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UNCONVENTIONAL MONETARY POLICY SHOCKS AND THE SPILLOVERS TO EMERGING MARKETS

Peter Tillmann

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Peter Tillmann*

Justus-Liebig-University Gießen

Hong Kong Institute for Monetary Research

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Abstract

Unconventional monetary policy such as Quantitative Easing (QE) is often considered to have considerable spillover effects on emerging market economies (EME). Aims at quantifying these effects so far mostly use high-frequency data around announcement dates, panels or VAR models. This paper proposes an alternative way to estimate the effects of QE on emerging markets that allows us to include macroeconomic, i.e. low-frequency, data together with announcement dates. A Qual VAR is estimated that integrates binary information of QE announcements with an otherwise standard VAR including US and emerging market variables. The model uncovers the Fed's latent, unobservable propensity for QE and generates impulse responses for EME variables to QE shocks. The results suggest that QE has strong effects on EME's financial conditions and plays a large role in explaining capital inflows, equity prices and exchange rates.

Keywords: Qual VAR, Unconventional Monetary Policy, Emerging Markets, Spillovers, LSAP

JEL Classification: E32, E44, F32

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Email: peter.tillmann@wirtschaft.uni-giessen.de

1. Introduction

Upon reaching the zero lower bound on nominal short-term interest rates, the US Federal Reserve and other central banks adopted a range of unconventional monetary policies. In the US case, these policies are known as Quantitative Easing (QE) and involve a multitude of measures such as large scale asset purchases (LSAP), a maturity extension program ("Operation Twist") and efforts of forward guidance in order to manage expectations of a prolonged period of low policy rates. Since late 2008 QE was introduced in several steps (i.e. QE1, QE2 and QE3). While the policy rationale differs across each measure and across the steps of QE, all measures are directed towards improving financial conditions for firms and thereby eventually supporting an expedited recovery from the financial crisis.

Asset purchases of the central bank affect the economy through two alternative transmission channels. First, through the signaling channel the Fed transmits information about the future monetary policy stance and thereby reduces the expectations component of long-term rates, which eventually drive consumption and investment. Second, to the extent that different assets are imperfect substitutes, the term premium reflected in long-term bond yields is reduced through the portfolio balance channel.

The LSAP program led to an explosion of the Fed's balance sheet and with it an abundance of global liquidity. A fraction of this liquidity spilled-over into emerging market economies (EME) and is widely believed to have led to appreciation pressure on local currencies, soaring asset prices and heightened concerns about renewed boom-bust cycles reminiscent of the 1980s and 1990s. Brazil's president Dilma Rousseff refers to a "monetary tsunami" hitting emerging economies while the Deputy Governor of the Banco Central de Brasil, Luiz Pereira da Silva, alludes to the experiences of emerging economies with "sudden stops" when speaking about "sudden floods" of liquidity. Very recently, however, the concerns in emerging markets such as India, Turkey and others pertain to the tapering of QE, which leads to a fierce reversal of capital flows back into mature economies. Policymakers struggle again with the consequences of a "sudden stop" of inflows or even a reversal of flows rather than a "sudden flood".[1]

In light of these concerns, quantifying the effect of QE on EME is very much needed, yet also very difficult. This is because applying the empirical tools from conventional monetary policy analysis to QE is not straightforward. The empirical literature so far typically studies the response of high-frequency financial data to QE announcements or includes QE announcements among other variables in a panel model in order to explain capital flows. The challenges for empirical work are, first, to acknowledge the endogenous nature of QE, second, to isolate the unexpected component of QE

[1] See Eichengreen and Gupta (2013) and Aizenman et al. (2014) for early empirical analyses of the emerging market response to tapering.

announcements and, third, to link low-frequency macro data with high-frequency announcement effects.

In this paper we propose a new approach to estimating the response of EME to QE shocks. We combine the virtues of a standard vector autoregression (VAR), i.e. the ability to study policy in terms of unexpected shocks, with the information contained in QE announcements. For that purpose we set up a Qual VAR (Dueker, 1995) that integrates binary information on QE announcements into an otherwise standard monetary policy VAR. This Qual VAR as an approach to study the domestic effects of QE is proposed in Meinusch and Tillmann (2014). Here we extend the model to the international dimension of QE. The Qual VAR is estimated on standard variables reflecting US real economic activity plus a measure of emerging markets' financial conditions. We deliberately keep the model parsimonious and do not aim at providing a full explanation of, say, capital flows to EME. The focus is on quantifying the contribution of QE shocks only.

The model uncovers the latent, unobservable propensity for QE through Markov Chain Monte Carlo techniques. In addition, we derive impulse response functions for a QE shock and show that financial conditions in EME such as capital inflows originating in the US, exchange rates, equity prices and bond prices are significantly affected by QE. We can also decompose these variables into the part reflecting QE shocks and the remaining part driven by all other determinants. While the impact of QE1 on emerging markets is found to be limited, QE2 and QE3 explain a substantial fraction of emerging market variables.

The remainder of this paper is organized as follows. Section two briefly surveys the relevant literature. The Qual VAR model is introduced in section three. Section four is dedicated to the data set and the identification of monetary policy shocks. The main results and some robustness checks are discussed in section five. Section six contrasts the results for unconventional monetary policy shocks to those for conventional policy shocks. Finally, section seven concludes.

2. The International Effects of Quantitative Easing

Since the adoption of unconventional policies in 2008, the new policy measures have enjoyed an enormous amount of scientific attention and triggered several empirical investigations into the effectiveness of QE. A subset of papers also studies the international effects of QE. Here we review the most important contributions in this field.[2]

[2] The leading studies on the domestic effects of QE, both in the US and the UK, are Gagnon et al. (2011), Krishnamurty and Vissing-Jorgensen (2011), Hamilton and Wu (2012), D'Amico et al. (2012) and Kapetanios et al. (2012). Chen, Curdia and Ferrero (2012) propose a simulated DSGE model to quantify the contributions of QE to business cycle dynamics.

The literature can broadly be divided into two different strands.[3] First, researchers study the immediate response to QE announcements using high frequency data. Glick and Leduc (2013), for example, use intraday data and extract the surprise component of announcements from the futures market. They find that an announcement significantly lowers the value of the dollar. The effect is similar in size to an announcement of a conventional monetary policy step. Likewise, Neely (2013) focuses on the announcements of QE1 to show that news about policy reduced international bond yields and the USD exchange rate against several developed economies. To differentiate between the signaling and the portfolio balance channel of monetary transmission, Bauer and Neely (2014) estimate a term structure model of international interest rate dynamics. Rogers et al. (2014) compare the causal effects of unconventional monetary policy surprises on high-frequency asset prices for major central banks.

A second line of research adopts a macroeconomic perspective using panel data or VAR models. Chen et al. (2012) study the financial market impact of QE announcements and also use a global vector error-correction model with the term US spread as the policy variable. The model is able to show the effects of QE shocks on a large set of countries. Moore et al. (2013) set up a panel model to explain the effect of QE on local currency bond markets. A reduction in the US Treasury yield of 10 percentage points, which is interpreted as reflecting QE, leads to a 0.4 percentage point increase in the foreign ownership share of emerging market debt and a significant reduction in government bond yields. Interest rates respond similarly to conventional monetary easing steps prior to reaching the zero lower bound. The authors also estimate bivariate VAR models including US and foreign interest rates to confirm their findings. Lim et al. (2014) estimate that three percent of gross flows to developing countries are explained by QE. They derive their result in a panel model for capital flows that includes appropriate control variables to differentiate different channels of transmission.

The papers which are closest to this paper are Fratzscher et al. (2013), Gambacorta et al. (2013) and Berman et al. (2014). The first uses a unique data base of high-frequency portfolio flows into emerging market investment funds, Fratzscher et al. (2013) relate these flows to news about QE and other determinants. They find that QE1 lowered interest rates and raised equity prices across several countries. Interestingly, capital account restrictions did not shield countries from the "monetary tsunami". Since their paper includes data until the end of 2010, we cannot directly compare our findings to theirs. Gambacorta et al. (2013) use macroeconomic variables in a panel VAR consisting of countries that adopted QE such as the US, the euro area and Japan. QE shocks are identified using sign restrictions on the admissible impulse responses. While eventually our paper also generates standard impulse response functions capturing the adjustment following a QE shock, Gambacorta et al. (2013) include domestic variables only. Berman et al. (2014) use a VAR system of interest rates of different maturities that also includes emerging markets rates, and identify unconventional monetary policy through changes in the variance of policy shocks on QE announcement days.

[3] Chinn (2013) and IMF (2013a,b) provide very useful surveys of the literature and also some country studies and VAR estimates, respectively.

3. A Qual VAR Approach to QE

In this section we offer an alternative to conventionally used event studies or VAR models, respectively. The idea is to link these two approaches, that is, to directly include the binary information of QE announcements dates into an otherwise standard monetary policy VAR. Dueker's (2005) Qual VAR model is then used to extract the latent, i.e. unobservable, variable driving the observed QE announcements. The QE dates are thus interpreted as realizations of a latent, unobservable propensity for Quantitative Easing.[4] Once this latent propensity for QE is filtered out of the data, standard VAR tools such as impulse response analysis or historical decompositions can be applied. Since policy is assumed to react endogenously to the state of the business cycle, the interaction captured by the VAR together with the few observable QE dates allows the model to estimate the latent propensity for QE.

The advantage of the Qual VAR is that, first, unconventional monetary policy is acknowledged as being endogenously responding to US business cycle variables. Second, we can study the effect of QE in terms of shocks, i.e. through the non-systematic, unexpected part of QE. Third, we are not confined to using high-frequency data only since the underlying VAR extracts the unexpected component of QE, which previously is associated with selected dates only. Finally, the feasibility of impulse response functions allows us to directly compare the effects of QE shocks with conventional monetary policy shocks stemming from interest rate policy.

