WORKING paper

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Monetary Policy and Corporate Debt Structure

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Abstract

This paper evaluates and compares the effects of conventional and unconventional monetary policies on the corporate debt structure in the United States. It does so by using a vector autoregression in which policy shocks are identified through high-frequency external instruments. Our results show that conventional and unconventional expansionary monetary policies have similar positive effects on aggregate activity, but their impact on corporate debt structure goes in opposite directions: (i) conventional monetary easing increases loans to non-financial corporations and reduces corporate bond financing; (ii) unconventional monetary easing increases bond finance without affecting the loans.[3]

Keywords: Conventional and unconventional monetary policy, Vector autoregression, External instruments, Corporate debt structure, Bank lending, Bond issuance

JEL classification: E43; E44; E52

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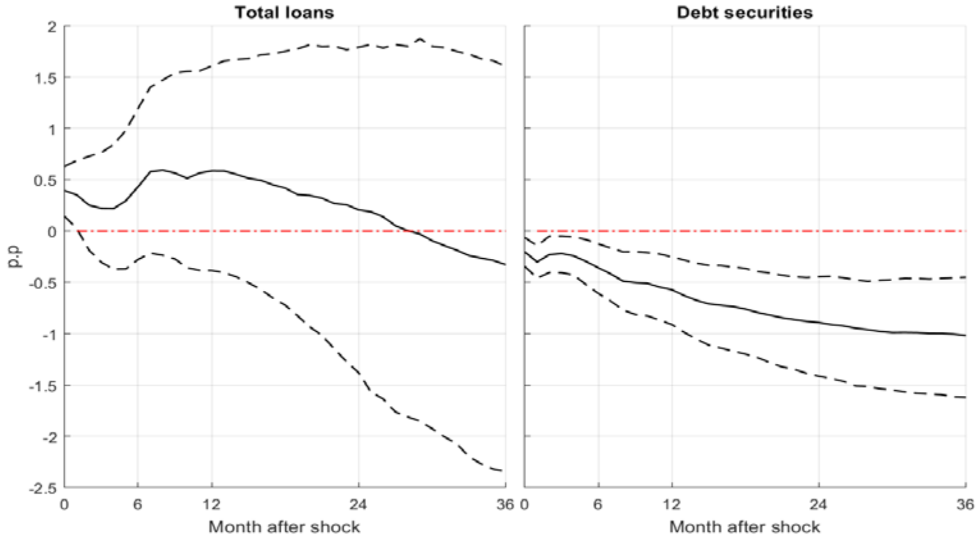
NON-TECHNICAL SUMMARY

The years following the Great Recession have been challenging in the field of theoretical monetary economics. The new forms of monetary policy implemented after the crisis, more commonly called "unconventional", were an important innovation that have encouraged economists to revise the existing theories. This paper aims at studying the transmission mechanism of U.S. monetary policy shocks on borrowing activities of non-financial corporations, during both conventional and unconventional policy periods. By doing so, we aim to provide a set of stylized facts on similarities and differences in transmission mechanisms across monetary policy regimes that would help generating improved business cycle models.

Specifically, we employ a vector autoregression (VAR) in which monetary policy shocks are identified with high frequency external instruments, along the lines of Stock and Watson (2012) and Mertens and Ravn (2013). For each monetary policy regime, we estimate our benchmark VAR model for the U.S. economy at monthly frequency with real interpolated GDP, consumer prices, the Gilchrist and Zakrajsek (2012)'s excess bond premium, and a measure of monetary policy stance. Because the nature of conventional and unconventional policy measures strongly differ, the instruments we use to identify exogenous monetary policy shocks are not the same across policy regimes.

Our results consistently show that dynamic effects of expansionary monetary policy are remarkably similar across the conventional and unconventional policy period, with a fall in the policy indicator and credit spread, and a persistent rise in output and prices. By extending our VAR model to a wider set of macroeconomic variables, we also show that our measures of expansionary monetary policy shocks are associated with long-lasting positive effects on consumption, residential and non-residential fixed investment, and employment under each monetary policy regime.

Differences in responses to conventional and unconventional monetary shocks



Note: The solid black line represents the median responses. The 16th and 84th percentile are displayed in dotted black.

Nevertheless, we show that the transmission channels of conventional and unconventional monetary policies are not the same with respect to corporate credit (loans and debt securities) availability. We show that conventional monetary policy easing increases the share of the loans in corporate debt, while unconventional policy easing increases the bond financing share. We argue that unconventional monetary policy has an opposite effect on loans and bonds through their impact on longer-term corporate bond markets conditions.

Our approach compares the effects of U.S. conventional monetary policy on the macroeconomy and corporate debt structure with those of unconventional measures. Most of the studies focus exclusively on one of the two monetary policy regimes, and do not attempt to compare them with each other. Regarding conventional measures, see for example Leeper, Sims, and Zha (1996), Christiano, Eichenbaum, and Evans (1999) and more recently Gertler and Karadi (2015). Regarding unconventional measures, notable examples include Baumeister and Benati (2013), Gambacorta, Hofmann, and Peersman (2014) and Weale and Wieladek (2016). We also contribute to the literature on the monetary policy effects on the corporate debt structure, which is relatively scarce. Becker and Ivashina (2014) study conventional monetary policy shocks and find that a more restrictive stance pushes non-financial corporations towards bond markets. For the unconventional monetary policy period, Lo Duca, Nicoletti, and Vidal Martinez (2016) show that U.S. expansionary policies increased corporate bond issuance worldwide. A unified framework across conventional and unconventional monetary policy allows us to provide a set of stylized facts on similarities and differences in transmission mechanisms across monetary policy regimes that would help generating improved business cycle models. Our results imply that a successful model of the monetary transmission mechanism ought to consider two types of external debt as their responses differ deeply following a monetary policy shock.

Politique monétaire et structure de la dette des entreprises

RÉSUMÉ

Ce document évalue et compare les effets des politiques monétaires conventionnelles et non-conventionnelles sur la structure de la dette des entreprises aux États-Unis. Pour ce faire, nous employons un modèle vectoriel autorégressif dans lequel les chocs monétaires sont identifiés à l'aide d'instruments externes à haute fréquence. Nous établissons que les politiques monétaires expansionnistes conventionnelles et non-conventionnelles ont des effets positifs similaires sur l'activité économique, mais que leurs impacts sur la structure de la dette des entreprises s'inscrivent dans deux directions opposées : (i) les politiques conventionnelles stimulent les prêts bancaires mais diminuent le financement par émission de titres ; (ii) les politiques non-conventionnelles encouragent le financement obligataire sans affecter les prêts bancaires.

Mots-clés : Politique monétaire conventionnelle et non conventionnelle, VAR, instruments externes, structure de la dette des entreprises, prêts bancaires, émission d'obligations

I Introduction

The years following the Great Recession have been challenging in the field of theoretical monetary economics. The new forms of monetary policy implemented after the crisis, more commonly called "unconventional", were an important innovation that have encouraged economists to revise the existing theories, and in particular monetary models of business cycles. This paper aims at studying the transmission mechanism of U.S. monetary policy shocks on borrowing activities of non-financial corporations, during both conventional and unconventional policy periods. By doing so, we aim to provide a set of stylized facts on similarities and differences in transmission mechanisms across monetary policy regimes that would help generating improved business cycle models.

Specifically, we employ a vector autoregression (VAR) in which monetary policy shocks are identified with high frequency external instruments, along the lines of Stock and Watson (2012) and Mertens and Ravn (2013). To our best knowledge, this is the first paper to compare macroeconomic effect of conventional and unconventional monetary policies using high-frequency instruments. For each monetary policy regime, we estimate our benchmark VAR model for the U.S. economy at monthly frequency with real interpolated Gross Domestic Product (GDP), consumer prices, the Gilchrist and Zakrajšek (2012)'s excess bond premium, and a measure of monetary policy stance. Because the nature of conventional and unconventional policy measures strongly differ, the instruments we use to identify exogenous monetary policy shocks are not the same across policy regimes. We consider changes in the three month ahead monthly fed funds futures (FF4) and changes in the 5-year nominal U.S. monthly Treasury yield (T5Y) for the conventional and unconventional policy periods, respectively.[1] The changes in these instruments are calculated within a narrow window surrounding FOMC dates and other policy announcements and reflect unexpected changes in the stance of U.S. monetary policy. Our results consistently show that dynamic effects of expansionary monetary policy are remarkably similar across the conventional and unconventional policy period, with a fall in the policy indicator and credit spread, and a persistent rise in output and prices. By extending our VAR model to a wider set of macroeconomic variables, we also show that our measures of expansionary monetary policy shocks are associated with long-lasting positive effects on consumption, residential and non-residential fixed investment, and employment under each monetary policy regime.

Nevertheless, we show that the transmission channels of conventional and unconventional monetary policies are not the same with respect to corporate credit availability. In particular,

[1]For conventional period, we follow exactly Gertler and Karadi (2015).

we look at the liabilities of the balance-sheet of non-financial corporate business, reported in the Flow of Funds report (L.103), to better understand the mechanism of monetary transmission. We decompose the corporate debt structure into two parts: loans and debt securities. Our major findings can be summarized as follows. Following an expansionary monetary policy shock, the transmission mechanism — i.e., the way aggregate corporate debt variables respond to shocks — is remarkably different across the two policy regimes. More accommodative monetary policy stance induces a rise in bank loans for a roughly two years under conventional policy regime, but has no significant effect on bank loans under unconventional policy regime. However, we observe the opposite phenomenon regarding debt securities: they decline sharply in the conventional period after monetary easing but rise strongly and persistently in unconventional times, in line with portfolio balance channel of unconventional monetary policy.

