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ON THE MACROECONOMIC AND WEALTH EFFECTS OF UNCONVENTIONAL MONETARY POLICY

FREDJ JAWADI
University of Evry

RICARDO M. SOUSA
University of Minho
NIPE
and
LSE Alumni Association

RAFFAELLA TRAVERSO
University of Minho

This paper focuses on the macroeconomic and wealth effects of unconventional monetary policy. To this end, we estimate a Bayesian structural vector autoregression (B-SVAR) using U.S. monthly data for the post-Lehman Brothers' collapse period. We show that a positive shock to the growth rate of central bank reserves does not have a substantial impact on industrial production or consumer prices. However, it also gives a strong boost to asset prices, which is larger in magnitude for stock prices than for housing prices. Thus, unconventional monetary policy typically operates via portfolio-rebalancing effects. A VAR counterfactual exercise confirms the role of the shocks to the growth rate of central bank reserves in explaining the dynamics of the variables included in the system, especially in the case of asset prices. Finally, additional empirical assessments uncover an important change in the conduct of monetary policy from "standard" to"exceptional" times and the suitability of our model to capture such a structural transformation.

Keywords: Unconventional Monetary Policy, Macroeconomic Impact, Wealth Effects, Bayesian Structural VAR

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Address correspondence to: Ricardo M. Sousa, University of Minho, Department of Economics and Economic Policies Research Unit (NIPE), Campus of Gualtar, 4710-057 Braga, Portugal; e-mail: rjsousa@eeg.uminho.pt, rjsousa@alumni.lse.ac.uk.

1. INTRODUCTION

Conventional monetary policy is typically conducted through control over short-term nominal interest rates. Its implementation is generally done by announcing a reference rate and using open market operations to align interbank rates with the target.

However, policy rates are bounded by the zero floor, which limits the extent to which monetary stimulus can be provided via rate cuts. In fact, when the policy rate is zero, cash and bank deposits become very close substitutes [Meier (2011)].[1] Moreover, the possibility of a breakdown in money market activity due to the lack of trade incentives may impose a strictly positive interest rate. As a result, even a zero policy rate may be too high to boost an economy that is under deflationary prospects. Another reason for the switch to nonstandard policies can be associated with the severe turmoil in credit markets induced by the bursting of the U.S. real estate market bubble. Putting it differently, rate cuts might be constrained both by the zero bound and by the lack of policy effectiveness during financial crises.

Not surprisingly, the international financial turmoil of 2008–2009 has led to a dramatic change in the way monetary policy is conducted. In this context, rather than limiting the choice to just a target for the short-term nominal interest rate, other dimensions of monetary policy, such as changes in the assets acquired by central banks, variation in the supply of bank reserves, and changes in the term spread have started to capture the attention of many central banks. Indeed, as highlighted by Takeda and Yajima (2014), unconventional monetary policy was first implemented by the Bank of Japan (BOJ) in 1999. However, in response to the recent global financial crisis, several central banks around the world have also designed policy measures with the purpose of expanding credit and included explicit communication on future policy rates, refinancing operations at different maturities, and mainly large-scale asset purchases (LSAP) with base money expansion [Blinder (2000); Clouse et al. (2003); Bernanke and Reinhart (2004)].

There are four main channels by which unconventional monetary policy takes effect. First, it signals the desire of the central bank to hold short-term interest rates low for a long period, which generates the expectation of lower future short-term interest rates and influences long-term interest rates. This is the so-called expectation channel, which includes "signaling effects," whereby the central bank provides information about the intended state of monetary conditions, and "policy duration effects," which reflect the commitment to keep the unconventional measures in effect until the main goals are achieved. Second, it generates beneficial market effects, in particular during stress periods, by helping to reduce the spreads between long-term rates (such as mortgage rates) and short-term rates (such as Treasury yields) through the action on the yield curve. Third, it reduces the overall supply of long-term securities that is available to investors, which pushes up prices and brings down yields. Fourth, it produces portfolio rebalancing effects, which embrace the expansion of the central bank's balance sheet via increasing the size of the monetary base or the quantity of bank reserves and/or changes in the composition of assets through the program of purchases. Accordingly, unconventional monetary policy includes quantitative easing (QE) through the expansion of the money supply, action on the yield curve by narrowing the difference between long-term and short-term interest rates, and credit easing, whereby the central bank replaces banks and directly finances the economy.

The existing studies show that nonstandard monetary policy in the United States and Japan narrowed the term spread on targeted assets and weathered the fluctuations of financial markets [Bernanke et al. (2004)].[2] Furthermore, even though the main objectives of such policies are to improve market confidence, reduce systemic risk, and and bottom out the recession, economists and policy makers did not provide unanimous conclusions and analyses about them. Indeed, although, according to Greenspan (2012), the macroeconomic impact of unconventional monetary policy seems very small, Stein (2012) suggests that QE measures such as large-scale asset purchases have played an important role in supporting economic activity. Taylor (2013) argues that QE can generate uncertainty, as an increase in central bank reserves does not immediately imply an increase in money supply, particularly if banks hold excess reserves and do not lend money. Also, Lacker (2012), who voted against the third round of QE in the United States, highlights that there is a risk of increase in income and wealth inequality as QE boosts the wealth of agents with large holdings of financial assets, typically the rich.[3] Internationally, other policy makers and countries, such as the BRICs (Brazil, Russia, India, and China), have criticized the QE carried out by central banks of developed countries, as this penalizes their industries and induces inflation for these countries.