Let us start introducing the Qual VAR approach by highlighting the close analogy with a dynamic probit model. Suppose we observe a binary dependent variable $y_t \in (0,1)$, which is driven by a continuous latent variable y^*

$$y_t = \begin{cases} 0 \; if \; y_t^* \leq 0 \\ 1 \; if \; y_t^* > 0 \end{cases}$$

with

$$y_t^* = \rho y_{t-1}^* + \boldsymbol{X}_{t-1}\beta + \varepsilon_t \,, \quad \varepsilon_t \sim N(0,1),$$

where $\boldsymbol{X}_{t-1}$ is a set of explanatory variables. Since the latent variable has some autoregressive dynamics, this property can be used to combine the dynamic probit model with a standard VAR. The Qual VAR used in this paper simply includes this equation in a VAR system of the $\boldsymbol{X}_{t-1}$vector. A Qual VAR model with k endogenous variables and p lags can be written as

$$\Phi(L)Y_t = \mu + \varepsilon_t$$

[4] See He and Pauwels (2008) for a study of the People's Bank of China's monetary policy that is similar in spirit to our approach. These authors also use observables to estimate the latent policy stance.

where

$$Y_t = \begin{pmatrix} \boldsymbol{X}_t \\ y_t^* \end{pmatrix}$$

consists of macroeconomic data, $\boldsymbol{X}_t$, and the latent variable, y_t^*.

In a Markov Chain Monte Carlo (MCMC) estimation, the latent variable is extracted from the interaction within the VAR and the observed binary information. To accomplish this, we have to make the following distributional assumptions: First, the VAR coefficients, Φ, are assumed to be normally distributed with the mean and the variance given by the OLS estimates. Second, for the covariance matrix, Σ, an inverted Wishart distribution is assumed. Third, the latent variable, y^*, is required to be positive whenever y_t is equal to one and is assumed to follow a truncated normal distribution.

Given the VAR coefficients, the conditional distribution of the latent variable can be derived. Given the latent variable, in turn, the conditional distribution of the VAR coefficients is given by the OLS estimates. As we have to estimate both the latent variable and the coefficient matrix, an MCMC can be adopted to estimate both pieces simultaneously. After a sufficient number of iterations, a draw from either conditional distribution can be seen as a draw from the joint posterior distribution. As in Dueker (2005), we run 10,000 iterations from which the first 2,000 are discarded to allow for convergence towards the posterior distribution.[5]

Other applications of the Qual VAR include Dueker (2005) on binary NBER indicators and "Romer dates", Bordo et al. (2007) incorporating a binary indicator of stock market conditions and Amstad et al. (2008) and Assenmacher-Wesche and Dueker (2010 studying the forecasting properties of the Qual VAR. Tillmann (2014) includes binary information on macroprudential tightening episodes. Meinusch and Tillmann (2014) use a Qual VAR to further analyze the domestic effects of QE shocks.

4. Data and Identification

We estimate the Qual VAR model on monthly data covering the period from 2007:08 to 2013:03. Hence, the sample starts with the outbreak of the US subprime crisis and ends right before the first comments on "tapering", i.e. the gradual exit from unconventional measures, were made by Fed officials. Within this time frame, the Fed engaged in several rounds of Quantitative Easing. Table (1) lists the most important announcements on QE, i.e. speeches by Chairman Bernanke, releases of FOMC minutes or FOMC announcements, which are commonly used in event studies on the effects of QE on financial variables. We do not include announcements of the phasing out of the different QE programs. The announcement dates are taken from Fawley and Neely (2013).

[5] For details we refer to Dueker's (2005) original contribution.

From these announcements we construct a binary indicator variable which is one in the month of a QE announcement and zero otherwise. Note that we only include announcements pertaining to an easing of the monetary stance. The resulting latent propensity for QE is labeled latent QE. Besides, we include three other variables, two characterizing the US business cycle and one reflecting potential spillovers to emerging market economies. When choosing the variables, we were guided by the desire to keep the VAR as parsimonious as possible. Since the sample is relatively short, the number of parameters to be estimated has to be kept small.[6] In the figures presented below these dates are represented as shaded areas.

Besides the indicator of QE announcements, the VAR includes two US macroeconomic time series. First, the growth rate of the index of industrial production (IP) taken from the FRED database of the Federal Reserve Bank of St. Louis.[7] Second the long-term nominal interest rate measured by the 10-year Treasury constant maturity rate (Yield). The series on industrial production and the nominal interest rate are taken from FRED. Since QE was adopted in order to stimulate an economic recovery and improve firms' refinancing conditions (through different channels of transmission), we expect industrial production to increase after an unconventional monetary easing and the long-term interest rate to fall. In contrast to standard monetary policy VAR models, we do not include the US inflation rate because inflationary developments appear to play only a minor role in US monetary policy since 2008.

The fourth variable reflects the effects of QE on emerging markets. We alternatively include one of the following four variables: first, total capital outflows from the US to countries in the Asia-Pacific region and Latin America (Outflows to EME). The data is measured in percent of US GDP and is obtained from the website of the Bureau of Economic Analysis (BEA). The BEA provides standard balance of payments items broken down to different countries and regions. In contrast to, say, the International Financial Statistics database we have information about the direction of capital flows.[8] In a separate specification we estimate the model with portfolio outflows (Portfolio outflows to EME) only. QE is expected to raise outflows to emerging economies. Standard event studies, which are typically conducted at a daily frequency, are confined to price data alone. It is an attractive feature of the Qual VAR that we can include standard balance of payments items such as capital outflows which are available only at a lower frequency.

Second, the change in the EMBI+ index (EMBI) covering the most liquid US-dollar denominated emerging markets bonds. This index is constructed by J.P. Morgan and is accessed through Bloomberg. A shock to QE should raise bond prices in emerging markets. Third, the change in the MSCI emerging market equity price index (MSCI), also accessed via Bloomberg. Finally, we construct

[6] Chinn (2013), Lim et al. (2013) and Moore et al. (2013) also estimate parsimonious VAR models including US and emerging market variables.

[7] Throughout the paper all growth rates are year-on-year changes expressed in percentage points.

[8] The quarterly series is converted to monthly data using quadratic-match average procedure implemented in EVIEWS.

the average change in the value of the USD against six major emerging market currencies (EME FX), i.e. Brazil, India, Korea, Mexico, Thailand, South Africa. According to commonly held views, QE led to a depreciation of the USD vis-a-vis emerging market currencies. We thus expect a fall in our exchange rate index after a QE shock.

We estimate the model in first differences for two reasons. First, the variables have to be stationary in order to be consistent with the assumptions in the MCMC estimations. Second, growth rates appear to be more consistent with the idea of the latent variable reflecting the propensity to easing - that is, with the accumulated latent series indicating the stance of unconventional monetary policy. Since the sample is short, we chose a parsimonious specification and estimate each VAR model with p=3 lags.[9]

For a Qual VAR the standard information criteria used to determine the appropriate lag order are not appropriate as they focus on non-binary data only. Instead, we check the estimated models for serial correlation in the error terms using a multivariate Q test. In all specifications, we are unable to reject the absence of serial correlation in the residuals for a lag order of p=3.

In order to derive the responses of both domestic and global macroeconomic variables to unconventional monetary policy shocks, these shocks have to be identified from the reduced form innovations of the estimated VAR model. To achieve identification, we use a Cholesky factorization which implies a specific order of the variables' responses within a given month. Here we order the variables as follows: IP, latent QE, Yield, Outflows to EME / EMBI / MSCI / EME FX.

Thus, monetary policy through QE affects the real interest rate and emerging markets financing conditions within a given month, while policy itself responds with a lag of one month to industrial production. In principle, this ordering corresponds to the conventional ordering in the monetary policy literature (see, for example, Christiano et al., 1999) An alternative would be to impose restrictions on the sign of the responses as e.g. in Gambacorta et al. (2013).[10]

Finally, including emerging market variables in an otherwise standard monetary policy VAR for the US might be seen as problematic as it implies that emerging market variables also impact the US business cycle and, in particular, US monetary policy. It turns out, however, that the effect of external variables on the dynamics of US variables is negligible. Excluding emerging market variables from the VAR system results in almost identical impulse responses and a very similar path of the latent policy stance. It seems that including emerging markets into the VAR is an innocuous assumption whose main purpose is to gauge the dynamics of the transmission of US policy shocks to emerging markets.

[9] The Qual VAR is estimated using the RATS codes written by Michael Dueker available on www.estima.com.

[10] Kim (2001) and Mackowiak (2007) propose alternative identification schemes for VAR models that comprise US and emerging market variables.

In a similar vein, Berman et al. (2014) also include an emerging market variable in a VAR model for US interest rates.

The results of the Qual VAR are presented in three steps. We first show the latent propensity for QE uncovered from the model. We then discuss the impulse responses of the macro variables following a shock to latent QE. Finally, we elaborate on the fraction of the emerging markets' financial variables explained by QE shocks. All results are consistent with the view that QE has sizable effects on EME.

5. Main Results and Robustness Checks

5.1 The Resulting Dynamics in Emerging Economies

For each Qual VAR model, the estimated propensity for QE is depicted in figures (1) to (5). The latent variable tracks the predefined QE events quite well and even reflects a growing likelihood of QE in the months before each QE announcement. The estimated latent QE does not differ very much across the alternative VAR models, a feature that suggests that including emerging market variables does not hamper the VAR in describing policy events which were surely driven by domestic considerations alone.

