the Fed been constrained by the ZLB. More specifically, unconventional monetary policy boosted long-term credit reallocation (1.31 percentage points) while having a substantially smaller effect on short-term credit reallocation (0.25 percentage points). The impact on long-term credit reallocation was larger for high default probability firms and highly leveraged firms than their counterparts (i.e., low default probability firms and low leverage firms).

Because long-term credit tends to finance long-term investment projects, our results suggest that unconventional monetary policy provided the much needed stimulus to investment and growth. Although we do not have firm-level productivity measures for Compustat firms, we provide an additional piece that supports this claim. Productive firms, according to the investment efficiency index of Galindo, Schiantarelli and Weiss (2007), benefited more from the increased credit reallocation induced by unconventional monetary policy

[1] See Krishnamurthy and Vissing-Jørgensen (2011), Di Maggio, Kermani, and Palmer (2016), Rodnyansky and Darmouni (2017), Chakraborty, Goldstein, and MacKinlay (2017), and Fieldhouse, Mertens, and Ravn (2018).

than the less productive firms.

Our paper contributes to two key strands of literature. The first explores how the impact of monetary policy shocks varies across different firms. Starting with the work by Kashyap, Lamont and Stein (1994), Gertler and Gilchrist (1994), and Kashyap and Stein (1995), several articles have argued that monetary policy effects have greater impacts on small firms, which are likely to face more credit constraints. We contribute to this literature by showing that credit reallocation, and not just changes in net credit, for small and high debt probability firms was more responsive to unconventional monetary policy measures. Moreover, we show that this response was driven by long-term credit. Furthermore, our paper complements the work by Kudlyak and Sanchez (2017) who document a smaller decline in credit for small firms during the Great Recession and the start of the ZLB period and show that the tightening of collateral constraints did not play a notable role in describing credit markets of borrowing firms during the Great Recession. However, they do not quantify the impact of unconventional monetary policy to credit reallocation.

The second strand of literature empirically studies the transmission of monetary policy to the aggregate economy. To date, this literature has focused on the impact of monetary policy shocks on macroeconomic aggregates (see e.g., Bernanke, Boivin and Eliasz, 2005; Wu and Xia, 2016; Gertler and Karadi, 2015) or has used firm-level data level data to investigate the impact on investment and credit spreads (see, e.g., Cloyne, Ferreira, Froemel and Surico, 2018; Anderson and Cesa-Bianchi, 2018). To the best of our knowledge, our paper is the first to inquire into the impact of monetary policy on credit reallocation.

This paper is organized as follows. Section 2 describes the data used in analysis and the evolution of credit flows during the ZLB. Section 3 describes the empirical methodology. Section 4 provides the results of the counterfactual analysis during the ZLB, including the rounds of quantitative easing and Section 5 concludes.

2 Data and Measurement

2.1 Credit Flows

As in Herrera, Kolar and Minetti (2011) –hereafter HKM–, we compute measures of inter-firm credit flows starting from the balance sheets and income statements of all publicly traded U.S. firms reported in the Standard and Poor's Full-Coverage Compustat tapes. Firms in finance, insurance, and real estate industry sectors are removed from the sample given our aim to study the impact of unconventional monetary policy on the firms that demand credit, instead of firms that create credit. Using these data to study the effect of monetary policy shocks on credit reallocation presents some advantages and shortcomings. A clear shortcoming is that Compustat only includes publicly traded firms, which tend to be large and less financially constrained. Thus, small private firms that were traditionally thought to exhibit larger declines in short-term credit and sales than large firms when faced by tighter monetary policy (see Gertler and Gilchrist, 1994) are excluded. However, recent work by Kudlyak and Sanchez (2017) finds that large firms exhibited a greater contraction in sales and short-term credit than small firms in 2008–09. Moreover, in the last three decades, the employment and revenue shares of large firms have increased greatly (Bergenau, Farboodi and Veldkamp 2018), thus increasing the contribution of these firms to the aggregate dynamics of employment and output. Understanding how credit is reallocated among large firms is thus essential in evaluating the impact of unconventional monetary policy during and after the Great Recession.

A key advantage of the Compustat tapes is the lengthy period of time spanned by the data and the availability of quarterly data. This allows us to estimate a factor vector autoregressive (FAVAR) model to study the dynamic response of credit flows to monetary policy shocks and compute historical decomposition to construct counterfactual scenarios (see Kudlyak and Sanchez 2017).

We follow HKM's definition and measurement of credit flows in most aspects. In particular: (i) our unit of observation is the firm, as we do not have data on the firm's individual projects; (ii) we exclude accounts payable by suppliers from the measure of credit; (iii) we exclude firms for which the ratio of end-of-period gross capital to end-of-period net capital exceeds 120% to control for existing firms that enter the data-set;[2] (iv) only exits due to merger or acquisition, liquidation or bankruptcy are treated as credit subtractions.

[2]See Ramey and Shapiro (1998) for the use of a similar criteria applied to flows of physical capital and Herrera, Kolar and Minetti (2011) for a detailed description.

We depart from HKM in using quarterly, instead of annual, data and expand the sample to include the period of the ZLB.[3] While using annual data would permit the inclusion of earlier years –annual data is available since the early 1950s–, the use of higher frequency data is key for our identification strategy. Hence, we compute the quarter-to-quarter rate of debt growth, g_{it}, for firm i in quarter t as

$$g_{it} = \frac{debt_{it} - debt_{it-1}}{(debt_{it} + debt_{it-1})/2}. \tag{1}$$

This measure follows the rate of growth for job flows by Davis, Haltiwanger, and Schuh (1998) and is akin to quarterly job flow measures used in related studies (see Davis and Haltiwanger, 2001; Davis, Faberman and Haltiwanger, 2012; Davis and Haltiwanger, 2014). Moreover, as in the cited studies, the rate of growth is symmetric around zero and bounded, thus allowing for a unified treatment of continuing, newborn and dying firms (see, e.g. Davis and Haltiwanger 1992, Herrera, Kolar and Minetti, 2011). In particular, $g_{it} \in [-2, 2]$, where -2 corresponds to debt growth of firms that died in the current year and 2 is debt growth of newborn firms.

With the rate of growth defined as above, we proceed to compute aggregate credit creation and credit destruction for a set of firms s in quarter t. These are weighted sum of the rates of debt growth for expanding or entering firms and the weighted sum of the rates of debt growth for contracting or exiting firms, respectively. Specifically, aggregate credit creation for group s in t (POS_{st}) is defined as

$$POS_{st} = \sum_{g_{it}>0, i \in s_t} g_{it} \left(\frac{debt_{it}}{debt_{st}} \right). \tag{2}$$

Similarly, credit destruction (NEG_{st}) is defined as

$$NEG_{st} = \sum_{g_{it}<0, i \in s_t} |g_{it}| \left(\frac{debt_{it}}{debt_{st}} \right). \tag{3}$$

Furthermore, we compute gross credit reallocation as the sum of credit creation and credit destruction

$$SUM_{st} = POS_{st} + NEG_{st}. \tag{4}$$

We obtain net credit growth by subtracting credit destruction from credit creation

$$NET_{st} = POS_{st} - NEG_{st} \tag{5}$$

and excess credit reallocation as

$$EXC_{st} = SUM_{st} - |NET_{st}|. \tag{6}$$

2.1.1 Aggregate Credit Flows

We start by examining the magnitude and volatility of aggregate credit flows. Table 1 reports the average credit creation, destruction, gross reallocation, net credit change, and excess credit reallocation for the 1974:Q1–2017:Q1 period. The first row of panel (a) shows that during this period total credit creation averaged 5.4% and credit destruction 3.5%, amounting to a net credit change of 1.9% and gross and excess credit reallocation of 9.0% and 6.9%, respectively. This confirms HKM's finding that the intensity of inter-firm credit flows for all firms far exceeds the reallocation needed to accommodate net credit changes. In addition, the table illustrates how the volatility of total credit creation has been substantially larger than that of total credit destruction; note how the coefficient of variation for POS in the first row (All firms) equals 40.6 whereas that for NEG is 28.0.

Panels (b) and (c) of Table 1 report the averages and the coefficients of variation for short-term[4] and long-term credit flows. The first row of the panels reveals that average short-term credit creation and

[3] HKM compute annual credit flows using Compustat over the period 1952–2007. Reliable quarterly data is only available from Compustat starting in the early 1970s. See the Appendix for descriptive statistics for annual credit flows that resemble those by HKM.

[4] Short-term credit refers to credit maturing in less than 12 months and the portion of long-term credit maturing in less than

destruction for all firms are notably higher than long-term creation and destruction. Indeed, short-term credit creation and destruction for all firms averaged 15.1% and 7.1%, respectively, over the sample period. These magnitudes are considerably larger than the corresponding 5.9% and 3.6% for long-term credit.

Inspection of Figure 1 illustrates that the intensity of credit reallocation varies across quarters. Three characteristics of the intensity of reallocation stand out. First, the intensification of credit reallocation during the 1980s relative to the 1970s, which had been noted by HKM. Second, while the U.S. has experienced a secular decline in the pace of job reallocation since 1990 (see Davis and Haltiwanger, 2014), this pattern in absent from credit flows. Third, the U.S. credit market did become less fluid since the onset of the Great Recession in 2007. Credit reallocation rates fell from a pre-recession rate of roughly 10 percent to 2.5 percent prior to 2010. Further, this reduction in credit reallocation and its fluidity was driven mainly through activity in the long-term credit market.

To what extent does Figure 1 capture credit creation and destruction of existing firms, rather than of those entering or exiting. In Figure 2, we plot credit flow measures for all firms and excluding entering and exiting firms. In other words, we plot credit flow measures at the extensive and intensive margin jointly and at the intensive margin alone.[5]

The first panel of Figure 2 plots credit creation in aggregate (i.e. all firms) and existing firms (i.e. the intensive margin). These measures track strikingly close to one another, suggesting that entering firms are not impacting movements and fluctuations of this series across time. The two exceptions though occur in 1977:Q1 and 1984:Q1 when credit creation is flat at the intensive margin, but spikes dramatically at the jointly intensive and extensive margins. This suggest that these spikes are driven by firms entering the database. In 1977:Q1, firms entering with database with positive debt tended to operate in utilities companies,[6] and in 1984:Q1, from the utilities and telecommunications sectors.[7] As seen in the third panel of Figure 2, the net credit change at the intensive margin alone are free of these two spikes in the data.

Unlike credit creation, credit *destruction* at the intensive margin differs from that at the intensive and extensive margin jointly, as shown the second panel of Figure 2. This indicates that much of credit destruction is due to bankruptcies, mergers, acquisitions, and liquidations as firms exit the database. The most drastic difference occurs in the late 1990s to the early 2000s. This illustrates that, at the intensive margin, that the peak of credit destruction occurs instead in the mid-2000s, prior to the financial crisis. By the beginning of the official start of the Great Recession, credit destruction fell to a measure not experienced before, at 1.77 percent before rising again during and after the Great Recession.

At the joint intensive and extensive margins, credit reallocation and excess credit reallocation are both high in the late 1990s and early 2000s. This alone suggests that credit creation and destruction are jointly elevated during this time. However, at the intensive margin alone, excess credit reallocation is flat. This suggests that, at the intensive margin, the credit reallocation was not intense or caused by simultaneous increases in credit creation and destruction. Instead, excess credit reallocation at the intensive margin is largest in 2006. This is followed by a considerably decrease prior to the start of the Great Recession in late 2007. It is unclear how much of the credit reallocation coupled with rising excess credit reallocation at this time is due to refinancing of debt.[8] This is because Compustat only provides information on the dollar amount of short- and long-term debt. However, the divergence between credit reallocation and excess reallocation in the late 1990s and early 2000s suggest that refinancing was not likely prevalent during this time.

2.1.2 Group Credit Flows

A question that emerges from observing these patterns is whether the declines in reallocation observed since the Great Recession cut across firms facing varying degrees of financial frictions and investment efficiency. To address these questions, we borrow from Cloyne, Ferreria, Froemel and Surico (2018) and compute

12 months.

[5]Credit flows at the extensive margin (i.e. credit flows only for entering and exiting firm) are not shown as they are simply series with the value of two over the time period.

[6]Companies entering the database with the largest debt in the quarter include Georgia Power, Alabama Power Company, Ohio Power, El Paso Corporation, and the Indiana Michigan Power Company.

[7]Companies entering the database with the largest debt in the quarter include Royal Dutch Shell, BellSouth, NYNEX Corporation, Pacific Telesis Group, and AT&T (reformation).

[8]That is, obtaining financing to pay off existing debt, resulting in increases in credit creation *and* destruction.

credit flows for subgroups according to various proxies of financial constraints used in the corporate finance literature. These proxies comprise (i) the value of total assets at the beginning of the quarter (Gertler and Gilchrist, 1994; Kudlyak and Sanchez 2017), (ii) debt service computed as the ratio of short-term debt to total assets (i.e. leverage) following Merton (1974), (iii) need for external financing defined as capital spending less cash flows as a portion of capital spending as in Rajan and Zingales (1998), (iv) firm age computed as the number of years since the firm was incorporated in Compustat, and (v) default probability. The latter is computed as in Farre-Mensa. and Ljungqvist (2016):

$$DD_{it} = Distance - to - default_{it} = \frac{log(\frac{E_{it}+F_{it}}{F_{it}}) + r_{it} - 0.5\sigma_{it}^2}{\sigma_{it}} \tag{7}$$

where

$$E_{it} = \frac{|prccq| \times cshoq}{10^3} \tag{8}$$

$$F_{it} = dlcq + \frac{1}{2}dlttq \tag{9}$$

$$\sigma_{it} = [\frac{E}{E+F} \times \sigma_{E,it}] + [\frac{F}{E+F} \times (0.05 + 0.25 \times \sigma_{E,it})] \tag{10}$$

where $\sigma_{E,it}$ is the rolling one-year standard deviation of *prccq* (stock price), r_{it} is the year-over-year stock return, *dlttq* is total long-term debt, *dlcq* is short-term debt, and *cshoq* is common shares outstanding. Default probabilities are obtained from the cumulative standard normal function. A firm is classified as having high default probability if it exceeds 25% at the beginning of the quarter and low default probability otherwise.