Against this background, there is no agreement yet on the effectiveness of unconventional monetary policy in boosting the economy. In fact, Rudebusch et al. (2007) show evidence supporting the existence of a negative relationship between the term premium and real economic activity. Del Negro et al. (2010) find that changes in the relative supply of liquid and illiquid assets available in the economy helped to avoid a second Great Depression by counteracting a decline in real economic activity and the emergence of deflationary pressures (the so-called"Great Escape"). The work of Carvalho et al. (2011) corroborates the view that unconventional monetary policies and fiscal expansions implemented in the 2008–2009 period had a stabilizing effect on inflation expectations and GDP growth. In contrast, Ait-Sahalia et al. (2012) highlight that announcements of interest rate cuts, liquidity support, liability guarantees, and recapitalization are normally followed by a fall in interbank risk premia. As for Chen et al. (2012), they emphasize that the macroeconomic effects of LSAPs are likely to be small, because of the low degree of financial market segmentation.

Additionally, central banks have, alongside the central objective of monetary stability, the goal of preserving financial stability. Thus, there is a concern that retaining such policy measures for too long might negatively impinge on the functioning financial markets. Kapetanios et al. (2012) argue that the difficulty of identifying the necessary counterfactual may lead to a focus of research on the impact of nonstandard monetary policy on financial markets when compared to the effects on real activity or inflation. Bridges and Thomas (2011) estimate the effects of QE on asset prices and nominal spending in the United Kingdom and show that a 5–13% increase in money holdings temporarily increased asset values by between 10% and 30% in 2009 and 2010.

Consequently, a better understanding of the transmission mechanism and the impact of unconventional monetary policy on economic activity and asset prices is essential for academics, central banks, and policy makers. In this context, we assess the macroeconomic effects of shocks to the growth rate of the central bank reserves and thus investigate their impact on real output and inflation. Moreover, we analyze the asset price effects associated with unconventional monetary policy, in particular by distinguishing between the impacts on stock prices and housing prices.[4] Accordingly, these are the main goals of the current paper.

Using data for the United States at monthly frequency for the post-Lehman Brothers' collapse period and estimating a Bayesian structural vector autoregression (B-SVAR), we show that a positive shock to the growth rate of the central bank reserves (i) only marginally expands economic activity and (ii) leads to a persistent rise in the price of raw materials despite not impacting consumer prices. Interestingly, both the housing price and the stock price are given a significant boost by the shock. This suggests that the main channel of this type of unconventional monetary policy is wealth allocation.

We also build a VAR counterfactual exercise where we shut down the unconventional monetary policy shocks and back out the implied dynamics of the variables included in the system. The empirical findings show that a large fraction of the variation in the growth rate of central bank reserves was unexpected at the beginning of the sample. Moreover, although the differences between the actual and the counterfactual series of the asset prices, the commodity prices, and the term spread remains reasonably large throughout the sample, those discrepancies for industrial production and consumer prices basically disappear after 2011–2012. Consequently, shocks to the growth rate of central bank reserves typically operate via changes in asset portfolio composition.

Finally, we confirm that the conduct of monetary policy suffered important changes from "standard"to "bad" times. Moreover, our model is especially suited to capture the impact of unconventional monetary policy in "exceptional" circumstances, while delivering predictions that are in accordance with economic theory.

The rest of the paper is organized as follows. Section 2 presents the data and the econometric methodology. Section 3 discusses the empirical results. Section 4 concludes.

2. DATA AND METHODOLOGY

2.1. Data

We collected monthly frequency data for (i) the housing price index; (ii) the producer price index of all commodities; (iii) the industrial production index;

(iv) the consumer price index; (v) the growth rate of the central bank reserves; (vi) the interest rate spread; and (vii) the stock price index. Our sample period is 2008:M9–2013:M8. Thus, it refers to the post-Lehman Brothers' collapse period, which marks the beginning of unconventional monetary policy.

The main data sources are the Bureau of Economic Analysis (for macroeconomic variables), the Bureau of Labor Statistics (for information on prices), the Board of Governors of the Federal Reserve System (for data on the central bank's balance sheet, interest rates, and monetary aggregates), the U.S. Census Bureau (for housing price data), and the Datastream (for information on stock prices).

All variables are in natural logarithms and measured at constant prices, with the obvious exception of the interest rates.

