DISCUSSION PAPER SERIES

DP16395
(v. 3)

Financial 'Side Effects' of QE and Conventional Monetary Policy Compared

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FINANCIAL ECONOMICS

INTERNATIONAL MACROECONOMICS AND FINANCE

MONETARY ECONOMICS AND FLUCTUATIONS

CEPR

ISSN 0265-8003

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Discussion Paper DP16395
First Published 25 July 2021
This Revision 18 November 2021

Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

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JEL Classification: E50, E51, E52

Keywords: QE, monetary policy, Risk-taking channel of monetary policy

Tomasz Wieladek - tomaszwieladek@gmail.com
T. Rowe Price and CEPR

M Weale - martin.weale@kcl.ac.uk
King's College ,London

Acknowledgements
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Martin Weale[(1)] and Tomasz Wieladek[(2)]

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(1) King's College, University of London. Email: martin.weale@kcl.ac.uk

(2) King's College, T. Rowe Price and CEPR. Email: tomaszwieladek@gmail.com
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'It would have been incumbent upon the ECB to weigh these and other considerable economic policy effects and balance them, based on proportionality considerations, against the expected positive contributions to achieving the monetary policy objective the ECB itself has set'
– Federal Constitutional Court of Germany, May 2020

'The first is what should be the **standardised toolkit for a world where unconventional policy is "normal"**. So we need to further our understanding of the transmission channels of our different instruments, and to evaluate their relative side effects, both intended and unintended, as they work their way through the economy.'
– Christine Lagarde, President of the European Central Bank, September 2020

'As things stand, the housing market in the UK is on fire.'
– Andy Haldane, Chief Economist of the Bank of England, June 2021

1 Introduction

Central banks around the world have deployed aggressive quantitative easing in response to the Covid-19 Pandemic induced recession. Most previous academic work focused on the macroeconomic effects of this unconventional policy on the real economy[1] or the high frequency effects on financial markets. In light of this aggressive QE response and the expectation that this policy will become the new normal, the international policy debate has now turned to the unintended side effects of QE with respect to financial stability and wealth inequality. To our knowledge, this is the first paper to test formally, within an agnostic BVAR framework, whether measures of private credit imbalances, financial market risk spreads, asset price overvaluation and Emerging Market (EM) bond spreads show a greater or smaller reaction to QE than to conventional monetary policy in the Euro Area, UK and US.

[1] For example, Chung et al. (2012) used the Federal Reserve Board's macroeconomic model to show that real GDP and inflation were respectively three and one percent higher as a result of US LSAPs. Kapetanios *et al.* (2012) used a range of methods to explore the effects of the Bank of England's purchases, finding that GDP and inflation were raised by 2.5% and 1.5% as a result of the first round of asset purchases in the UK.

This question is central to the current monetary and macroprudential policy debate around the world. All monetary policy instruments have costs and benefits. Many outside observers, including the German Constitutional Court, have expressed concerns about the unintended consequences of QE. ECB President Lagarde also recently highlighted the need to understand the potential side effects of QE relative to other policy instruments, including short-term interest rates. To our knowledge, no previous work has tested the implicit assertion in this debate that the evolution of credit imbalances, financial market risk spreads, asset prices and EM bond spreads would have been any different if central banks had been able to ease using conventional monetary policy instead. Does QE influence these variables relatively more or would the impact have been much the same if central banks used interest rate policy instead? While these potential unintended consequences are at the heart of the current debate about QE, to our knowledge, it remains to be established whether or not QE does indeed have a relatively greater impact on private credit imbalances, risk spreads, asset prices and EM bonds spreads than conventional monetary policy. Understanding the size of these effects is at the heart of several current policy debates.

The relative size of effects on risk spreads and credit imbalances is important for the calibration of macroprudential policy to help maintain financial stability. Differential effects on asset prices could exacerbate the effect of monetary policy on wealth inequality, a topic of recent interest among policy-makers. Finally, EM policy makers are concerned with adverse financial stability spillovers due to expansionary monetary policy in advanced economies. To our knowledge, this is the first paper systematically to explore whether or not QE has a bigger impact than conventional monetary policy across all of these important dimensions.

Economic theory suggests that conventional monetary policy should affect financial variables via the effect on the risk-free rate, the banking system and risk taking. Theory and evidence show that QE tends to lower long-term government bond yields, the key risk-free rate in the financial system. The channels through which 'conventional' monetary policy affects financial variables should therefore operate with QE as well. To test this hypothesis, we use Bayesian VARs to study the impact of QE and conventional monetary policy, on measures of private credit imbalances (the BIS Credit-to-GDP GAP, Household Credit to GDP, PNFC Credit to GDP) , financial markets risk (VIX and BAA-AAA spread). asset price valuation (Equity Price to Earnings ratio, House Price to Rent/Income ratio) and USD denominated EM bond spreads (EMBIG – Sovereign spread and ICE BOFA EM – Corporate spread) expressed relative to the corresponding US treasury bond.

The lack of standard identification restrictions and short time series present challenges to identifying QE in VAR models. To address these issues, we follow Weale and Wieladek (2016) and estimate our BVAR models on monthly data from 2009M3 to 2015M11 in the US, 2009m3 to 2016m5 in the UK and 2015m1-2020m2 in the Euro Area, when the corresponding central banks were relying on QE as their main policy instrument. We focus on identifying 'asset purchase announcement' shocks with four different identification schemes. These broadly reflect the different identification philosophies applied today, including Choleski decomposition, sign restrictions, sign-zero restrictions and sign variance decomposition restrictions. The advantage of this comprehensive approach is that, by considering results across four different identification schemes, and only during the time period when the policy took place, the results will be less susceptible to identification uncertainty and bias from structural breaks. The proposed financial side effects variables are included one-by-one as a sixth variable in our model to test whether asset purchases affect them or not.

While our use of four different QE identification schemes can help partially to address identification uncertainty, asset purchase announcements are not the only way to measure unconventional monetary policy. The shadow short-term interest rate proposed in Xia and Wu (2016), which can also take negative values, provides an alternative measure of unconventional monetary policy, similar in spirit to the more traditional short rate instrument. We also apply our identification schemes to the shadow short-term interest rate.

In this paper, we are interested in comparing the effects of QE to those of the short-term interest rate to understand better if one policy has a more powerful impact on measures of credit imbalances, risk spreads or asset prices than the other. To ensure that the results are comparable, and not due to differences in identification schemes, we apply the same four identification schemes we use for QE to the short-term interest rate. The corresponding BVAR models are estimated from 1997M1 to 2007M6 for the US and the UK, and from 1999M1 to 2007M6 for the Euro Area. A second issue is the scaling of impulse response in the comparison exercise. Typically VAR impulse responses are scaled by the size of the shock to the policy instrument. This approach is not suitable in our application given the difference in policy instruments. As all three central banks target inflation, we propose to compare the impact for every percentage point of inflation that each policy creates at the two-year horizon. That is, we scale by the peak CPI response in each VAR to compare the impact on our variables of interest across these two different policies. To test for statistical significance, we compare the distributions of impulse responses, as in Sa, Towbin and Wieladek (2014).

Our results show that QE, whether measured by asset purchases or the shadow rate, has a statistically significant and negative effect on risk spreads. On the other hand, conventional monetary policy has a statistically significant and positive impact on private credit and house price measures. The comparison between conventional monetary policy and QE reveals the following result: For the stimulus necessary to achieve the same amount of inflation, there is no statistically significant difference in the effect of QE and conventional monetary policy on these variables across countries and unconventional policy measures. This finding is robust across specifications and variables. Two exceptions, present in at least two countries, are the effect on private credit to firms and the EMBIG spread, where the short-term interest rate has a statistically significant more powerful impact than QE, whether measured by asset purchases or the shadow rate.

There is an active current debate about the financial 'side effects' of QE, partially in recognition that after the Covid-19 recession, this policy will become the new standard tool that central banks will rely on to reach their inflation targets. Some policy makers are concerned that the financial 'side effects' of QE are greater than those of conventional monetary policy. This is the first paper to test this hypothesis. Our VAR results show that for the same amount of inflation, the variable targeted by central banks, there is no statistical evidence that the effects of these policies are systematically different. Therefore, at first sight, QE does not seem different from conventional monetary policy after all, at least in terms of financial 'side effects'.

The remainder of this paper proceeds as follows. Section two summarises the theory and previous work, our model and discusses the details of our identification schemes. Section three presents the results and section four concludes.

2. Theory and Methodology

2.1 Theory and previous work

Economic theory provides several channels by which conventional monetary policy affects credit imbalances, risk spreads and asset prices. A key transmission channel of monetary policy is the ability to temporarily lower the real risk-free rate. This in turn leads to higher equity market valuation, higher credit growth and house prices in response to a lower cost of capital. The bank lending channel postulates an additional effect on bank's cost of funds, leading to an even greater rise in credit to the private sector. The 'risk-taking' channel of monetary policy, first coined by Borio and Zhu (2008), suggests that expansionary monetary policy leads to increased risk-taking and leverage in the financial system. Adrian, Shin and Estrella (2012) show that a flattening yield curve lowers banks net interest margin, resulting in greater leverage and risk-taking behaviour. Lower sovereign bond yields could also lead non-bank investors to 'search for yield' in riskier assets, including housing, to achieve the same return on investment. While the former two channels are part of widely accepted monetary policy transmission channels, it is the 'risk-taking' channel and the associated build-up of financial system imbalances that policy makers are most concerned about. Interestingly, these channels operate via the effects of monetary policy on the real risk-free rate, at all maturities. Since QE affects government bond yields, it is theoretically plausible that these channels operate in the case of QE as well.

Empirically, many studies confirm the effects of conventional monetary policy on credit to the private sector, financial market risk spreads and asset prices, within the VAR framework used in this paper. Iacoviello and Minetti (2003), Iacoviello (2005), Calza, Monacelli and Stracca (2013), Wieladek, Towbin and Sa (2014), to mention just a few VAR studies[2], all find that monetary policy shocks have a significant positive effect on credit to the private sector and house prices in OECD countries. Rigobon and Sack (2003) find that conventional monetary policy easing shocks tend to raise the S&P500 in the US in a higher frequency VAR model[3]. Bekaert, Hoerova and Lo Dua (2013) document that expansionary monetary policy lowers the VIX, a key measure of financial market risk taking. Adrian and Shin (2008), Adrian, Shin and Estrella (2018) and Bruno and Shin (2012) use VAR models to show that expansionary monetary policy raises leverage in the banking system through a rise in risk appetite (VIX) as evidence for the

[2] Many studies, such as Kashyap and Stein (2000), rely on bank-level data to examine monetary policy transmission.

[3] Bernanke and Kuttner (2005) and Guerkaynak, Sack and Swanson (2005) show that the stock market reacts to monetary policy announcements in the US with an event study approach.

risk-taking channel of monetary policy. Miranda-Agrippino and Rey (2020) show that these risk-taking effects of US monetary policy spread across the globe.

The macroeconomic theory behind asset purchases remains focused on whether QE has an impact on the real economy. Vayanos and Villa (2009) show that asset purchases operate via the portfolio balance channel and have a negative impact on long-term rates in the presence of preferred habitat investors. An alternative mechanism is the signalling mechanism- that asset purchases provide a signal that the policy interest rate is going to remain at its effective lower bound for longer, originally suggested by Eggertson and Woodford (2003) and Bernanke, Reinhart and Sack (2004). A third possible transmission mechanism is that asset purchases reduce uncertainty about financial markets and the economy more generally. If these channels operate, asset purchases should lower the cost of capital by reducing the level and slope of the yield curve. In that case, QE is likely to affect credit to the private sector, financial market risk spreads and asset prices through the same channels, including the risk-taking channel, as conventional monetary policy. However, economic theory doesn't say whether the effects of these channels would be stronger or weaker with QE relative to conventional monetary policy or whether these channels operate with QE to begin with. These are empirical questions.