We classify a firm as financially constrained if: (i) its assets value falls in the bottom tercile of the distribution in a given quarter, (ii) its leverage ratio falls in the top tercile of firms in a given quarter, (iii) its need for external financing is in the top tercile of firms in a given quarter, (iv) age is less than sixteen years, or (iv) default probability exceeds 25 percent as in Farre-Mensa and Ljungqvist (2016).[9]

Table 2 reports the percentage of time that firms are classified in specific group at time t, conditional on classifications in time $t-1$. The table shows that these alternative proxies for financial constraints capture different aspects of a firm. For instance, default probabilities tend to fluctuate with equity prices and are therefore noisy measures. If a firm is classified as having a high default probability in $t-1$, then it is likely to remain in the same group in t 84.3% of the time. However, a firm that is classified as having a low default probability in $t-1$ is substantially more likely to remain in the low tercile in t (96.3%) than moving to the high default probability tercile. The distribution of firms' asset tends to be more stable over time, therefore, firms that are classified in the low tercile, small, in $t-1$ are 98% likely to stay in the same tercile in t. Similarly, firms that are in the top tercile of asset value in $t-1$, which we classify as large, have a probability of 98.1% to stay in the same tercile in t.

Table 3 provides the change in the credit flow measures for financially constrained and non-financially constrained firms between 2009:Q3 and 2015:Q3, the period after the recession when unconventional monetary policy was conducted. For short-term maturities, the largest increase in net credit was for high default probability firms (8.06 percentage points). For this group, credit creation increased 9.70 percentage points and credit destruction increased 1.64 percentage points. While credit reallocation was high for these firms (11.34 percentage points), the intensity of credit reallocation, as measured by excess credit reallocation, did not increase substantially. This was the result of a one-sided, rather than simultaneous and intense increase in credit creation and credit destruction.

Recall that Kudlyak and Sanchez (2017) find that median short-term credit for large firms contracted more than small firms during the Great Recession. After this time and during the ZLB, short-term net credit of firms also increased relatively more for those classified as large, rising 2.37 percentage points. Short-term net credit for small firms decreased 0.62 percentage points. However, this decline in short-term net credit masked the large and intense reallocation of short-term credit of these firms occurring during the ZLB. Short-term credit creation of small firms increased 4.35 percentage points, but short-term credit destruction

[9] Our empirical results are robust to alternatively grouping firms by default probability terciles. These results are shown in the Appendix.

increased 4.97 percentage points. While the short-term net credit change was negative, short-term credit reallocation and excess credit reallocation were 9.32 and 8.70 percentage points, respectively. The change in excess credit reallocation during this period was larger for small firms than any other subset under analysis.

Small firms also experienced a large increase in long-term credit creation (9.96 percentage points) relative to large firms (-0.15 percentage points). Long-term credit creation also increased disproportionately more for financially dependent firms (3.88 percentage points) and high default probability firms (4.64 percentage points). These results are consistent with easing of collateral constraints that likely occurred during the ZLB. However, we also find that long-term credit creation increased for low debt service firms (3.73 percentage points) but decreased for high debt service firms (-0.38 percentage points). Further, we find that old firms' credit creation increased (1.09 percentage points), but dropped for young firms (-2.06 percent). However, credit destruction increased for high debt service firms, suggesting that these firms engaged in deleveraging during the ZLB.

2.2 Monetary Policy Measure

Empirical investigations into the effect of monetary policy shocks on economic activity often identify the federal funds rate as the monetary policy instrument. However, from December 2008 until December 2015, the federal funds rate was effectively at the ZLB, thus limiting the use of the instrument to stimulate the economy and invalidating its use as the monetary policy variable in SVARs. An alternative measure of the monetary policy stance at the ZLB has been proposed by Wu and Xia (2016), who develop an approximation to the forward rate in the multifactor shadow rate term structure model. This rate can be used to replace the effective federal funds rate in SVARs during the ZLB period. As Wu-Xia show, their proposed shadow rate contains relevant information about the effect of monetary policy when the effective federal funds rate is bounded by the ZLB. Moreover, it allows us to study the effect of unconventional monetary policy on credit flows during this time. We thus employ the effective federal funds rate as our measure of monetary policy for the period of time where it did not hit the ZLB and replace it with the Wu-Xia shadow rate during the ZLB period.

Data for the Federal funds rate is obtained from the Federal Reserve's H.15 releases, while Wu and Xia's shadow rate –which corresponds to their benchmark shadow rate term structure model (SRTSM) – is provided by the Federal Reserve Bank of Atlanta. Figure 2 depicts the effective Federal funds rate (EFFR) and the Wu-Xia shadow rate across time.

As Wu and Xia (2016) –hereafter WX– note, the shadow federal funds rate became negative during the ZLB period and exhibited considerable variation. In fact, the shadow rate exhibited a negative trend until May of 2014, shortly before the Fed halted bond purchases after having accumulated $4.5 trillion in assets.

2.3 Other Variables

As in Bernanke, Boivin and Eliasz (2015) –hereafter BBE– we include a large set of economic variables to capture the information available to Federal Reserve policymakers in determining the course of monetary policy. The variables included in this study cover broad markets such as labor, consumption, housing, exchange rates, etc. Following WX, we utilize 97 of the 120 original series used by BBE, and we update these series beyond the ZLB, through 2017:Q1. We also include aggregate credit creation and destruction measures, for a total of 99 series. When the variables are not expressed in rates or indices, we transform them into logged differences to induce stationarity. Table A.1 of the Appendix provides a detailed description of the variables and their sources.

3 Empirical Methodology

To study the effect of monetary policy shocks, we utilize a FAVAR model with three factors as in BBE and WX. Let r_t be the observed monetary policy instrument and let F_t be a vector of unobserved factors that jointly follow the vector autoregression:

$$\begin{bmatrix} F_t \\ r_t \end{bmatrix} = \Phi(L) \begin{bmatrix} F_{t-1} \\ r_{t-1} \end{bmatrix} + \upsilon_t \tag{11}$$

where $\Phi(L)$ is a lag polynomial of order four and υ_t is a normally distributed mean zero vector with covariance matrix, Ω. As in BBE, the unobserved factors are estimated from the large set of macroeconomic variables, X_t, described in the previous section. The observed variables are related to the unobserved factors and observed policy rate in the following manner:

$$X_t = \Lambda F_t + \lambda r_t + e_t \tag{12}$$

where Λ and λ are (98×3) and (98×1) matrices of factor loadings.[10]

Following BBE and WX, we extract the first three principal components from the observed macroeconomic variable, X_t, spanning the period between 1974:Q1 and 2017:Q1. We then purge the principal components to obtain factors that are orthogonal to the policy rate and employ these purged factors, $\widehat{F}_t$ to estimate the FAVAR in (11). The monetary policy shock, ε_t^r, is identified using a recursive scheme similar to BBE and WX. That is, we assume that the latent factors do not respond to monetary policy innovations contemporaneously. The response of the i^{th} macroeconomic variable at horizon h to a monetary policy shock is given by

$$\Psi_h^{r,i} = b_i^{x^1} \frac{\partial F_{t+h}^1}{\partial \varepsilon_t^r} + b_i^{x^2} \frac{\partial F_{t+h}^2}{\partial \varepsilon_t^r} + b_i^{x^3} \frac{\partial F_{t+h}^3}{\partial \varepsilon_t^r} + b_i^r \frac{\partial r_{t+h}}{\partial \varepsilon_t^r} \tag{13}$$

where F_{t+h}^j denotes the $j = 1, 2, 3$ factor, $\frac{\partial F_{t+h}^j}{\partial \varepsilon_t^r}$ and $\frac{\partial r_{t+h}}{\partial \varepsilon_t^r}$ are the VAR impulse responses of factor j and the policy rate, respectively, to a monetary policy shock.

To study the effect of unconventional monetary policy, we follow Kilian and Lütkepohl (2017) in first expressing the paths of the variables of interest as a function of all the past shocks and initial conditions. We then compute the contribution of the monetary policy shocks to the path of these variable across time. Second, we construct policy counterfactuals to describe the path that the economy would have taken had certain scenarios occurred as in Sims and Zha (2006). We analyze the contribution of monetary policy shocks to credit flows over the period where the shadow rate was negative (2009:Q3–2015:Q3). We examine two policy counterfactuals as in Wu and Xia (2016). In the first counterfactual, we replace the column of the matrix of structural shocks that corresponds to the shadow federal funds rate with zero. In effect, this forces the actual shadow federal funds rate to a hypothetical rate that is fully determined by lagged macroeconomic variables. In other words, the monetary policy shock is shut down and policy is assumed to follow a rule that would have been expected given past observations of the macroeconomic variables. In the second counterfactual, we replace the monetary policy shock series with one that forces the shadow federal funds rate to the ZLB during the counterfactual period. This is achieved by adding the difference between the observed shadow rate and the ZLB rate, 0.25%, to the monetary shock series. Doing so allows us to quantify how credit flows would have responded had monetary policy been constrained by the ZLB. We proceed by creating artificial historical decompositions that show the contributions of these hypothetical monetary policy shocks to the creation and destruction of credit of borrowing firms. We compute counterfactual wedges between the actual and counterfactual values of the variables of interest at time τ such that

$$wedge_\tau^i = Y_\tau^i - \sum_{s=t_1}^{\tau} \Psi_s^{r,i} \upsilon_s^{cf} \tag{14}$$

where t_1=2009:Q3. In the first counterfactual, we let $\upsilon_s^{cf} = 0$. In the second counterfactual, we let $\upsilon_s^{cf} = \upsilon_s + 0.25 r_s$. Then, using the definitions for credit reallocation, net credit change, and excess credit reallocation in (4)-(6), we compute the counterfactuals for the remaining credit flow measures.

4 Monetary Policy and Credit Flows

4.1 The Effect of Monetary Policy Shocks

This section inquires into the effect of monetary policy shocks on key macroeconomic variables and, especially, on aggregate credit flows. The solid lines in Figure 3 depict the responses of the variables of interest to a -25 basis point shock to the monetary policy rate along with the 90% confidence interval. For the sake of brevity,

[10] We omit the constant for simplicity.

we plot the responses of the policy rate, the industrial production index (IP), the consumer price index (CPI), capacity utilization, the unemployment rate, housing rates, credit destruction and credit creation. We find similar results to those obtained by WX using monthly data from January 1960 to December 2013 and excluding credit flows. Namely, a -25 basis point shock to monetary policy leads to an economic expansion over the following two years with the response of unemployment lagging about a quarter. The expansion is illustrated in Figure 3 by the increase in industrial production, capacity utilization, and housing starts and the decline in the unemployment rate. For instance, a year after the shock, industrial production is 2.37% above the steady state. The effect of the monetary policy on most macroeconomic variables –with the exception of the unemployment rate– dies out after eight quarters. Finally, the response of the CPI reveals only a very slight decrease in inflation, which is consistent with the price puzzle.

What would be the effect of a 25 basis point reduction in the monetary policy rate on credit flows? The bottom panels of Figure 3a show that monetary policy easing induces an increase in credit destruction and creation. More specifically, the rate of destruction rises from the second to the eighth quarter after the shock, while credit creation exhibits a statistically significant increase between the third and ninth quarters. At its peak, three quarters after the shock, credit creation raises 4.7% above its steady state level, while the increase in credit destruction just surpasses 2%. Credit reallocation (that is, the sum of credit creation and destruction) accordingly increases over 7%, while the net credit increases 2.3% after one year. While Compustat does not record the reason for firms' credit changes from one period to the next, our results suggest that monetary policy easing not only leads to an increase in credit creation –through lines of credit, bank loans, or bond issuance, for instance– but it also induces firms to deleverage (i.e. repay debt or allow debt to mature), such as to reduce the overhang of debt (see, e.g., Eggertsson and Krugman, 2012).

To further illustrate monetary policy's impact on credit flows, Table 3b shows the impulse responses of the net credit change, credit reallocation, and excess credit reallocation. Because of the magnitude of the relative increase in credit creation as the result of monetary easing compared to credit destruction, the net credit change increased nearly 3 percentage points seven quarters after the shock. Because credit destruction also increased, credit reallocation and excess credit reallocation (a measure of the intensity of credit reallocation) increased substantially beyond two years after the monetary policy shock. We also plot the impulse responses of the 1-, 5-year, and 10-year Treasury spread and two measures of credit (C&I loans outstanding and consumer credit outstanding). In a similar fashion, the latter two credit aggregates increased substantially following the monetary policy shock. However, neither of these are able to capture any potential reallocation of credit.

4.2 Unconventional Monetary Policy at the ZLB

This section reports the results for the two counterfactual described in section 3. Recall that the first counterfactual quantifies the effect of shutting down the monetary policy shocks during the ZLB or, equivalently, of not deviating from a traditional monetary policy rule. The second counterfactual evaluates the impact of the unconventional monetary policy measures by assuming that the shadow rate remains at 0.25 during the period of analysis.

Figure 4 plots the actual and counterfactual paths followed by the key macroeconomic variables as well as that of aggregate credit creation and destruction. The figures show that had the monetary policy shocks been shut down or if unconventional monetary policy measures had not been implemented in such a manner that the policy rate was bounded by the ZLB, unemployment and consumer prices would have been higher than observed. Additionally, industrial production, capacity utilization, and housing starts would have been lower. In other words, we find that both monetary policy shocks and unconventional monetary policy contributed to curb the economic contraction following the Great Recession. This is consistent with the results obtained by WX using a sample period ending in December 2013, which excludes a year quantitative easing (QE3).

The actual and the counterfactual paths for total credit creation and destruction reveal three important insights. First, credit creation would have been somewhat lower, while credit destruction would have remained virtually unchanged, had the Fed avoided any deviations from the traditional monetary policy during the ZLB. Second, unconventional monetary policy during the ZLB led to a slight increase in credit destruction. Note how the dashed line (counterfactual 2) in the bottom left panel falls below the solid line (actual). Third, had the Federal Reserve not implemented the policy observed at the ZLB, credit creation would have fallen substantially (see the difference between the dashed and solid lines in the bottom right

panel of Figure 4).