Our results imply that a successful model of the monetary transmission mechanism ought to consider two types of external debt as their responses differ deeply following a monetary policy shock. This not the case for the vast majority of macro-finance models of business cycle, which usually stress the importance of asymmetric information and the role of bank credit.[2] Hence, these models provide an incomplete explanation of the monetary transmission mechanism as they abstract from the role of bond issuance. The channel through which monetary policy is transmitted to the real economy turns out to be quite different across conventional and unconventional policy regimes, where the former apparently puts more emphasis on the bank-lending channel, while the latter appears to favor bond-issuance channel in the detriment of bank-lending channel. Under these circumstances, a successful model should be able to disentangle both channels to better understand the monetary policy transmission.

The reminder of the paper is organized as follows. Section II places our paper with respect to the existing literature. Section III explains our VAR methodology with external instruments. It also motivates the choice of policy stance indicator, along with its high-frequency instrument, for both conventional and unconventional monetary policy periods. Section IV presents the data and the results of the paper. Section V concludes.

[2]For example, see the "financial accelerator" models in Bernanke and Gertler (1989) and Bernanke, Gertler, and Gilchrist (1999).

II Related Literature

This paper belongs to the strand of literature on the financial and macroeconomic effects of monetary policy measures, both conventional and unconventional, in an identified VAR framework. Most of the studies focus exclusively on one of the two monetary policy regimes, and do not attempt to compare them with each other. Regarding conventional measures, see for example Leeper, Sims, and Zha (1996), Christiano, Eichenbaum, and Evans (1999) and more recently Gertler and Karadi (2015).[3] Regarding unconventional measures, notable examples include Baumeister and Benati (2013), Gambacorta, Hofmann, and Peersman (2014) and Weale and Wieladek (2016). By contrast, our approach compares the effects of U.S. conventional monetary policy on the macroeconomy and corporate debt structure with those of unconventional measures in one unified framework.

Our study is also related to the literature on the impact of monetary policy on the corporate debt structure, which is relatively scarce. For the conventional monetary policy period, Kashyap, Stein, and Wilcox (1993) show that monetary policy tightening is associated with bank loans decrease and debt securities issuance. Becker and Ivashina (2014), can be seen as complementary to our analysis, as they study conventional monetary policy shocks and find that a more restrictive stance pushes non-financial corporations towards bond markets.[4] For the unconventional monetary policy period, Lo Duca, Nicoletti, and Vidal Martínez (2016) show that U.S. expansionary policies increased corporate bond issuance worldwide.[5] We contribute to this literature with unified framework across conventional and unconventional monetary policy in the United States. We show that conventional monetary policy easing increases the share of the loans in corporate debt, while unconventional policy easing increases the bond financing share. We argue that unconventional monetary policy has an opposite effect on loans and bonds through their impact on longer-term corporate bond markets conditions.[6]

[3] Recently, Hofmann and Peersman (2017) compare the differences in the effects of conventional monetary policy on aggregate activity, as well as on credit and housing markets, between the pre- and post-1980s.

[4] For the euro area, Altavilla, Darracq Paries, and Nicoletti (2015) show that negative bank loan supply shocks explain the substitution between bank loans and bonds issued by firms.

[5] For the euro area, and using micro-level data, Grosse-Rueschkamp, Steffen, and Streitz (2018) and Arce, Gimeno, and Mayordomo (2017) show the ECB corporate bond purchases made firms substitute bank loans with bond debt.

[6] Governor Jeremy C. Stein argues in his speech (Stein (2012)) that unlike conventional monetary policy, the unconventional measures work by moving term premia and therefore alter the transmission to the real economy in important ways, in particular by encouraging firms to issue long-term bonds and to increase investment.

Because our results have shown important changes in relative shares of loans and bonds in non-financial corporate financing following a monetary policy shock, they deliver powerful empirical implications for macroeconomic resilience and financial stability. There exist several theoretical and empirical studies that showed that access to corporate bond finance can provide macroeconomic benefits in some phases of the cycle.[7] For example, Grjebine, Szczerbowicz, and Tripier (2018) analyze the behavior of corporate debt structure along the business cycle in twenty three countries over the period 1989-2013 and show that economies with a high share of bond financing and significant bond-loan substitution recover faster from recessions. Thus, our results indicate that unconventional monetary policy measures might have contributed to foster the recovery of U.S. economy by stimulating corporate bond issuance. Nevertheless, one should bear in mind that the development of bond markets also carries risks, as described by Krishnamurthy (2010) for the Great Recession. For instance, in the context of a financial crisis, market liquidity can drop suddenly, making it harder to roll over corporate debt. This uncertainty can have an immediate impact on corporate expenditure. To prevent such adverse effects, bond markets should be subject to adequate regulation. It is also important that monetary policy itself takes into account its role on the debt composition of non-financial corporations.

III VAR with external instruments

Over the last decades, VAR models have been widely employed to estimate the effects of monetary policy shocks on the economy. Identified VAR modeling allows to analyze and interpret the data while avoiding potentially "incredible restrictions" on the structure of the economy. In this paper, we follow this long tradition and use the VAR framework to better

[7] For theoretical studies, see for example, Adrian, Colla, and Shin (2013), and Fiore and Uhlig (2011, 2015). They show that this substitution can help to mitigate the financial constraints restricting investment. Using a partial equilibrium approach Adrian, Colla, and Shin (2013) show that banks following "Value-at-Risk" approach deleverage when the default risk of non-financial corporations rises, while risk-averse bond investors increase their credit supply as the corporate bond spread rises. Fiore and Uhlig (2011) generate an endogenous corporate debt structure in a general equilibrium framework where information acquisition by banks is costly, and hence loans are more expensive but less risky than bonds. Fiore and Uhlig (2015) extend this analysis and show that an increase in the banks information acquisition costs increases the cost of indirect finance and induces a shift from loans to bonds. Under a scenario where debt markets are shut down and the bank financing is not flexible, a shock to the bank information acquisition costs coupled with uncertainty shocks reduces investment five times more than in the case when firms can substitute among instruments of debt finance.

understand the transmission mechanism of both conventional and unconventional monetary policy. We employ a VAR model of the following form:

$$y_t = \sum_{i=1}^{\rho} B_i y_{t-i} + C_y + \upsilon_t, \qquad t = 1, \ldots, T, \tag{1}$$

where y_t is an $n \times 1$ vector of endogenous variables; C_y contains the constant terms; ρ is the number of lags; and T is the sample size. We assume that $\upsilon_t = A\varepsilon_t$ where ε_t has the following distribution:

$$p(\varepsilon_t) = \text{normal}(\varepsilon_t|0, I), \tag{2}$$

with I is an $n \times n$ identity matrix, and normal$(x|\mu, \Sigma)$ denotes the multivariate normal distribution of x with mean μ and variance Σ. This implies that υ_t has the following distribution $p(\upsilon_t) = \text{normal}(\upsilon_t|0, AA')$. The variable ε_t represents all structural shocks hitting the economy.

We apply the following partition $y_t = \left[y_t^p, y_t^{\neq p}\right]$ where y_t^p represents the policy indicator, and $y_t^{\neq p}$ denotes the remaining endogenous variables; and $\varepsilon_t = \left[\varepsilon_t^p, \varepsilon_t^{\neq p}\right]$ where ε_t^p represents exogenous variations in the policy indicator, and $\varepsilon_t^{\neq p}$ denotes the remaining structural shocks of the model.

Our approach to identification of monetary policy, that is ε_t^p, is based on the use of one external instrument z_t, along the lines of Stock and Watson (2012) and Mertens and Ravn (2013). It may be worth mentioning that we make an explicit distinction between the policy indicator and the policy instrument. The latter helps us to isolate the movements of the policy indicator that are only due to monetary policy actions. It must satisfy several critical assumptions in order to identify movements in the policy indicator that are due to purely exogenous monetary policy disturbances. The instrument must be correlated with the unconventional monetary policy ε_t^p but uncorrelated with all other structural shocks $\varepsilon_t^{\neq p}$. This assumption can be summarized as follows:

$$\mathrm{E}\left[z_t \varepsilon_t^p\right] = \psi \tag{3}$$

$$\mathrm{E}\left[z_t \varepsilon_t^{\neq p}\right] = 0 \tag{4}$$

We use unexpected changes in different interest rates on FOMC dates as potential instruments z_t. The choice of the best instrument z_t for conventional and unconventional monetary policy period is motivated in Section IV.1.

We re-write the system in (1) in a more compact form. The model becomes as follows:

$$y_t = By_{t-1} + C_y + \upsilon_t, \tag{5}$$

where $B = [B_1 \dots B_\rho]$, and $y_{t-1} = [y_1 \dots y_\rho]'$. We introduce an observation equation, which relates our instrument to the structural shocks:

$$z_t = [\psi \quad \mathbf{0}]\varepsilon_t + C_z + \Omega^{-\frac{1}{2}} u_t, \tag{6}$$

where $\mathbf{0}$ is an $1 \times (n-1)$ row of zeros, and C_z contains the constant term. This equation is directly based on the assumptions in (3) and (4). The observation equation can also directly relate the instrument to the reduced-form shocks:

$$\begin{aligned} z_t &= [\psi \quad \mathbf{0}]A^{-1}A\varepsilon_t + C_z + \Omega^{-\frac{1}{2}} u_t, && (7)\\ &= [\psi \quad \mathbf{0}]A^{-1}\upsilon_t + C_z + \Omega^{-\frac{1}{2}} u_t, && (8)\\ &= F\upsilon_t + C_z + \Omega^{-\frac{1}{2}} u_t, && (9) \end{aligned}$$

with $F = [\psi \quad \mathbf{0}]A^{-1}$.