Previous empirical work on QE doesn't address these important questions. The focus is almost exclusively on studying the consequences for output and inflation with VAR models and for high frequency financial market movements with event studies. Baumeister and Benati (2013), Kapetanios, Mumtaz, Theodories and Stevens (2012) and Gambetti and Musso (2020) all find that Federal Reserve, Bank of England and ECB QE all had a positive impact on real GDP and CPI in the US, UK and Euro Area, respectively. Gambacorta, Peersman and Hoffman (2014) and Weale and Wieladek (2016) confirm these findings when using the balance sheet and asset purchase announcements to identify QE shocks in Bayesian VAR models. Event studies, such as Joyce, Lasaosa, Stevens and Tong (2010), D'Amico and King (2013) and Swanson (2013) all find that QE had an impact on financial market variables upon announcement. However, none of these previous studies systematically explore the financial system 'side effects' of QE or compare them to conventional monetary policy.

2.2 Methodology

We use the following VAR model estimated on monthly data:

$$\boldsymbol{Y_t} = \boldsymbol{\alpha_c} + \sum_{k=1}^{L} \boldsymbol{A_k Y_{t-k}} + \boldsymbol{e_t} \qquad \boldsymbol{e_t} \sim \boldsymbol{N(0, \Sigma)} \qquad (1)$$

where $\boldsymbol{Y_t}$ is a vector of the following endogenous variables: the announcement of asset purchases divided by nominal GDP; the log of CPI; the log of real GDP; the yield on the 10-year government bond and the log of real equity prices at time $\boldsymbol{t}$. $\boldsymbol{A_k}$ is the array of coefficients associated with the corresponding lagged vector of variables for lag $\boldsymbol{k}$. $\boldsymbol{e_t}$ is a vector of residuals at time $\boldsymbol{t}$. This is assumed to be normally distributed with variance-covariance matrix $\boldsymbol{\Sigma}$. When the time-series dimension is small, estimates of $\boldsymbol{A_k}$ are likely to be imprecise. Previous work has addressed this problem by relying on Bayesian methods of inference and imposing a Litterman (1986), or time-varying parameter, prior. But there is always the risk that tight priors dominate information from the data. Our approach avoids this problem. A non-informative normal inverse-Wishart prior is used , following the approach[4] in Uhlig (2005). A lag length, L, of two is used throughout.[5]

2.3 Identification

To identify QE shocks, we broadly follow Weale and Wieladek (2016), with the important difference that we rely on both asset purchase announcements and the shadow short rate as measures of QE. The challenge for structural VAR models is to disentangle orthogonal, structural economic shocks, $\boldsymbol{\varepsilon}_{c,t}$, from the correlated reduced form shocks $\boldsymbol{e}_{c,t}$. This is typically achieved using a matrix $\boldsymbol{C_0}$, such that $\boldsymbol{C_0}\boldsymbol{e}_{c,t} = \boldsymbol{\varepsilon}_{c,t}$. We use four ways of inferring $\boldsymbol{C_0}$, zero restrictions, sign restrictions, a combination of zero and sign restrictions, and sign variance decomposition restrictions. All of these identification schemes are described in table 1.

Identification scheme I uses a lower-triangular scheme, with asset purchases ordered after real GDP and prices, but before all of the other variables. The identifying assumptions are therefore that output and prices react with a lag and that aside from responding to these two, asset purchases do not react to any other variable upon impact.

[4]Jarocinski and Marcet (2013) propose imposing priors on the growth rates of variables, as opposed to priors on parameters, as the least controversial way to impose priors in small sample VARs. But it is unclear how to choose suitable priors for variables in our VAR such as asset purchase announcements. Our model was therefore estimated using the normal inverse-Wishart prior, with hyperparameters set to small values to ensure that the prior is non-informative (Uhlig, 2005).
[5] *Ex ante* lag length tests such as the Hannan-Quinn or BIC criterion suggest a lag length of 2.

VAR identification schemes that employ timing exclusion restrictions have been criticised in recent years, on the grounds that such restrictions do not naturally emerge from DSGE models. Canova and De Nicolo (2002), Faust and Rogers (2003) and Uhlig (2005) have therefore proposed identifying shocks by means of the implied signs of the impulse responses that they produce. Clearly, for identification restrictions of this type to be valid, they need to be strongly supported by economic theory. In the presence of financial frictions, such as imperfect substitutability between long and short bonds (Harrison, 2012) or preferred habitat investors (Vayanos and Villa, 2009), economic theory does suggest that a rise in asset purchases will lead to a fall in the interest rate on long-term bonds, by reducing term premia. But even in the absence of frictions, announcements of asset purchases can signal that the short-term interest rate is going to stay lower for longer (Eggertson and Woodford, 2003), depressing the long rate. Secondly, lower yields on longer maturity bonds are likely to lead to some reallocation towards other assets, such as equities, leading to a rise in real equity prices. Thus our definition of a positive asset purchase shock is that it leads to lower long-term rates and a rise in equity prices.

The other shocks that we identify are an aggregate demand shock, which would typically lead to a rise in prices and output. The rise in prices, together with the fact that firms may require greater finance for production, is likely to lead to a non-negative response of the long interest rate. The rise in demand would also lead to a rise in expected profits and thus to a rise in real equity prices. The sign restrictions used to identify an aggregate supply shock are identical, other than assuming that prices fall rather than rise. This identification scheme, referred to as scheme II throughout the paper, is summarised in Table 1 and implemented with the QR approach presented in Rubio-Ramirez, Waggoner and Zha (2010). Unless otherwise noted, all sign restrictions are imposed upon impact and one month thereafter with the exception of asset purchase announcements, where we impose the sign restriction upon impact and for five months thereafter here and also in identification schemes III and IV.

In identification scheme II, the assumption is that asset purchases affect the real economy via portfolio rebalancing from long-term government bonds into equities, to distinguish them from aggregate supply and aggregate demand shocks. But *a priori* it is not clear to what extent the mechanisms that are required for asset purchases to affect the yield on long-term government debt operate in reality. More importantly, to distinguish asset purchase from aggregate supply shocks, it was necessary to assume that long-term interest rates rise in response to an aggregate supply shock. Theoretically, a positive aggregate supply shock may lead to a rise in investment, competition for funds and higher bond yields, but also a decline in bond yields as a result of the monetary policy reaction to lower consumer prices. Empirically, Dedola and Neri (2007) and Peersman and Straub (2009) examine the reaction of the short-term interest rate in response to technology shocks in SVARs for the US and Euro Area, respectively. Peersman and Straub (2009) show a positive medium-term reaction of the short rate to technology shocks, while Dedola and Neri (2007) find no significant effect. While the long-rate restrictions are therefore consistent with their results, we nevertheless drop them in identification scheme III below.

This is possible, as long as one is willing to make the assumption that asset purchases do not react contemporaneously to aggregate demand and aggregate supply shocks. In that case, the restriction on real equity prices is sufficient to distinguish these shocks from asset purchases. Given that monetary policy makers do not observe aggregate demand or supply shocks within a month, the assumption of a zero contemporaneous reaction of asset purchases to aggregate demand and supply shocks is realistic. An additional advantage is that this allows us to identify a fourth shock, namely a rise in uncertainty/risk premia. This shock is identified as a decline in real equity prices, to which the monetary policy authority reacts with a rise in asset purchases, perhaps as a result of a coincident financial crisis. Unlike demand and supply, these types of shocks can be observed in real time. This identification scheme is referred to as identification scheme III throughout. It is implemented using the procedure in Arias, Rubio-Ramirez and Waggoner (2014), who generalise the standard QR restrictions algorithm to include zero restrictions as well. This is not the only paper to use a combination of zero and sign restrictions to identify unconventional monetary policy shocks. Gambarcorta, Hofmann and Peersman (2014) adopt a similar approach.

Identification schemes I – III rely on the idea that shocks can be distinguished based on restrictions on impulse responses. But it is also possible to use variance decomposition restrictions to separate different economic shocks (Faust and Rogers, 2003; Uhlig, 2005). The idea here is that a shock that is variable-specific should explain the largest fraction of the variance in that variable.[6] In identification scheme IV, asset purchase announcement shocks are assumed to explain the largest fraction of variation in asset purchases upon impact and with a three period delay. This makes it possible to drop the zero restrictions and also the sign restrictions on the long rate. This scheme is implemented in a similar fashion to identification scheme II, with the QR approach by Rubio-Ramirez, Waggoner and Zha (2010), but rather than keeping impulse responses which are consistent with a particular sign, retaining only those consistent with the variance decomposition restrictions in table 1.

At present the transmission mechanisms of QE are not sufficiently well understood to devise an identification scheme which would allow us to identify asset purchase announcement shocks perfectly. It is for this reason that we sequentially relax the strongest identification restrictions from the first scheme to the last one. Despite this pecking order, it is nevertheless not possible to claim that one scheme is necessarily better identified or preferable to another. As a result we study the effects of asset purchases in all four cases paying particular attention to results which are significant with at least three of the four schemes adopted in this paper.

[6] Our approach is similar in spirit, but not technique, to the penalty function approach first proposed in Uhlig (2005).

Table 1 – Identification schemes

	p Log CPI	y Log real GDP	AP Asset Purchases	i_t Long Interest Rate	sp_t Log Real Equity Price
			Identification Scheme I		
Log CPI	1	0	0	0	0
Log real GDP	x	1	0	0	0
Asset Purchases	x	X	1	0	0
Long Interest Rate	x	X	x	1	0
Log Real Equity Price	x	x	x	X	1
			Identification Scheme II		
Supply Shock	−	+		+	+
Demand Shock	+	+		+	+
Asset Purchase Shock	?	?	+	−	+
			Identification Scheme III		
Supply Shock	−	+	0		
Demand Shock	+	+	0		
Asset Purchase Shock	?	?	+		+
Uncertainty Shock			+		−
			Identification Scheme IV		
				Variance Decomposition Restrictions	
Supply Shock	−	+		$\frac{Var(Shock)}{Var(Asset\ Purchases)} < MAX(\frac{Var(Shock)}{Var(Asset\ Purchases)})$	
Demand Shock	+	+		$\frac{Var(Shock)}{Var(Asset\ Purchases)} < MAX(\frac{Var(Shock)}{Var(Asset\ Purchases)})$	
Asset Purchase Shock	?	?	+	$\frac{Var(Shock)}{Var(Asset\ Purchases)} = MAX(\frac{Var(\ Shock)}{Var(Asset\ Purchases)})$	

This table shows the restrictions imposed as part of all four identification schemes.

While our use of four different QE identification schemes can help to address partially identification uncertainty, our discussion so far has focused on only one measure of unconventional monetary policy: asset purchase announcements. This is of course not the only way to measure unconventional monetary policy. So long as it is assumed that all of the effect of asset purchase announcements can be summarised by the yield curve, the shadow short-term interest rate proposed in Xia and Wu (2016), which can also take negative values, provides an alternative measure of unconventional monetary policy, similar in spirit to the more traditional short rate instrument when rates are not constrained by the zero lower bound. We therefore also apply the four identification schemes in table 1 to the shadow short rate rather than asset purchase announcements. Sign-identification based schemes are modified to allow for the fact that a rise in the asset purchase announcement implies a lower shadow short rate.