2.2. Theoretical Predictions

Unconventional monetary policy shocks are retrieved by identifying the unexpected component of the growth rate of the central bank reserves (i.e., the policy instrument) and estimating a Bayesian structural vector autoregressive framework.

The macroeconomic impact of unconventional monetary policy is estimated by assessing the effect of a positive shock to the growth rate of the central bank reserves on the industrial production index and the consumer price index. As this (expansionary) unconventional measure aims at stimulating real economic activity, we expect that it will have a positive effect on the industrial production. A similar response can occur in the case of the consumer price index. However, as these policy actions take place in an exceptional environment where the degree of economic slack is likely to be large, it may also be the case that unconventional monetary policies contribute to the economic recovery without leading to inflation risk. Thus, the effect of the shock to the growth rate of central bank reserves on the consumer price index is unknown.

The wealth effects of unconventional monetary policy are investigated by looking at the impact of a positive shock to the growth rate of the central bank reserves on the housing price and stock price indices. Given that portfolio rebalancing effects are an important channel via which unconventional measures operate, we expect that the expansionary policy will have a positive impact on both sets of asset prices. However, they may react differently. More specifically, as stock prices adjust immediately to new information, we expect them to rise on impact after the positive shock to the growth rate of the central bank reserves. In contrast, given that the housing supply is typically rigid, it takes time to build new housing, and transaction costs are reasonably large, the response should be positive but also smaller in magnitude and somewhat more gradual.

Another transmission channel for unconventional monetary policy is commodity prices. On one hand, expansionary monetary policies can improve general market conditions and thus boost the prices of commodities. On the other hand, even if unconventional monetary policy does not have a stimulus effect on the economy, it can still have a positive impact on commodity prices, as these may be treated as another asset class. Put differently, by compressing the rate of return on long-term government bonds, unconventional monetary policy may lead investors to seek other diversification opportunities and thus to reallocate their wealth toward commodities in line with their increasing financialization.

Finally, we also take into account the impact of unconventional monetary policy on the term spread, i.e., the difference between the long-term and short-term interest rates. By acting on the demand side, LSAPs financed by the expansion of bank reserves can push upward the price of long-term government bonds and therefore bring downward the corresponding yields. At the zero lower bound, i.e., when short-term interest rates are near zero, this would be equivalent to narrowing the term spread. However, the implementation of unconventional monetary policy actions can also generate the expectation of a removal of further policy measures in the future, in which case investors may actually sell their long-term bonds with the goal of rebuying them at a later stage at a higher price. In these circumstances, the sales may exceed the purchases of long-term bonds, which would lead to a rise in the term spread. Consequently, the effect of a positive shock to the growth rate of central bank reserves on the term spread is unknown.

2.3. Econometric Methodology

In this paper, we consider the following SVAR:

$$\underbrace{\Gamma\left(L\right)}_{n\times n}\underbrace{X_t}_{n\times 1} = \Gamma_0 X_t + \Gamma_1 X_{t-1} + ... = c + \varepsilon_t, \qquad (1)$$

where $\varepsilon_t | X_s, s < t \sim N\left(\underline{0}, \Lambda\right)$, X_t is the vector of endogenous variables included in the system, $\Gamma\left(L\right)$ is a matrix-valued polynomial in positive powers of the lag operator L, n is the number of variables in the system, and ε_t is the vector of fundamental economic shocks. Thus, in reduced form , the VAR can be represented as

$$\Gamma_0^{-1}\Gamma\left(L\right) X_t = B\left(L\right) X_t = a + v_t \sim N\left(\underline{0}, \Sigma\right), \qquad (2)$$

where $\Sigma := \Gamma_0^{-1}\Lambda\left(\Gamma_0^{-1}\right)'$, $v_t = \Gamma_0^{-1}\varepsilon_t$ is the vector of innovations of X_t, and Γ_0 is the matrix of coefficients that capture the contemporaneous relations among the variables in the system. Without any loss of generality, we use the normalization $\Lambda = I$.[5]

We identify the unconventional monetary policy shock via a recursive partial framework. This procedure assumes that X_t can be split into the set of variables that respond to the unconventional monetary policy shock with a lag (X_{1t}), the monetary policy instrument (in our case, the growth rate of the central bank reserves), and another set of variables that react 1gcontemporaneously to the policy shock (X_{2t}). The approach is similar to the works of Christiano et al. (1996, 2005), Sousa (2010, 2014a, 2014b), and Mallick and Sousa (2012) for the case of conventional monetary policy. However, in this paper, we implement it in the context of unconventional monetary policy.