Using (5) and (9), we compact the overall system as:

$$\mathrm{E}\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \text{normal}\left(\begin{bmatrix} y_t \\ z_t \end{bmatrix} \middle\| \begin{bmatrix} C_y + By_{t-1} \\ C_z \end{bmatrix}, \begin{bmatrix} (AA')^{-1} & \Gamma' \\ \Gamma & \tilde{\Omega} \end{bmatrix} \right), \tag{10}$$

where Γ is the variance-covariance matrix between the instruments and the forecast errors are as follows:

$$\begin{aligned} \Gamma &= \mathrm{Cov}[z_t, \upsilon_t], && (11)\\ &= FAA', && (12)\\ &= [\psi \quad \mathbf{0}]A^{-1}AA', && (13)\\ &= [\psi \quad \mathbf{0}]A'. && (14) \end{aligned}$$

Following Mertens and Ravn (2013), we can now identify the parameters of the contemporeanous matrix A. We assume that $A = [\alpha^{[1]}, \alpha^{[2]}] = \begin{bmatrix} \alpha_{1,1} & \alpha_{1,2} \\ \alpha_{2,1} & \alpha_{2,2} \end{bmatrix}$ with $\alpha^{[1]} = [\alpha_{1,1}, \alpha_{2,1}]'$ and $\alpha^{[2]} = [\alpha_{1,2}, \alpha_{2,2}]'$. Using the definitions of Γ and the forecast errors, it follows that:

$$\begin{aligned} \Gamma &= \mathrm{Cov}[z_t, \upsilon_t],\\ &= [\psi \quad \mathbf{0}]A',\\ &= \psi\alpha^{[1]},\\ &= [\psi\alpha_{1,1}, \psi\alpha_{2,1}]. \end{aligned}$$

Partitioning $\Gamma = [\Gamma_1, \Gamma_2]$, we can identify the contemporaneous matrix, A, as follows:

$$\alpha_{1,1} = \frac{1}{\psi}\Gamma_1$$
$$\alpha_{2,1} = \frac{1}{\psi}\Gamma_2 = \alpha_{1,1}\left(\Gamma_1^{-1}\Gamma_2\right).$$

After identifying the structural parameters, we can directly compute the impulse responses of y_t to the unconventional monetary policy shock ε_t^p from the system (1).

To characterize the uncertainty of our results, we follow Drautzburg (2016) by employing modern Bayesian methods to estimate our VAR model. More specifically, we use a Gibbs-sampling procedure to alternately sample from conditional distributions, namely a normal posterior distribution and a wishart posterior distribution. Equation (10) corresponds to a SUR model, allowing us to employ a standard technique of inference reviewed in any Bayesian textbook. We vectorize the model (10) as:

$$Y_{\text{SUR}} = X_{\text{SUR}}\beta_{\text{SUR}} + \nu_{\text{SUR}}, \qquad \text{normal}(\nu_{\text{SUR}}|0, V \otimes I_T), \tag{15}$$

where

$$V = \begin{bmatrix} AA' & \Gamma' \\ \Gamma & \tilde{\Omega} \end{bmatrix}. \tag{16}$$

with $\tilde{\Omega} = \Omega + FAA'F'$ as the covariance-variance matrix of the external instrument. Under the flat prior $p(\beta) = \text{normal}(\beta|\bar{\beta}_0, N_0)$ and $p(V^{-1}) = \text{wishart}(V^{-1}|((\nu_0 S_0)^{-1}, \nu_0)$, where $\text{wishart}(x|S, n)$ is the wishart distribution with S as the scale matrix and n as the degree of freedom, we can employ the Gibbs sampler technique for simulations by alternately sampling from two conditional posterior distributions. For $i = 1, 2, \ldots, N_1 + N_2$,

1. Draw $\beta^{(i)}$ conditional on $V^{(i-1)}$:

$$\text{normal}\left(\beta^{(i)}|\bar{\beta}_T(V), (N_{XX}(V) + N_0)^{-1}\right), \tag{17}$$

   with $\bar{\beta}(V) = (N_{XX}(V) + N_0)^{-1}(N_{XY}(V) + N_0\bar{\beta}_0)$.[8]

[8] The posterior parameters $N_{XX}(V)$ and $N_{XY}(V)$ are defined as follows:

$$N_{XX}(V) = \tilde{X}'\tilde{X}, \qquad N_{XX}(V) = \tilde{X}'\tilde{Y}, \tag{18}$$

where $\tilde{X} = \left((U^{-1})' \otimes I_T\right)\begin{bmatrix} I_n \otimes X_y & \underset{T(n\rho+1)\times T}{\mathbf{0}} \\ \underset{T\times Tn}{\mathbf{0}} & X_z \end{bmatrix}$, $\quad \tilde{Y} = \left((U^{-1})' \otimes I_T\right)\begin{bmatrix} I_n \otimes Y & \underset{T(n\rho+1)\times T}{\mathbf{0}} \\ \underset{T\times Tn}{\mathbf{0}} & Z \end{bmatrix}$, $X_y = [Y_{-1} \quad \ldots \quad Y_{-\rho} \quad \mathbf{1}_T]$, and $X_z = [\mathbf{1}_T]$.

2. Draw $V^{(i)}$ conditional on $\beta^{(i)}$:

$$\text{wishart}\left(V^{(i)}\middle|\frac{S_T(\beta)^{-1}}{\nu_0+T},\nu_0+T\right),\tag{19}$$

with $S_T(\beta)=\frac{1}{\nu_0+T}\begin{bmatrix}(Y-XB)'\\(Z-1_{T\mu_z'})'\end{bmatrix}\begin{bmatrix}(Y-XB) & (Z-1_{T\mu_z'})\end{bmatrix}+\frac{\nu_0}{\nu_0+T}S_0$.

Note that $S_T(\beta)^{-1}$, $N_{XX}(V)$ and $N_{XY}(V)$ are the posterior parameters.

3. Repeat (1) and (2) until the entire sequence (N_1+N_2 draws) is simulated;

4. Keep the last N_2 draws in the sequence.

The results shown in next section are based on $10,000$ draws. We discarded the first ten percent draws as burn-in ($N_1=1,000$) so that to keep $N_2=9,000$ draws

By combining high-frequency identification with VAR models, our approach allows to trace out the dynamic effects (i.e., persistence and magnitude) of shifts in monetary policy. The next section aims at choosing our policy indicator along with its instrument to identify policy shocks.

IV Data, Identification and Results

In Section IV.1, we describe how we distinguish between the policy indicator and the policy instrument for both conventional and unconventional monetary policy measures. Then, in Section IV.2 we present the macroeconomic effects of monetary policy. Finally, Section IV.3.2 presents the effects on corporate debt structure.

IV.1 Policy indicator and instrument

Until the end of 2008, the federal funds rate, which was generally used as policy indicator, was mainly controlled by the Federal Reserve. However, since 2008 the zero lower bound on the short-term nominal interest rates and non-standard policy measures by the Federal Reserve have brought the profession to use long-term interest rates, such as Treasury bonds yields, as a measure of policy stance. In this section, we choose the policy indicator along with its instrument to identify conventional and unconventional monetary policy shocks. We do so relying on existing theoretical and empirical literature.

For the conventional monetary policy period, we follow Gertler and Karadi (2015)'s identification of monetary policy shocks. Their policy surprises include the shocks to current short-term interest rate and the shocks to forward guidance. This is in line with Gürkaynak, Sack, and Swanson (2005) who show that the Federal Reserve's communication influences market expectations of future policy actions. Therefore, capturing the effects of FOMC announcements on financial markets as the changes in the federal funds rate target without accounting for a "future path of policy" factor would be inadequate. Following Gertler and Karadi (2015), we use the one-year government bond rate as the relevant monetary policy indicator, and use directly their monetary policy surprises based on the three month ahead monthly fed funds futures changes around FOMC announcements.

Unconventional monetary policies have different transmission channels than conventional monetary policy. They impact the long-term interest rates and credit spreads to a much larger extent. According to theoretical literature, unconventional monetary policies work mainly through "signaling " and "portfolio rebalance" channels. The signaling channel represents the central bank commitment about future path of expected interest rates that can be implemented either by explicit forward guidance statement or by large-scale asset purchases (see Eggertsson and Woodford (2003) and Bhattarai, Eggertsson, and Gafarov (2015)). In the first case, the central bank makes a statement that affects the expectations of the future federal funds rates.[9] In the second case, accumulation of risky assets on the central bank's balance sheet associated with important balance sheet expansion can be understood by financial markets as a signal that the monetary easing will continue longer than previously expected.[10] "Portfolio balance effect" of asset purchases works when the securities are not perfect substitutes (Gertler and Karadi (2011), Farmer and Zabczyk (2016), Vayanos and Vila (2009), Christensen and Krogstrup (2016)). In the context of financial frictions, reducing the quantity of selected assets available for private investors increases their prices and diminishes yields by suppressing the risk premia (Bernanke (2010)).

The existing studies confirm the effectiveness of the Federal Reserve's unconventional monetary confirm in reducing longer-term yields and risk premia ((e.g., Wright, 2012; Gilchrist, López-Salido, and Zakrajšek, 2015; Rogers, Scotti, and Wright, 2016)). Some studies confirm the signaling channel (see for instance Bauer and Rudebusch (2014) and Christensen

[9]For instance, on December 16, 2008 the FOMC stated that "the Committee anticipates that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time". In practice, it is not clear whether the statements issued by the Federal Reserve after the 2008 crisis were more a commitment ("Odyssean forward guidance") or bad news about the state of the economy ("Delphic forward guidance"). Both interpretations reduce the interests rates but can have different macroeconomic effect (Andrade, Gaballo, Mengus, and Mojon (2018)).