The wedges between the actual and the counterfactual credit flows are reported in Table 4. Throughout the remainder of the paper we will refer to these counterfactuals as the "no monetary shock" and the "ZLB" counterfactuals. In both counterfactuals, monetary policy during the ZLB positively impacted total credit reallocation as both observed credit creation and destruction measures were higher than their counterfactual values. The no monetary shock counterfactual leads to an increase of 0.20 (0.06) percentage points in total credit creation (destruction). This results in a 0.26 percentage point increase in credit reallocation, thus suggesting a relatively small impact of the monetary policy shocks under the ZLB. In contrast, the effect of unconventional monetary policy during the ZLB was substantial. Our estimates suggest that total credit creation (destruction) would have been 0.89 (0.38) percentage points lower if monetary policy had been bounded by the ZLB. The contribution of unconventional monetary policy to increasing the dynamism of credit reallocation over this period was nontrivial. Recall that total credit reallocation and excess reallocation averaged 9.0% and 6.9%, respectively, over the sample period. Hence, the decline in credit reallocation experienced with the onset of the Great Recession would have been more than one tenth lower had the shadow rate been kept at the ZLB due to the absence of unconventional monetary policy measures.

A question that arises when considering total credit flows is whether the change in credit reallocation stemmed from the impact of monetary policy on long-term or short-term credit. In particular, an increase in the dynamism of long-term credit reallocation would likely result in future investment and economic growth. To answer this question, we disaggregate credit flows into short- and long-term components, re-estimate the FAVAR by rotating in the credit flow measures of interest, and compute the contribution of monetary policy shocks under the two counterfactuals of interest.

Note that for the no monetary shock counterfactual, Table 4 shows that the responses of short and long-term credit creation (destruction) mirror those of total credit creation (destruction). The impact on short-term (long-term) credit creation is slightly larger than that on short-term (long-term) credit destruction, yet both magnitudes are small relative to their historical averages (less than 5%). As for the ZLB counterfactual, the positive effect of unconventional monetary policy on total credit reallocation is explained by an increase in short- (0.51 percentage points) and long-term credit creation (0.88 percentage points) as well as in long-term credit destruction. In contrast, unconventional monetary policy led to a decline of 0.26 percentage points in short-term credit destruction. On the one hand, given that short-term debt mostly serves to cover the time lag between a firm's payment of its operational costs (e.g., wages) and the accrual of returns, the rise (decline) in credit creation (destruction) suggests unconventional monetary policy facilitated firm's operations during the ZLB. On the other hand, because long-term debt typically finances long-term investment plans, the increased reallocation of long-term credit appears to have been a channel through which unconventional monetary policy had a positive impact on firm output and, thus, on aggregate economic activity.

4.3 Unconventional monetary policy, credit reallocation and financial frictions

Did unconventional monetary policy result in increased credit reallocation among firms that faced greater financial constraints? Was monetary policy during the ZLB able to foster the dynamism of the credit reallocation process among firms with different financial characteristics? Theoretical macroeconomic models suggest financial frictions play an important role in the transmission of monetary policy shocks. However, the role of these frictions in the propagation of monetary policy to credit reallocation is limited. One exception is the work by Bianco (2018), who finds that expansionary monetary policy is associated with positive long-term credit creation and reallocation, specifically for firms that are financially constrained or perceived as relatively risky. These findings are consistent with theoretical transmission mechanisms of monetary policy. Nevertheless, Bianco (2018) does not inquire into the effect of unconventional monetary policy during the ZLB.

To answer these questions, we extend the counterfactual analysis carried out in the previous section. First, we divide Compustat firms into subgroups using the proxies described in section 2.1.2. Then, we re-estimate the FAVAR with the addition of these measures in Y_t, and compute the two counterfactuals during the ZLB.

We begin by analyzing the policy counterfactuals for financially dependent and non-financially dependent firms. As the no monetary shock counterfactual in Table 4 illustrates, had the Fed avoided deviations from the traditional monetary policy rule during the ZLB, credit creation and destruction for both groups would have

been lower. The only noticeable difference is a larger increase in short-term credit creation for financially-dependent firms and a greater rise in long-term credit creation for non-financially dependent firms. In addition, the ZLB counterfactual illustrates how unconventional monetary policy generated similar increases in long-term credit creation and destruction for both groups, yet it resulted in decreased short-term credit reallocation. Note how both short-term credit creation and destruction have negative signs for both groups. These results suggest that monetary policy during the ZLB had comparable effects on credit reallocation for both financially and non-financially dependent firms, with the exception that unconventional measures led to a greater rise in long-term credit creation for non-financially dependent firms. In brief, there appears to is no evidence that unconventional monetary policy had a greater impact on financially-dependent firms.

To put our results in perspective, recall that Kudlyak and Sanchez find that the median decrease in short-term credit was relatively large for non-financially dependent firms during the Great Recession. Our results suggest that part of the decline in short-term credit for financially dependent firms could be explained by the implementation of unconventional monetary policy during the ZLB. In fact, the ZLB counterfactual implies a decline in net short-term credit of 0.31 percentage points for financially-dependent firms, while the decline for non-financially dependent was a mere 0.05.

Recall, however, that a firm might be classified as financially dependent if it faces any of the financial constraints that are proxied by variables such as default probability, size, etc. Thus, to dig deeper into the possible heterogeneity in the response of credit flows to unconventional monetary policy across different firm groups we now present the results for the different groups.

Next, we examine monetary policy counterfactuals for high and low default probability firms. Total credit creation was 1.26 percentage points larger for high default probability firms and 0.89 percentage points for low default probability firms for the ZLB counterfactual. Further, actual credit destruction was 0.79 percentage points higher for high default probability firms and 0.44 percentage points higher for low default probability firms compared to the counterfactual. These amount to nearly identical net credit changes for these groups of firms. However, actual monetary policy induced a far larger and more intense credit reallocation for high default probability firms during the ZLB. These effects were concentrated on long-term credit flows; short-term credit creation fell for high default probability firms.

Did credit reallocation for small –usually more credit constrained– firms experienced a greater boost from unconventional monetary policy than credit reallocation for large firms? Estimation results reported in Table 4 reveal only small effects and differences across size for the no monetary policy shocks counterfactual. Nevertheless, the ZLB counterfactual reveals that unconventional monetary policy had a greater boost on short-term credit creation for small firms (1.07 percentage points) relative to large firms (0.21 percentage points). In contrast, the estimated wedges for short-term credit destruction show a larger decline for large (-0.34) than small (-0.10) firms. Put together, these number imply a larger effect of the ZLB on the reallocation of short-term credit for small firms. This is also the case for long-term credit reallocation, which increased substantially for small firms under the ZLB counterfactual.

Perhaps more striking are the differences in the effects of unconventional monetary policy on high and low debt service firms. Given that external finance is more costly and marginally more difficult to obtain for the latter (Calomiris and Himmelberg, 1995), we would suspect that the easing of credit conditions implied by the ZLB counterfactual would have played a greater role in channeling credit. Indeed, as illustrated by the results in Table 4, unconventional monetary policy caused large increases in short and long-term credit creation for high debt service firms. Note the increase of 0.94 and 1.18 percentage points in short and long-term credit creation, respectively, for high debt service firms in the ZLB counterfactual. In addition, the estimated wedges for short-term (long-term) credit destruction were negative (positive) for both groups. Two results stand out when we compute the effects of the ZLB on net credit changes and credit reallocation. First, unconventional monetary policy led to an increase in both short- and long-term credit for high and low debt service firms. Second, while these policies resulted in increased credit reallocation for high debt service firms, credit reallocation fell for low debt service firms. However, a caveat is needed here. Because low debt service firms hold little or no debt whatsoever, and by our classification, 4.22 percent of quarter-firm observations in Compustat report no holdings of debt. Accordingly, each firm considered as low debt service that has positive debt receives a relatively large weight in the overall credit flow measures. Hence, our finding of increased reallocation for high debt service firms is consistent with unconventional monetary policy's impact on credit markets working through the easing of financial constraints.

Lastly, we examine the impact of unconventional monetary policy on old and young firms. For young

firms, whom are more likely to be financially dependent, both long- and short-term credit creation increased substantially, rising 1.05 and 0.65 percent, respectively, in the ZLB counterfactual. These wedges are larger than the 0.89 and 0.32 percentage point for old firms. The impact of unconventional monetary policy on credit destruction is similar for both groups. These results imply that whereas unconventional monetary policy had only a small impact on net credit changes for old firms, it had a negative impact for the young. However, it boosted short- and long-term credit reallocation for the latter.

To summarize, we find only some evidence that the no monetary policy shocks counterfactual had an heterogenous effect across groups of firms facing different degrees of financial constraints. More precisely, had the Fed followed a traditional monetary policy rule, credit reallocation would have been more intense for large (high debt service) firms than for small (low debt service) firms whereas the differences across other proxies would have been small. In contrast, differences in the response of credit flows to unconventional monetary policy cut across various dimensions. If the Fed had been constrained by the ZLB, long-term credit reallocation would have been considerably lower for small and high-debt service firms.

4.4 The Contribution of the Different Rounds of Quantitative Easing

Between November 2008 and October 2014, the Federal Reserve conducted several rounds of quantitative easing, referred to as QE1 (Q3:2009–2010:Q1),[11] QE2 (2010:Q4–2011:Q2), operation twist (2011:Q3–2012:Q4), and QE3 (2012:Q3–2014:Q4). These rounds were intended to extend credit to certain financial institutions, provide liquidity to credit markets, and affect long-term interest rates via the purchase long-term securities. In this section, we quantify the contribution of these rounds of quantitative easing on the allocation of credit.

4.4.1 QE1

The period known as QE1 began in November 2008 and ended in March 2010. During this time, the Federal Reserve Board established the Term Asset-Backed Securities Loan Facility (TALF). This facility was created to lend (non-recourse) to holders of AAA-rated asset-backed securities that were backed by new or recent loans. Initially, up to $180 billion was funded by the Federal Reserve and $20 billion from the Troubled Asset Relief Program (TARP). This amount later increased to $1 trillion with expanded acceptable collateral. The Federal Reserve also agreed to purchase up to $200 billion in agency debt, $1.25 trillion in agency mortgage-backed securities, and $300 billion in long-term Treasury securities.

Table 5 reports the counterfactuals for QE1, 2009:Q3–2010:Q1. As the first panel illustrates, monetary policy shocks had a negligible impact on the evolution of credit flows during this period. The effect of the ZLB was somewhat greater, but still small in magnitude for the aggregate and across different groups of firms. As it was the case for the whole ZLB period, the largest increases in credit creation during QE1 are observed in long-term credit creation for small and young firms, whereas the largest increase in credit destruction is observed for low debt service and high default probability firms.

Through TALF and the purchases of agency mortgage-backed securities, policymakers provided funding to holders of toxic assets to ease credit markets. During QE1, unconventional monetary policy caused relatively large increases in short-term credit creation for low debt service and small firms compared to high debt service and large firms. However, we find that increases in long-term credit creation due to unconventional monetary policy were greatest for financially constrained firms. Specifically, we find that small firms' credit creation increased 0.22 percentage points and young firms' credit creation increased 0.14 percentage points due to unconventional monetary policy. This was the likely result of the Federal Reserve's purchases of long-term Treasury securities, aimed at lowering long-term yields to stimulate long-term lending.

4.4.2 QE2

QE2 began in November 2010 and concluded in June 2011. This round of quantitative easing included monthly $75 billion purchases of Treasury securities, up to a total of $600 billion. At the end of QE2, the Federal Reserve continued to reinvest principal payments of their holdings. In a sense, QE2 was aimed at providing funding to lenders in the same manner as QE1. Hence, the question that arises is whether this policy effected the reallocation of credit among firms.

[11] While QE1 started in 2008:Q4, we start the counterfactual period in 2009:Q3 as in Wu and Xia (2016) because the shadow rate does not become negative until this quarter.

Table 6 reports the counterfactuals for QE2 (2010:Q4–2011:Q2). As with QE1, the first panel indicates that monetary policy shocks had a rather small effect during QE2. The only exception appears to be long-term credit creation for small firms, which experienced a 0.22 percentage points increase. The ZLB counterfactual shows a positive but small effect of unconventional monetary policy on long-term credit destruction (0.06) and creation (0.12) during QE2. Conversely, the contribution of the policy to aggregate short-term credit creation and destruction was small during QE2. In line with our findings for QE1, we estimate that unconventional monetary policy during QE2 exerted a larger stimulus on the reallocation of long-term credit than on short-term credit. This result is robust across different groups and more pronounced for high debt service firms.

4.4.3 Operation Twist

In September 2011, the Federal Reserve announced that they would hold more long-term relative to short-term Treasuries, popularly referred to as operation twist. This would be achieved by simultaneously purchasing $400 billion of 6-30 year Treasuries and selling $400 billion of Treasuries with maturities of 3 years or less. The aim of operation twist was to put downward pressure on long-term yields so as to boost credit markets beyond the stimulus provided by QE1 and QE2. The Federal Reserve also agreed to purchase additional agency mortgage-backed securities. While the simultaneous purchase and sale of Treasuries concluded in December 2012, the purchase of mortgage-backed securities continued beyond this time.

Even though these actions were intended to boost long-term credit, we find little evidence that unconventional monetary policy caused a notably larger increase in long-term credit reallocation during operation twist compared to QE1 and QE2. The second panel of Table 7 indicates that unconventional monetary policy caused long-term credit creation to increase 0.15 percentage points and short-term credit creation to increase 0.12 percentage points. Furthermore, unconventional monetary policy had only a minor impact on credit destruction during operation twist.

Operation twist made lenders' holding of long-term Treasuries less appealing because of their smaller yield. In effect, it may have induced lenders to seek higher returns elsewhere (Rajan, 2006). The ZLB counterfactual in Table 7 reveals some heterogeneity in the responses to unconventional monetary policy during operation twist. First, the increase in short-term credit creation was greater for financially dependent (0.24 percentage points), low default probability (0.15 percentage points) and high debt service firms (0.22 percentage points) relative to their counterparts. Second, the effect on short-term credit destruction was negligible for all groups but low debt service firms, which experienced a decline in credit destruction. As for long-term credit, the ZLB counterfactual indicates unconventional monetary policy boosted credit creation for almost all groups –with the exception of low debt service firms– and only a small increase in long-term credit destruction.