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TABLE 1. Identification of the unconventional monetary policy shock

	Sector						
				Production			
Variable	Financial	Monetary	Monetary	CPI	Ind. prod.	Commodities	Housing
Stock prices	+						
Interest rate spread	+	+					
Central bank reserves	+	+	+				
Consumer prices	+	+	+	+			
Industrial production	+	+	+	+	+		
Commodity prices	+	+	+	+	+	+	
Housing prices	+	+	+	+	+	+	+

Therefore, our model is distinguished from the previous ones along three major dimensions. First, unconventional measures typically make use of the growth rate of central bank reserves as a policy instrument, and not the short-term policy rate, as for conventional measures. Second, at the zero lower bound, it is the term spread (that is, the difference between the long-term and short-term interest rates) instead of the short-term interest rate per se that becomes relevant. Third, stimulating the economy via boosting asset prices is one of the main channels through which unconventional monetary policy impacts real economic activity, as a result of the importance of the portfolio rebalancing effects.

More specifically, we divide the economy into a financial sector, an (unconventional) monetary sector, and a production sector. The financial sector is captured by the dynamics of the stock price index, as it responds contemporaneously to all sources of information news. The (unconventional) monetary sector includes an equation for the growth rate of the central bank reserves and an equation for the term spread.[6] Finally, the production sector includes the consumer price index, the industrial production index, the commodity price index, and the housing price index. Table 1 provides a summary of the identification of unconventional monetary policy, where "+" indicates nonzero (i.e., unrestricted) elements.

In this context, we assume that the consumer price, the industrial production, and the commodity price are included in the set of variables that respond to the policy shock with a lag (i.e., X_{1t}), which is in accordance with the works of Christiano et al. (1996, 2005). In line with the research by Sousa (2010, 2014b), the housing price is also part of this vector of variables. In what concerns the set of variables that react to the policy shock in a contemporaneous manner (i.e.. X_{2t}), we consider the interest rate spread (in the light of the simultaneity between this variable and the central bank reserves in the functioning of the unconventional monetary sector) and the stock prices (in accordance with the previously mentioned

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works). We also include a constant and a time trend in the set of exogenous variables.

Finally, we account for the uncertainty about the posterior distribution of the impulse-response functions by constructing probability bands drawn from the normal-inverse-Wishart posterior distribution of $B(L)$ and Σ:

$$\beta|_{\Sigma} \sim N\left[\hat{\beta}, \Sigma \otimes \left(X'X\right)^{-1}\right] \tag{3}$$

$$\Sigma^{-1} \sim \text{Wishart}\left[\left(T\hat{\Sigma}\right)^{-1}, T-m\right],$$

where β is the vector of VAR coefficients, Σ is the covariance matrix of the residuals, the variables with a circumflex are the maximum-likelihood estimates, T is the sample size, and m is the number of estimated parameters per equation. Thus, we follow Sims and Zha (1999) and use a Monte Carlo Markov chain (MCMC) algorithm.

3. EMPIRICAL RESULTS

3.1. Baseline Model

We now investigate the effects of a positive shock to the central bank reserves. Figure 1 plots the impulse-response functions: the solid line denotes the median response and the dashed lines are the 68% posterior probability intervals. The empirical findings highlight that the shock expands economic activity in a persistent manner, but only marginally, as real industrial production grows by just 0.1% from the fourth month onward. The consumer price index is not impacted by the shock, which is in accordance with the large amount of slack in the economy, which avoids the existence of inflationary pressures when the unconventional monetary policy is implemented. However, the commodity price persistently increases. This suggests that investors respond to the policy measure by reallocating wealth toward other assets such as commodities in the light of their increasing financialization.

Interestingly, the housing prices, the stock prices, and the interest rate spread all rise after the shock. In particular, at the peak—which is reached four months after the shock—(i) housing prices are 1% higher than their original levels; (ii) stock prices are 2.5% higher; and (iii) the spread between the long-term and short-term interest rates has risen by 20 basis points. This confirms that the main effects of this type of unconventional monetary policy take place via portfolio rebalancing: by expanding the size of its balance sheet and purchasing troubled assets, the central bank releases money that economic agents use to increase their exposure to risk by investing in real estate, stocks, and long-term debt. Additionally, the fact that the term spread increases in response to the shock suggests that it reinforces the expectation of the dropping of further (expansionary) policies in the future.[7]