Finally, we also apply these identification schemes to identify conventional monetary policy shocks. The restrictions we used to identify QE shocks above are also, conveniently, the same minimal set of restrictions that can be used to identify conventional monetary policy and this is how we proceed. Since the seminal work of studying monetary policy in VARs by Sims (1980), a large amount of evidence has accumulated to support the Choleski timing restrictions, sign restrictions or variance decomposition shown in table to identify a conventional monetary policy shock. As with the shadow short rate, we modify sign restrictions based schemes to ensure that a negative short-term rate is expansionary monetary policy. We estimate the corresponding BVAR models from 1997M1 to 2007M6 and replace the QE variable with the ECB's MRO rate, the BoE's Bank rate and the Federal Reserve's Fed Funds Rate. The sample starts in 1999M1 for the Euro Area.

2.4 Data

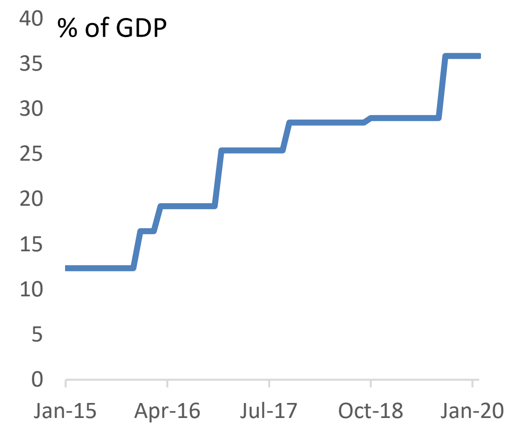
All of the VAR models in this paper are estimated on monthly data for the period when asset purchases were an active policy tool in the US, from 2009m3 to 2015m11. In December 2015, the Federal Reserve began to use interest rate policy again. Monthly real GDP data for the US are taken from Macroeconomic Advisers. For the CPI, we use the variable used is the consumer price index published by the Bureau of Labour Statistics. Real equity prices are calculated by averaging daily data for EuroSTOXX 50, FTSE100 and S&P500 obtained from Thomson DataStream and deflating by CPI. The asset purchase announcement series are constructed in the following manner: We attach the same weight to the maturity extension program (Operation Twist) as asset purchase announcements of government bonds financed with the issue of central bank reserves. Assigning a smaller weight does not make much a difference to our results. We also use the shadow short rate first described in Xia and Wu (2016). For the UK, we collect asset purchase announcements, without any modification, from the policy announcements of the Bank of England's MPC. We use a monthly real GDP indicator produced by the UK's National Institute for Social and Economic Research. UK CPI is taken from the Office of National Statistics. For the Euro Area, we use the CEPR's EUROCOIN index as an indicator of real GDP. The asset purchase announcement series, the ECB's flow announcements expressed as a stock measure, is taken from Wieladek and Garcia-Pascual (2016). We use the HICP excluding energy and unprocessed food as our measure of inflation in the

Euro Area VAR model. All financial market variables, including 10-year government bond yields, price to earnings ratio, BAA-AAA spreads and VIX[7] indices are taken from Bloomberg. Private credit to households and PNFC's is taken from the BIS database and divided by nominal GDP prior to linear interpolation to monthly frequency. We also linearly interpolate the BIS credit to GDP gap to monthly frequency. The House Price to Income and House Price to Rent indices are taken from the OECD main economic indicators database and interpolated linearly to monthly frequency. The EMBIG spread is the spread of USD sovereign EM bonds relative to the corresponding US Treasury Bond and provided by JP Morgan. The ICE BofA EM CORP spread, is the spread of USD corporate EM bonds, weighted by capitalisation, relative to the corresponding US treasury bond, provided by Bank of America and taken from the Federal Reserve Bank of St. Louis FRED database.

[7] We use the VSTOXX for the Euro Area, the VFTSE100 for the UK and the CBOE VIX for the US.

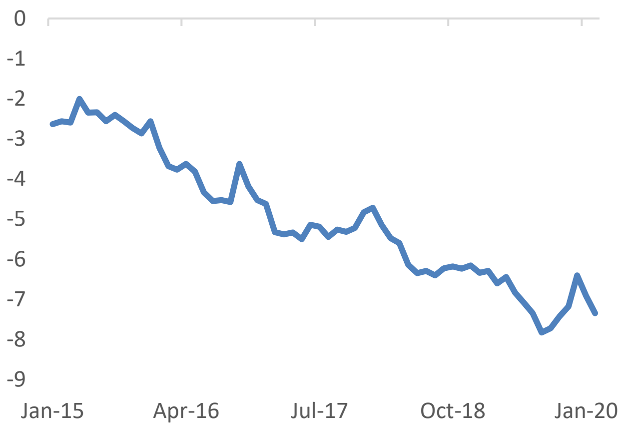
Figure 1: Different measures of unconventional monetary policy in the EA, UK and US

ECB Asset Purchase Announcements



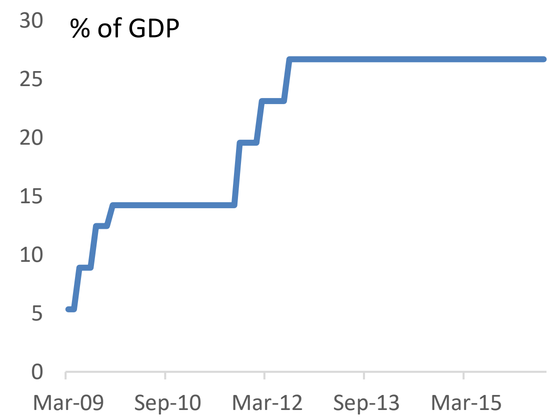
Source: ECB GC policy announcements.

EA Shadow Rate



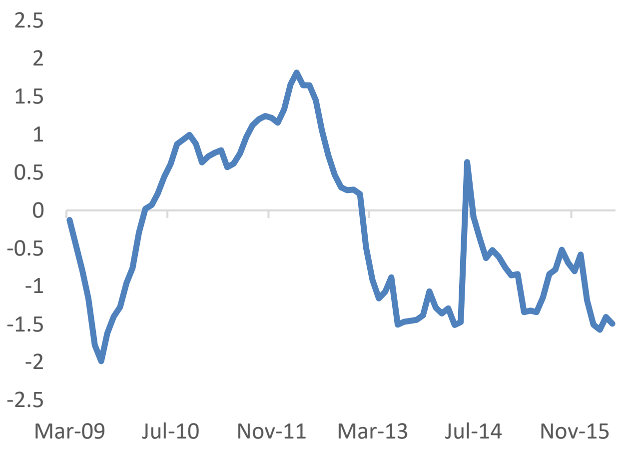
Source: Xia and Wu (2016).

UK Asset Purchase Announcements



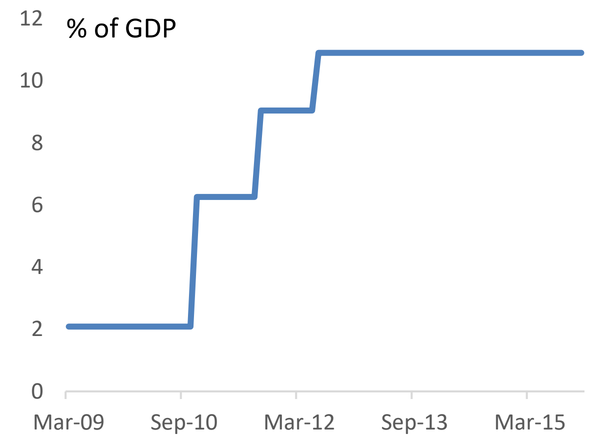
Source: BoE minutes.

UK Shadow Rate



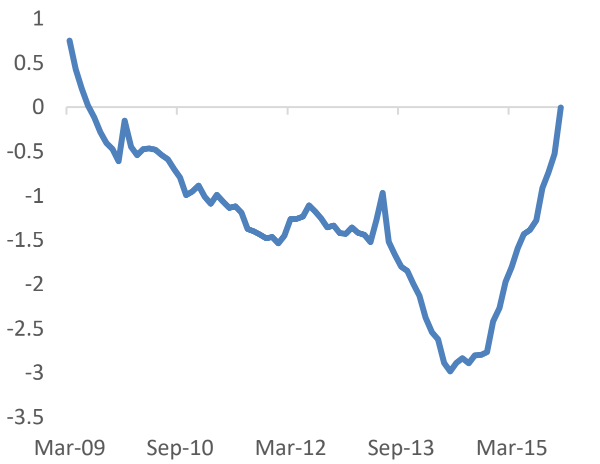
Source: Xia and Wu (2016).

US Asset Purchase Announcements



Source: FOMC minutes.

US Shadow Rate



Source: Xia and Wu (2016).

3. Results

In this paper, we are interested in exploring two questions. First, does QE, whether measured by asset purchase announcements or the shadow rate, have a significant effect on private credit imbalances, financial market risk spreads, asset prices and EM bond spreads? The second question is whether the size of these effects is any different from the effects of conventional monetary policy on these variables?

To answer the first question, we assess the corresponding impulse responses and their 68% quantiles. As discussed in section 2, the identification of asset purchase announcement shocks is subject to significant identification uncertainty. In the rest of our discussion, we therefore describe an effect as robust to identification uncertainty, if it is present in at least three of the four proposed identification schemes. Even then, it is unclear whether asset purchase announcements or the shadow short rate are the 'ideal measure of QE. We only refer to an effect as statistically significant if it is present with at least three of the four identification schemes for both QE measures.

To make these results comparable to answer the second question, despite the fact that a different policy variable is involved in each specification, we scale each impulse response by the peak CPI response in each model. Given that price stability is an important mandate of the ECB, BoE and Federal Reserve, this approach allows us to compare effects conditional on the stimulus required, regardless of instrument, to achieve a given inflation outcome. This scaling allows to subtract the distribution of impulse response to the short-term rate from the distribution of the response to QE. The resulting median and 68% quantile are informative whether or not these two different policies have different effects on private credit imbalances, risk spreads, asset prices and EM bond spreads in this study.

The breadth of this study, given three countries, four identification schemes, ten variables of interest and two measures of QE, means that there are 30 figures with 20 impulse responses each. Because it would be easy to get lost in the detail, we choose to summarise the results in Table 2, leaving a more careful examination of the individual impulse responses in the figures appendix to the interested reader. To ensure comparability, all impulse responses shown in all of the figures are standardised by the peak impact on CPI.

Table 2 summarizes our results. A '+' or '-' entry means that the effect was statistically significant (68% quantiles above/below zero) in at least three of the four identification schemes. The columns indicate the variables of interest, while the rows indicate the policy and country. For example, the '+' in the Credit Gap column in the EA row under asset purchase announcements indicates that the 68% quantiles of the Credit Gap impulse response distribution in response to the asset purchase announcement shock were statistically significant and positive in at least three of the four identification schemes in the Euro Area. Similarly, the '-' sign in the BAA column in the short-term interest rate EA row indicates that the responses of BAA spreads to a conventional monetary policy shock were statistically significant and negative in at least three of the four identification schemes. Finally, the columns 'Short-term interest rate-Asset purchase announcements' show results from the 68% quantile and median of the difference in impulse responses from the short-term interest rate and asset purchase announcements, respectively. The 'Short-term interest rate – Shadow short rate' repeats this exercise for the shadow short-term rate. The '+' in the US row of the BAA 'Short-term interest rate – Shadow short rate' column therefore indicates that the effect of the shadow short-rate on BAA spreads is statistically larger than the effect of conventional monetary policy.