Once the latent variable is uncovered, the VAR can be estimated in order to derive impulse response functions. Figures (6) to (10) show the responses of all four endogenous variables to a one standard deviation shock to latent QE. The shaded areas in these graphs represent periods with QE announcements. Confidence bands covering 90% of the responses are generated by 10,000 bootstrap replications. In all estimated specifications, an unexpected easing raises the growth rate of industrial production with the peak response occurring after about a year. The real interest rate reacts immediately upon the shocks and falls significantly by about 0.10 percentage points. Thus, QE had the intended consequences and indeed improved firms' long-term financing conditions in real terms.

Let us now turn to the responses of the emerging market variables. A QE shock leads to a significant increase in capital outflows to emerging markets, see figure (6). Since we measure outflows relative to US GDP, a maximum response of 0.015 percentage points is quite large. In figure (7) we replace total outflows from the US to emerging market economies by a measure of portfolio outflows only. Portfolio outflows respond much more strongly to a policy shock than total outflows. At the peak of the response portfolio outflows relative to GDP increase by 0.03 percentage points. Note also that the response of portfolio flows occurs much earlier than the response of total inflows with the peak of the response appearing six months after the shock. As shown below, the explanatory power of QE shocks for portfolio outflows is much larger than for total outflows.

The response of emerging markets' bond prices is reported in figure (8). After a monetary easing, investors rush into emerging economies pushing up bond prices by 1.5%. Since this response is significantly positive for several months, the cumulated effect on asset prices is quite large. For equity prices, see figure (9), the sensitivity to an unexpected unconventional easing is even larger. The MSCI stock price index increases by 5%, again for some months in a row, following a QE shock. Finally, figure (10) reveals that the USD depreciates by about 2% after a QE shock. The maximum response kicks in five months after the shock. After 10 months, the response becomes insignificant again.

Taken together, all these impulse response functions show that unconventional monetary policy in the US does indeed have a strong impact on emerging financial markets. Importantly, the size of the estimated responses indicates the lower end of the true responses. The reason is that the VAR generates responses to a typical, i.e. one standard deviation in size, shock to the propensity for QE. This obstructs the fact that in those months with a QE announcement, the standard deviation of latent QE is about 1.4 times higher than the full sample standard deviation. Since the model is linear, the responses will also be scaled upwards.

The estimated VAR system also allows us to decompose the forecast error variance into the contribution of the QE shock. While the impulse response function show that a QE shock indeed has an effect on emerging economies, this decomposition tells us how large the overall role of QE shocks is in explaining the dynamics of our endogenous variables is. Table (2) shows that QE shocks account for a large portion of the dynamics, particularly over a horizon of one year or more. For example, for a horizon of six months, more than 25% of portfolio capital flows into emerging markets are explained by QE shocks. For emerging markets' asset prices the explanatory power of QE shocks is smaller.

5.2 The Explanatory Power of QE Shocks over Time

In a final step, we use a historical decomposition of the VAR model to isolate the explanatory power of QE shocks over time. Rather than asking how the variables respond to a QE shock we investigate the timing of when QE shocks played a large role, or were negligible. For that purpose we plot the difference of the VAR projections for the respective emerging market variable with and without QE shocks against the observed emerging market variable itself. As a matter of fact, the aim of Qual VAR is not to provide a full account of all determinants of emerging markets' financial conditions.

Figure (11) plots total outflows of private capital to emerging economies (in red) and the fraction explained by QE shocks (in green). QE shocks account for about five percentage points of capital flows relative to GDP. When turning to portfolio flows only, see figure (12), however, the explanatory power is much larger. Almost half of the overall inflows into emerging economies in 2011 are explained by the QE shocks. In addition, the decline in capital outflows in 2012 can almost completely be explained by unexpected monetary policy shocks. For EMBI bond prices, see figure (13), the explanatory power is largest in 2010, while for stock prices, as can be seen in figure (14), QE shocks, for example, account for the entire fall in stock prices in 2012. A negative contribution of QE shocks in these figures reflects negative policy shocks, i.e. a situation in which the Fed provided a smaller easing of monetary conditions than was expected based on the estimated VAR coefficients. In 2009 and 2010, however, the role of QE shocks in driving emerging economies' equity markets is relatively small.

Finally, figure (15) shows the decomposition of exchange rate returns. Again, in 2009 and 2010 the role of QE shocks is limited. In 2012, in contrast, almost the entire appreciation of emerging market currencies can be traced back to QE shocks originating in the US.

Previous research, e.g. Fratzscher et al. (2013) and others, argues that the effects of QE on domestic and foreign economies depends on the economic environment and, hence, is possibly time-varying. While the sample is too short to apply formal structural break tests of split sample estimates, we nevertheless clearly see that QE had a bigger effect on emerging economies in the period after 2010. Figures (12) to (15) show that the fraction of the series explained by QE shocks is generally larger under QE2 and QE3 than under QE1. This is consistent with the findings of IMF (2013a,b). They state that QE1 triggered capital flows out of emerging markets into the US and led to an appreciation of the dollar. In addition, QE2 and QE3 were found to have pushed capital into high-yield emerging market assets which put downward pressure on the dollar.

5.3 Results from Alternative Specifications

In this section we assess the robustness of the results. For this purpose, we ran the Qual VAR in four alternative specifications. Rather than presenting all modifications of the VAR specification for each set of variables, we focus on three modifications and discuss each of them using a different set of model variables.

In a first analysis, we replace industrial production by the growth rate of non-farm employment. This is a variable closely watched by both the Federal Reserve and market participants. Figure (17) shows the resulting impulse responses. After a surprise easing, employment increases and reaches a maximum after ten months. The strong response of equity prices in emerging markets remains unchanged compared to the baseline specification presented before.

In a second modification we replace the long-term nominal interest rate with the yield on 10-year Treasury Inflation Protected Securities (TIPS), a proxy for the long-term real interest rate. The resulting impulse response functions are shown in figure (18). Following an unconventional policy shock, the real interest rate falls by 10 basis points. At the same time, the EMBI bond price index still exhibits a very high sensitivity to QE shocks.

Our third modification pertains to the set of binary policy announcements used before to extract the latent propensity to QE. This set of dates includes announcements of LSAP programs and Operation Twist, but does not include announcements of Forward Guidance. To check the robustness of our findings, we now extend the set of binary dates by announcements meant to guide market expectations about the future path of the Federal Funds target rate. The dates are taken from Hattori et al. (2013). Figure (19) reveals that taking a wider set of policy steps into account does not affect our baseline results. In particular, the impulse responses still show a strong and persistent increase in portfolio outflows following an unconventional policy easing.[11]

Finally, a natural question is whether using a sophisticated model such as the Qual VAR which is computational demanding is rewarded. One could argue that simply treating policy announcements on QE as exogenous is a sufficient approximation. The Qual VAR instead models the binary QE announcements as endogenously reflecting the stance of the economy. To address this issue, we estimate a VARX, i.e. a VAR model on real activity, long term bond yields and emerging market bond prices in which the announcements of QE are included as an exogenous variable. Note that in this case QE impulses are exogenous events, and they can no longer be referred to as shocks.

The resulting impulse response functions are given in figure (20). The long-term interest rate falls immediately by 15 basis points after a QE announcement. Bond prices increase in the month of the announcement. Most importantly, however, industrial production drops sharply on impact. According to these results, industrial production responds immediately and falls rather than increases. Both of these patterns underline the inappropriateness of a VARX approach. As the model does not account for the endogenous nature of QE, the observation of a fall in industrial production in a month of a QE announcement is interpreted as a consequence of QE, not as a motivation for doing QE. It seems that estimating a model that takes account of the endogeneity of the QE announcements is highly warranted.

6. How Does Conventional Monetary Policy Affect Emerging Markets?

Having established how emerging markets respond to QE shocks, we now study whether this response differs from the response to a typical monetary easing when interest rates are used as the policy instrument. In other words, how unconventional is the response to unconventional monetary policy? For that purpose, we take the VAR model and replace the latent propensity for QE with the Federal Funds rate, which was the Fed's main policy instrument before adopting QE1. For that exercise we choose the model with the EMBI bond market index. The identification strategy remains unchanged, that is, the Federal Funds rate is ordered after industrial production but before the real interest rate and EMBI. The model is estimated for the period 2000:1 to 2007:7, which precedes our baseline sample and is of similar length. We plot the response to an unexpected easing of monetary conditions.

The key finding, see figure (16) is that a reduction in the Federal Funds rate significantly raises industrial production in the medium run, i.e. after 18 months and also reduces the long-term interest

[11] The estimated latent variable for this specification as well as the list of policy announcements are available on request.

rate after 10 months. Furthermore, a surprise monetary easing leads to an increase in emerging markets' bond prices by one percentage points on impact.

A comparison of a one standard deviation cut in the Federal Funds rate and an increase in latent QE by one standard deviation is not straightforward. One way to make both easing steps comparable is to normalize the variables' responses by the peak response of the long-term interest rate. A QE shock leads to a maximum fall in yields of six basis points while a Federal Funds rate reduction leads to a fall in yields of 10 basis points. From this we can conclude that the EMBI response of one percentage point in the first case and 1.5 percentage points in the latter is broadly consistent with the view that unconventional policies have spillover effects on emerging markets which are similar in size to conventional monetary policy. As mentioned before, however, the effects of a typical QE shock of one standard deviation most likely underestimate the true impact as the standard deviation on QE announcement dates is considerably larger.

7. Conclusions

Unconventional monetary policy is often believed to have contributed to emerging markets' asset price boom and exchange rate appreciation, respectively, since 2008. With the Fed pumping liquidity into the market by letting its balance sheet explode, the argument goes, liquidity flows into emerging markets generating risky boom-bust cycles.