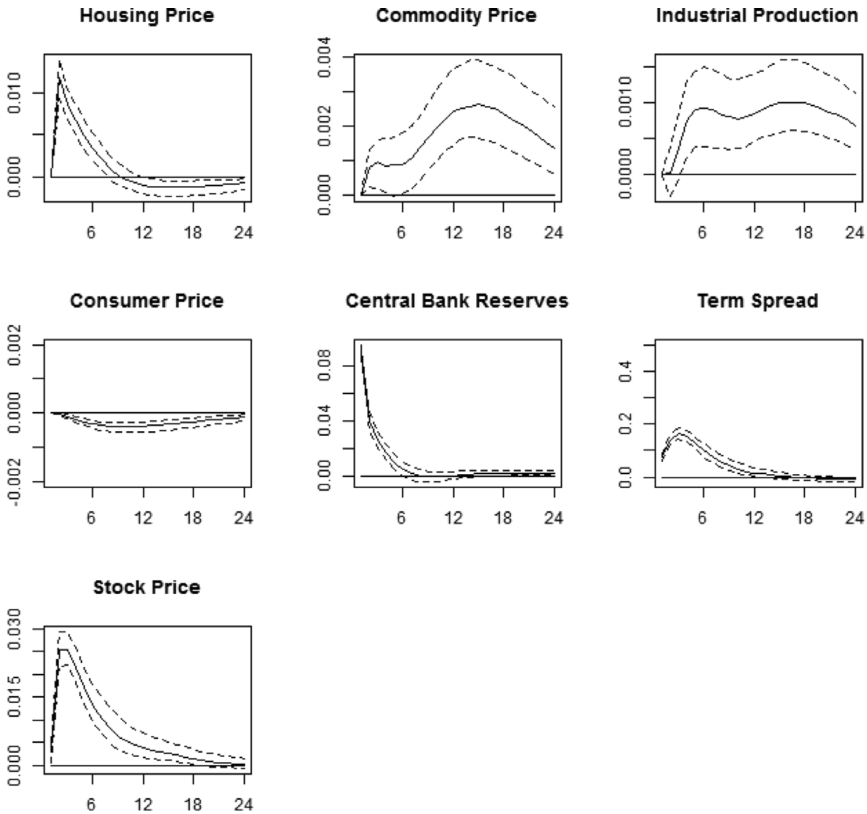

FIGURE 1. Impulse-response functions: Positive shock to the growth rate of the central bank reserves.

3.2. A VAR Counterfactual Application

How would our description of the economy perform in the absence of unconventional monetary policy shocks? What would be the dynamics of the variables included in the system if the shocks to the growth rate of central bank reserves were set to zero?

With the aim of answering these questions, we build a VAR counterfactual exercise.[8] More specifically, after estimating the B-SVAR summarized by (1), we take the vector of fundamental economic shocks, ε_t, and shut down the shocks to our policy instrument (i.e., we set $\varepsilon_t^{\text{CBR}} = 0, \forall t$, where CBR denotes the growth rate of central bank reserves). This is equivalent to considering the following vector of counterfactual structural shocks:

$$\varepsilon_t^* = [\varepsilon_t^{\text{HP}}, \varepsilon_t^{\text{Com}}, \varepsilon_t^{\text{IP}}, \varepsilon_t^{\text{CPI}}, \varepsilon_t^{\text{CBR}}, \varepsilon_t^{\text{TS}}, \varepsilon_t^{\text{SP}}]',$$

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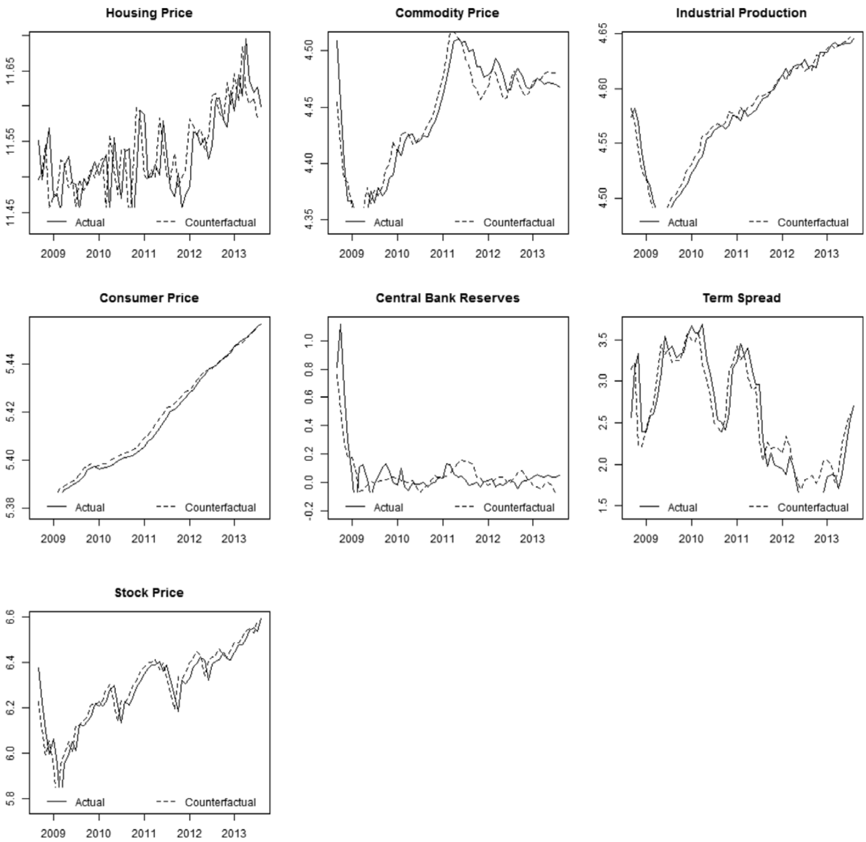

FIGURE 2. Actual and counterfactual time series of the variables included in the system.