[10] Raising interest rates in these circumstances would expose the central bank to capital losses on the assets it holds.

and Rudebusch (2012)) while other highlight underlying "portfolio balance" channel (see for instance Gagnon, Raskin, Remache, and Sack (2011), Krishnamurthy and Vissing-Jorgensen (2011), Nakamura and Steinsson (2013)). Swanson (2017) shows that large-scale asset purchases were more effective in lowering longer-term Treasure while forward guidance was more effective in moving shorter-term yields.

We consider here all types of unconventional monetary policies, i.e. asset purchases and forward guidance, given that both measures were often announced on the same day. Therefore, we use a medium-term Treasury yield (5-year rate) as unconventional monetary policy stance. An instrument for unconventional monetary policy shock is approximated by the daily variations in the 5-year nominal rate on the Federal Reserve's announcement days.[11] The movements in the interest rates on FOMC dates reflect revisions in beliefs about the future path of short-term rates and the expected risk premia. Measuring this surprise allows us to isolate the portion of the innovation in the monetary policy indicator coming from VAR that is due to the exogenous policy surprise. We consider all FOMC meetings and several speeches.[12] If the announcement was not surprising, the interest rate change would automatically be zero.[13]

IV.2 Macroeconomic Impact of monetary policy shocks

In our benchmark specification the VAR model has six lags and includes the following four endogenous variables: interpolated monthly real GDP (gdp_t), the core personal consumption expenditure price index (p_t), the Gilchrist and Zakrajšek (2012)'s excess bond premium (ebp_t)

[11]Our VAR has a monthly frequency, thus we need to turn the daily financial markets surprises on FOMC days into monthly average surprises. The day of announcement is important feature as an announcement made on November 25 would affect only last few days of the month, while the announcement on December 1 would affect the whole month. To be sure to capture all the information in a given month we follow Gertler and Karadi (2015) procedure and attribute weights to each surprises according to the day of the month it occurred on. For instance, in case of the 25-November surprise 5/30 would be attributed to the month of November and the remaining 25/30 to December.

[12]We follow Rogers, Scotti, and Wright (2014) and consider all FOMC announcements during the estimation period, as well as the following communications: announcement of LSAP-I on 2008-11-25 and B. Bernanke's speeches and testimony containing information about future policy actions: 2008-12-01, 2010-08-27, 2010-10-15, 2011-08-26, 2012-08-31, 2013-05-22.

[13]We regress the reduced-form residuals of the policy indicator (5-year rate) from the simple monthly VAR (including GDP, prices, EBP and policy indicator) on the instrument (5-year interest rate change around monetary policy announcement) to be confident that weak instrument problem is not present. The F-statistic from the first-stage regression is equal to 19.75, which is above a threshold of ten recommended by Stock, Wright, and Yogo (2002).

and a policy indicator: 1-year or 5-year nominal interest rate, for conventional and unconventional policy, respectively. As explained before, we also use different instrument for each policy indicator. We consider changes in the three month ahead monthly fed funds futures (FF4) for the conventional policy period and changes in the 5-year nominal U.S. monthly Treasury yield (T5Y) for the unconventional policy period. These instruments are calculated within a narrow window surrounding FOMC dates and other policy announcements and reflect unexpected changes in the stance of U.S. monetary policy.

Note also that the VAR model is estimated separately for each policy regime. Given that we impose a six-period lag, all calculations described in this section include the period 1990.M1-2008.M10 (Conventional) and 2008.M11-2015.M11 (Unconventional). Appendix A provides a description of the data. We measure all variables in log units, except for the excess bond premium, corporate bond yields and the policy indicator and instrument. In the figures, we report the deviation in percent for the series entered in log-levels, and the deviation in percentage points for the remaining variables. For each panel, we report the median in solid black line and the 68% error bands in dotted black lines.

Figure 1 reports the impulse responses of endogenous variables to conventional (left panel) and unconventional monetary policy (right panel) shocks. The dynamic effects of expansionary monetary policy are similar across the conventional and unconventional policy period. Indeed, a one standard deviation monetary policy shock that moves down the 1-year (5-year) Treasury rate by about 20 basis points increase both output and prices, and reduces excess bond premium in both regimes. After monetary policy easing, output increases and reaches its maximum after $18 - 24$ months, with a decline of 0.25% in conventional period and 0.3% in unconventional period. Note that the 68 percent error bands lie within the positive region, making the estimates robust. Looking at the financial variables, the expansionary shock induces a 8 basis point decline in the excess bond premium, which then returns to its original level over the course of two years, in both policy regimes. A decline in the excess bond premium represents an increase in investors' risk appetite in the corporate bond market. The response of prices however is much stronger and immediate in unconventional monetary policy period. This is in line with Weale and Wieladek (2016) who employ a VAR with zero-sign restrictions to measure the effects of unconventional monetary policy and obtain comparable responses of output and prices. In particular, the response of the CPI in the United States in their framework occurs right on impact.

We take advantage of the new high-frequency identification suited for unconventional monetary policy to investigate its impact on a wider set of macroeconomic variables.[14] We add each of them into the benchmark separately to avoid the degrees-of-freedom issues. Figure 2 characterizes the dynamic effects of policy shocks on a wider range of economic variables: consumption, investment (residential and non-residential) and employment. Each panel refers to a specific estimation of the model. Looking at the first row, consumption increases after conventional and unconventional monetary policy shock, with a maximum effect of respectively 0.5% and 0.65% reached after 30 and 8 months. Interestingly, the effects seem to be more persistent in conventional monetary policy period. The estimates further show that the effects of standard and non-standard policy shocks are important for residential and non-residential investment (i.e., the second and third rows). Finally, there is also evidence that Federal Reserve interventions have positive effects on labor markets (i.e., the fourth row column). Indeed, the number of employees increases persistently in response to a policy shock, especially in conventional monetary policy period.

Overall, our findings indicate that U.S. both conventional and unconventional monetary policy had powerful effects on economic activity. The behavior of the economy shown in Figures 1 and 2, using a VAR with high-frequency identification, is consistent with a number of studies analyzing the macroeconomic effects of U.S. unconventional monetary policy. Notable examples include Chen, Cúrdia, and Ferrero (2012), Baumeister and Benati (2013), Gambacorta, Hofmann, and Peersman (2014), and Del Negro, Eggertsson, Ferrero, and Kiyotaki (2017).

IV.3 Monetary Policy and Corporate Debt Structure

We divide this section into two parts. First, in Section IV.3.1, we discuss corporate debt data coming from the Flow of Funds dataset, and report some interesting descriptive analysis. Second, in Section IV.3.2, we assess the effects of conventional and unconventional monetary policy shocks on a corporate debt structure.

IV.3.1 Flow of Funds dataset

To analyze the impact of monetary policy on corporate debt structure we use time series on debt instruments of Nonfinancial Corporate Business sector (L.103) from Financial Accounts of the United States (Z.1). Figure 3 shows the evolution of two instruments of corporate debt:

[14]The existing studies either evaluate the macroeconomic impact of standard monetary policy using the high-frequency instrument up to two years (Gertler and Karadi (2015) or used longer-maturity instrument to study the effects on the financial markets (Wright (2012), Rogers, Scotti, and Wright (2016)).

loans and debt securities. It also highlights the increase of share of bond finance observed since 2008.

To have a better look of each category of debt, we decompose each of them into subcategories. Loans to non-financial corporations (NFCs) include: (i) depository institution loans not elsewhere classified ("bank loans"); (ii) mortgages; and (iii) other loans and advances ("other loans"). Depository institution loans not elsewhere classified are primarily loans from U.S.-chartered depository institutions, foreign banking offices in the U.S., banks in U.S.-affiliated areas, and credit unions. Mortgages include commercial mortgages. "Other loans and advances" include loans made by finance companies, savings institutions, and credit unions but also other entities. This category is an important component as the non-financial corporations receive loans not only from depository institutions, but also from insurance companies and pension funds, other financial institutions, other NFCs, governments and creditors resident in the rest of the world. Figure 4 shows the evolution and the relative importance of each category of loans. The proportion of other loans to all outstanding loans granted to NFCs increased from 33% in 1990 to 45% in 2017. Bank share in total loans diminished from 46% in 1990 to 20% in 2010 and recovered to 36% in 2017. Mortgage share represented 21% in 1990 than increased from 2002 to attain 35% in the end of 2006 and descended to 18% in 2018. Overall, all loans granted to non-financial firms increased from \$1000 billion in 1990 to \$2800 billion in 2017. The increase in debt securities has been much more spectacular, as they went up from \$1200 billion in 1990 to \$6100 billion in 2017. Regarding debt securities, they include (i) commercial paper; (ii) municipal securities[15]; and (iii) corporate bonds, with corporate bonds being an overwhelming majority as shown on Figure 5 (80% in 1990 and 87% in 2007).

IV.3.2 The impact of monetary policy shocks on corporate debt structure

In this section, we assess the impact of conventional and unconventional monetary policy shocks on the corporate debt structure. To do so, we extend the VAR model presented in section IV by adding one by one corporate financing variables: loans (bank loans, other loans and mortgages) and debt securities (corporate bonds, commercial paper and municipal securities).[16] Again, we estimate the VAR separately in conventional and unconventional monetary policy period. The left column of Figure 6 shows that an expansionary conven-

[15]Municipal Securities issued by the non-financial corporate business are principally industrial revenue bonds.

[16]We interpolate the quarterly Flow of Funds series described in the previous section into monthly frequency.

tional monetary policy shock induces a 0.5% increase in all loans granted to non-financial corporations after 18 months. This increase is mostly due to other loans and mortgages. However, the right column of Figure 6 shows that unconventional monetary policy easing doesn't have the same effect. Indeed, total loans distributed to non-financial corporations do not respond significantly to unconventional monetary easing.