This paper proposes estimating a Qual VAR to quantify the contribution of Fed policy to the evolution of emerging markets' external financial conditions since 2008. The Qual VAR combines the advantages of a standard monetary policy VAR with the ability to take binary events such as QE announcements into account. The model is estimated on US macro data and includes an indicator of emerging markets' financial conditions. The results show that an unconventional monetary policy shock, that is, an unexpected increase in the Fed's propensity to undertake Quantitative Easing, strongly increases emerging markets' capital inflows, bond prices, equity prices and exchange rates.

We also compare the spillovers of unconventional monetary policies with those of conventional policy steps implemented by a reduction in the Federal Funds target rate. A typical QE shock leads to roughly the same response of emerging economies' bond prices as a typical cut in the Federal Funds rate.

Besides the core findings of the paper, another conclusion from this project is that the methodology applied in this paper, the Qual VAR, is certainly a well suited tool to study the effects of QE. It could be applied to many other facets of QE such as unconventional policies in other countries such as the UK, the euro area and Japan. It might also offer insights into the crucial question at the moment of writing: are the effects of unconventional monetary policy in emerging markets symmetric? Whether tapering QE leads to macroeconomic effects that are similar in absolute value to announcements of QE is an important question for future research.

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Table 1. Important Quantitative Easing Announcements

Date	Program	Event	Content
11/25/2008	QE1	FOMC statement	LSAP initially announced
12/01/2008	QE1	Bernanke speech	Suggestion of extending QE to Treasuries
01/28/2009	QE1	FOMC statement	Fed stands ready to expand QE
03/18/2009	QE1	FOMC statement	LSAP expanded
08/12/2009	QE1	FOMC statement	details about LSAP
08/27/2010	QE2	Bernanke speech	Bernanke sees role for additional QE
09/21/2010	QE2	FOMC statement	FOMC emphasizes low inflation
10/12/2010	QE2	FOMC minutes	"additional accommodation needed"
11/03/2010	QE2	FOMC statement	QE2 announced
09/21/2011	"Twist"	FOMC statement	Maturity Extension Program announced
06/20/2012	"Twist"	FOMC statement	Maturity Extension Program extended
08/22/2012	QE3	FOMC minutes	"additional accommodation ... warranted"
09/13/2012	QE3	FOMC statement	QE3 announced
12/12/2012	QE3	FOMC statement	QE3 expanded

Notes: The announcement dates are taken from Fawley and Neely (2013).

Table 2. Forecast Error Variance Decomposition

variable	impact of QE shock (in % of total variation) at horizon			
	1 month	6 months	12 months	24 months
Total outflows	0.26	1.63	2.25	2.77
Portfolio outflows	8.05	28.52	32.04	31.41
EMBI	3.53	6.58	6.32	6.56
MSCI	1.21	7.35	8.83	8.45
FX	4.99	7.22	8.55	8.41

Figure 1. QE Announcements and Latent Propensity for QE Estimated on Outflows to EME

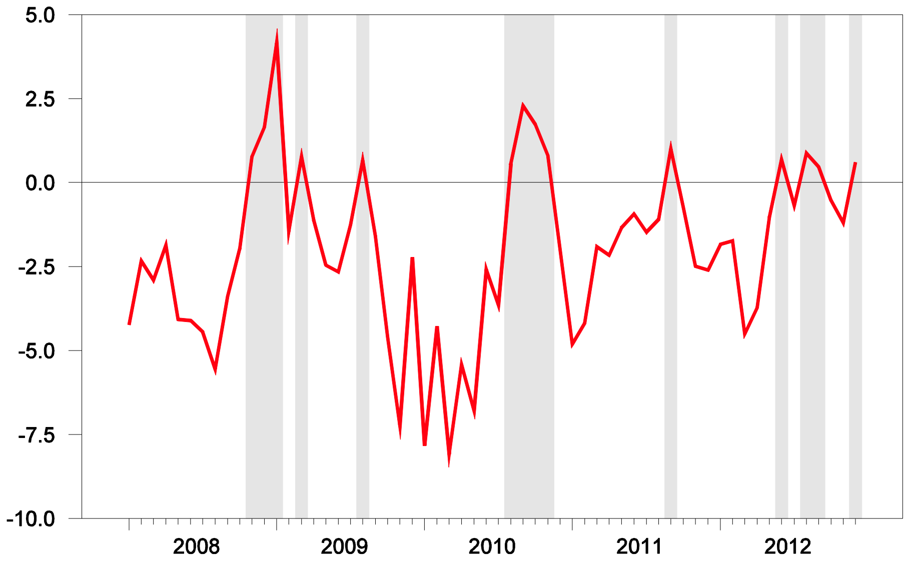

Figure 2. QE Announcements and Latent Propensity for QE Estimated on Portfolio Outflows to EME