All in all, we find that monetary policy shocks –no monetary shock counterfactual– had a negligible effect on credit reallocation, whereas unconventional monetary policy measures –ZLB counterfactual– led to a 0.21 (0.12) percentage point increase in gross (excess) credit reallocation during operation twist. The increased fluidity in credit reallocation appears to have been somewhat greater for high default, high debt service and large firms than for their counterparts.

4.4.4 QE3

In September 2012, during operation twist, the Federal Reserve announced their plans for the final round of quantitative easing (QE3). During this round, the Federal Reserve purchased $40 billion of agency mortgage-backed securities and $45 billion of long-term Treasuries per month. At this time, they also announced that these purchases would continue until economic conditions improved. By early 2014, the Federal Reserve reduced purchases by $5 and $10 billion each month, eventually concluding QE3 by October 2014.

Estimated wedges for credit creation and destruction during QE3 (2012:Q3-2014:Q4) are reported in Table 8. A quick glance at the table reveals a somewhat different picture for the no monetary shock counterfactual relative to the previous rounds of QE and operation twist. Monetary shocks lead to greater aggregate credit reallocation. More precisely, credit creation and destruction increased 0.14 and 0.24 percentage points, respectively. That is, while the induced change in aggregate net credit equaled 0.10 percentage points, gross (excess) credit reallocation increased by 0.38 (0.28) percentage points.

The ZLB counterfactual results in Table 8 show that unconventional monetary policy caused a substantial reallocation of aggregate long-term credit during QE3. The estimated wedges for long-term credit creation and destruction equaled 0.40 and 0.23 percentage points, respectively. These imply an increase of 0.63 (0.46) in gross (excess) long-term credit reallocation. The boost in long-term credit creation tended to be larger for financially constrained firms, specifically for high debt service firms, high default probability firms, small, or young firms. In contrast, while the policy led to an expansion in aggregate short-term credit creation (0.17 percentage points), it caused a larger contraction in short-term credit destruction (-0.21 percentage points). These changes amount to a decline in short-credit reallocation during QE3. Notable increases in short-term credit creation were also experienced by firms less likely to be financially constrained such as low default probability and low debt service firms.

4.5 Unconventional Monetary Policy and Investment Efficiency

A question that arises when studying the link between the allocation of credit, investment and monetary policy is whether the effect of the latter varies across firms with varying degrees of investment efficiency. Answering this question is key as credit extended to firms of high investment efficiency ought to lead to higher economic growth.

As in Herrera, Kolar and Minetti (2014), we use an investment efficiency index by Galindo, Schiantarelli and Weiss (2007), constructed as

$$I_{it} = \frac{\frac{sales_{it}}{capital_{it}} \frac{debt_{it}}{debt_{st}}}{\frac{sales_{it-1}}{capital_{it-1}} \frac{debt_{it-1}}{debt_{st-1}}}. \tag{15}$$

A ratio exceeding one indicates that a firm's investment, on average, is efficient because the debt-weighted sales as a percentage of capital is growing. Many firms tend to have indexed close to one, so we classify firms in the top tercile as productive firms and firms in the bottom tercile as less productive firms to analyze dissimilarities in credit flows of such firms across time.

A priori, it is unclear if firms of high or low investment efficiency are likely to be financially constrained. Table 9 describes these two groups in terms of the average default probabilities, leverage ratios, asset size, and need for external finance. On average, we find that high productivity firms tend to have lower default probabilities than low productivity firms. We also find that low productivity firms tend to have less need for external financing across time, although for both groups of firms –because the need for external financing ratio is negative– this implies that firms on both ends of the investment efficiency index spectrum tend to generate a relatively large amounts of cash flow. While a brief analysis of the average default probabilities and need for external finance would suggest that low productivity firms are also financially constrained, we also find that these firms tend to have lower leverage and higher asset values. Therefore, a priori the relationship between investment efficiency and financial constraints is unclear.

We compute credit flow measures for high and low investment efficiency firms (i.e. productive and less productive firms), shown in Table 9. At short and long maturities, credit creation of productive firms largely exceeds credit creation of less productive firms. On the contrary, credit destruction of less productive firms more than doubles that of productive firms. Thus, net credit grew for productive firms, while it decreased for less productive firms over the whole sample. Moreover, Table 9 reveals an increase in the fluidity of total credit for productive firms ($SUM = 2.53\%$) and a decrease for less productive ($SUM = -0.83\%$) firms during the ZLB.

How much in this reshuffling of credit towards more productive firms is explained by monetary policy shocks and unconventional monetary policy? To answer this question, Table 10 reports the estimated wedges under the two policy counterfactuals during the rounds of quantitative easing and operation twists. The methodology used to compute these wedges is similar to that used in the earlier sections with the differences that in the FAVAR, we rotate in the credit flows of productive and less productive firms.

Four results stand out. First, consistent with our earlier findings, the effects of the no monetary policy shock counterfactual are negligible for all rounds but QE3. Second, monetary policy shocks during QE3 lead to a greater increase in credit creation among productive firms, especially for long-term credit. Third, unconventional monetary policy gave rise to greater increases –an order of magnitude larger– in credit creation for productive firms. Finally, the impact of unconventional monetary policy on credit reallocation

was about twice as large during QE3 than during the earlier rounds.

5 Conclusion

In this paper, we show that unconventional monetary policy had a large and persistent impact on the allocation of credit among borrowing firms during the ZLB. Unconventional monetary policy led to a 0.89 (0.38) percentage points increase in total credit creation (destruction) during the ZLB. The resulting increase in credit reallocation was mainly driven by the response of aggregate long-term credit creation and destruction, although unconventional monetary policy also caused substantial increases in short-term credit creation and destruction. This reallocation of credit is not accounted for when analyzing the impact of monetary policy shocks on net credit changes alone. However, it highlights the ability of unconventional monetary policy to reshuffle long-term credit and thus foster investment and growth.

We computed credit flows of financially constrained and non-financially constrained firms and investigated whether the effect of unconventional monetary policy was heterogeneous. We showed that unconventional monetary policy caused relatively large increases in long-term credit creation for high default probability, small, high debt service, and young firms. This suggest that unconventional monetary policy was effective at easing financial constraints of firms in long-term credit.

Because unconventional monetary policy was conducted in rounds of quantitative easing, we separated the contribution of monetary policy shocks to credit creation and destruction during these periods. We showed that QE3 exerted the largest stimulus on credit reallocation. Indeed, it led to about a tenth more total credit creation and destruction (42 and 0.20 percentage points, respectively) than it would have been observed in the absence of unconventional monetary policy measures. We showed that long-term credit creation increased substantially more for groups of firms classified as financially constrained during this round of quantitative easing, implying that unconventional monetary policy was effective at easing financial constraints of borrowing firms.

Finally, our results show that short- and long-term credit creation for productive firms were more responsive to unconventional monetary policy during the ZLB. Our results provide important insights into the transmission of unconventional monetary policy to credit flows and the aggregate economy. First, they imply that the measures taken by the Fed once the federal funds rate had hit the ZLB were effective in reshuffling credit toward financially constrained firms. Second, unconventional monetary policy fostered the allocation of credit towards those better equipped to invest and grow. In other words, our results provide evidence suggesting these policies had a positive impact on the aggregate economy by increasing the fluidity of long-term credit markets.

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6 Tables

Table 1: Descriptive Statistics for Financially Constrained and Non-Financially Constrained Firms (1974:Q1–2017:Q1)

		Average					Coefficient of variation				
		POS	NEG	NET	SUM	EXC	POS	NEG	NET	SUM	EXC
(a) Total credit	All firms	5.4	3.5	1.9	9.0	6.9	40.6	28.0	111.1	30.1	27.3
	Financially dependent firms	6.1	3.7	2.4	9.8	6.2	71.6	64.5	208.9	49.8	51.7
	Non-financially dependent firms	6.8	5.2	1.7	12.0	8.2	71.9	58.3	356.1	45.9	40.0
	High default probability firms	7.5	4.4	3.1	12.0	6.8	79.9	124.0	270.3	65.8	53.9
	Low default probability firms	5.2	3.6	1.5	8.8	7.0	37.4	30.7	123.0	28.7	27.9
	Large firms	5.1	3.2	1.9	8.2	6.1	49.1	36.3	121.1	37.8	35.6
	Small firms	8.0	6.2	1.8	14.2	11.9	33.5	28.6	129.4	27.3	27.0
	Old firms	5.0	3.0	2.0	7.9	5.7	45.8	27.0	115.3	31.4	24.2
	Young firms	6.7	2.8	3.8	9.5	5.6	70.3	28.1	127.4	48.7	26.3
	High debt service firms	5.5	3.0	2.5	8.6	5.9	52.2	36.7	113.5	38.8	36.7
	Low debt service firms	7.4	11.7	-4.2	19.1	13.2	72.1	42.9	-143.3	44.1	58.7
(b) Short-term credit	All firms	15.1	7.1	8.1	22.2	14.1	30.4	23.4	56.6	23.3	22.7
	Financially dependent firms	16.3	7.3	9.0	23.6	13.1	62.3	72.6	129.3	47.6	51.8
	Non-financially dependent firms	18.4	8.7	9.7	27.0	16.0	58.1	45.2	122.9	40.1	41.8
	High default probability firms	15.8	7.9	8.0	23.7	13.6	58.4	73.0	133.4	47.0	56.1
	Low default probability firms	15.1	7.1	8.0	22.2	14.2	34.2	25.5	64.9	25.9	24.9
	Large firms	13.6	6.5	7.1	20.1	12.8	38.1	25.7	73.6	28.0	25.4
	Small firms	27.3	11.4	15.8	38.7	22.9	19.9	18.6	34.6	15.9	18.6
	Old firms	15.0	6.8	8.1	21.8	13.6	41.6	29.3	76.3	31.5	28.3
	Young firms	16.0	5.8	10.2	21.8	11.6	43.8	31.9	69.8	33.8	31.7
	High debt service firms	15.1	6.2	8.9	21.3	12.4	43.3	31.2	72.0	33.8	31.2
	Low debt service firms	7.3	8.3	-1.0	15.6	11.6	60.8	64.7	-609.5	50.0	50.8
(c) Long-term credit	All firms	5.9	3.6	2.3	9.5	7.1	41.6	32.7	94.3	33.6	32.6
	Financially dependent firms	7.0	3.8	3.3	10.8	6.5	90.7	60.6	207.2	62.6	54.0
	Non-financially dependent firms	7.1	5.0	2.1	12.1	8.2	79.9	69.7	334.0	53.3	44.8
	High default probability firms	8.5	4.2	4.3	12.7	6.6	98.8	112.1	238.8	71.3	45.4
	Low default probability firms	5.6	3.7	1.9	9.3	7.3	37.8	33.6	95.3	31.8	32.1
	Large firms	5.5	3.3	2.2	8.8	6.4	48.8	40.0	105.4	40.3	41.4
	Small firms	8.8	5.6	3.1	14.4	11.2	36.9	30.4	85.5	30.8	29.6
	Old firms	5.4	3.0	2.4	8.4	5.9	44.4	29.4	93.7	33.6	28.6
	Young firms	7.1	2.8	4.3	10.0	5.6	70.3	26.1	119.3	50.2	25.9
	High debt service firms	6.2	3.3	2.8	9.5	6.6	50.6	40.0	100.4	40.7	40.2
	Low debt service firms	20.5	9.5	11.0	29.9	18.3	55.0	58.0	98.3	46.9	54.1

Note: Following Farre-Mensa and Ljungqvist (2016), high default probability firms are those which the default probability exceeds 25 percent at a point in time and all others are low default probability firms. High debt service firms are those which the leverage ratio is in the top tercile of firms in a given quarter and low debt service are those for which the leverage ratio is in the bottom tercile of firms in a given quarter. Firms are large if the value of their total assets is in the top tercile of firms in a given quarter and are small if the value of their total assets is in the bottom tercile of firms in a given quarter. Financially dependent firms are those which the need for external financing (Rajan and Zingales,1998) is in the top tercile in a given quarter and are non-financially dependent if this ratio is in the bottom tercile of firms in a given quarter. Young firms are those listed in Computstat fewer than 16 years prior to the date of inclusion.

Table 2: Transitions Between Classifications

t-1 \ t	High default probability	Low default probability	Large	Small	High debt service	Low debt service	Old	Young	Financially dependent	Non-financially dependent
High default probability	0.843	0.037								
Low default probability	0.157	0.963								
Large			0.981	0.000						
Small			0.000	0.980						
High debt service					0.917	0.012				
Low debt service					0.011	0.929				
Old							0.984	0.000		
Young							0.016	1.000		
Financially dependent									0.787	0.053
Non-financially dependent									0.050	0.735

Note: This table provides probabilities that a firm belongs to a certain classification in time t conditional on the classification in $t-1$. In classifying firms by terciles, the omitted probability corresponds to the probability of being in the middle tercile conditional on being in the top or bottom tercile in the previous quarter. Following Farre-Mensa and Ljungqvist (2016), high default probability firms are those which the default probability exceeds 25 percent at a point in time and all others are low default probability firms. High debt service firms are those which the leverage ratio is in the top tercile of firms in a given quarter and low debt service are those for which the leverage ratio is in the bottom tercile of firms in a given quarter. Firms are large if the value of their total assets is in the top tercile of firms in a given quarter and are small if the value of their total assets is in the bottom tercile of firms in a given quarter. Financially dependent firms are those which the need for external financing (Rajan and Zingales,1998) is in the top tercile in a given quarter and are non-financially dependent if this ratio is in the bottom tercile of firms in a given quarter. Young firms are those listed in Computstat fewer than 16 years prior to the date of inclusion.