Table 2 – Impulse responses of financial variables to various monetary policies

	HH Credit	PNFC Credit	Credit Gap	BAA	VIX	PTE	HPI	HPR	EMBIG	EM CORP
Asset purchase announcements										
EA			+	-		-	+	+	-	-
UK				-	-				-	-
US	-			-	-					
Shadow short rate										
EA		+	+	-		+		+	-	
UK					-		+	+		
US				-	-					
Short-term interest rate										
EA	+	+		-		-	+	+	-	-
UK				-		+				+
US				-		+				
Short-term interest rate-Asset purchase announcements										
EA						-				
UK				+	+	+				+
US				+	+				+	
Short-term interest rate-Shadow short rate										
EA		+	-			-				
UK						+				+
US				+	+				+	

Note: '+'/ '-' indicates that the impulse response is positive/negative and statistically significant across at least three of the four proposed identification schemes. HH Credit is credit to the household sector to GDP ratio, PNFC Credit is credit to the PNFC sector to GDP ratio, Credit gap is the BIS Credit gap to GDP ratio, BAA the BAA to AAA spread on corporate bonds, VIX the VIX, PTE the equity price to earnings ratio, HPI/HPR the House Price to Income/ House Price to rent ratios.

What do the results summarised in Table 2 reveal about our two questions of interest? While the results are different for each country and variable combination, several interesting patterns emerge. QE, whether measured through asset purchase announcements or the shadow rate, has a statistically significant and negative effect on BAA spreads and the VIX, and the positive effect on the house price to rent ratio, but only in the Euro Ara. For the credit variables, on the other hand, the evidence is less convincing as there is either lack of significance or there is a statistically significant and negative reaction, which is counter intuitive. It is plausible that either the effect of QE on GDP is stronger than on private credit, or that this is reflective of the private sector deleveraging which coincided with QE following the 2008/2009 GFC. For conventional monetary policy, there is evidence for a statistically significant and positive reaction of the credit to private sector measures and house price valuation measures in the Euro Area. There is also a consistent negative effect on the BAA spread across countries. However, the VIX reacts positively in the UK and US, which is counter-intuitive. Overall, these results show that there is consistent evidence for a reduction in corporate risk (BAA) spreads for all three countries and both types of policies. House price valuation and credit measures only respond to both types of policies in the Euro Area.

The key question of interest in this paper is if the effects of QE on these variables are any different from those of conventional monetary policy. These results can be seen in the columns labelled ‘Short-term interest rate-Asset purchase announcements’ and ‘Short-term interest rate-Shadow short rate’ in table 2. These show several entries denoted ‘+’. For variables which react negatively to a monetary policy shock, such as the BAA spread, this means that the effect of QE is greater than that of conventional monetary policy, given the same effect on inflation, and that this difference is statistically significant. It is difficult, if not impossible, to know if the asset purchase announcement or shadow short rate is a better reflection of QE. As a result, we only consider results of the difference between QE and conventional monetary policy to be statistically significant if they are present with both measures. This is the case in six instances, for the US VIX, US BAA spread, US EMBIG, UK ICE BOFA EM CORP spread, UK and EA PTE. In the first four cases, the difference in effects between conventional monetary policy and QE is statistically significant and positive. This suggests QE has a more powerful effect on these variables than conventional monetary policy. It is important to note however, that we use 68% confidence bands to assess statistical significance in this paper. While this is in line with previous work on Bayesian VARs, it implies that up to 32% of the results could be random and still consistent with a null-hypothesis of no effect. The risk that of making this mistake is therefore clearly larger is there is a statistically significant difference for only one country (the US). If evidence of a difference was present across at least two countries, it would be possible to argue that a difference is present, given the 68% confidence bands employed in this paper. Overall, for the vast majority of country/variable combinations there is no evidence to suggest a statistically significant difference between QE and conventional monetary policy.

While applying the same identification scheme to identify conventional monetary policy as QE shocks has a conceptual advantage, there is a risk that the restrictions presented in table 1 are insufficient to identify a conventional monetary policy shock. Uhlig’s (2005) work suggested that leaving output unrestricted when identifying monetary policy may lead to a statistically insignificant output impulse response. For this reason, most subsequent papers, such as Canova and De Nicolo (2005), impose sign restrictions on output and prices as well, to help support the interpretation of the identified shock as a conventional monetary policy shock. Furthermore, to compare effects we standardise them by the peak median CPI response in the model. However, leaving the CPI response unrestricted may not just affect the confidence bands, but the median response as well. If the median CPI response is imprecisely estimated, there is a risk that the 'financial' side effects documented in this paper could either be over or understated. Overall, our failure to find a statistically significant effect could stem from the imprecise identification of monetary policy shock both because of minimal identification assumptions and imprecise estimation of the median CPI response. To examine if this is the case, we augment all of the sign restriction identification schemes (Schemes II-IV) in table 1, with the additional restriction that output and prices have a non-negative response to an expansionary monetary policy shock, whether QE or conventional monetary policy. The results of this exercise are shown in table 3.

Relative to table 2, there are many more statistically significant results in table 3, as could be expected due to the reduction in uncertainty from imposing that output and prices have a non-negative response to an expansionary monetary policy shock. In addition to the previous results, the results in this table show that conventional monetary policy has a greater effect than QE on Household credit in the UK and PNFC credit in the Euro Area. The previous result which implied that the effect of QE on the EMBIG is greater than that of conventional monetary policy for the US, now has a '-' sign. This implies that, with these additional restrictions, conventional monetary policy has a greater effect on the EMBIG in the US than QE. The previous results that QE has a larger effect on the BAA spread and the VIX in the US survives.

Table 3 – Replication of table 2 with additional identification restrictions

	HH Credit	PNFC Credit	Credit Gap	BAA	VIX	PTE	HPI	HPR	EMBIG	EM CORP
Asset purchase announcements										
EA			+	-		-	+	+	-	-
UK	-	-		-	-		+		-	-
US	-			-	-					
Shadow short rate										
EA		+	+	-		-	+	+	-	-
UK	-	-		-	-	+	+	+		-
US			+	-	-	+				
Short-term interest rate										
EA	+	+		-		-	+	+	-	-
UK	+			-		+	+			
US	+					+	+	+	-	
Short-term interest rate-Asset purchase announcements										
EA		+				-	-	-		
UK	+		+	+		+		+	-	+
US	+			+	+				-	
Short-term interest rate-Shadow short rate										
EA		+	-			-		-		
UK	+	+		+		+				
US				+	+				-	

Note: '+'/ '-' indicates that the impulse response is positive/negative and statistically significant across at least three of the four proposed identification schemes. HH Credit is credit to the household sector to GDP ratio, PNFC Credit is credit to the PNFC sector to GDP ratio, Credit gap is the BIS Credit gap to GDP ratio, BAA the BAA to AAA spread on corporate bonds, VIX the VIX, PTE the equity price to earnings ratio, HPI/HPR the House Price to Income/ House Price to rent ratios.

A key critique of VARs is that impulse responses are estimated with low precision when the sample is small. This means that our proposed comparison of impulse responses could suffer from low statistical power.

Most work based on sign restrictions, including this paper, relies on the algorithm of Rubio-Ramirez, Waggoner and Zha (2010) to find candidate rotations of the VAR impact matrix. Baumeister and Hamilton (2015, 2018) and Watson (2019) argue that the Haar distribution used to find candidate rotations in this algorithm is only uninformative with respect to the proposed rotations, but not impulse responses, as they are a non-linear function of the proposed rotation. As a result, the algorithm can assign higher probability to certain impulse responses randomly. This has important implications for sign restriction identification schemes drawing inference from the response of the 'unrestricted variable' in the VAR. Baumeister and Hamilton's (2015) findings imply that the additional variable in the VAR, like in this paper, is not truly left unrestricted because impulse responses are a non-linear transformation of the proposed rotation. In general, this approach only affects papers which rely on sign restriction identified VARs to answer the question whether or not a variable reacts to a shock of interest. However, the main question of interest in this paper is not whether variables react, but whether the reaction of these variables is different across different monetary policies. The solution to this issue in this paper is therefore impose the theoretically correct sign on the variable of interest and compare the resulting distributions as before.

To address both of these issues, we therefore re-estimated our results and imposed that each of the proposed variable of interest has the correct sign (positive for asset prices and credit variables; negative for risk and EM bond spreads) in response to monetary policy as part of the identification scheme. These results are shown in table 4.

Table 4 – Impulse response of financial variables to various monetary policies when the correct sign is imposed as part of the identification scheme

	HH Credit	PNFC Credit	Credit Gap	BAA	VIX	PTE	HPI	HPR	EMBIG	EM CORP
Asset purchase announcements										
EA	+	+	+	-	-	+	+	+	-	-
UK	+	+	+	-	-	+	+	+	-	-
US	+	+	+	-	-	+	+	+	-	-
Shadow short rate										
EA	+	+	+	-	-	+	+	+	-	-
UK	+	+	+	-	-	+	+	+	-	-
US	+	+	+	-	-	+	+	+	-	-
Short-term interest rate										
EA	+	+	+	-	-	+	+	+	-	-
UK	+	+	+	-	-	+	+	+	-	-
US	+	+	+	-	-	+	+	+	-	-
Short-term interest rate-Asset purchase announcements										
EA		+						-		
UK	+	+	+	+		+		+	-	
US	+	-			+				-	
Short-term interest rate-Shadow short rate										
EA		+	-			-		-		+
UK	+	+		+		+			-	
US					+				-	

Note: '+'/ '-' indicates that the impulse response is positive/negative and statistically significant across at least three of the four proposed identification schemes. HH Credit is credit to the household sector to GDP ratio, PNFC Credit is credit to the PNFC sector to GDP ratio, Credit gap is the BIS Credit gap to GDP ratio, BAA the BAA to AAA spread on corporate bonds, VIX the VIX, PTE the equity price to earnings ratio, HPI/HPR the House Price to Income/ House Price to rent ratios.

Table 4 shows the results when the ‘right’ sign has been imposed on the variable in the sign restriction identification schemes. The responses in the ‘Asset purchase announcements’, ‘Shadow short rate’ and ‘Short-term interest rate’ all have the right sign by construction. However, the result in the ‘Short-term interest rate – Asset purchase announcements’ and ‘Short-term interest rate – Shadow short rate’ columns are still informative on whether the size of the ‘financial’ side effect is larger with one policy than the other. These results show a similar pattern to Table 2. In the vast majority of cases, there is no statistically significant difference between the effects of conventional monetary on those variables and those from QE. There are two cases where there is a statistically significant difference for at least two countries, the EMBIG spread and private credit to firms. In both cases, conventional monetary policy has a greater and statistically significant effect than QE.

4. Conclusion

Central banks have engaged in aggressive QE in response to the Covid-19 induced global recession. In light of the expectation that this policy will become the new ‘normal’, the international debate has now shifted to the financial side effects of QE. An implicit assertion in this debate,by the German Constitutional Court among others, is that QE has stronger side effects than conventional monetary policy. This assertion is also at the heart of the current debate about the effects of accommodative monetary policy on wealth inequality and financial stability. Previous research focused on investigating the real effects of QE and cannot answer this important question. To our knowledge, this is the first paper systematically to examine this issue empirically.