Interestingly, monetary policy shocks seem to push loans and debt securities in opposite directions. Figure 7 shows that debt securities, and their main component corporate bonds, decrease after conventional monetary easing to reach a minimum after 24 months (i.e., about -0.45% and -0.55% decrease for all debt securities and corporate bonds, respectively). By contrast, unconventional monetary easing increases the amount of debt securities, both in short and longer run (after 24 months all debt securities and corporate bonds rise by about 0.25% and 0.35%, respectively).

As a way to illustrate the differences in dynamics between the two policy regimes, we report for total loans and debt securities, the differences in their impulse responses across regimes, as shown in Figure 8. For total loans, when looking at the 16% and 84% percentiles (i.e., the left panel), the responses to conventional and unconventional monetary policy shocks are remarkably different. The error bands lie within the same (positive) region in the short-run, indicating that differences between regimes are robust. Note, however, that these differences disappear quickly over the next months that follow the initial shock. By contrast, regarding the differences in impulse responses of debt securities, the error bands lie well within the same (negative) region throughout the months, reinforcing our results. Summarizing, there is strong evidence of changes in the way that corporate debt structure responds to monetary policy shocks across the two policy regimes.

Looking at the conventional monetary policy period, our results are in line with the findings of Becker and Ivashina (2014): conventional monetary policy easing increases loans granted to non-financial corporations but reduces corporate bond issuance. Unconventional monetary policy seems to have a different transmission channel: unconventional easing does not affect loans granted to firms but stimulates their debt securities issuance. The results for securities are driven by the increase in longer-term corporate bonds which is consistent with the "gap-filling" theory by Greenwood, Hanson, and Stein (2010). When the central bank purchases long-term government bonds, there is a lack of long-term assets in the market. Acting as macro liquidity providers, the firms fill the gap by issuing more long-term bonds to meet the demand for long-term assets. Overall, these results imply that expansionary conventional and unconventional monetary policies affect the real economy through different transmission channels. One of the possible explanations for different impact of unconventional monetary policy is their influence on the corporate bond market.

To test this hypothesis, we introduce one by one the corporate yields series in our benchmark VAR: Moody's BAA and AAA corporate bond yield. Figure 9 reports the responses of AAA and BAA corporate bond yield to conventional and unconventional monetary policy shocks. Corporate yields are particularly sensitive to unconventional monetary policy shock, with the corresponding declines of around 15 basis points on impact for both types of bonds. By contrast, the response of AAA and BAA yields to conventional monetary policy is muted on impact, and the decline that arrives later is much smaller in magnitude (around 4 basis points). It might be due to the "default risk channel" of non-standard policies that predicts that the purchases of long-term Treasuries and agency MBSs should boost the economy, implying a fall in the default risk of corporations and thus a decline in corporate bond spreads (Krishnamurthy and Vissing-Jorgensen, 2011). Such effect also confirms the so-called "portfolio-balance" effect, which is one of the desired objectives of the Federal Reserve. By providing large amount of liquidity, the asset purchase programmes give incentives to investors who sold Treasuries to the central bank to rebalance their portfolio with riskier assets, such as corporate bonds, which in turn would drive up the prices of these assets. Our results suggest that the non-standard measures stimulated investors' "reach for yield" behavior. They substituted away from government bonds towards more risky securities. It is consistent with the argument that the expectation of low nominal interest rates creates incentives for yield-oriented investors to take additional risk, increasing the demand and reducing the risk premia for higher-yielding debt (See Hanson and Stein, 2015; Foley-Fisher, Ramcharan, and Yu, 2016).

The improved conditions on the corporate bonds markets following unconventional monetary policy shock could explain the increase in corporate bonds that follows unconventional monetary policy shock that we found earlier.

V Conclusion

We have examined the macroeconomic effects of conventional and unconventional monetary policy shocks using a VAR model identified with external instruments. Our results consistently show that dynamic effects of expansionary monetary policy are quite similar across the conventional and unconventional policy period, with a fall in the policy indicator and credit spread, and a persistent rise in output and prices.

Nevertheless, the transmission channels of conventional and unconventional monetary policies are different when corporate debt structure is taken into account. Indeed, their impact on corporate debt structure goes in opposite directions: conventional monetary easing increases the share of loans in corporate financing while unconventional monetary easing increases the share of debt securities.

Overall, our findings suggest that further empirical research on conventional and unconventional monetary policy and their effects on the structure of corporate debt is crucial in order to better understand the mechanism of monetary transmission to the real economy. From a theoretical perspective, modeling such patterns is also an interesting future research topic.

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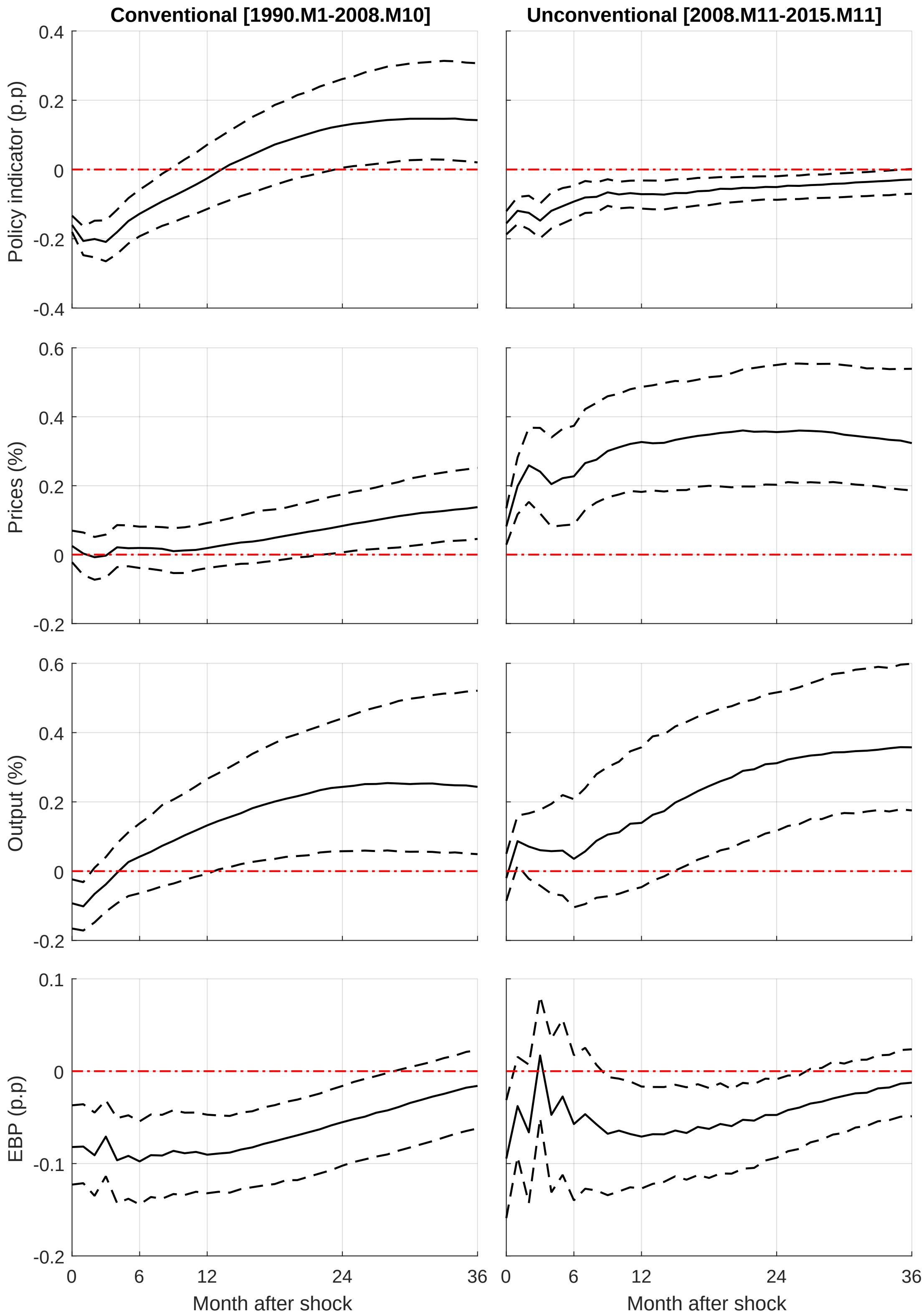
A VAR Data

- gdp_t: output is the real interpolated GDP (GDPC1). Source: FRED (Federal Reserve Economic Data). The Chow and Lin (1971) procedure is used to interpolate the real quarterly GDP.
- p_t: prices are the monthly consumer price index (CPI). Source: FRED.
- policy indicators and instruments: the five-year Treasury yield. Source: Datastream;
- Residential and non residential investment (interpolated), consumption and all employees from FRED.
- debt instruments of Nonfinancial Corporate Business sector (L.103) from Financial Accounts of the United States (Z.1) (interpolated).;
- ebp_t: the excess bond premium. Source: Gilchrist and Zakrajšek (2012);
- Corporate BAA and AAA yields from Datastream.

For inference, we use the natural log of output. Our interest rate variables remain unchanged.