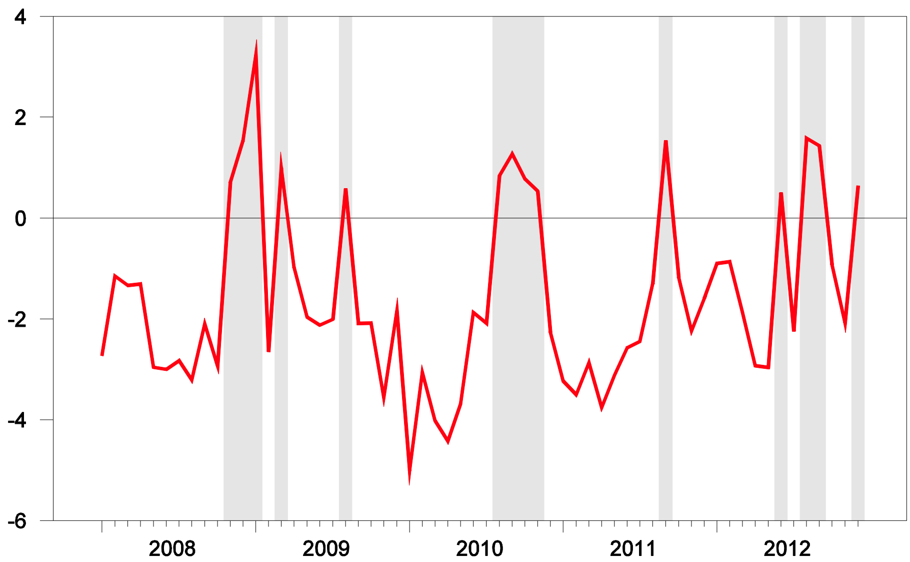

Figure 3. QE Announcements and Latent Propensity for QE Estimated on EMBI

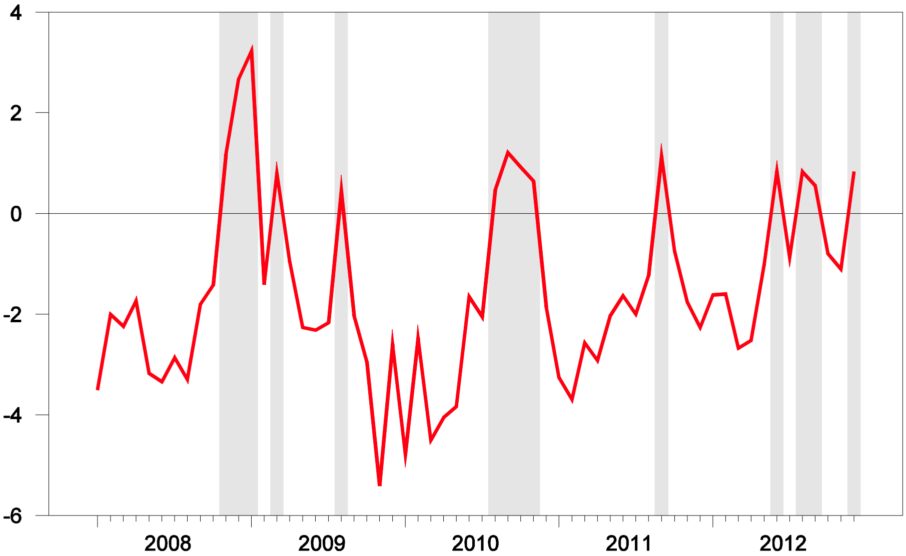

Figure 4. QE Announcements and Latent Propensity for QE Estimated on MSCI

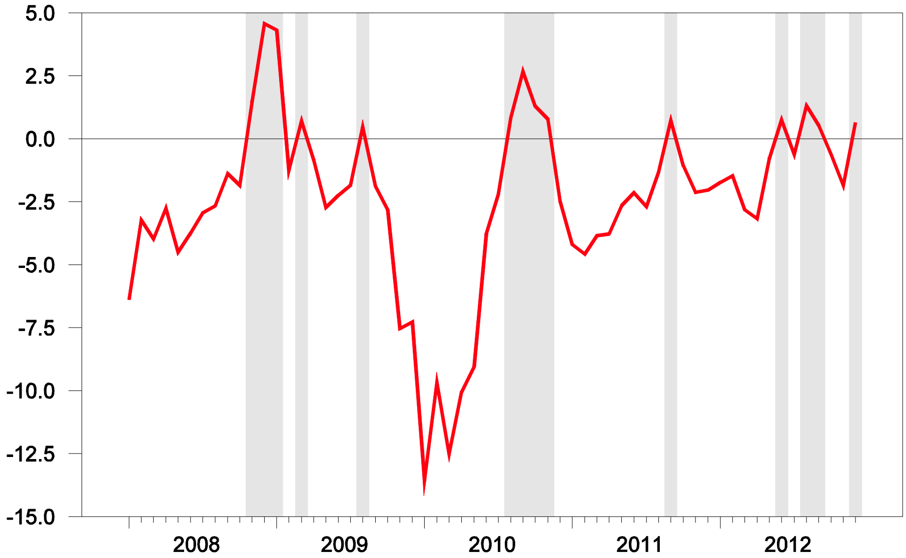

Figure 5. QE Announcements and Latent Propensity for QE Estimated on EME FX

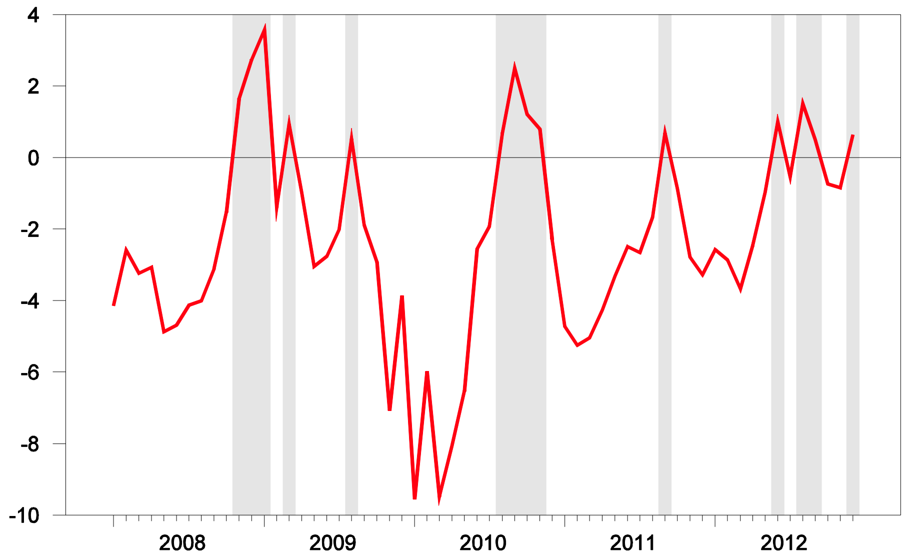

Figure 6. The Effect of a Shock to Latent QE

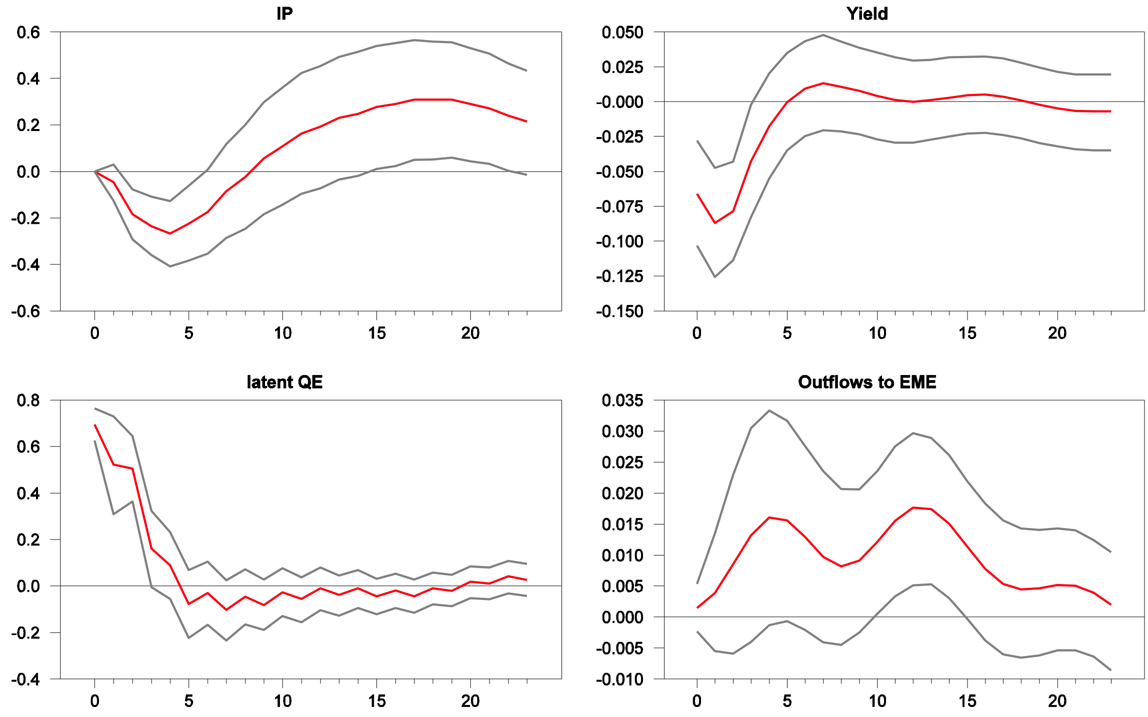

Figure 7. The Effect of a Shock to Latent QE

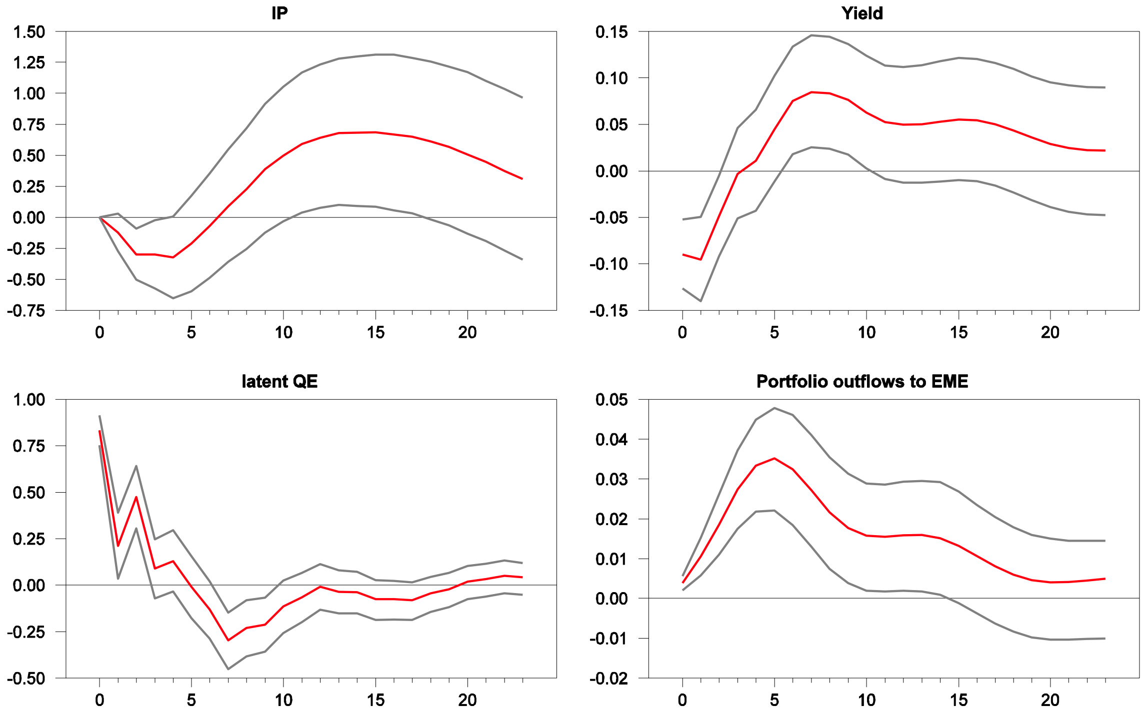

Figure 8. The Effect of a Shock to Latent QE