where $\varepsilon_t^{\text{CBR}} = 0, \forall t$, the * denotes the counterfactual, and the superscripts stand for the endogenous variables included in the system. Then we construct the counterfactual time series as follows:

$$\underbrace{\overset{\wedge}{\Gamma}(L)}_{n\times n}\underbrace{X_t^*}_{n\times 1} = \overset{\wedge}{\Gamma}_0 X_t^* + \overset{\wedge}{\Gamma}_1 X_{t-1}^* + ... = \hat{c} + \varepsilon_t^* \qquad \textbf{(4)}$$

$$v_t^* = \overset{\wedge}{\Gamma}{}_0^{-1} \varepsilon_t^*.$$

where the $^\wedge$ corresponds to the coefficient estimate and * is the counterfactual.

Figure 2 plots the actual and the counterfactual time series for the variables included in the system. It can be seen that the actual growth rate of the central bank reserves lies well above its counterfactual counterpart from the beginning of the sample period in late 2008 until the end of 2010, i.e., when the first round of quantitative easing (QE1) started being implemented and until the beginning

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of the second round of unconventional measures (QE2). This is not surprising, as in this period the Federal Reserve held between \$700 and \$800 billion of Treasury notes on its balance sheet before the 2008–2009 recession and, in June 2010, it held \$2.1 trillion of bank debt, mortgage-backed securities, and Treasury notes. This also suggests that most of these policy measures were unexpected, as the differences between the actual and counterfactual series are reasonably large. As for the asset prices, the commodity prices, and the term spread, the figure shows that the discrepancies between the actual and the counterfactual series unfold throughout the whole sample. In contrast, in the cases of industrial production and consumer prices, those differences are less sharp and basically erode after 2011–2012. Therefore, shocks to the growth rate of central bank reserves appear to operate mainly through portfolio-rebalancing effects and not via a direct macroeconomic impact.

3.3. Unconventional Policy in "Standard Times" vs. Conventional Policy in "Exceptional Times"?

As a final sensitivity assessment, we investigate how well the model is suited to "standard" and "exceptional" times. More specifically, we perform two econometric experiments. First, we use our model and benchmark it against the data from "standard" periods. Thus, we retrieve data for the variables included in the system for the longest time span and estimate the model over the period 1964:M1–2008:M8. In this way, we analyze how our unconventional monetary policy characterization would perform in "standard" times. Second, we consider a "conventional" description of the conduct of monetary policy and test it in "exceptional" circumstances. Therefore, we introduce three major changes into our baseline model: (1) the term spread is replaced by the short-term interest rate; (2) we use the growth rate of M2 instead of the growth rate of central bank reserves; and (3) we replace the growth rate of central bank reserves with the short-term interest rate as the policy instrument under control by the monetary authority. Then we estimate this "conventional" model over the period 2008:M9–2013:M8, i.e., in the post-Lehman Brothers' collapse period. By doing so, we are able to check how the conventional monetary policy characterization would perform in "exceptional" times.

Figure 3 displays the impulse-response functions of a positive shock to the growth rate of central bank reserves (i.e., an unconventional monetary policy expansion) using data for the longest time span and up to the collapse of Lehman Brothers (i.e., during"standard" times). In accordance with the theoretical predictions, this empirical exercise uncovers a positive and persistent response of the housing prices and the commodity prices. However, this model performs poorly, as it delivers a negative response of the stock price and an insignificant or even negative reaction of the industrial production to the unexpected variation in the growth rate of central bank reserves. As a result, these dynamics point to a model misspecification.