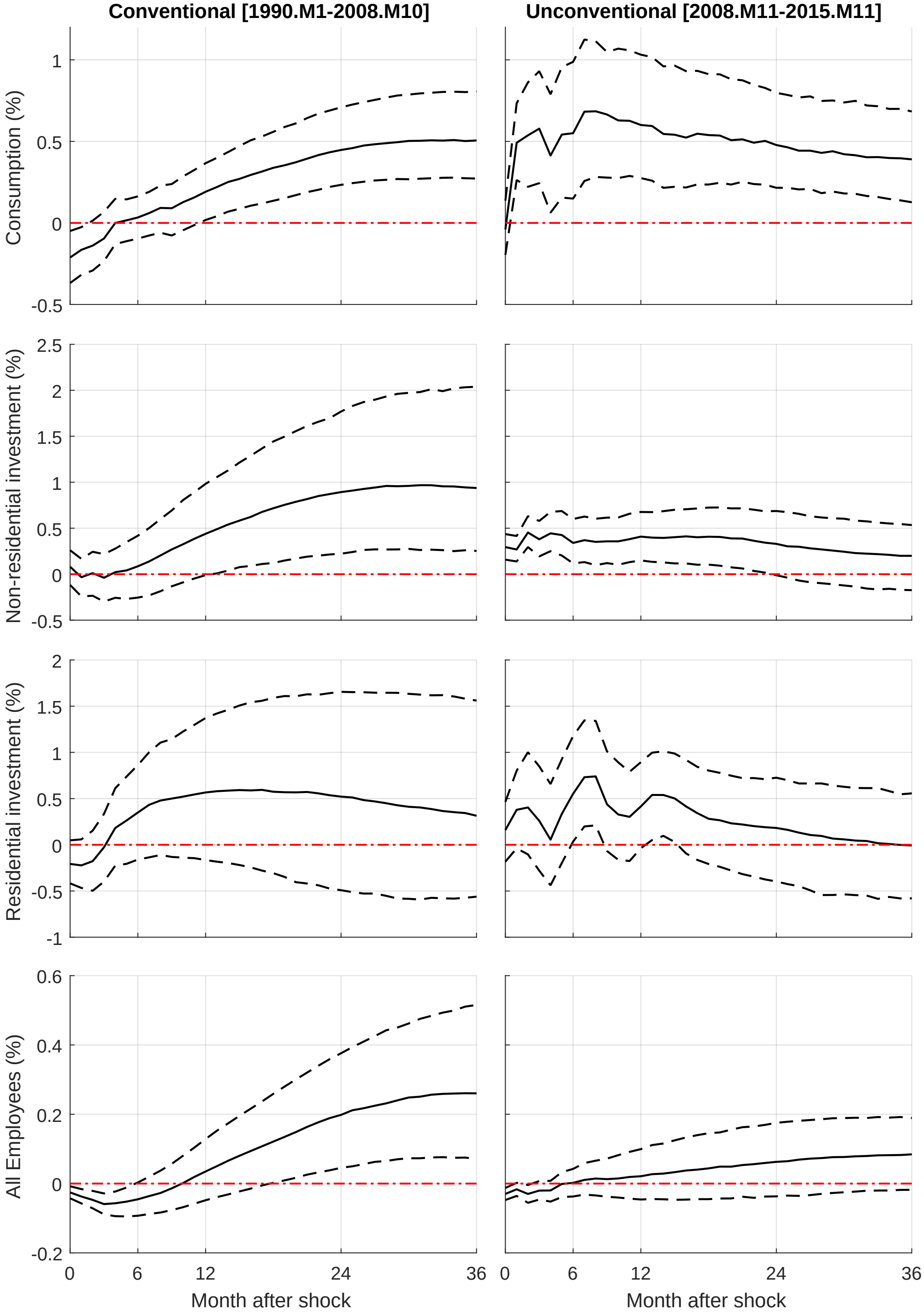
B Figures

Figure 1: Responses of macroeconomic variables to an expansionary monetary policy shock.



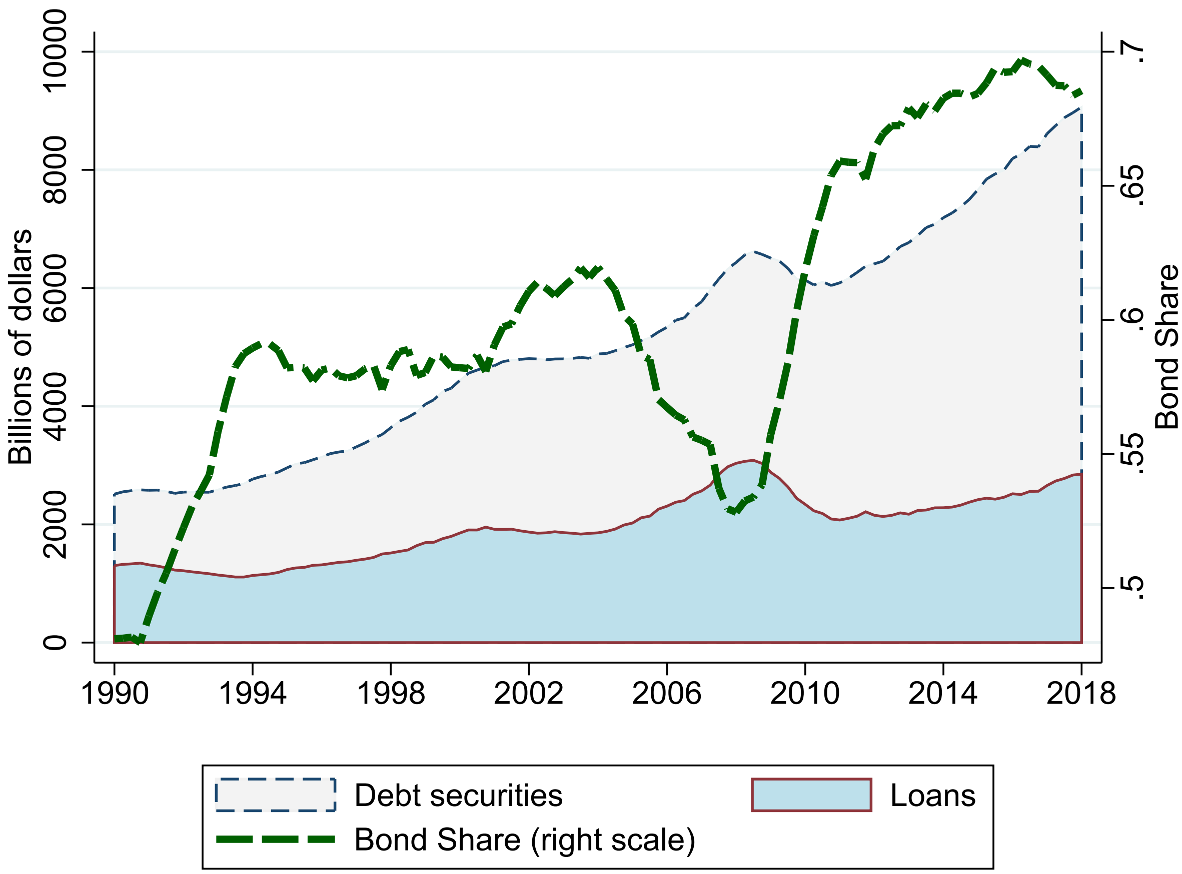
Note: The solid black line represents the median responses. The 16th and 84th percentile are displayed in dotted black.

Figure 2: Responses of additional macroeconomic variables to an expansionary monetary policy shock.



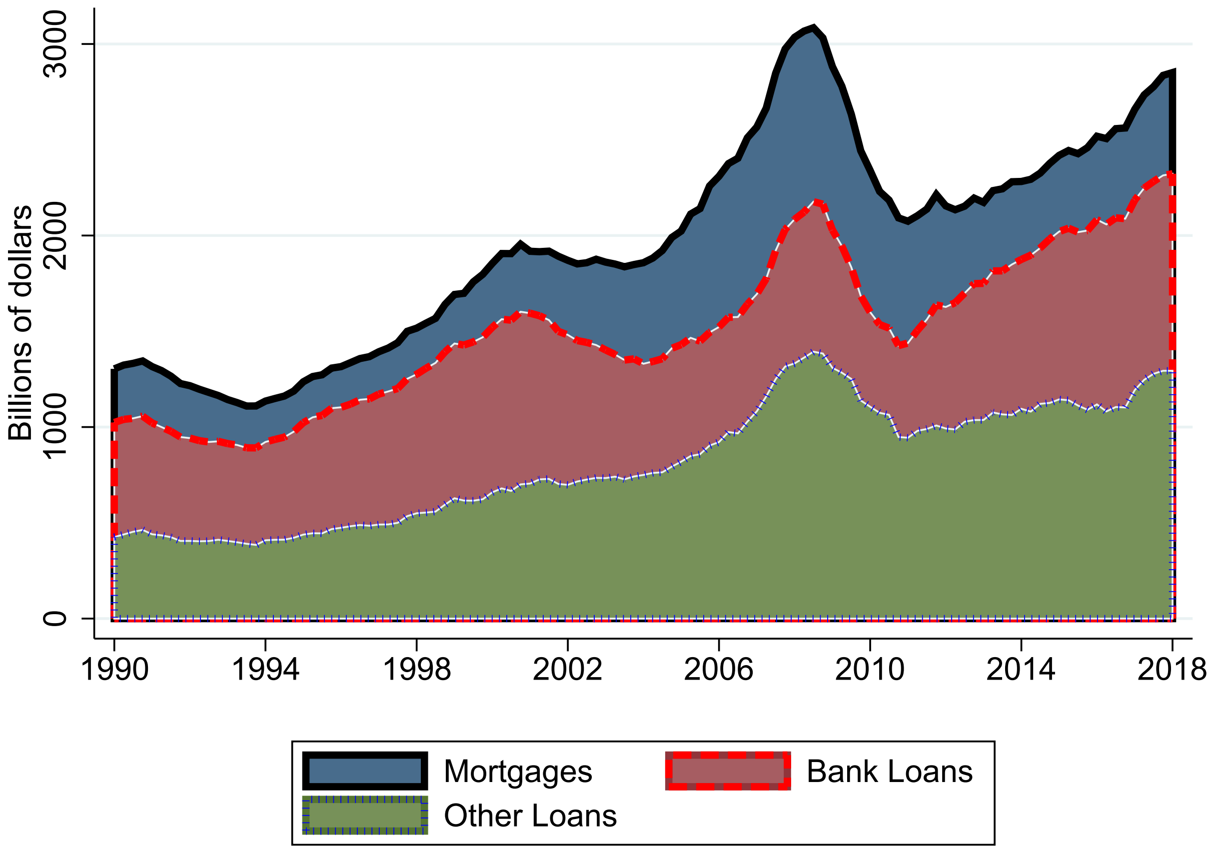
Note: The solid black line represents the median responses. The 16th and 84th percentile are displayed in dotted black.