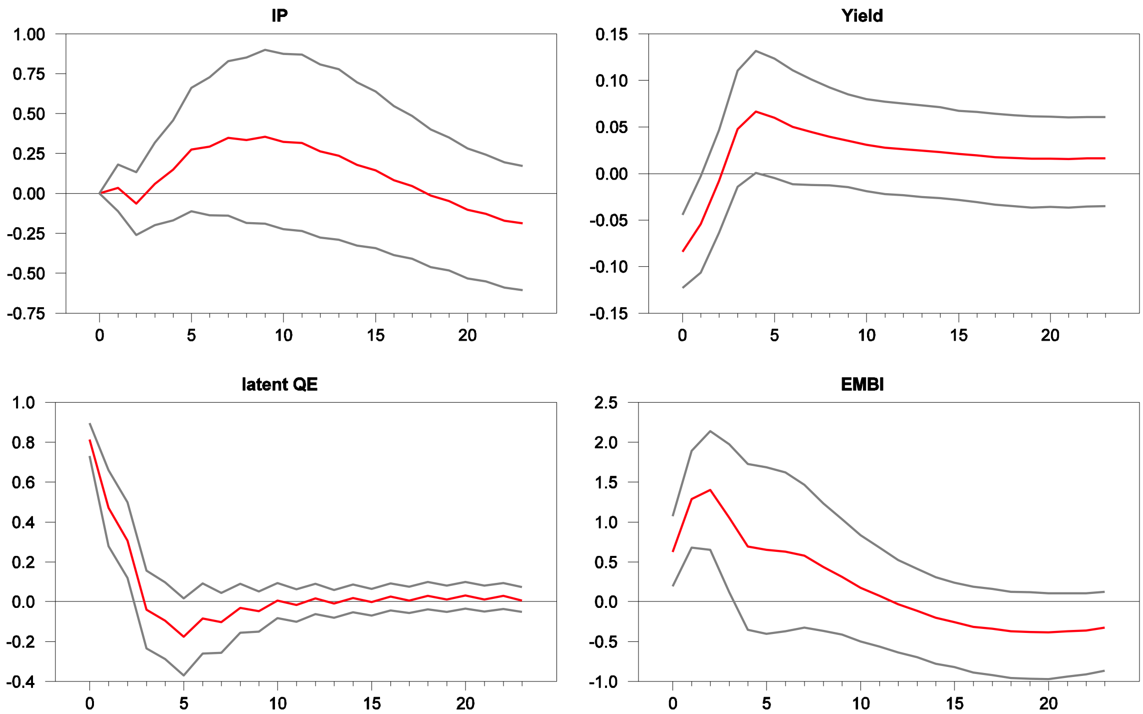

Figure 9. The Effect of a Shock to Latent QE

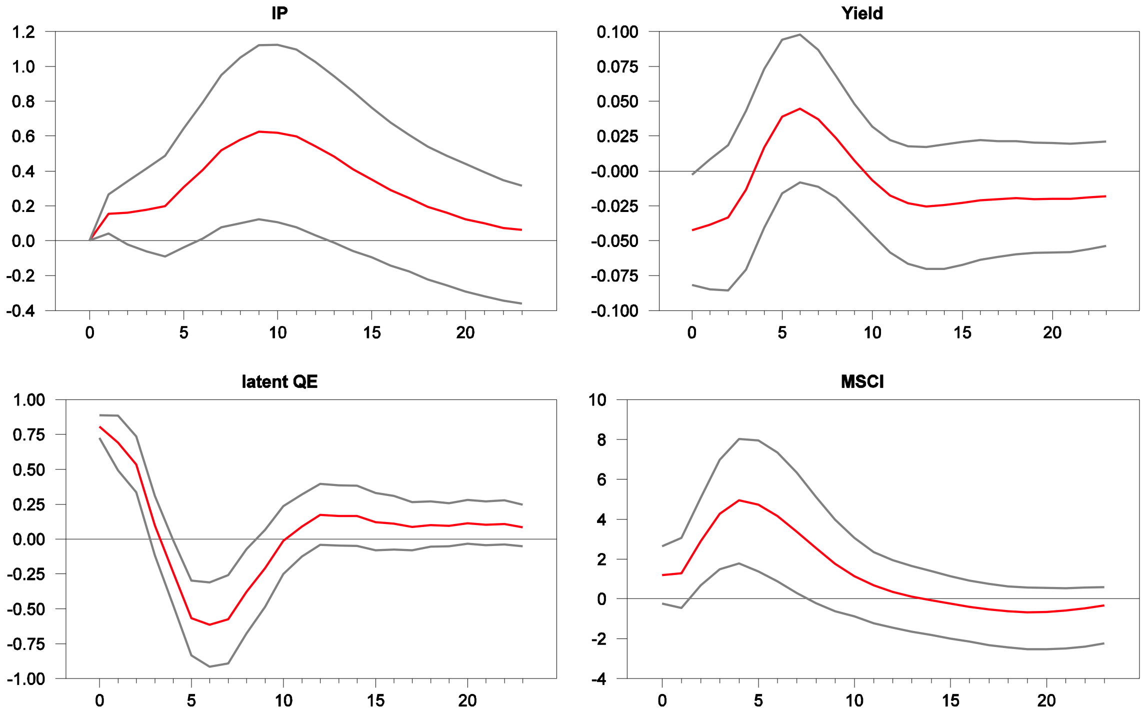

Figure 10. The Effect of a Shock to Latent QE

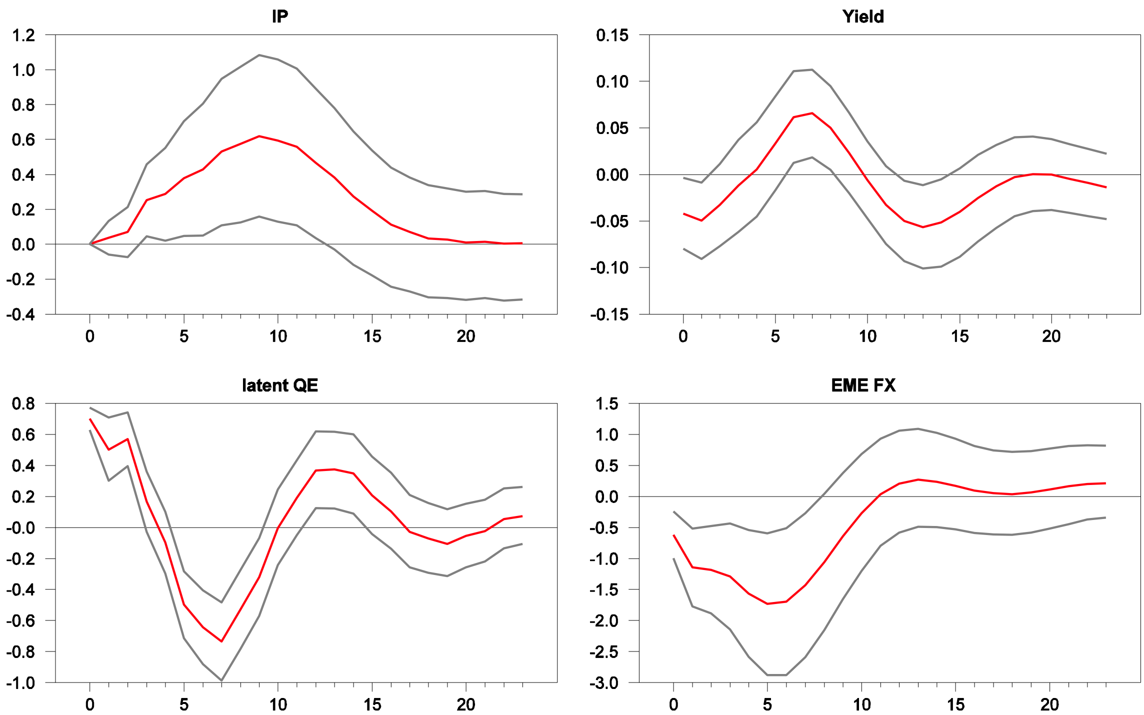

Figure 11. Outflows to EME (Red, in % of US GDP) and Fraction Explained by QE Shocks (Green)

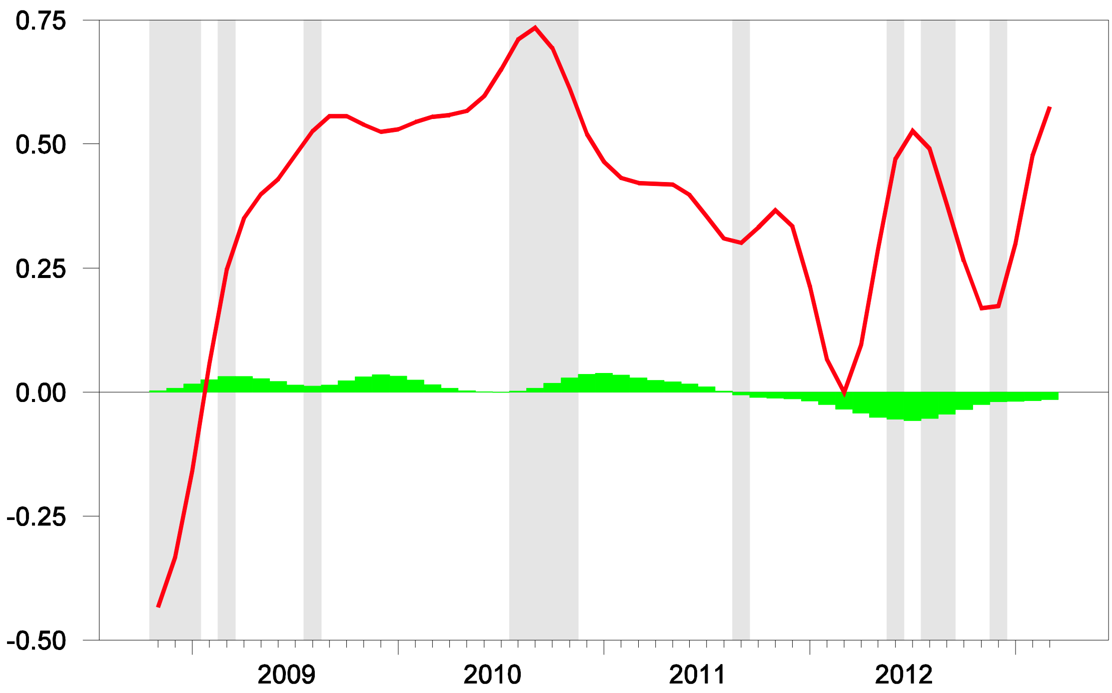

Figure 12. Portfolio Outflows to EME (Red, in % of US GDP) and Fraction Explained by QE Shocks (Green)

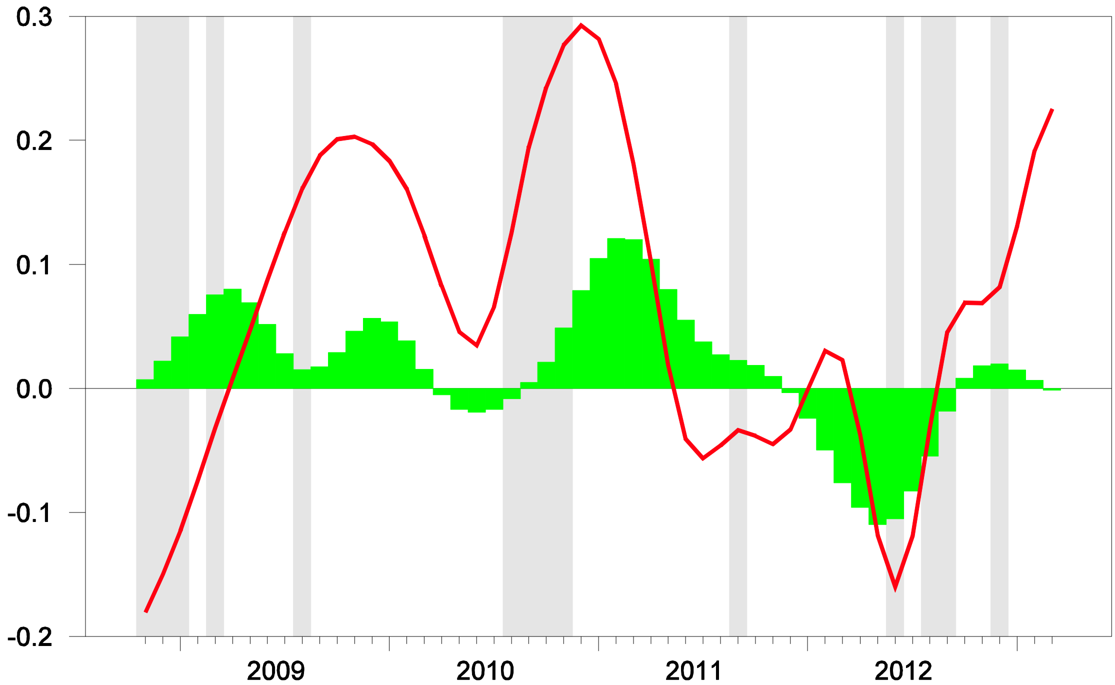

Figure 13. EMBI (Red, in % Change) and Fraction Explained by QE Shocks (Green)