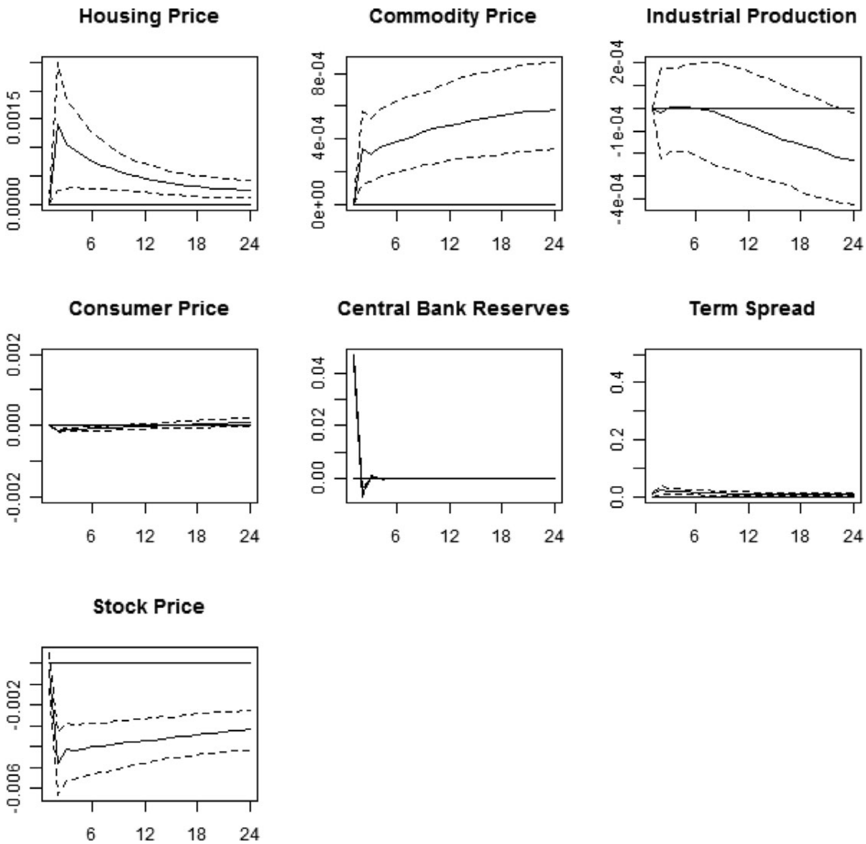

FIGURE 3. Unconventional monetary policy in "standard" times.

Figure 4 presents the impulse-response functions of a positive shock to the short-term interest rate (i.e., a conventional monetary policy contraction) using post-Lehman Brothers' collapse data (i.e., during "exceptional" times). In this case, the model correctly suggests a negative reaction of the commodity prices, a quick and temporary fall in the stock prices, and a short deterioration of liquidity market conditions. In contrast, it indicates an expansion of industrial production and a rise in housing prices, which goes against the economic theory.

All in all, these empirical exercises confirm that the conduct of monetary policy changed substantially from "standard" to "exceptional" times. Moreover, they provide a counterexample, which reflects the suitability of our unconventional monetary setting for "exceptional" circumstances. Indeed, as Figure 1 suggested, asset prices are strongly boosted when the growth rate of central bank reserves rises. However, neither Figure 3 nor Figure 4 is able to deliver a response of housing and stock prices that is consistent with the predictions of the model.

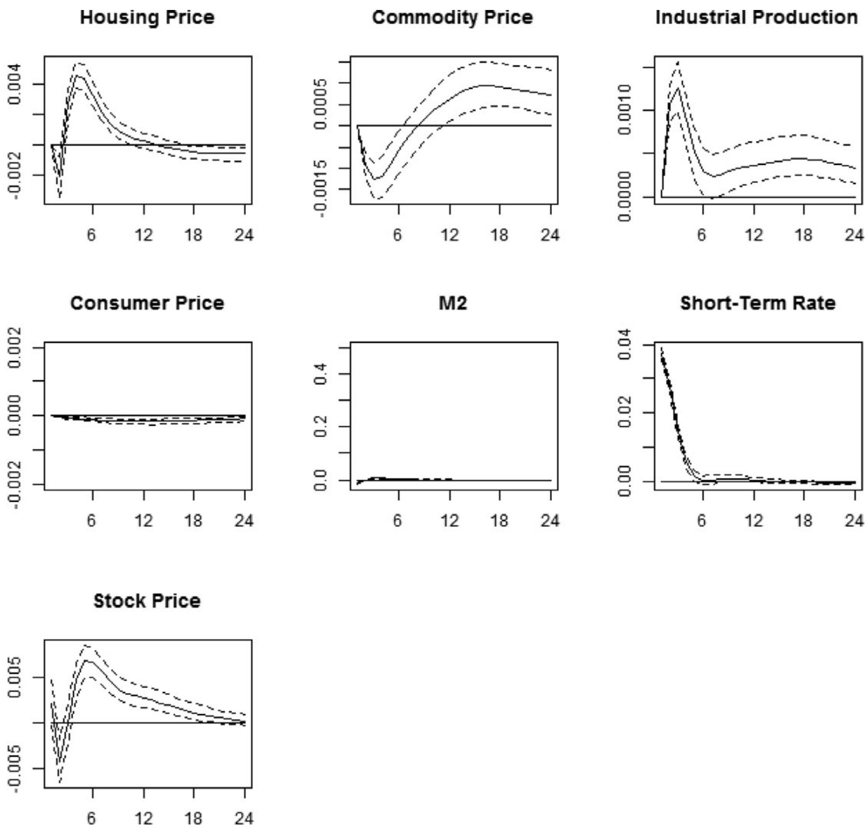

FIGURE 4. Conventional monetary policy in "exceptional" times.

4. CONCLUSION

Under unconventional monetary policies, the central bank uses its balance sheet to try to influence market prices and economic conditions. This is done beyond the standard conventional policy that sets the nominal short-term interest rate with the aim of targeting inflation. These "balance sheet policies" are the core of the current work.