Table 3: Change in Credit Flows During the Zero Lower Bound (2009:Q3–2015:Q3)

	Short-term credit				
	POS	NEG	NET	SUM	EXC
Small firms	4.35	4.97	-0.62	9.32	8.70
Large firms	0.20	-2.17	2.37	-1.97	-4.34
Financially dependent firms	-1.73	-5.12	3.39	-6.85	-10.24
Non-financially dependent firms	0.13	-1.28	1.41	-1.15	-2.56
High default probability firms	9.70	1.64	8.06	11.34	3.28
Low default probability firms	0.10	-2.29	2.39	-2.19	-4.58
High debt service firms	-1.68	-0.33	-1.35	-2.01	-3.36
Low debt service firms	-0.28	0.73	-1.01	0.45	-0.56
Old firms	2.93	-4.38	7.31	-1.45	-8.76
Young firms	-6.78	2.64	-9.42	-4.14	5.27
	Long-term credit				
	POS	NEG	NET	SUM	EXC
Small firms	9.96	-1.76	11.72	8.20	-3.52
Large firms	-0.15	1.00	-1.15	0.85	-0.30
Financially dependent firms	3.88	-1.56	5.44	2.32	-3.12
Non-financially dependent firms	-1.65	1.00	-2.65	-0.65	-3.30
High default probability firms	4.64	-0.28	4.92	4.36	-0.56
Low default probability firms	-0.36	0.93	-1.29	0.57	-0.72
High debt service firms	-0.38	1.36	-1.74	0.98	-0.76
Low debt service firms	3.73	-2.98	6.71	0.75	-5.96
Old firms	1.09	0.19	0.89	1.28	0.39
Young firms	-2.06	0.63	-2.69	-1.44	1.25

Note: This table provides the change in credit flow measures over the period 2009:Q3–2015:Q3. Following Farre-Mensa and Ljungqvist (2016), high default probability firms are those which the default probability exceeds 25 percent at a point in time and all others are low default probability firms. High debt service firms are those which the leverage ratio is in the top tercile of firms in a given quarter and low debt service are those for which the leverage ratio is in the bottom tercile of firms in a given quarter. Firms are large if the value of their total assets is in the top tercile of firms in a given quarter and are small if the value of their total assets is in the bottom tercile of firms in a given quarter. Financially dependent firms are those which the need for external financing (Rajan and Zingales,1998) is in the top tercile in a given quarter and are non-financially dependent if this ratio is in the bottom tercile of firms in a given quarter. Young firms are those listed in Computstat fewer than 16 years prior to the date of inclusion.

Table 4: Policy Counterfactuals During the Zero Lower Bound (2009:Q3–2015:Q3)

	(a) Counterfactual 1: no monetary shock						**(b) Counterfactual 2: zero lower bound**					
	Total credit		Short-term credit		Long-term credit		Total credit		Short-term credit		Long-term credit	
	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS
All firms	+0.06	+0.20	+0.02	+0.19	+0.07	+0.20	+0.38	+0.89	−0.26	+0.51	+0.43	+0.88
Financially dependent firms	+0.13	+0.26	+0.09	+0.68	+0.17	+0.28	+0.50	+0.75	−0.46	−0.35	+0.57	+0.77
Non-financially dependent firms	+0.19	+0.34	+0.19	+0.20	+0.16	+0.38	+0.65	+0.94	−0.36	−0.50	+0.63	+0.83
High default probability firms	+0.03	+0.35	−0.05	+0.02	−0.01	+0.39	+0.79	+1.26	+0.27	−0.10	+0.57	+1.30
Low default probability firms	+0.10	+0.24	+0.03	+0.26	+0.12	+0.28	+0.44	+0.89	−0.29	+0.67	+0.48	+0.86
Large firms	+0.08	+0.26	−0.08	+0.01	−0.08	+0.01	+0.40	+0.99	−0.34	+0.21	−0.34	+0.21
Small firms	−0.08	−0.04	−0.09	+0.25	−0.05	−0.14	+0.15	+0.70	−0.10	+1.07	+0.23	+0.54
High debt service firms	+0.07	+0.30	+0.04	+0.40	+0.11	+0.35	+0.37	+1.21	−0.34	+0.94	+0.46	+1.18
Low debt service firms	−0.12	−0.17	−0.29	−0.14	−0.19	−0.32	+0.25	−0.42	−1.10	+0.40	+0.33	−0.83
Old firms	+0.04	+0.25	+0.00	+0.17	+0.06	+0.29	+0.22	+0.93	−0.47	+0.32	+0.27	+0.89
Young firms	+0.04	+0.20	−0.04	+0.22	+0.06	+0.20	+0.09	+1.08	-0.44	+0.65	+0.13	+1.05

Note: This table shows the percentage difference in how credit destruction (NEG) and credit creation (POS) would respond to monetary policy counterfactuals. Counterfactual 1 is a scenario absent of monetary policy innovations and Counterfactual 2 is a scenario whereby monetary policy innovations are such that the policy rate (shadow federal funds rate as in Wu and Xia (2016) is at the zero lower bound. The table presents the wedge between the contribution of the counterfactual monetary policy innovations and the actual innovations. A positive number suggests that the actual monetary policy contributed positively to the credit flow measure relative to the counterfactual. Following Farre-Mensa and Ljungqvist (2016), high default probability firms are those which the default probability exceeds 25 percent at a point in time and all others are low default probability firms. High debt service firms are those which the leverage ratio is in the top tercile of firms in a given quarter and low debt service are those for which the leverage ratio is in the bottom tercile of firms in a given quarter. Firms are large if the value of their total assets is in the top tercile of firms in a given quarter and are small if the value of their total assets is in the bottom tercile of firms in a given quarter. Financially dependent firms are those which the need for external financing (Rajan and Zingales,1998) is in the top tercile in a given quarter and are non-financially dependent if this ratio is in the bottom tercile of firms in a given quarter. Young firms are those listed in Computstat fewer than 16 years prior to the date of inclusion.

Table 5: Policy Counterfactuals During QE1 (2009:Q3–2010:Q1)

	(a) Counterfactual 1: no monetary shock						**(b) Counterfactual 2: zero lower bound**					
	Total credit		Short-term credit		Long-term credit		Total credit		Short-term credit		Long-term credit	
	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS
All firms	−0.01	−0.01	+0.01	+0.01	+0.00	−0.01	+0.06	+0.10	−0.07	−0.01	+0.07	+0.10
Financially dependent firms	+0.00	+0.00	+0.02	+0.04	+0.00	+0.00	+0.04	+0.02	−0.16	−0.47	+0.04	+0.02
Non-financially dependent firms	−0.01	−0.01	+0.01	+0.03	+0.00	−0.01	+0.03	+0.01	−0.19	−0.24	+0.07	−0.02
High default probability firms	−0.01	−0.01	−0.01	+0.01	+0.01	−0.01	+0.18	+0.08	+0.09	−0.04	+0.15	+0.08
Low default probability firms	+0.00	+0.00	+0.00	+0.01	+0.01	+0.01	+0.05	+0.08	−0.08	+0.00	+0.06	+0.07
Large firms	+0.00	+0.00	+0.00	+0.00	+0.01	+0.01	+0.06	+0.10	−0.03	+0.04	+0.07	+0.09
Small firms	+0.00	+0.00	−0.01	−0.03	+0.01	+0.02	+0.10	+0.21	+0.04	+0.13	+0.09	+0.22
High debt service firms	+0.00	+0.01	+0.01	+0.01	+0.02	+0.03	+0.06	+0.13	−0.10	−0.03	+0.06	+0.12
Low debt service firms	−0.03	−0.01	+0.00	−0.02	+0.00	−0.01	+0.16	+0.03	−0.05	+0.19	+0.21	+0.01
Old firms	+0.00	-0.01	-0.01	+0.00	+0.01	+0.01	+0.03	+0.08	-0.10	-0.02	+0.04	+0.06
Young firms	+0.00	-0.01	+0.03	+0.00	+0.00	+0.01	-0.01	+0.14	-0.08	+0.00	+0.00	+0.14

Note: This table shows the percentage difference in how credit destruction (NEG) and credit creation (POS) would respond to monetary policy counterfactuals. Counterfactual 1 is a scenario absent of monetary policy innovations and Counterfactual 2 is a scenario whereby monetary policy innovations are such that the policy rate (shadow federal funds rate as in Wu and Xia (2016)) is at the zero lower bound. The table presents the wedge between the contribution of the counterfactual monetary policy innovations and the actual innovations. A positive number suggests that the actual monetary policy contributed positively to the credit flow measure relative to the counterfactual. Following Farre-Mensa and Ljungqvist (2016), high default probability firms are those which the default probability exceeds 25 percent at a point in time and all others are low default probability firms. High debt service firms are those which the leverage ratio is in the top tercile of firms in a given quarter and low debt service are those for which the leverage ratio is in the bottom tercile of firms in a given quarter. Firms are large if the value of their total assets is in the top tercile of firms in a given quarter and are small if the value of their total assets is in the bottom tercile of firms in a given quarter. Financially dependent firms are those which the need for external financing (Rajan and Zingales,1998) is in the top tercile in a given quarter and are non-financially dependent if this ratio is in the bottom tercile of firms in a given quarter. Young firms are those listed in Computstat fewer than 16 years prior to the date of inclusion.

Table 6: Policy Counterfactuals During QE2 (2010:Q4–2011:Q2)

	a) Counterfactual 1: no monetary shock						**b) Counterfactual 2: zero lower bound**					
	Total credit		Short-term credit		Long-term credit		Total credit		Short-term credit		Long-term credit	
	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS
All firms	+0.05	+0.08	-0.06	+0.01	+0.06	+0.08	+0.05	+0.11	−0.04	+0.03	+0.06	+0.12
Financially dependent firms	+0.04	+0.02	−0.13	−0.46	+0.04	+0.02	+0.06	+0.08	−0.09	−0.18	+0.06	+0.09
Non-financially dependent firms	+0.03	−0.01	−0.20	−0.22	+0.07	−0.04	+0.06	+0.09	−0.09	−0.13	+0.07	+0.08
High default probability firms	+0.16	+0.07	+0.07	−0.03	+0.14	+0.06	+0.12	+0.14	+0.05	−0.02	+0.09	+0.15
Low default probability firms	+0.05	+0.07	−0.08	+0.03	+0.06	+0.07	+0.06	+0.11	−0.05	+0.05	+0.07	+0.11
Large firms	+0.05	+0.08	−0.04	+0.04	+0.06	+0.08	+0.06	+0.13	−0.03	+0.03	+0.07	+0.12
Small firms	+0.08	+0.19	+0.01	+0.01	+0.08	+0.22	+0.05	+0.13	+0.01	+0.15	+0.06	+0.13
High debt service firms	+0.05	+0.12	−0.09	+0.02	+0.06	+0.11	+0.06	+0.16	−0.06	+0.05	+0.07	+0.16
Low debt service firms	+0.13	+0.01	−0.07	+0.15	+0.19	−0.03	+0.09	+0.00	−0.08	+0.10	+0.11	−0.03
Old firms	+0.02	+0.06	-0.11	+0.02	+0.04	+0.05	+0.03	+0.11	-0.07	+0.01	+0.04	+0.11
Young firms	-0.01	+0.13	-0.06	+0.02	+0.00	+0.15	+0.01	+0.14	-0.06	+0.04	+0.01	+0.14

Note: This table shows the percentage difference in how credit destruction (NEG) and credit creation (POS) would respond to monetary policy counterfactuals. Counterfactual 1 is a scenario absent of monetary policy innovations and Counterfactual 2 is a scenario whereby monetary policy innovations are such that the policy rate (shadow federal funds rate as in Wu and Xia (2016)) is at the zero lower bound. The table presents the wedge between the contribution of the counterfactual monetary policy innovations and the actual innovations. A positive number suggests that the actual monetary policy contributed positively to the credit flow measure relative to the counterfactual. Following Farre-Mensa and Ljungqvist (2016), high default probability firms are those which the default probability exceeds 25 percent at a point in time and all others are low default probability firms. High debt service firms are those which the leverage ratio is in the top tercile of firms in a given quarter and low debt service are those for which the leverage ratio is in the bottom tercile of firms in a given quarter. Firms are large if the value of their total assets is in the top tercile of firms in a given quarter and are small if the value of their total assets is in the bottom tercile of firms in a given quarter. Financially dependent firms are those which the need for external financing (Rajan and Zingales,1998) is in the top tercile in a given quarter and are non-financially dependent if this ratio is in the bottom tercile of firms in a given quarter. Young firms are those listed in Computstat fewer than 16 years prior to the date of inclusion.

Table 7: Policy Counterfactuals During Operation Twist (2011:Q3–2012:Q4)

	(a) Counterfactual 1: no monetary shock						**(b) Counterfactual 2: zero lower bound**					
	Total credit		Short-term credit		Long-term credit		Total credit		Short-term credit		Long-term credit	
	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS
All firms	−0.02	−0.01	+0.06	+0.07	−0.04	−0.02	+0.05	+0.15	−0.01	+0.12	+0.06	+0.15
Financially dependent firms	+0.03	+0.09	+0.15	+0.64	+0.04	+0.10	+0.10	+0.17	−0.01	+0.24	+0.11	+0.18
Non-financially dependent firms	+0.04	+0.12	+0.25	+0.28	+0.00	+0.16	+0.13	+0.23	+0.05	+0.04	+0.11	+0.23
High default probability firms	−0.13	+0.06	−0.09	+0.04	−0.13	+0.06	+0.07	+0.25	+0.00	+0.00	+0.03	+0.27
Low default probability firms	+0.00	+0.02	+0.08	+0.08	−0.02	+0.03	+0.07	+0.16	−0.02	+0.15	+0.08	+0.17
Large firms	-0.02	+0.01	+0.01	−0.04	−0.03	+0.00	+0.06	+0.18	−0.06	+0.02	+0.07	+0.18
Small firms	−0.11	−0.19	−0.06	+0.00	−0.11	−0.27	−0.02	+0.03	−0.04	+0.21	+0.00	−0.01
High debt service firms	−0.02	+0.00	+0.09	+0.14	−0.02	+0.01	+0.05	+0.21	−0.02	+0.22	+0.07	+0.22
Low debt service firms	-−.16	−0.08	−0.06	−0.19	−0.25	−0.12	−0.04	−0.11	−0.21	−0.03	−0.05	−0.19
Old firms	-0.01	+0.03	+0.09	+0.05	-0.02	+0.03	+0.03	+0.18	-0.05	+0.07	+0.04	+0.19
Young firms	+0.02	-0.03	+0.05	+0.07	+0.02	-0.06	+0.03	+0.17	-0.05	+0.15	+0.03	+0.16

Note: This table shows the percentage difference in how credit destruction (NEG) and credit creation (POS) would respond to monetary policy counterfactuals. Counterfactual 1 is a scenario absent of monetary policy innovations and Counterfactual 2 is a scenario whereby monetary policy innovations are such that the policy rate (shadow federal funds rate as in Wu and Xia (2016)) is at the zero lower bound. The table presents the wedge between the contribution of the counterfactual monetary policy innovations and the actual innovations. A positive number suggests that the actual monetary policy contributed positively to the credit flow measure relative to the counterfactual. Following Farre-Mensa and Ljungqvist (2016), high default probability firms are those which the default probability exceeds 25 percent at a point in time and all others are low default probability firms. High debt service firms are those which the leverage ratio is in the top tercile of firms in a given quarter and low debt service are those for which the leverage ratio is in the bottom tercile of firms in a given quarter. Firms are large if the value of their total assets is in the top tercile of firms in a given quarter and are small if the value of their total assets is in the bottom tercile of firms in a given quarter. Financially dependent firms are those which the need for external financing (Rajan and Zingales,1998) is in the top tercile in a given quarter and are non-financially dependent if this ratio is in the bottom tercile of firms in a given quarter. Young firms are those listed in Computstat fewer than 16 years prior to the date of inclusion.