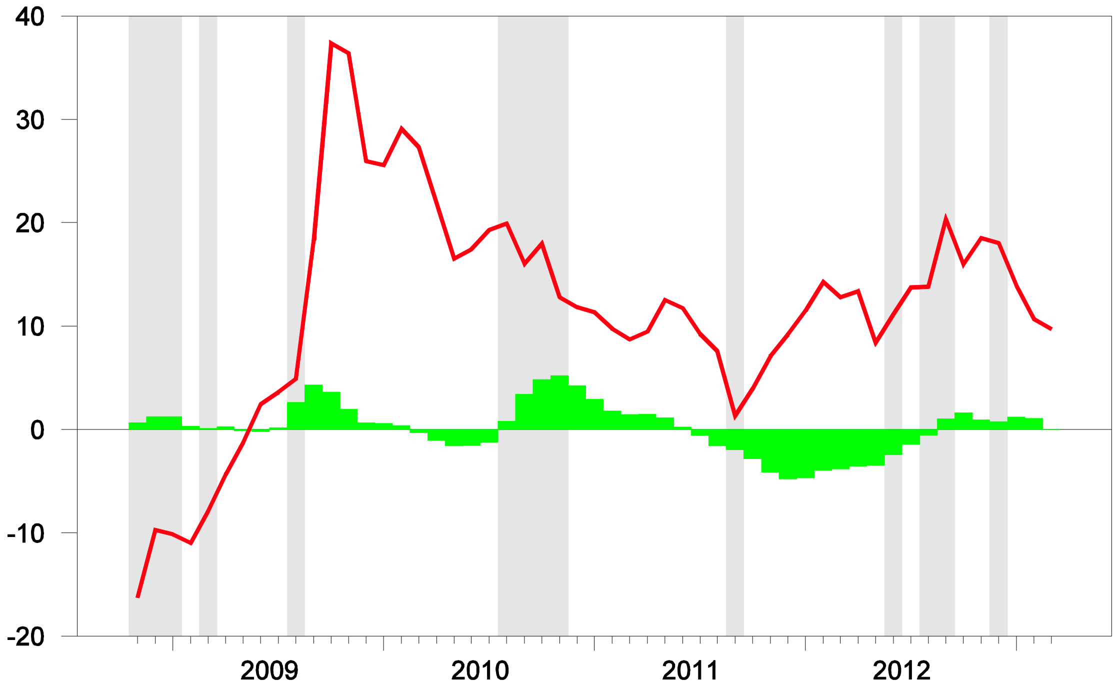

Figure 14. MSCI (Red, in % Change) and Fraction Explained by QE Shocks (Green)

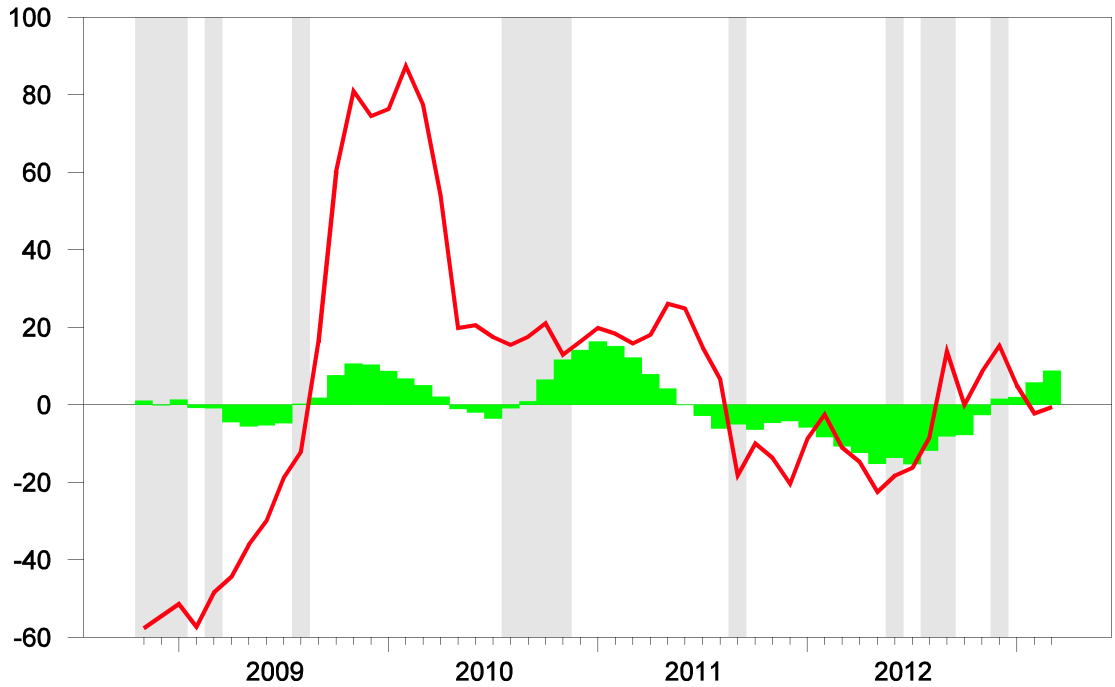

Figure 15. EME FX (Red, in % Change) and Fraction Explained by QE Shocks (Green)