We use a Bayesian VAR estimated on monthly data to study the effect of BoE, ECB, Fed QE and conventional monetary policy on domestic measures of private credit imbalances, financial market risk and asset price valuation as well as EM bond spreads. We rely on four different identification schemes and two different measures of QE, asset purchase announcements and the shadow short rate, to address the identification uncertainty associated with QE shocks. We use the same approach to estimate the effects of conventional monetary policy on these variables. The key purpose of this paper is to explore whether or not QE has led to significant financial ‘side effects’, relative to what conventional monetary policy would have delivered. To enable this comparison, we normalise impulse responses by the amount of inflation generated by each policy, since that was the variable targeted by central banks during this time. The results show that conventional monetary policy has a statistically significant impact on the house price and credit variables. For QE, there is more evidence for an impact on the VIX, the BAA spread and the share price to earnings ratio. However, in the majority of variables/country combinations, there is no statistically significant difference between the effects of conventional monetary policy and QE on these measures of financial ‘side effects’.

A common critique of QE has been that this policy leads to credit imbalances, greater risk-taking and asset overvaluation, especially when compared to conventional monetary policy. If true, this would have important consequences for the effects of accommodative monetary policy on financial stability and wealth inequality. This assertion is so deeply ingrained in the public debate that even the conservative German Constitutional Court relied on this argument in its ruling regarding the ECB’s PSPP earlier in May 2020. However, to our knowledge, no previous work has systematically tested this claim in the data. Our paper fills this important gap in the literature. While our results show that there is evidence for financial 'side effects' of both QE and conventional monetary policy, in the vast majority of cases, there is no statistically significant difference between the financial 'side effects' of these two policies. This paper is only the first empirical exploration of this important policy issue. Many fruitful avenues for future research remain, including testing the differences between these policies with microeconomic data.

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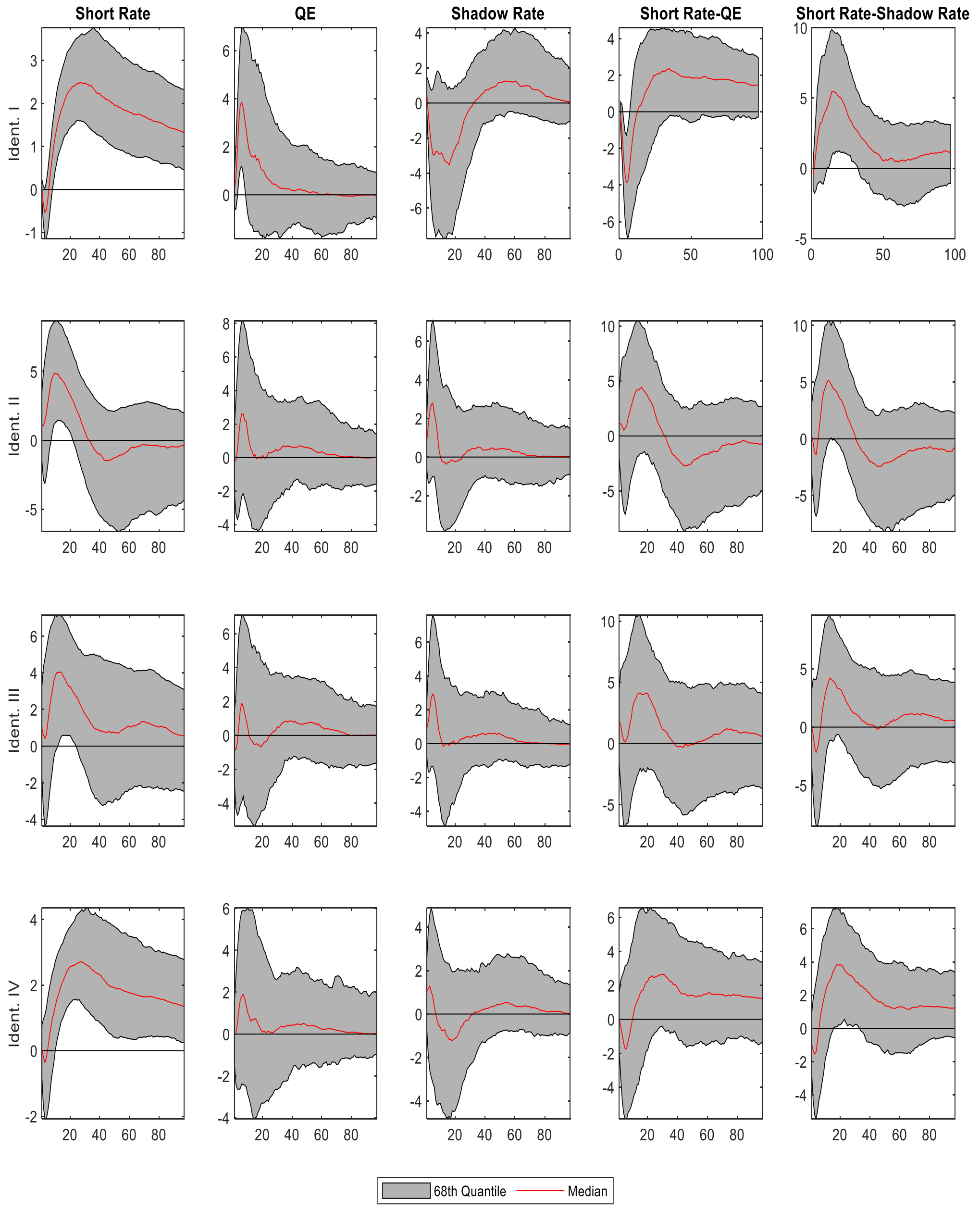
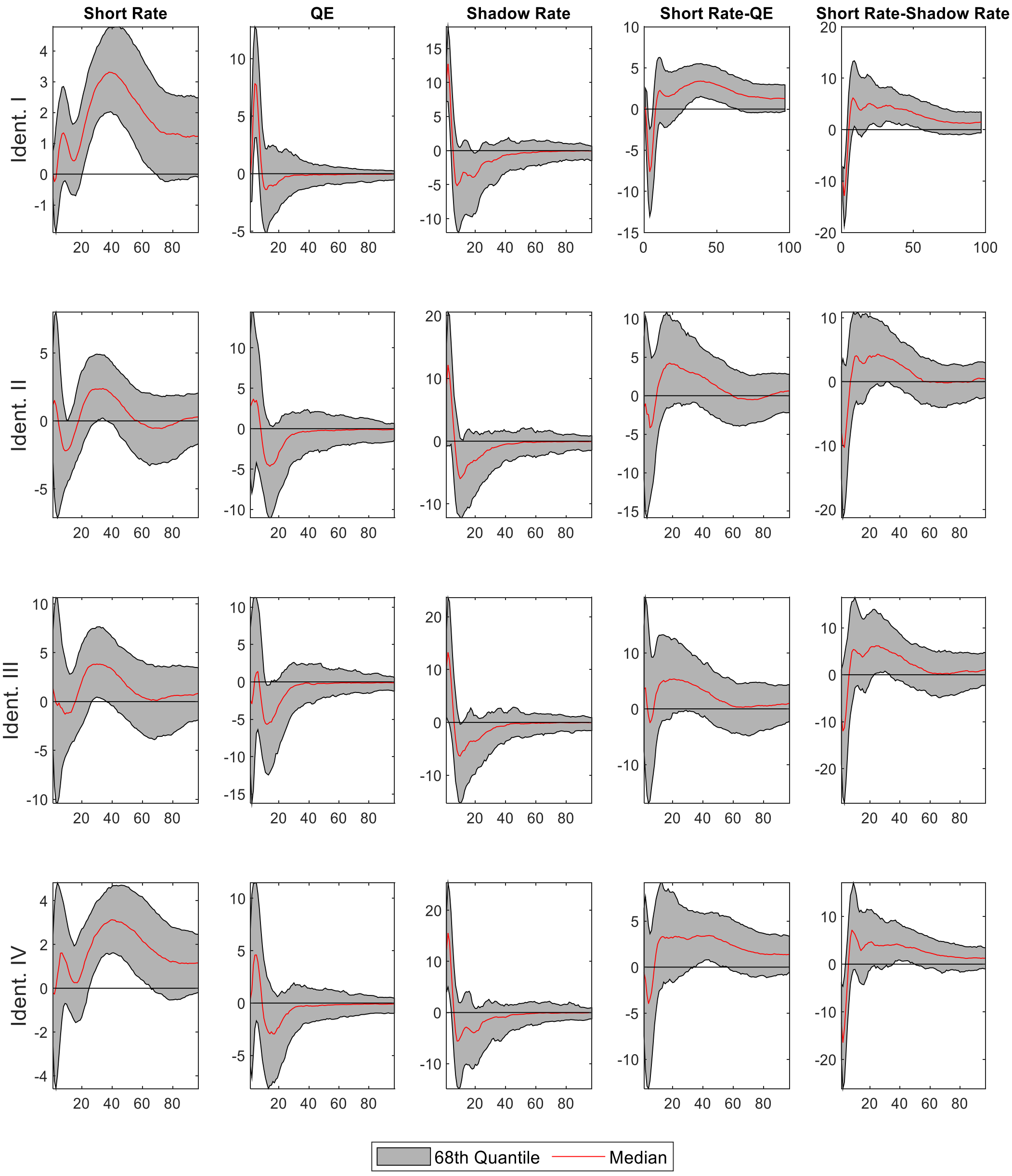
Figures

Figure 2: Impulse response of the EA private credit to household to GDP ratio to various monetary policies