Table 8: Policy Counterfactuals During QE3 (2012:Q3–2014:Q4)

	(a) Counterfactual 1: no monetary shock						**(b) Counterfactual 2: zero lower bound**					
	Total credit		Short-term credit		Long-term credit		Total credit		Short-term credit		Long-term credit	
	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS
All firms	+0.14	+0.24	−0.17	−0.01	+0.16	+0.24	+0.20	+0.42	−0.21	+0.17	+0.23	+0.40
Financially dependent firms	+0.09	+0.04	−0.38	−1.16	+0.09	+0.04	+0.20	+0.23	−0.39	−0.94	+0.22	+0.23
Non-financially dependent firms	+0.10	+0.04	−0.48	−0.58	+0.16	−0.07	+0.26	+0.27	−0.46	−0.55	+0.29	+0.15
High default probability firms	+0.45	+0.23	+0.22	−0.09	+0.38	+0.20	+0.56	+0.51	+0.23	−0.09	+0.44	+0.48
Low default probability firms	+0.13	+0.20	−0.20	+0.02	+0.14	+0.14	+0.20	+0.38	−0.23	+0.25	+0.23	+0.32
Large firms	+0.15	+0.24	−0.08	+0.11	+0.16	+0.19	+0.21	+0.43	−0.17	+0.14	+0.23	+0.38
Small firms	+0.23	+0.53	+0.10	+0.30	+0.21	+0.56	+0.18	+0.55	+0.01	+0.42	+0.19	+0.51
High debt service firms	+0.14	+0.34	−0.24	−0.02	+0.15	+0.27	+0.19	+0.55	−0.27	+0.31	+0.22	+0.49
Low debt service firms	+0.37	+0.04	−0.15	+0.46	+0.49	−0.01	+0.30	−0.14	−0.51	+0.43	+0.40	−0.33
Old firms	+0.08	+0.20	-0.24	-0.01	+0.09	+0.13	+0.11	+0.39	-0.31	+0.12	+0.14	+0.32
Young firms	-0.01	+0.35	-0.21	+0.02	+0.00	+0.35	+0.01	+0.56	-0.28	+0.24	+0.03	+0.54

Note: This table shows the percentage difference in how credit destruction (NEG) and credit creation (POS) would respond to monetary policy counterfactuals. Counterfactual 1 is a scenario absent of monetary policy innovations and Counterfactual 2 is a scenario whereby monetary policy innovations are such that the policy rate (shadow federal funds rate as in Wu and Xia (2016)) is at the zero lower bound. The table presents the wedge between the contribution of the counterfactual monetary policy innovations and the actual innovations. A positive number suggests that the actual monetary policy contributed positively to the credit flow measure relative to the counterfactual. Following Farre-Mensa and Ljungqvist (2016), high default probability firms are those which the default probability exceeds 25 percent at a point in time and all others are low default probability firms. High debt service firms are those which the leverage ratio is in the top tercile of firms in a given quarter and low debt service are those for which the leverage ratio is in the bottom tercile of firms in a given quarter. Firms are large if the value of their total assets is in the top tercile of firms in a given quarter and are small if the value of their total assets is in the bottom tercile of firms in a given quarter. Financially dependent firms are those which the need for external financing (Rajan and Zingales,1998) is in the top tercile in a given quarter and are non-financially dependent if this ratio is in the bottom tercile of firms in a given quarter. Young firms are those listed in Computstat fewer than 16 years prior to the date of inclusion.

Table 9: Characteristics of Productive and Less Productive Firms

	Default probability	
	High productivity firms	Low productivity firms
1970s	1.27	1.39
1980s	2.37	3.19
1990s	3.69	5.35
2000s	5.52	7.99
2010s	4.98	6.96

	Leverage	
	High productivity firms	Low productivity firms
1970s	89.98	83.80
1980s	56.75	50.78
1990s	41.65	38.12
2000s	37.11	32.29
2010s	40.29	33.20

	Asset size	
	Productive firms	Less productive firms
1970s	156,457	178,095
1980s	341,879	416,061
1990s	673,115	855,561
2000s	2,039,329	2,375,676
2010s	4,018,495	4,994,604

	Need for external financing	
	Productive firms	Less productive firms
1970s	-157.21	-165.12
1980s	-288.46	-272.90
1990s	-670.41	-642.25
2000s	-801.73	-707.82
2010s	-1104.39	-874.50

	Age	
	Productive firms	Less productive firms
1970s	16.26	16.85
1980s	14.92	16.18
1990s	13.98	15.33
2000s	15.84	17.15
2010s	18.63	20.52

Note: This table provides the 1 percent trimmed means of default probabilities, leverage ratio (total debt as a percentage of total assets), real assets in 2014 dollars, need for external financing (capital spending less cash flow from operations as a percentage of capital spending), and age for high and low productivity firms. Productive firms are those whose index of the change in debt-weighted sales as a percentage of capital (Galindo, Schiantarelli, and Weiss, 2007) is in the top tercile of firms at a point in time and less productive firms are those in the bottom tercile at a point in time.

*

Table 10: Policy Counterfactuals During the Zero Lower Bound for Productive and Less Productive Firms (2009:Q3–2015:Q3)

		(a) Counterfactual 1: no monetary shock						**(b) Counterfactual 2: zero lower bound**					
		Total credit		Short-term credit		Long-term credit		Total credit		Short-term credit		Long-term credit	
		NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS
QE1	Productive firms	+0.00	−0.02	+0.00	−0.04	+0.00	+0.02	+0.05	+0.32	−0.03	+0.20	+0.05	+0.34
	Less productive firms	−0.01	+0.00	+0.00	+0.00	+0.00	−0.01	+0.07	+0.01	−0.10	+0.00	+0.08	−0.02
QE2	Productive firms	+0.04	+0.24	−0.03	+0.18	+0.04	+0.29	+0.04	+0.36	−0.02	+0.28	+0.04	+0.38
	Less productive firms	+0.06	+0.01	−0.11	+0.02	+0.07	−0.02	+0.10	+0.02	−0.06	−0.02	+0.11	+0.01
Operation twist	Productive firms	−0.01	−0.01	+0.01	+0.11	−0.02	−0.05	+0.04	+0.45	−0.02	+0.55	+0.05	+0.47
	Less productive firms	+0.04	+0.02	+0.12	−0.04	+0.01	+0.04	+0.15	+0.04	+0.00	−0.05	+0.15	+0.04
QE3	Productive firms	+0.11	+0.79	−0.07	+0.58	+0.11	+0.81	+0.16	+1.27	−0.12	+1.37	+0.16	+1.28
	Less productive firms	+0.17	+0.03	−0.24	+0.00	+0.18	−0.06	+0.32	+0.07	−0.25	−0.04	+0.34	−0.03

Note: This table shows the percentage difference in how credit destruction (NEG) and credit creation (POS) would respond to monetary policy counterfactuals. Counterfactual 1 is a scenario absent of monetary policy innovations and Counterfactual 2 is a scenario whereby monetary policy innovations are such that the policy rate (shadow federal funds rate as in Wu and Xia (2016)) is at the zero lower bound. The table presents the wedge between the contribution of the counterfactual monetary policy innovations and the actual innovations. A positive number suggests that the actual monetary policy contributed positively to the credit flow measure relative to the counterfactual. Productive firms are those whose index of the change in debt-weighted sales as a percentage of capital (Galindo, Schiantarelli and Weiss, 2007) is in the top tercile of firms at a point in time and less productive firms are those in the bottom tercile at a point in time.

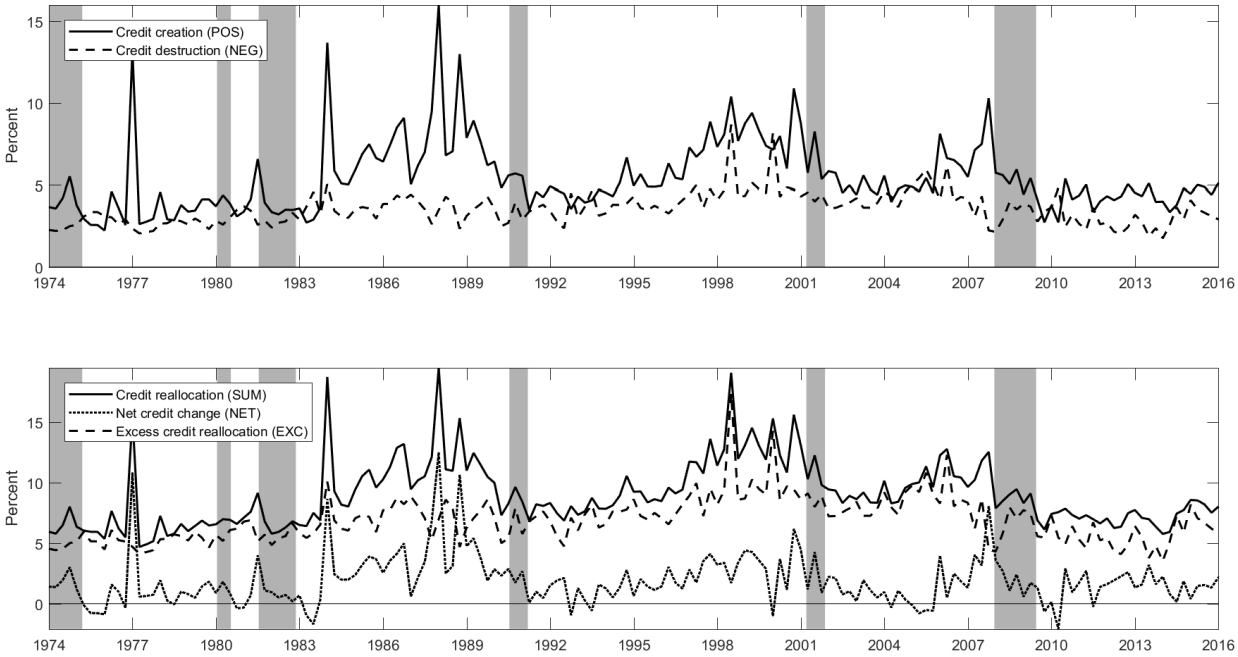
Table 11: Policy Counterfactuals During the Zero Lower Bound - Intensive Margin (2009:Q3–2015:Q3)

		(a) Counterfactual 1: no monetary shock						**(b) Counterfactual 2: zero lower bound**					
		Total credit		Short-term credit		Long-term credit		Total credit		Short-term credit		Long-term credit	
		NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS	NEG	POS
Zero lower bound	All firms	+0.06	+0.20	+0.02	+0.19	+0.07	+0.20	+0.38	+0.89	−0.26	+0.51	+0.43	+0.88
	Intensive margin	+0.03	+0.19	+0.05	+0.11	+0.02	+0.25	+0.16	+0.78	−0.45	+0.42	+0.21	+0.80
QE1	All firms	−0.01	−0.01	+0.01	+0.01	+0.00	−0.01	+0.06	+0.10	−0.07	−0.01	+0.07	+0.10
	Intensive margin	+0.00	−0.04	+0.02	+0.00	+0.00	−0.03	+0.02	+0.03	−0.08	+0.00	+0.02	+0.01
QE2	All firms	+0.05	+0.08	−0.06	+0.01	+0.06	+0.08	+0.05	+0.11	−0.04	+0.03	+0.06	+0.12
	Intensive margin	+0.02	+0.09	−0.08	−0.02	+0.03	+0.10	+0.02	+0.13	−0.07	−0.02	+0.03	+0.15
Operation twist	All firms	−0.02	−0.01	+0.06	+0.07	−0.04	−0.02	+0.05	+0.15	−0.01	+0.12	+0.06	+0.15
	Intensive margin	−0.01	+0.00	+0.09	+0.10	−0.01	−0.01	+0.02	+0.13	−0.05	+0.15	+0.04	+0.14
QE3	All firms	+0.14	+0.24	−0.17	−0.01	+0.16	+0.24	+0.20	+0.42	−0.21	+0.17	+0.23	+0.40
	Intensive margin	+0.04	+0.17	−0.16	−0.08	+0.05	+0.10	+0.08	+0.35	−0.25	+0.08	+0.10	+0.32

Note: This table shows the percentage difference in how credit destruction (NEG) and credit creation (POS) would respond to monetary policy counterfactuals. Counterfactual 1 is a scenario absent of monetary policy innovations and Counterfactual 2 is a scenario whereby monetary policy innovations are such that the policy rate (shadow federal funds rate as in Wu and Xia (2016)) is at the zero lower bound. The table presents the wedge between the contribution of the counterfactual monetary policy innovations and the actual innovations. A positive number suggests that the actual monetary policy contributed positively to the credit flow measure relative to the counterfactual. Intensive margin are firms who are neither entering or exiting Compustat in a period.