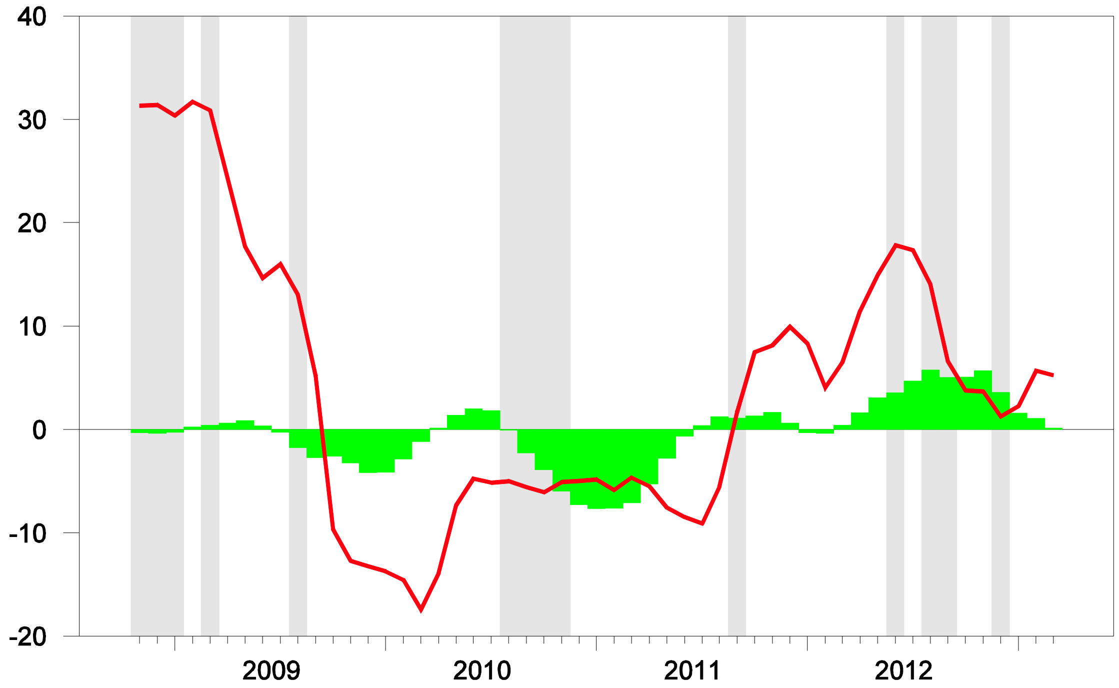

Figure 16. The Effect of a Conventional Monetary Policy Easing

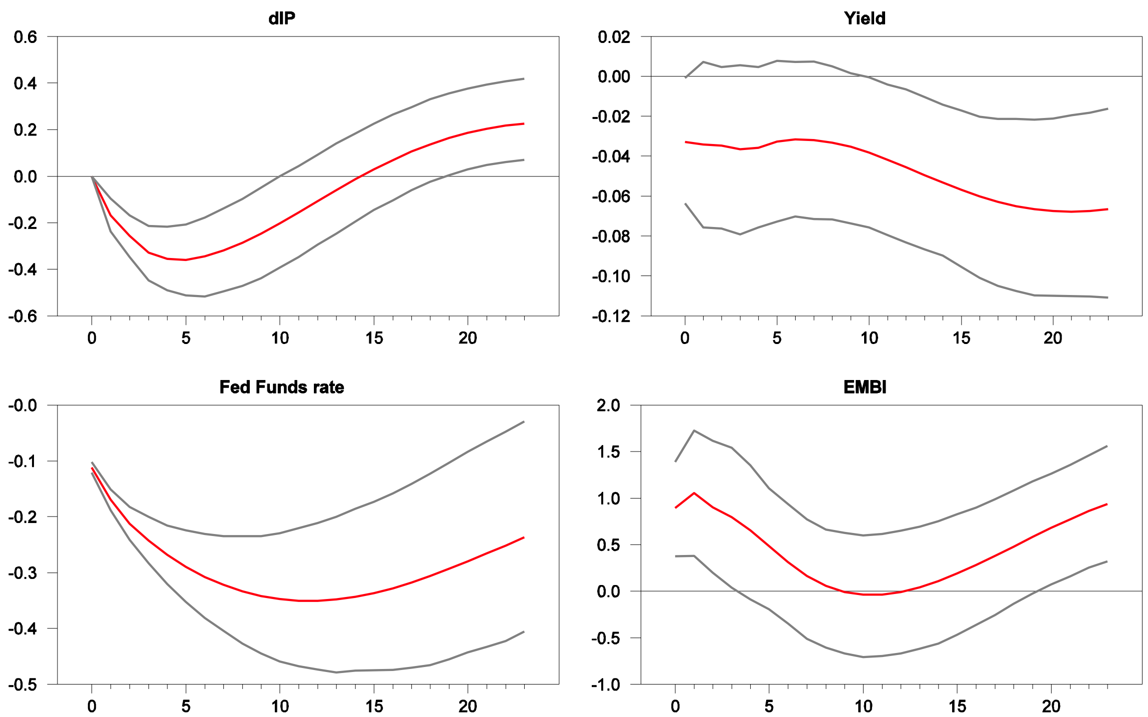

Figure 17. The Effect of a Shock to Latent QE in a Model with Employment

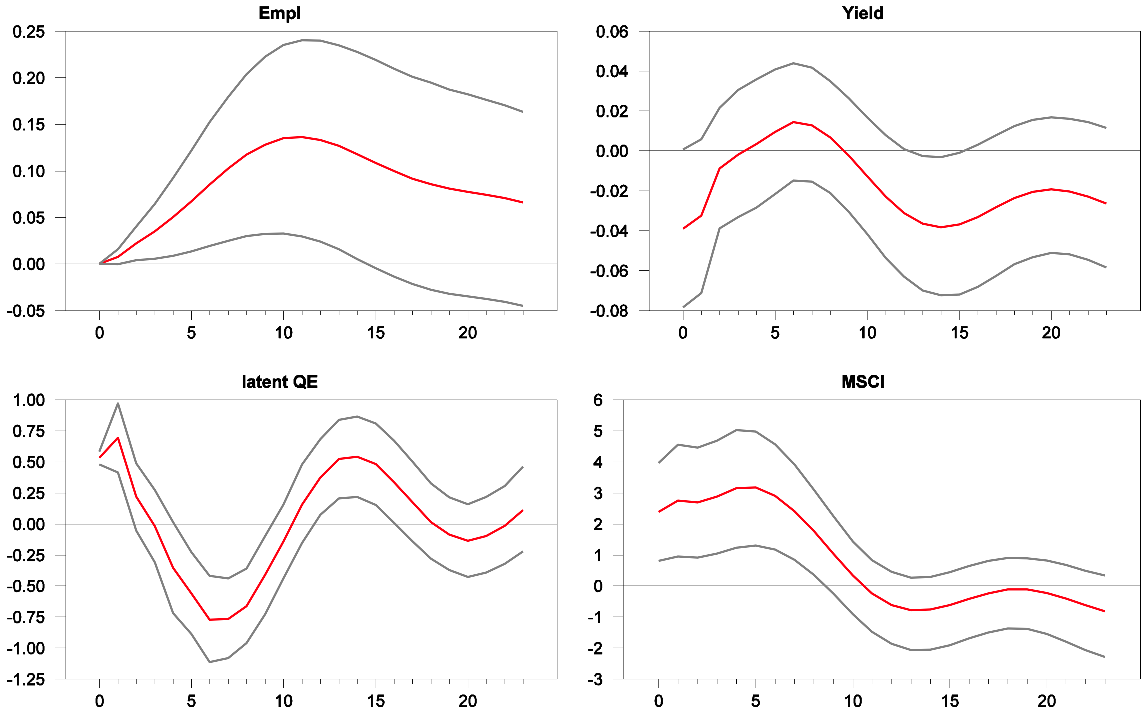

Figure 18. The Effect of a Shock to Latent QE in a Model with TIPS Rates

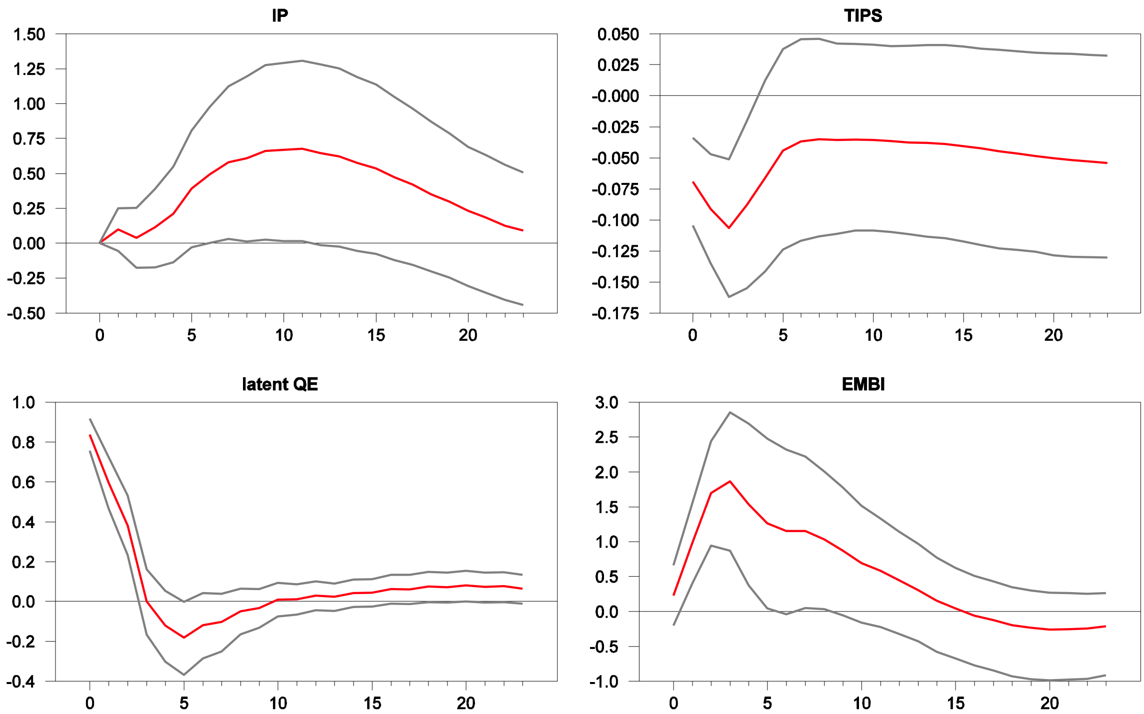

Figure 19. The Effect of a Shock to Latent QE in a Model with an Extended Set of QE Announcements

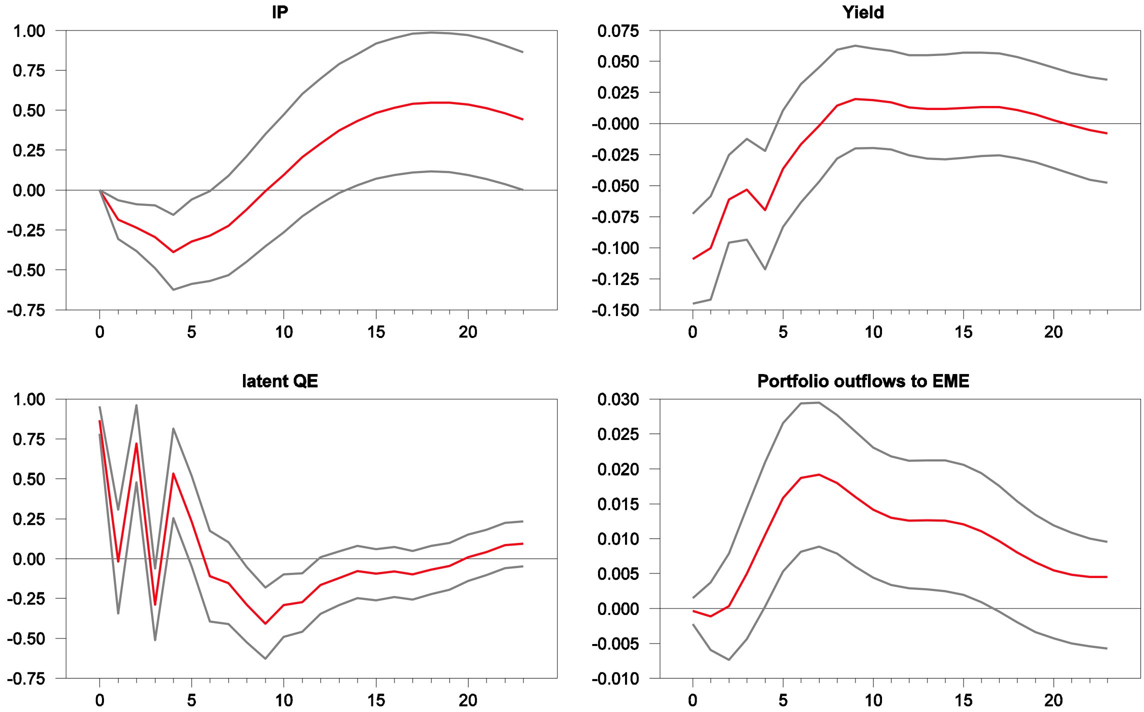

Figure 20. The Effect of a QE Announcement Estimated in a VARX