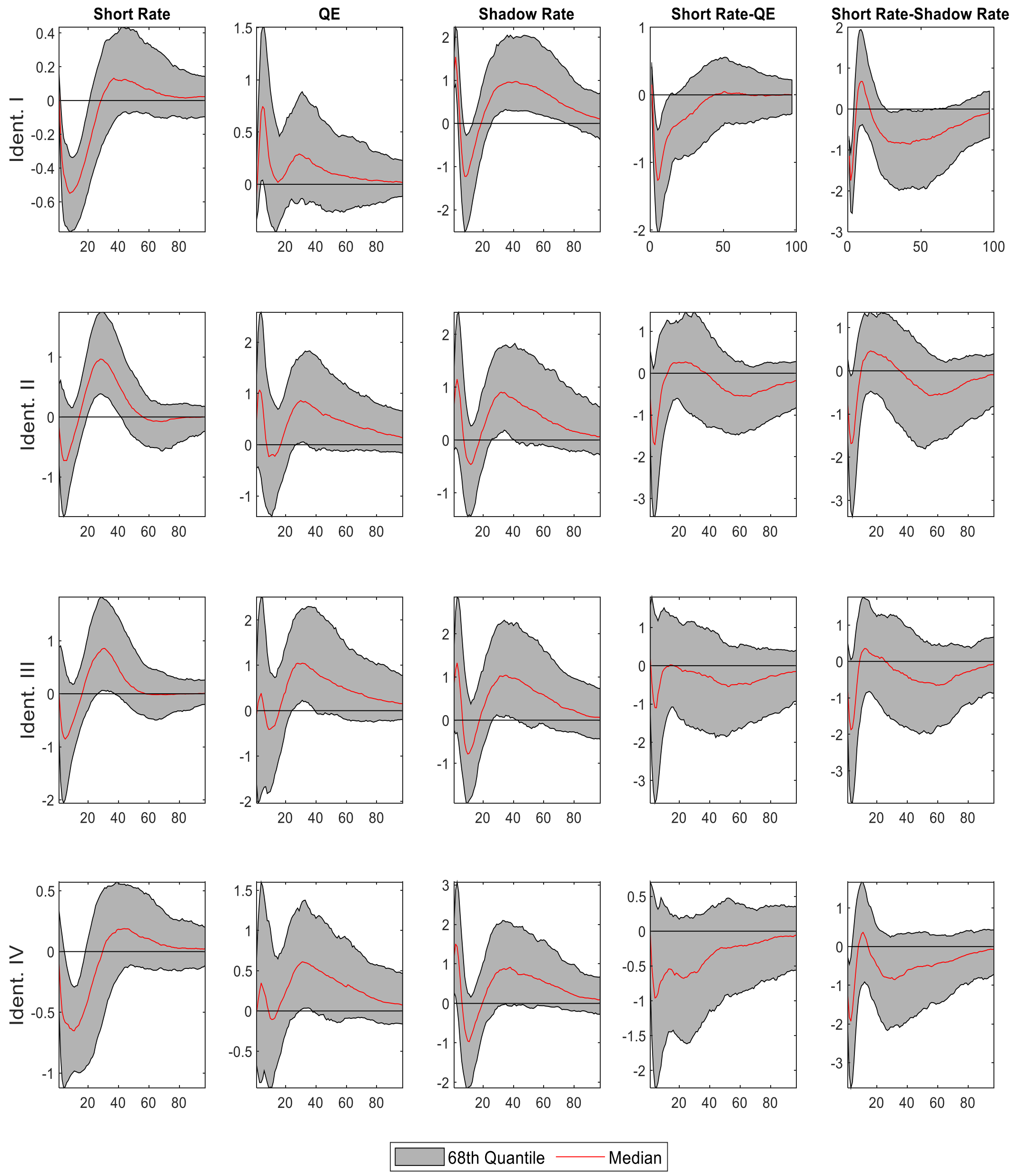
Note: This figure shows impulse responses of the EA private credit to household to GDP to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the EA private credit to household to GDP ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the EA private credit to household to GDP ratio impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 3: Impulse response of the EA private credit to PNFCs to GDP ratio to various monetary policies



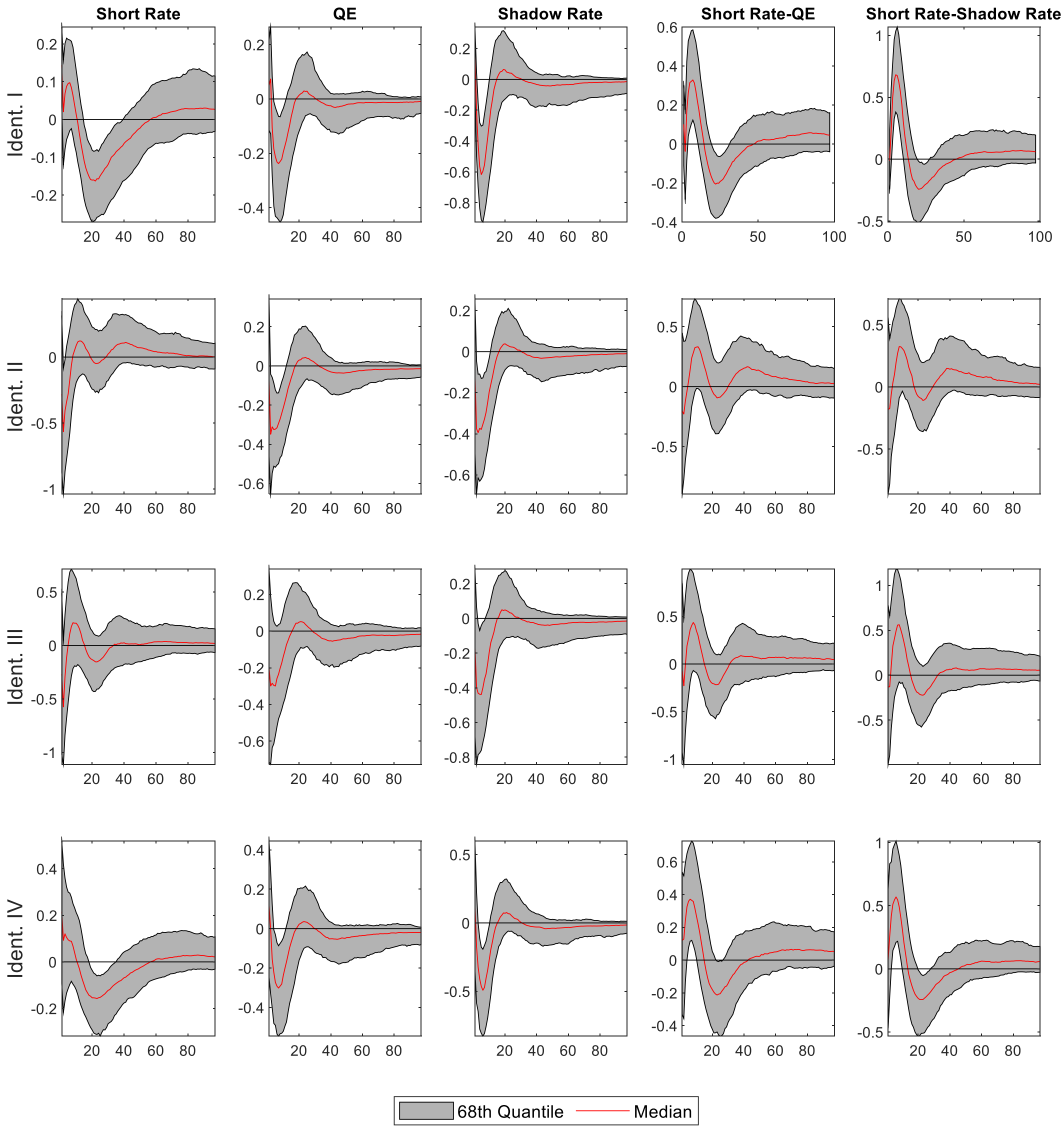
Note: This figure shows impulse responses of the EA's private credit to PNFCs to GDP ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the private credit to PNFCs to GDP ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the private credit to PNFCs to GDP ratio impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 4: Impulse response of the EA private Credit to GDP gap to various monetary policies



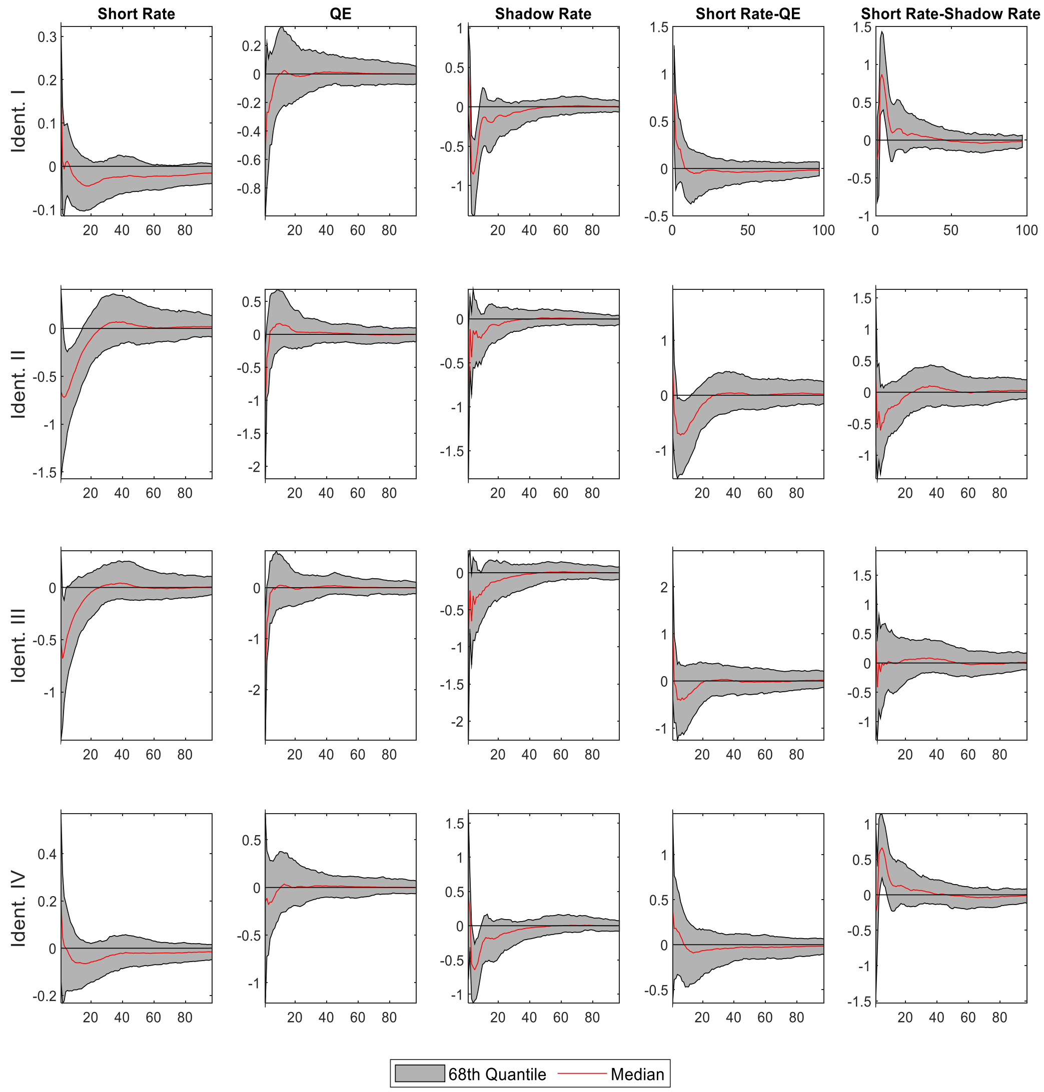
Note: This figure shows impulse responses of the EA private Credit to GDP gap to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the private Credit to GDP gap impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the private Credit to GDP gap impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 5: Impulse response of the EA BAA spread to various monetary policies