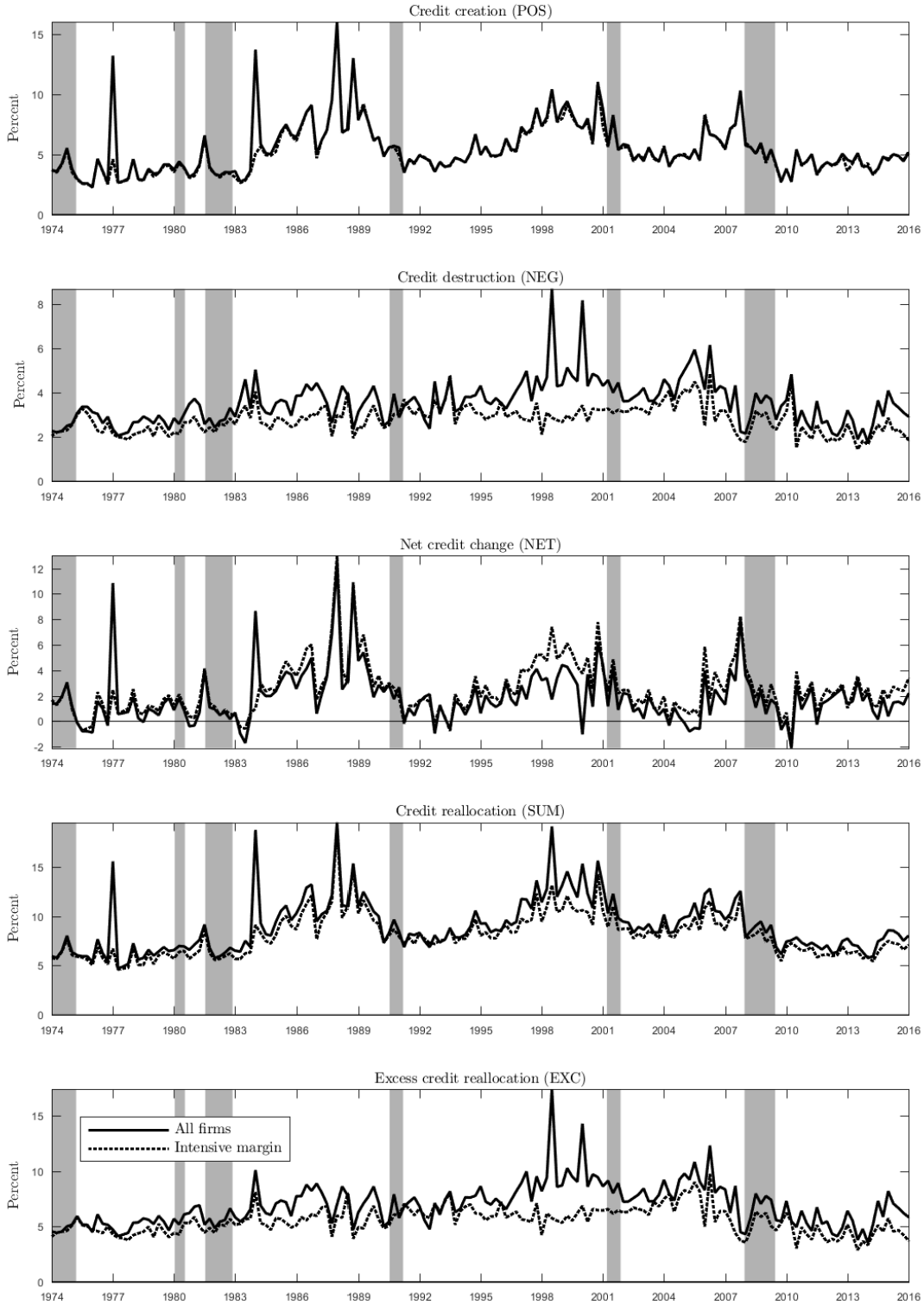
7 Figures

Figure 1: Total Credit Measures of All Publicly Traded Firms



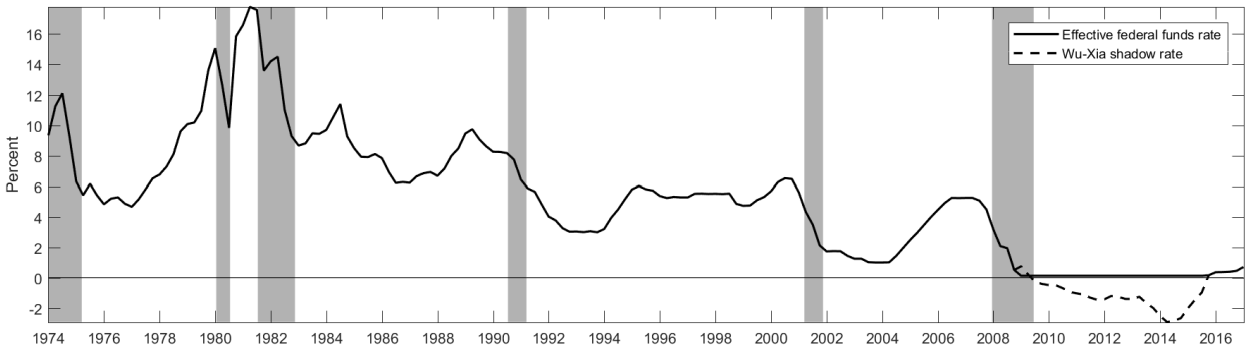
Note: POS refers to credit creation, NEG is credit destruction, NET is net credit change ($NET_{st} = POS_{st} - NEG_{st}$), SUM is credit reallocation ($SUM_{st} = POS_{st} + NEG_{st}$), and EXC is excess credit reallocation ($EXC_{st} = SUM_{st} - |NET_{st}|$) for total credit for all firms. Shaded bars indicate NBER recessions.

Figure 2: Credit flows - Intensive Margin



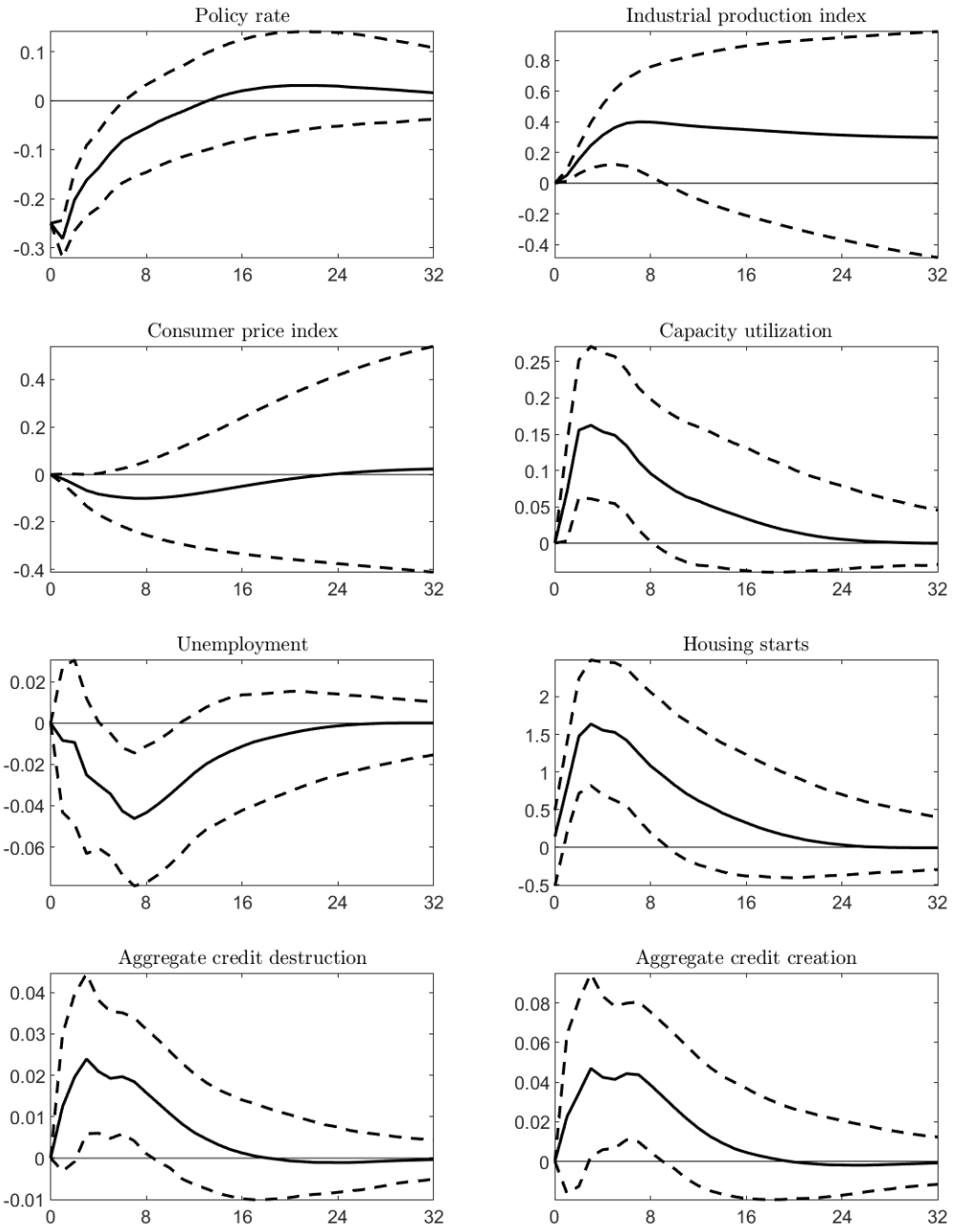
Note: The solid lines are credit flow measures for all firm, including firms entering and exiting the database. The dotted line (intensive margin) are firms that are neither entering or exiting the database in the current quarter. Shaded bars indicate NBER recession.

Figure 3: Effective Federal Funds Rate and Shadow Rate



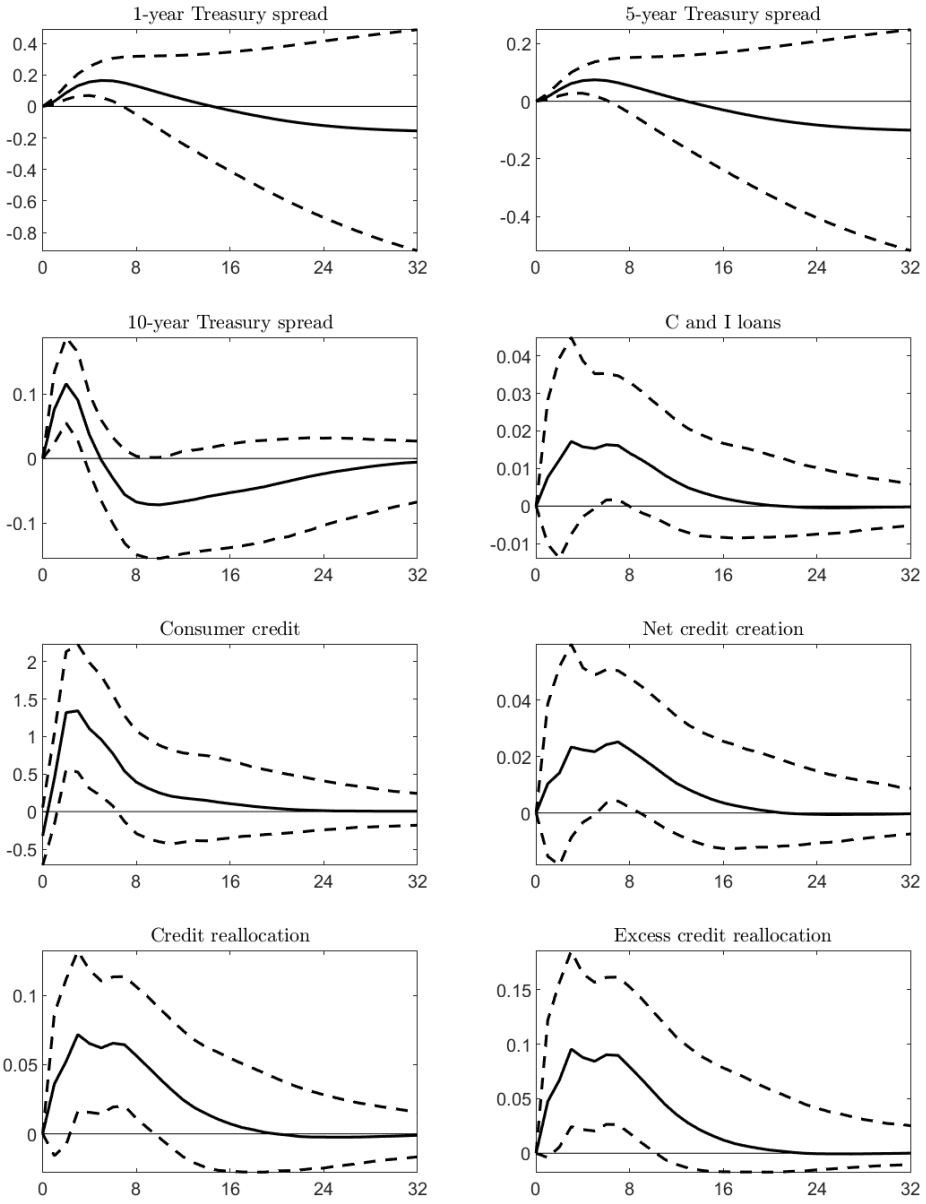
Source: Federal Reserve Board; Federal Reserve Bank of Atlanta.