Figure 3: Corporate debt structure in the U.S.: Loans and Debt Securities



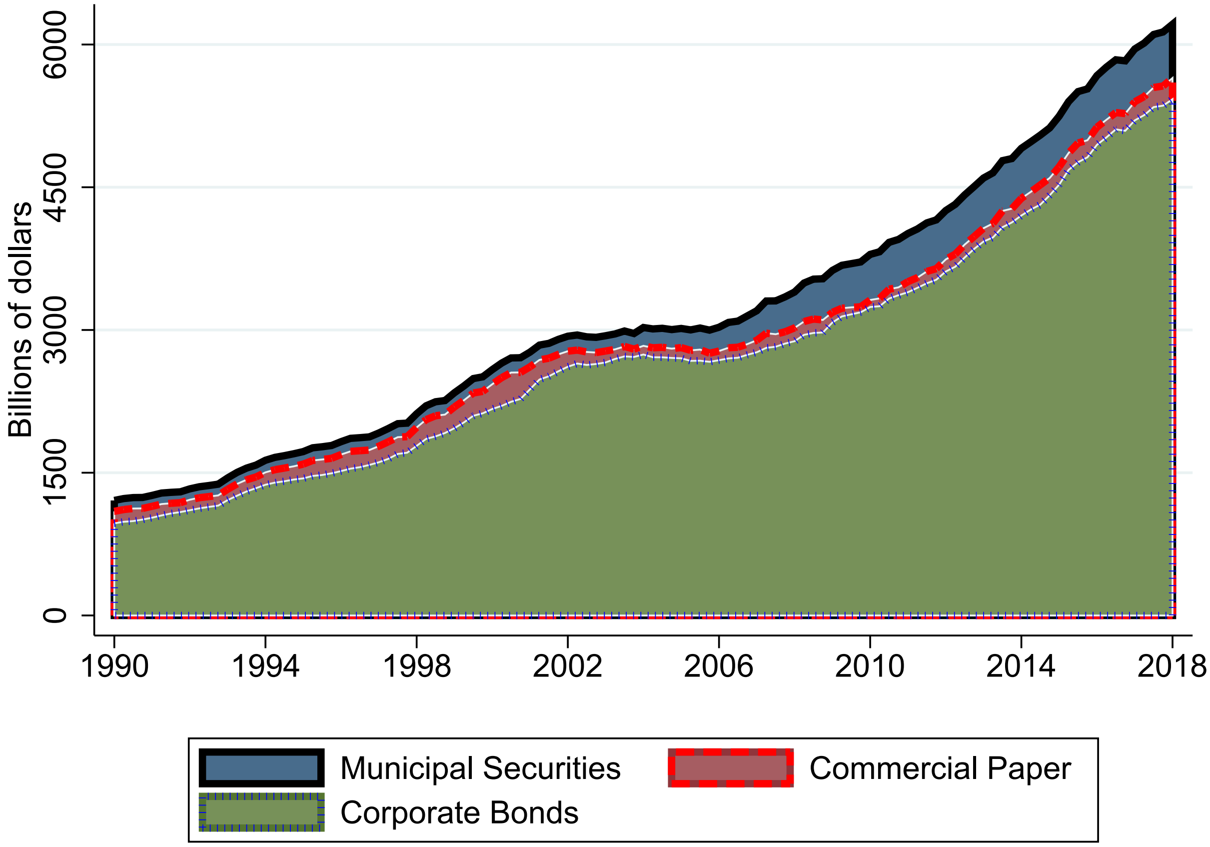
Note: Billions of dollars; amounts outstanding end of period, not seasonally adjusted. Source: Financial Accounts of the United States (Z.1), L.103 Nonfinancial Corporate Business.

Figure 4: Loans to Non-Financial Corporations



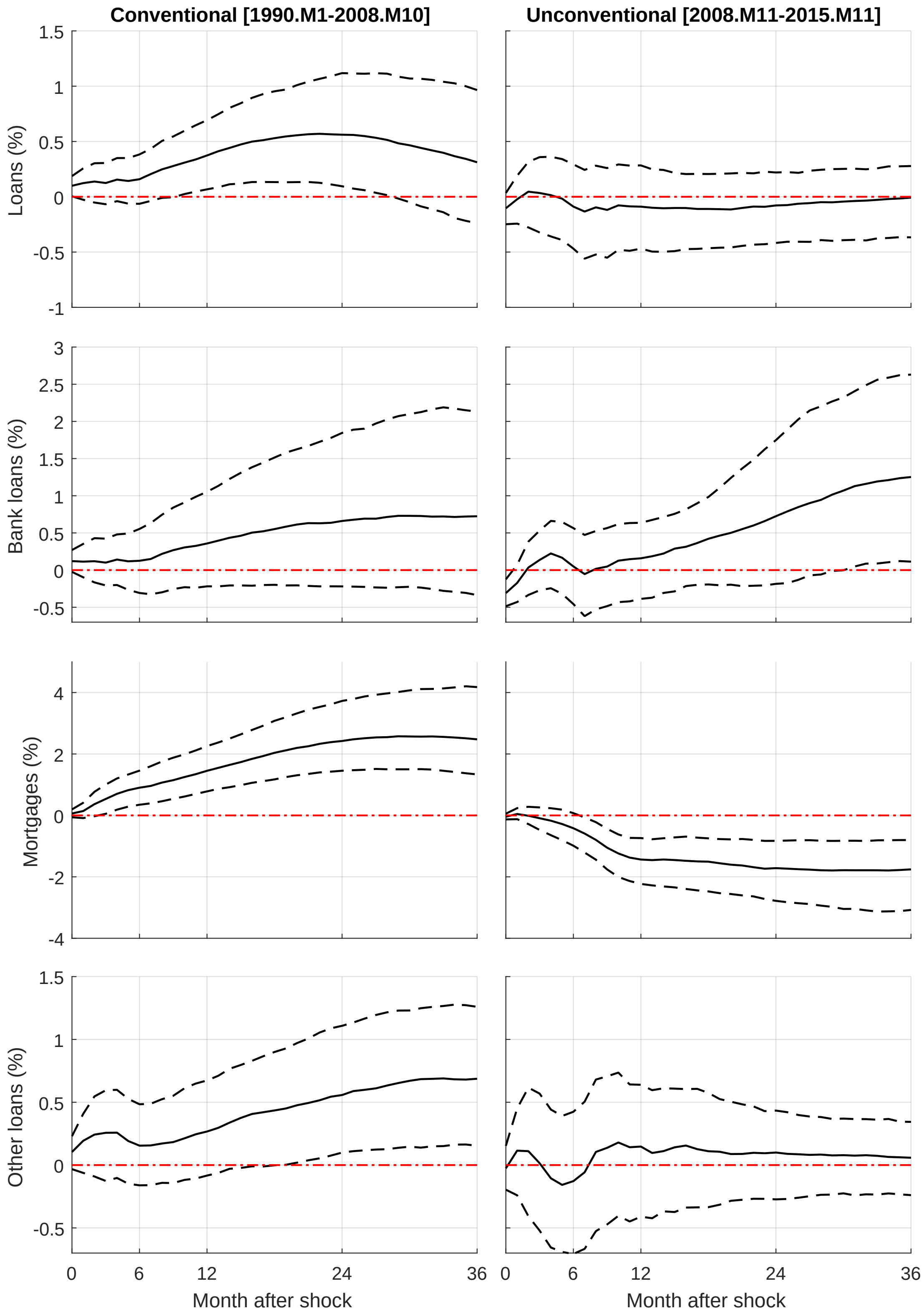
Note: Billions of dollars; amounts outstanding end of period, not seasonally adjusted. Source: Financial Accounts of the United States (Z.1), L.103 Nonfinancial Corporate Business.