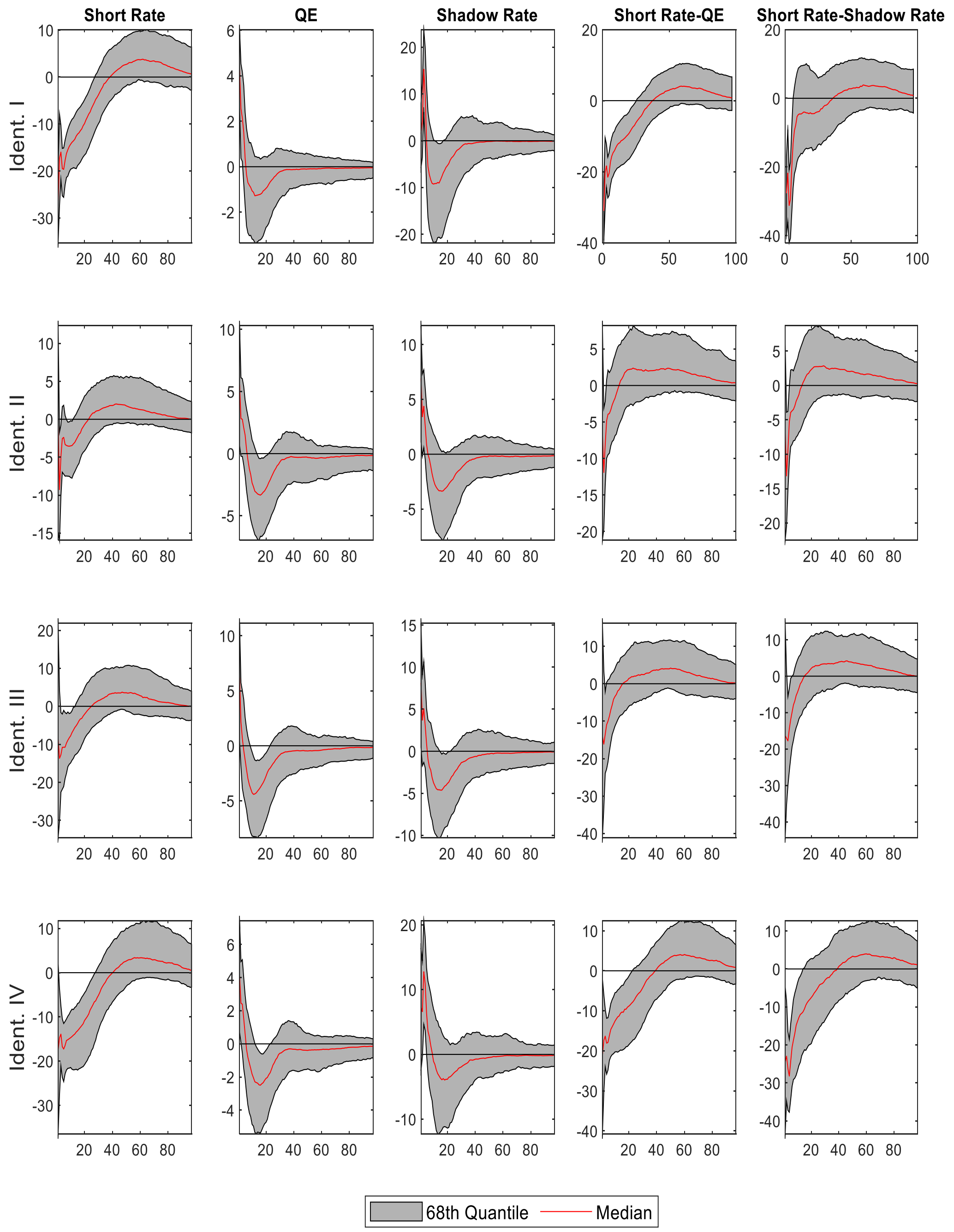
Note: This figure shows impulse responses of the EA BAA spread to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the EA BAA spread impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the EA BAA spread impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 6: Impulse response of the EA VIX to various monetary policies



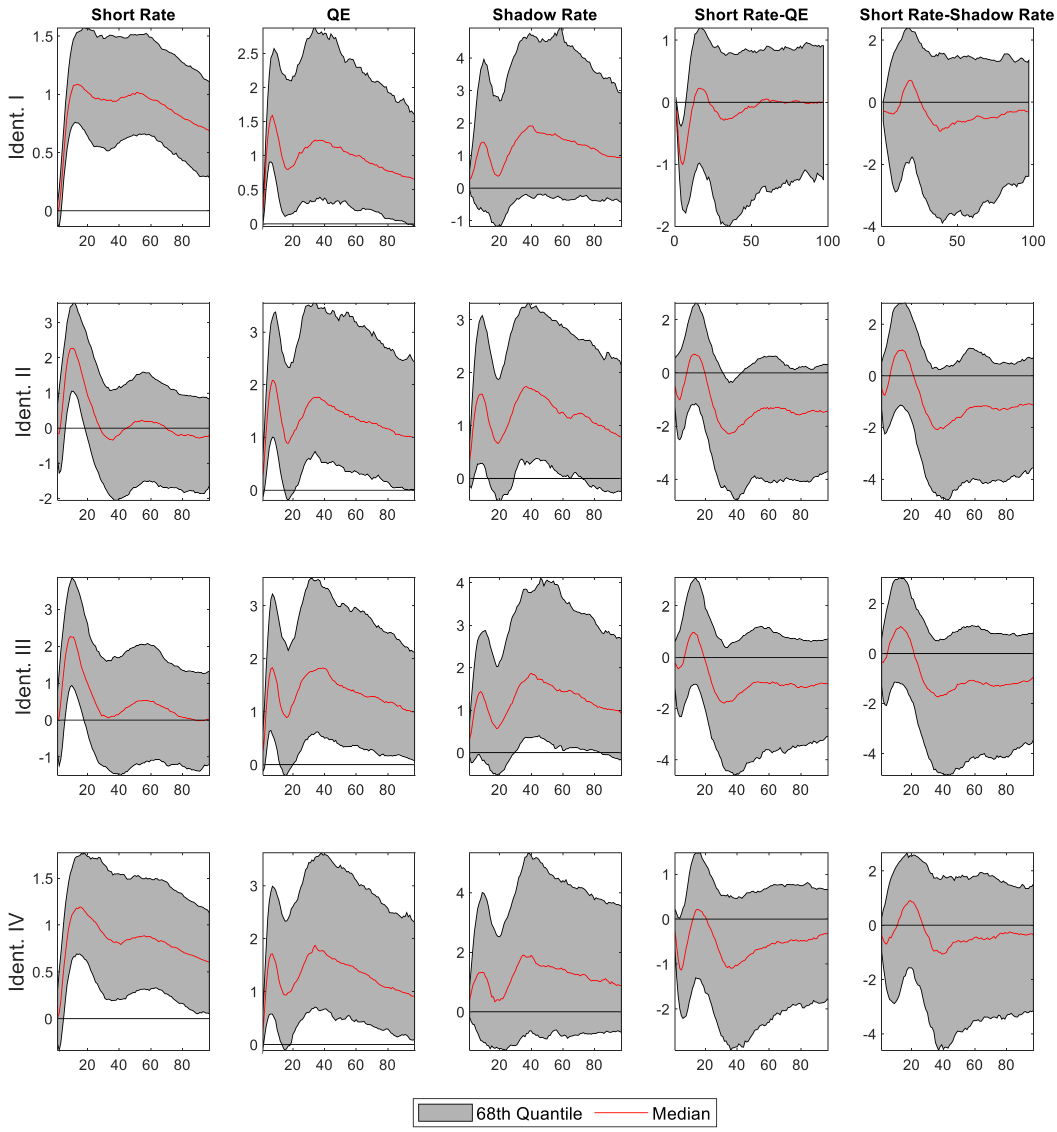
Note: This figure shows impulse responses of the EA VIX to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the EA VIX impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the EA VIX impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 7: Impulse response of the EA Price to Earnings Ratio to various monetary policies



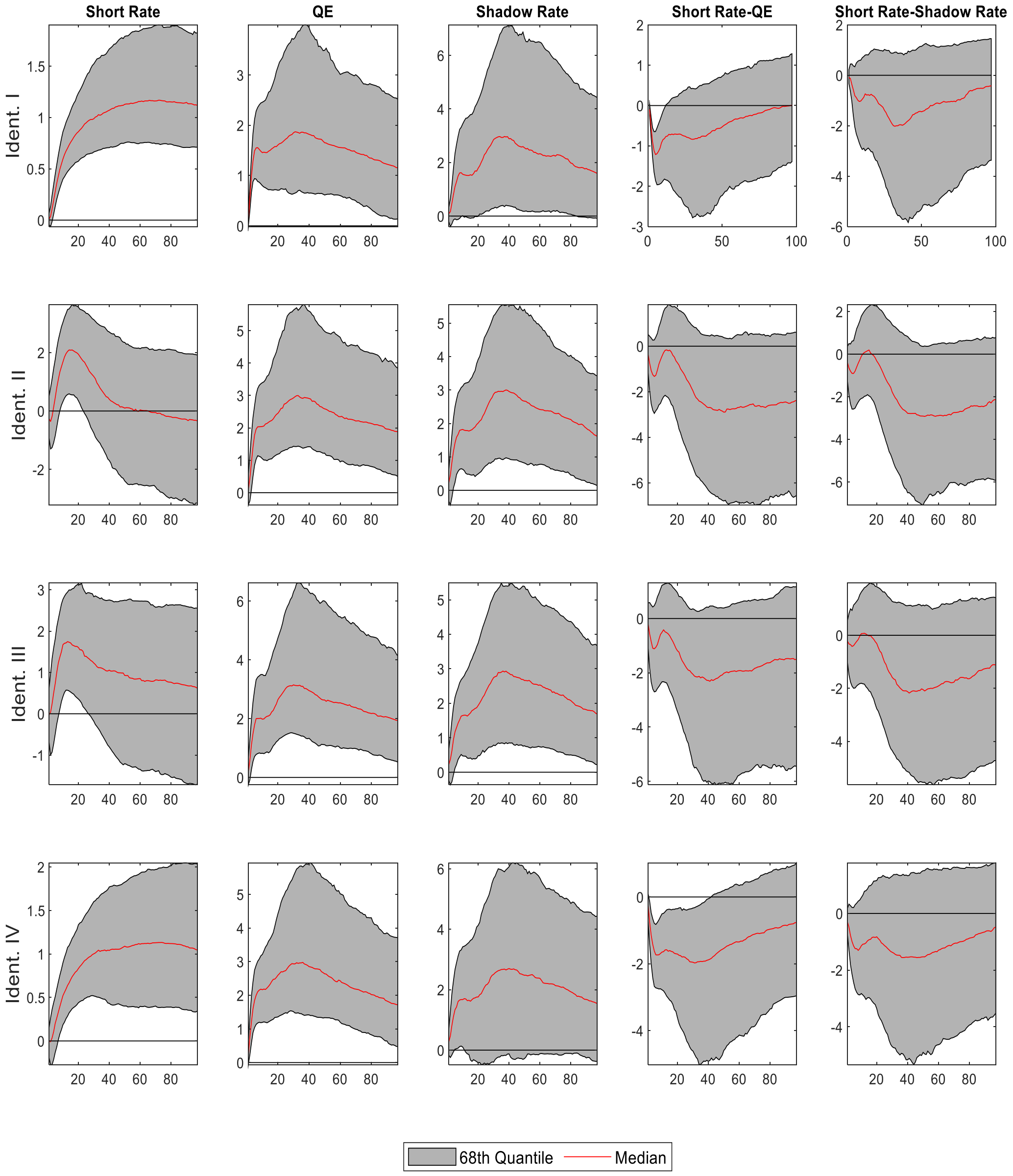
Note: This figure shows impulse responses of the EA Share Price to Earnings ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the Share Price to Earnings ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the Share Price to Earnings ratio impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 8: Impulse response of the EA House Price to Income ratio to various monetary policies