Using data for the United States at monthly frequency since Lehman Brothers' collapse and relying on a recursive partial identification, we estimate a B-SVAR model that accounts for the posterior uncertainty of the impulse-response functions. We find that although a positive shock to unconventional monetary policy does not have a significant macroeconomic impact, its wealth effects are non-negligible. Indeed, an unexpected increase in the growth rate of central bank reserves leads to only a marginal expansion of industrial production and does not change consumer prices. However, it substantially boosts commodity prices, housing prices, and, most importantly, stock prices. Consequently, by expanding

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the size of its balance sheet via large-scale asset purchases, the central bank stimulates risk exposure and risk-taking behavior through investments in commodities, real estate, and stocks. Hence, portfolio-rebalancing effects are crucial in the transmission channel of unconventional monetary policy.

Next, by constructing a VAR counterfactual exercise, we uncover the role played by unexpected variation in the growth rate of central bank reserves, especially at the beginning of the sample. Moreover, unconventional monetary policy shocks seem to have been determinant of the dynamics of asset prices throughout the period covered by our analysis. However, the difference between the actual and the counterfactual series (i.e., the ones implied by our model after the shutting down of the shocks) of industrial production and consumer prices roughly disappears after 2011–2012. As a result, although changes in the asset portfolio composition largely accrue to the shocks, the macroeconomic fluctuations do not appear to be explained by them.

Finally, additional econometric experiments confirm the important structural change in the conduct of monetary policy since the Great Recession and, thus, from "standard" to "bad" times. Additionally, our model is particularly well suited to evaluating the macroeconomic and wealth effects associated with the unconventional monetary policy shocks in "exceptional" circumstances. In fact, the empirical evidence that emanates from the estimation of the model is in accordance with the theoretical predictions.

From a policy perspective, our framework highlights the relevance of a continuous follow-up of wealth developments and a macroprudential policy conduct aimed at contributing to the stability of the financial system and the housing sector, even though it does not provide information about the best moment to move back to conventional monetary policy. This issue is at the center of the current policy debate.

NOTES

1. This is particularly true when the policy rate is nonnegative. Although the interest rate set by the monetary authority has been bounded from below at the zero floor, some central banks have set nominal rates at negative levels in recent times. For instance, in July 2012, the Danish central bank, Nationalbanken, cut the deposit rate to -0.20%, and in June 2014, the European Central Bank (ECB) lowered the deposit facility rate to -0.10%. These measures are equivalent to a tax on holding cash.

2. For example, some studies reveal that unconventional monetary policy contributed to a reduction of the yields in the United States [Gagnon et al. (2011); Hancock and Passmore (2011); Hamilton and Wu (2012); D'Amico and King (2013)] and in Japan [Kimura and Small (2006)]. Similar evidence is found for the United Kingdom [Joyce et al. (2011)]. Krishnamurthy and Vissing-Jorgensen (2011) uncover a large decline in interest rates following the first U.S. LSAP, but not for the second round of QE. Doh (2010) and D'Amico et al. (2012) confirm that changing the relative supply of assets (i.e., the scarcity channel) and the relative maturity of the assets in the balance sheet of the central bank (i.e., the duration channel) can influence long-rates. Chung et al. (2012) find that LSAPs lower the 10-year Treasury notes and high-grade corporate bonds by around half a percentage point. Put differently, a one-half percentage point drop in bond yields has the same impact on long-term interest rates as a two percentage point cut in the policy rate.

3. For an assessment of the relationship between consumption, wealth, and labor income using a nonlinear framework, see Jawadi and Léoni (2012).

4. For a review of alternative time-varying econometric frameworks allowing one to model macroeconomic and financial data, see Jawadi (2012).

5. The normalization of $\Sigma = I$ implies that flipping the sign of a row of Γ_0 does not change the value of the likelihood function. Thus, this does not impose any econometric issue foronthe coefficient point estimates. Similarly, it is also not problematic i estimating Γ_0 after drawing from the posterior distribution of the reduced-form VAR model. Therefore, our results are not conditioned by the normalization of the Γ_0 matrix.

6. Castelnuovo et al. (2014) estimate Taylor rules that account for instability in policy parameters and switches in volatility of policy shocks. The authors show that, from an empirical point of view, rules with a time-varying target for inflation are superior to those with a fixed target.

7. To control for the effects of unconventional monetary policy during the QE1, QE2, and QE3 programs, respectively, we create a dummy variable that takes the value of one during (i) the period 2008:11–2010:10, (ii) the period 2010:11–2012:8, and (iii) the period 2012:9-2013:12 and zero otherwise. Then each dummy variable is added to the set of exogenous variables of the system at time, and the baseline model is reestimated. If anything, the empirical findings show that the magnitude and the persistence of the effects conditional on the implementation of the QE3 program are somewhat lower than the ones found for QE1 and QE2, suggesting somewhat lower effectiveness of the third round of stimuli adopted by the Federal Reserve. These results are available upon request.

8. Castelnuovo (2012) analyzes the differences in outcomes between counterfactual simulations conditional on the "continuity" selection strategy and those from a "sign restriction" strategy. The author shows that the sign restriction–selection strategy is able to capture the tradeoff between inflation and output.

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