Figure 5: Non-Financial Corporations Debt Securities



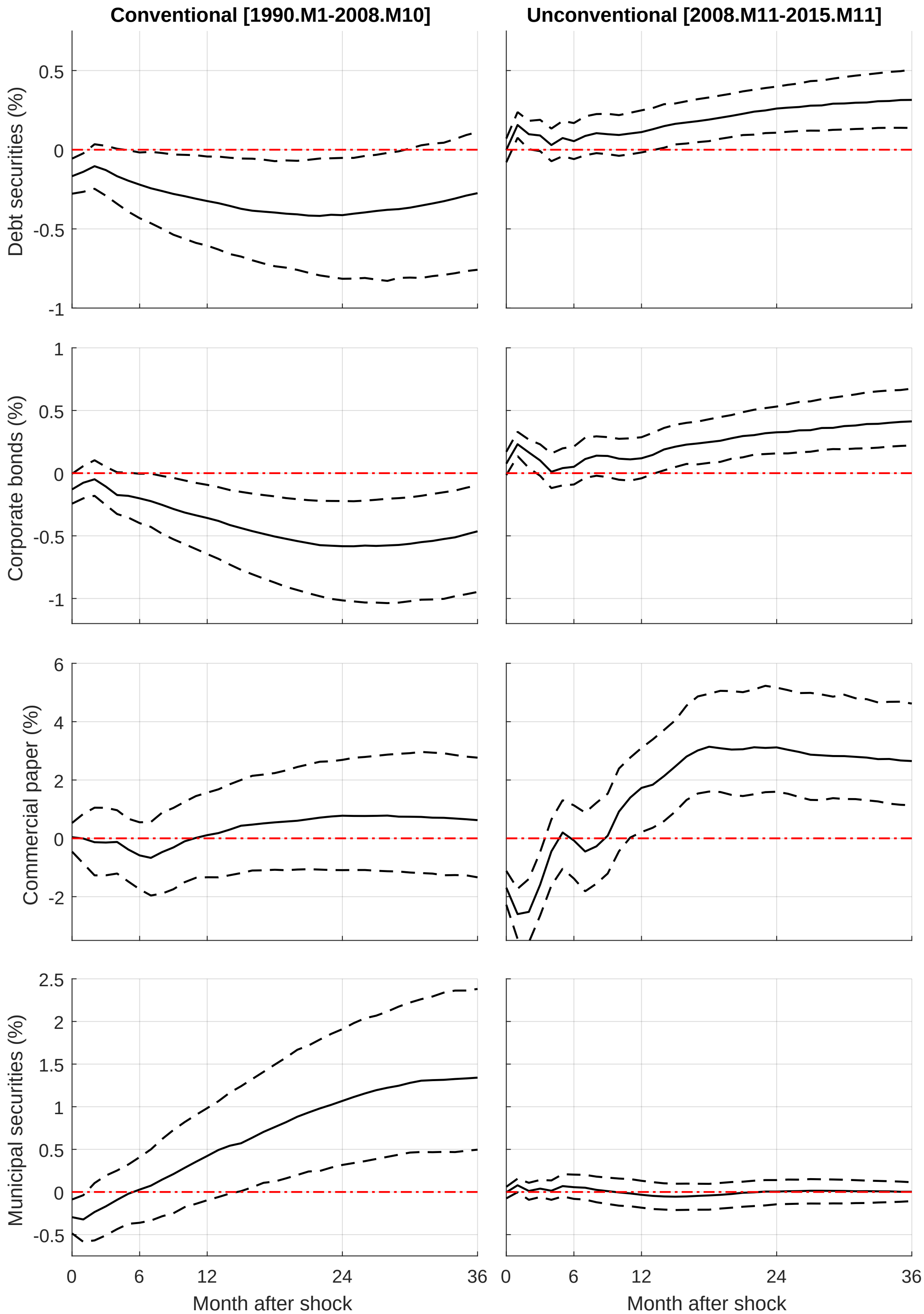
Note: Billions of dollars; amounts outstanding end of period, not seasonally adjusted. Source: Financial Accounts of the United States (Z.1), L.103 Nonfinancial Corporate Business.

Figure 6: Responses of loans to NFC to an expansionary monetary policy shock.



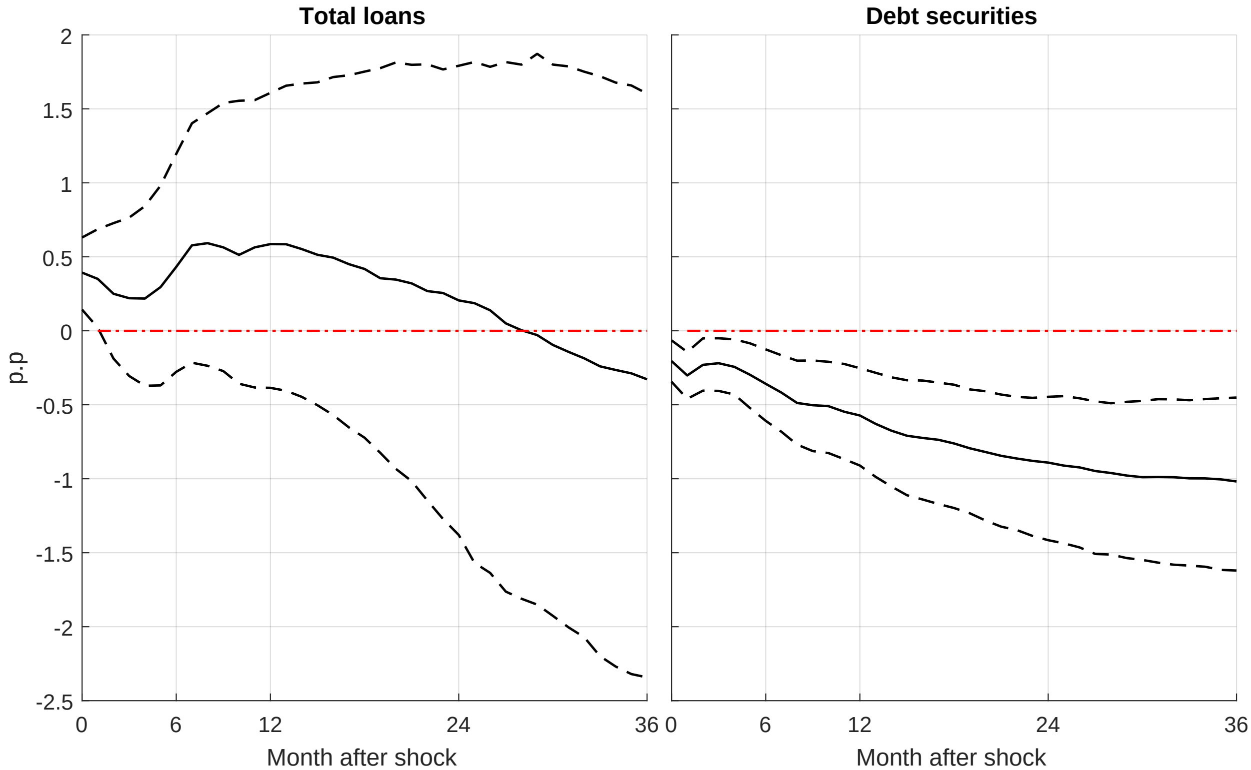
Note: The solid black line represents the median responses. The 16th and 84th percentile are displayed in dotted black.

Figure 7: Responses of debt securities to an expansionary monetary policy shock.



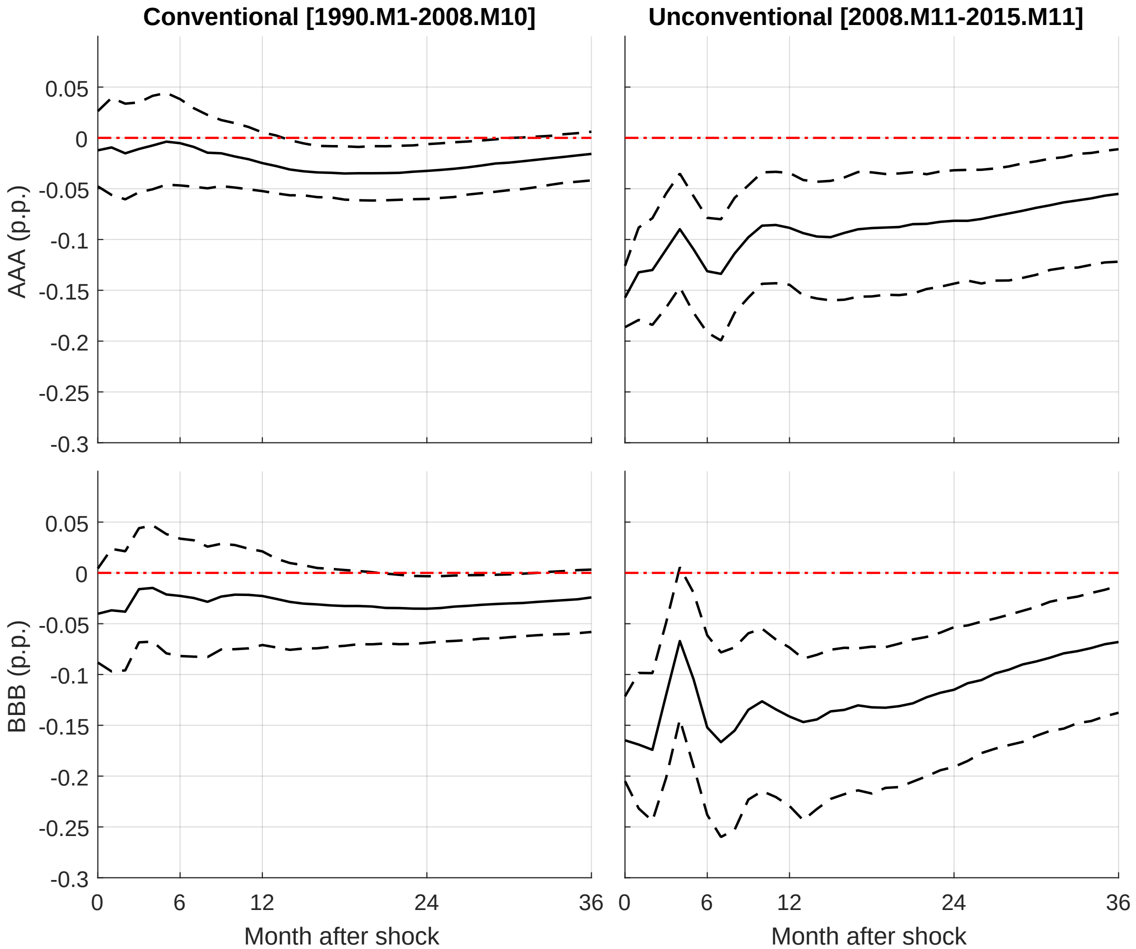
Note: The solid black line represents the median responses. The 16th and 84th percentile are displayed in dotted black.

Figure 8: Differences in responses to conventional and unconventional monetary shock.



Note: The solid black line represents the median responses. The 16th and 84th percentile are displayed in dotted black.

Figure 9: Responses of corporate yields to an expansionary monetary policy shocks.



Note: The solid black line represents the median responses. The 16th and 84th percentile are displayed in dotted black.