Figure 4: Impulse Responses to an Expansionary Monetary Policy Shock



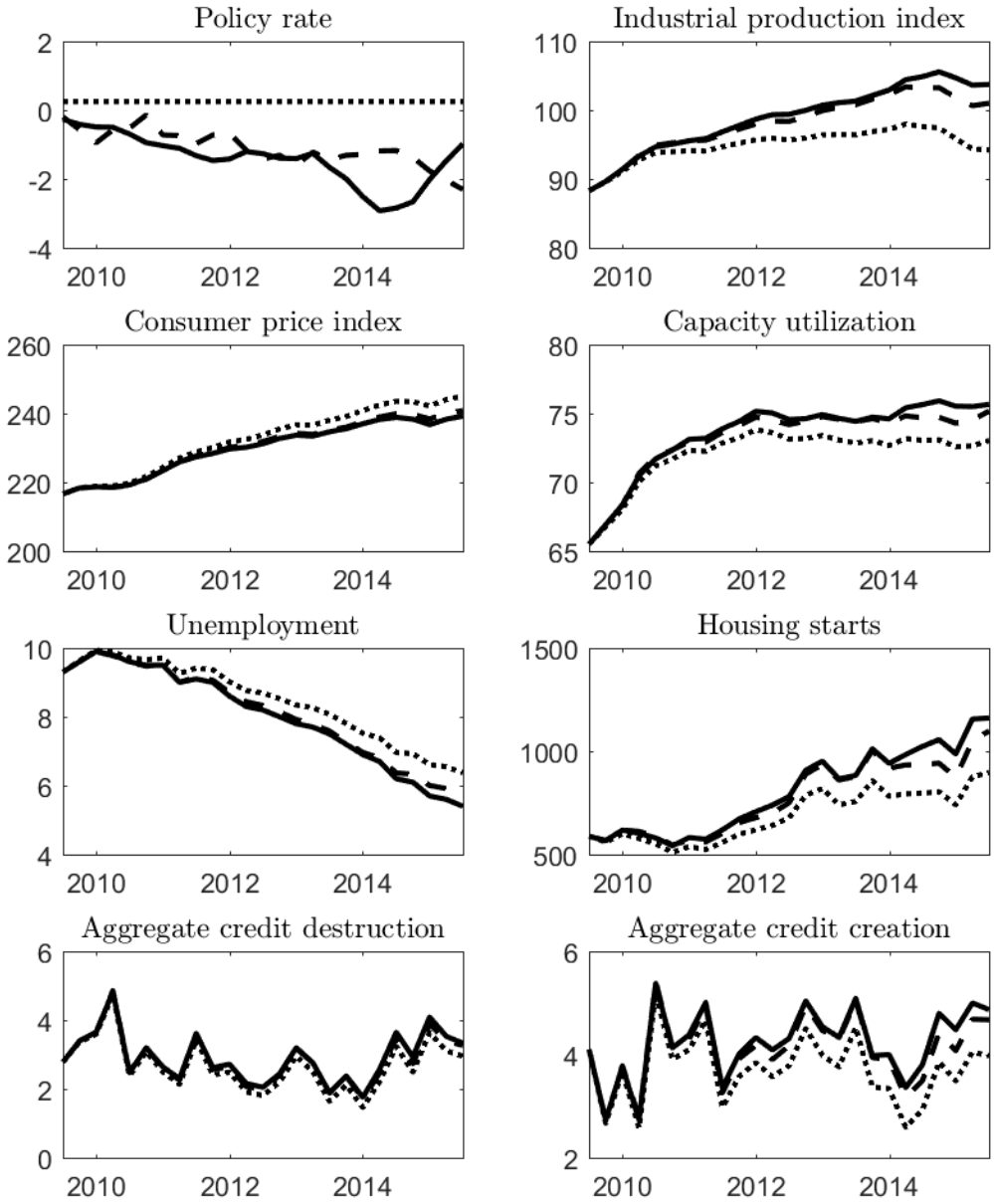
Note: These graphs plot quarterly impulse responses to a -25 basis point monetary policy shock using the sample, 1974:Q1–2017:Q1, in a FAVAR(4) setting. The x-axis is number of quarters following the monetary easing shock. The policy rate, aggregate credit destruction, and aggregate credit creation are percentage points and all remaining are percentage deviations from the steady state.

Figure 5: Impulse Responses of Credit Market Indicators to a Monetary Easing Shock



Note: These graphs plot quarterly impulse responses to a -25 basis point monetary policy shock using the sample, 1974:Q1–2017:Q1, in a FAVAR(4) setting. The x-axis is number of quarters following the monetary easing shock. C and I loans outstanding and consumer credit outstanding are percentage deviations from the steady state and all remaining variables are percentage points.

Figure 6: Policy Counterfactuals During the Zero Lower Bound



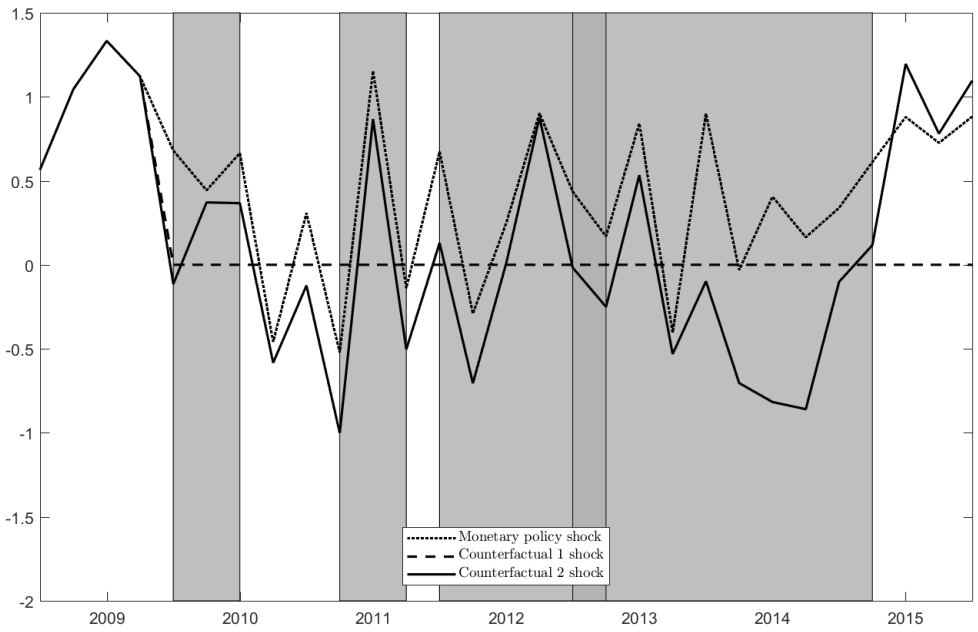
Note: The solid lines are the observed economic variables between 2009:Q3 and 2015:Q3. The dashed lines are the values if the monetary shocks were shut down and the dotted lines are the values of these variables if the shadow policy rate were at the zero lower bound.

Appendix

Table A.1: Macroeconomic Data and Loadings on Factors and Monetary Policy Rate

Macroeconomic variable	Loading on factor 1	Loading on factor 2	Loading on factor 3	Loading on the monetary policy rate
Industrial production - products, final	1.34	1.44	-0.66	0.00
Industrial production - final products	1.42	1.04	-0.47	0.00
Industrial production - consumer goods	0.98	1.20	-0.23	0.00
Industrial production - durable consumer goods	0.82	1.53	-0.66	0.00
Industrial production - nondurable consumer goods	0.84	0.34	0.23	0.00
Industrial production - business equipment	1.46	0.83	-0.52	0.00
Industrial production - materials	1.18	1.62	-0.78	0.00
Industrial production - durable goods materials	1.22	1.52	-0.64	0.00
Industrial production - nondurable goods materials	0.99	1.21	-0.77	0.00
Industrial production - manufacturing (sic)	1.36	1.39	-0.58	0.00
Industrial production - oil and gas well drilling and manufactures homes	0.62	0.15	-0.81	0.00
Industrial production - residential utilities	0.02	-0.16	0.17	0.00
Industrial production - total index	1.34	1.44	-0.66	0.00
Capacity utilization - manufacturing (sic)	1.59	-1.39	1.29	0.00
Purchasing managers' index	1.23	1.48	-0.67	0.00
NAPM production index (percent)	1.08	1.69	-0.83	0.00
Personal income	1.37	-0.99	-0.4	0.00
Personal income less transfer payments	1.01	0.84	0.35	0.00
Civilian labor force: employed, total	1.58	0.48	0.25	0.00
Civilian labor force: employed, nonagricultural industries	1.61	0.42	0.27	0.00
Unemployment rate: all workers, 16 and over	-0.54	1.39	-2.52	0.00
Unemployment by duration: average duration in weeks	-0.94	2.67	-1.73	0.00
Unemployment by duration: persons unemployed less than 5 weeks	-0.33	-0.82	-0.42	0.00
Unemployment by duration: persons unemployed 5 to 14 weeks	-1.59	1.59	-1.85	0.00
Unemployment by duration: persons unemployed 15+ weeks	-1.25	2.57	-2.41	0.00
Unemployment by duration: persons unemployed 15 to 26 weeks	-1.49	2.21	-2.25	0.00
Employees, nonfarm - total nonfarm	1.74	0.52	0.29	0.00
Employees, nonfarm - total private	1.67	0.75	0.07	0.00
Employees, nonfarm - goods-producing	1.54	1.04	-0.11	0.00
Employees, nonfarm - mining	0.51	-0.24	-0.76	0.00
Employees, nonfarm - construction	1.43	0.72	0.79	0.00
Employees, nonfarm - manufacturing	1.43	1.20	-0.52	0.00
Employees, nonfarm - durable goods	1.46	1.16	-0.42	0.00
Employees, nonfarm - nondurable goods	1.18	1.15	-0.74	0.00
Employees, nonfarm - service-producing	1.79	-0.25	0.58	0.00
Employees, nonfarm - trade, transport, and utilities	1.68	0.33	0.03	0.00
Employees, nonfarm - wholesale trade	1.67	0.00	-0.05	0.00
Employees, nonfarm - retail trade	1.56	0.22	-0.01	0.00
Employees, nonfarm - government	0.65	-1.52	1.50	0.00
Average weekly hours, production workers, nonfarm - manufacturing	0.24	1.92	0.42	0.00
Average weekly overtime hours, production workers, nonfarm - manufacturing	0.34	1.26	1.19	0.00
NAPM employment index	1.05	1.41	-0.96	0.00
Personal consumption expenditures	1.44	-1.26	-0.44	0.00
Personal consumption expenditures - durable goods	0.70	0.37	-0.25	0.00
Personal consumption expenditures - nondurable goods	1.17	-1.04	-1.22	0.00
Personal consumption expenditures services	1.24	-1.84	0.08	0.00
Housing starts - nonfarm - total farm and nonfarm	1.60	-1.36	2.18	0.04
Housing starts - northeast	1.38	-1.37	1.80	0.11
Housing starts - midwest	1.74	-2.04	2.09	-0.19
Housing starts - south	1.29	-0.72	1.95	0.16
Housing starts - west	1.63	-1.41	2.23	0.00
Housing authorized - total new private housing units	1.44	-1.00	2.13	-0.01
mobile homes - manufacturers' shipments	0.83	-0.52	1.37	0.60
NAPM inventories index	1.36	-0.34	-0.22	-0.39
NAPM new orders index	1.26	1.15	-0.62	-0.23
NAPM vendor deliveries index	1.03	0.40	-0.21	-0.19
New orders (net) - consumer goods and materials	0.50	1.47	-0.65	0.07
New orders, nondefense capital goods	0.68	0.95	-0.63	-0.03
S and P common stock price index - composite	0.00	0.32	-0.43	-0.01
S and P common stock price index - industrials	-0.04	0.34	-0.41	0.00
Foreign exchange rate - United Kingdom	0.52	-0.93	0.13	-0.31
Foreign exchange rate - Canada	-0.29	0.48	0.73	0.19
Interest rate - 3-month Treasury	-0.01	0.28	-0.14	1.04
Interest rate - 6-month Treasury	0.00	0.27	-0.12	1.03
Interest rate - 1-year Treasury	-0.01	0.35	-0.15	1.05
Interest rate - 5-year Treasury	-0.10	0.61	-0.24	1.07
Interest rate - 10-year Treasury	-0.18	0.76	-0.4	1.08
3-month Treasury yield less effective federal funds rate	-0.04	0.98	-0.49	-0.69
6-month Treasury yield less effective federal funds rate	0.02	0.91	-0.42	-0.70
1-year Treasury yield less effective federal funds rate	-0.02	1.38	-0.61	-0.45
5-year Treasury yield less effective federal funds rate	-0.22	1.34	-0.52	-0.45
10-year Treasury yield less effective federal funds rate	-0.29	1.24	-0.65	-0.53
C and I loans outstanding in 2009	0.10	0.10	0.73	0.20
Consumer credit outstanding - nonrevolving	1.16	-0.01	0.83	0.16
Money stock - M1	-0.64	0.67	-0.95	-0.05
Money stock - M2	-0.11	-0.43	0.22	0.11
Revised monetary base	-0.99	0.75	0.02	0.15
M2 - money supply - M1 + savings deposits, small time deposits, and MMMFs	-0.11	-0.43	0.22	0.11
NAPM commodity price index	1.28	-2.06	-1.40	-0.43
Producer price index - finished goods	0.80	-1.62	-1.47	0.00
Producer price index - finished consumer goods	0.79	-1.36	-1.54	0.00
Producer price index - intermediate material supplies and components	0.95	-1.23	-1.39	0.00
Producer price index - crude materials	0.70	-0.22	-1.36	0.00
CPI-U - all items	0.97	-2.22	-1.06	0.00
CPI-U - apparel and upkeep	0.49	-1.17	-1.12	0.00
CPI-U - transportation	0.79	-0.96	-1.73	0.00
CPI-U - medical care	0.51	-2.22	-0.36	0.00
CPI-U - commodities	0.91	-1.60	-1.53	0.00
CPI-U - durables	0.63	-1.65	-1.15	0.00
CPI-U - services	0.79	-2.33	-0.34	0.00
CPI-U - all items less food	0.94	-2.16	-1.13	0.00
CPI-U - all items less shelter	0.93	-1.93	-1.40	0.00
CPI-U - all items less medical care	0.97	-2.18	-1.09	0.00
Average hourly earnings, production workers, nonfarm - construction	0.33	-2.02	-0.07	0.00
Average hourly earnings, production workers, nonfarm - manufacturing	0.79	-2.03	-0.38	0.00
Business cycle indicator, consumer expectations	0.67	1.12	1.80	0.19
Credit destruction	0.26	0.09	1.55	0.00
Credit creation	0.37	-0.33	1.59	0.00

Figure A.2: Monetary Policy Shock throughout the Zero Lower Bound



Note: This graph shows the monetary policy shocks during the zero lower bound. These shocks come from a FAVAR(4) that includes four purged factors and the monetary policy rate.