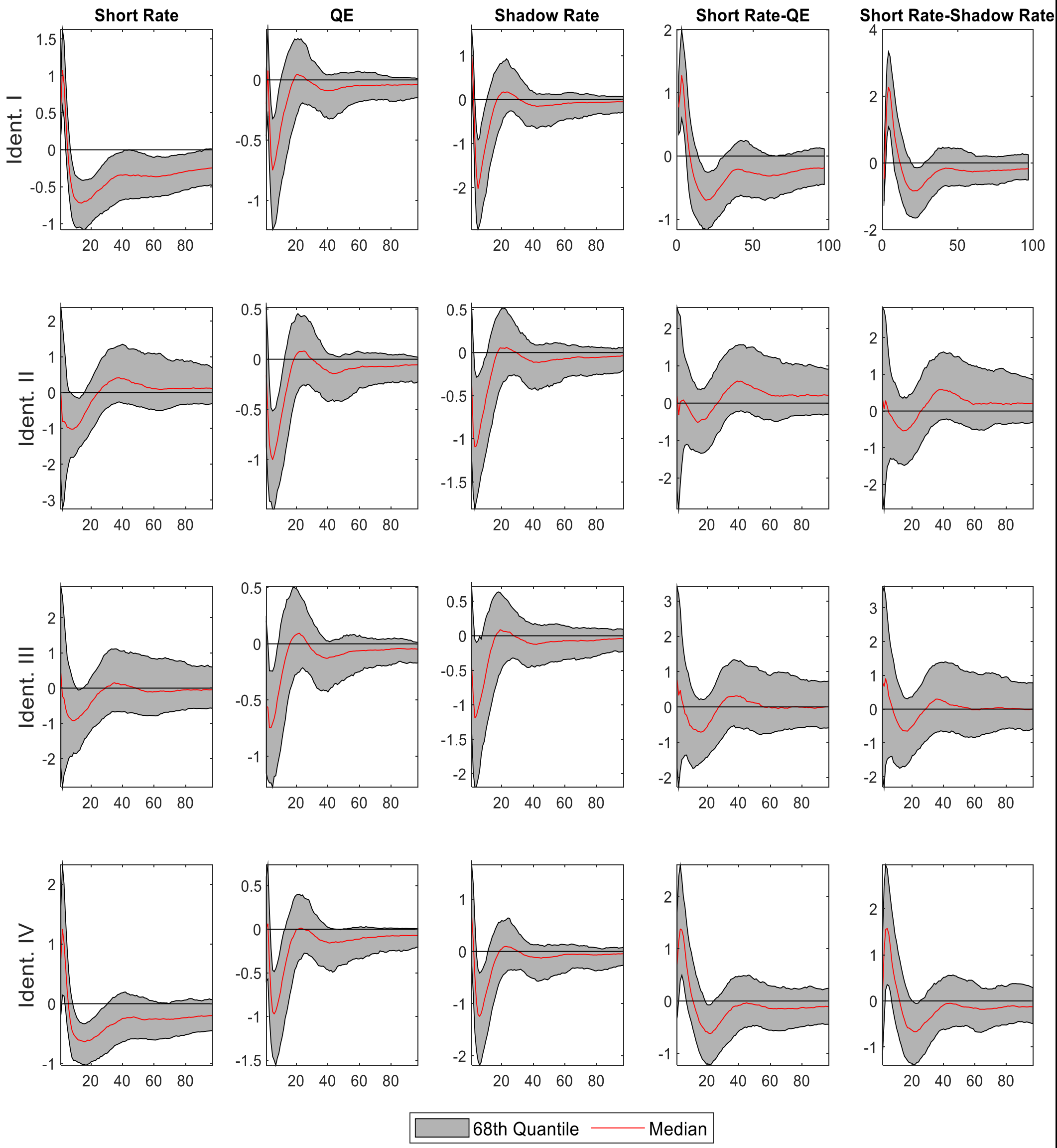
Note: This figure shows impulse responses of the EA House Price to Income ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the House Price to Income ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the House Price to Income ratio impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the House Price to Income ratio than conventional monetary policy.

Figure 9: Impulse response of EA House Price to Rent ratio to various monetary policies



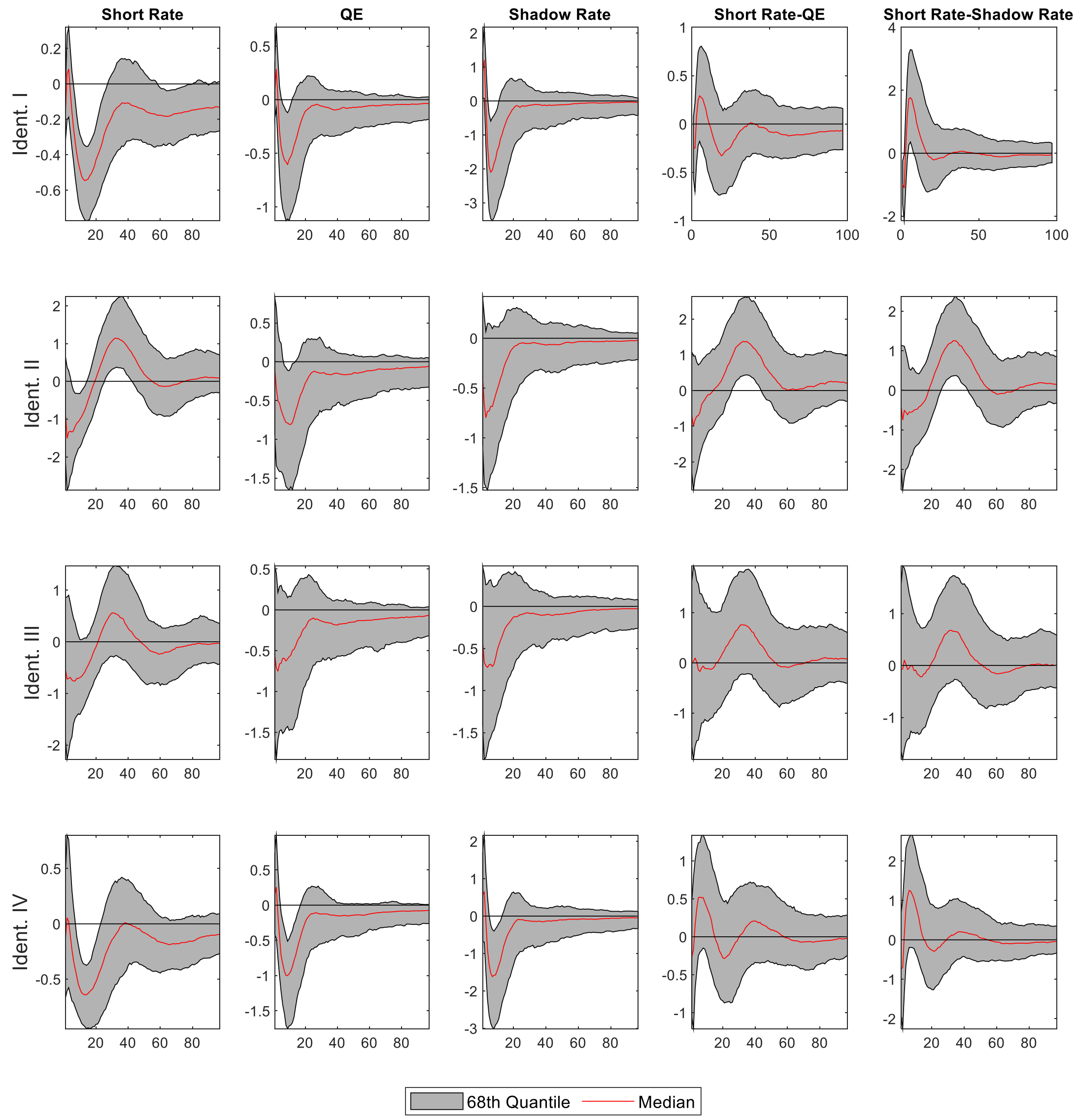
Note: This figure shows impulse responses of the EA House Price to Rent ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the House Price to Rents ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the House Price to Rent ratio impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the House Price to Rent ratio than conventional monetary policy.

Figure 10: Impulse response of the EMBIG Spread to various EA monetary policies



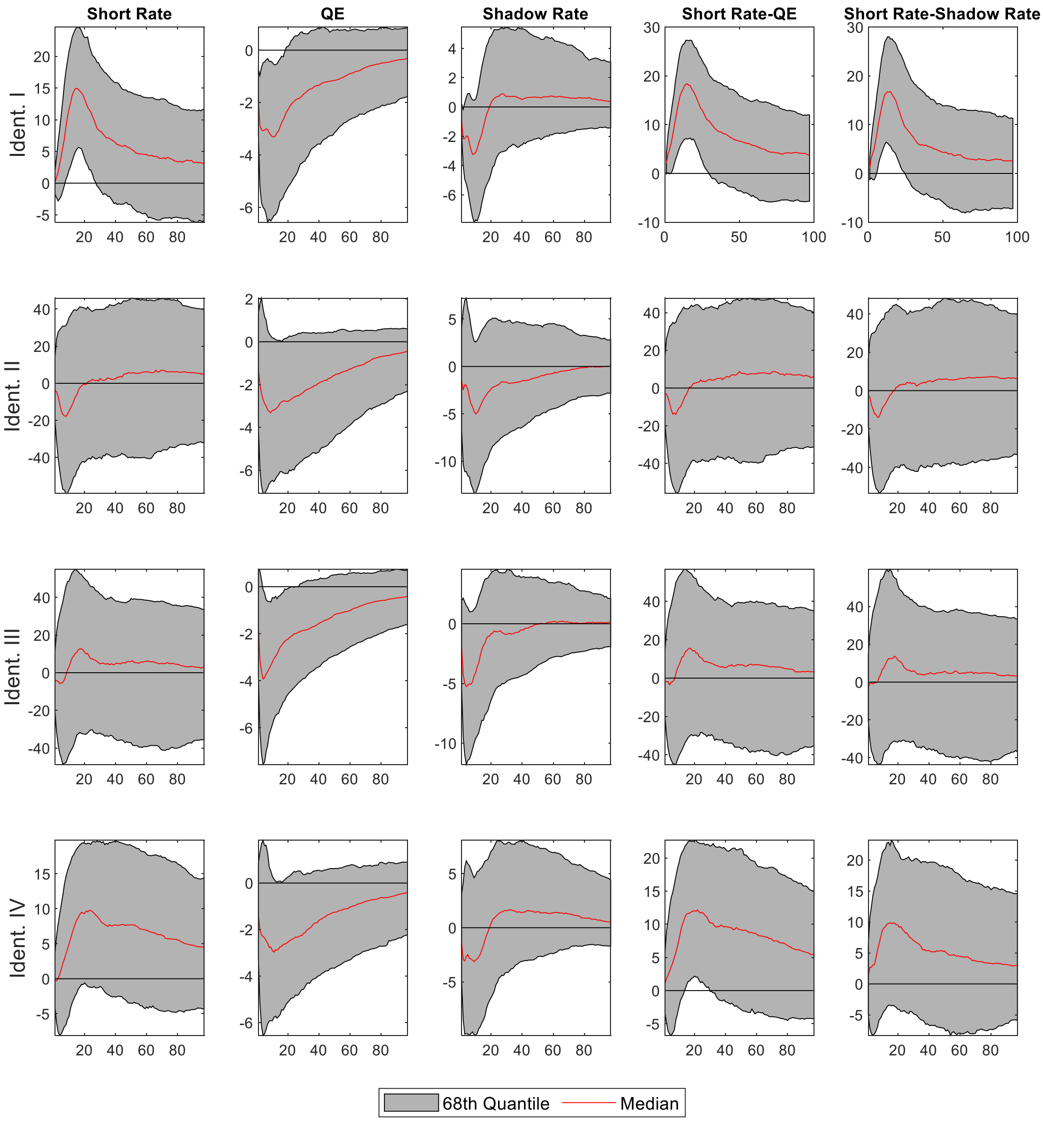
Note: This figure shows impulse responses of the EMBIG Spread to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the EMBIG Spread impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the EMBIG Spread impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the EMBIG Spread than conventional monetary policy.

Figure 11: Impulse response of the EM CORP Spread to various EA monetary policies



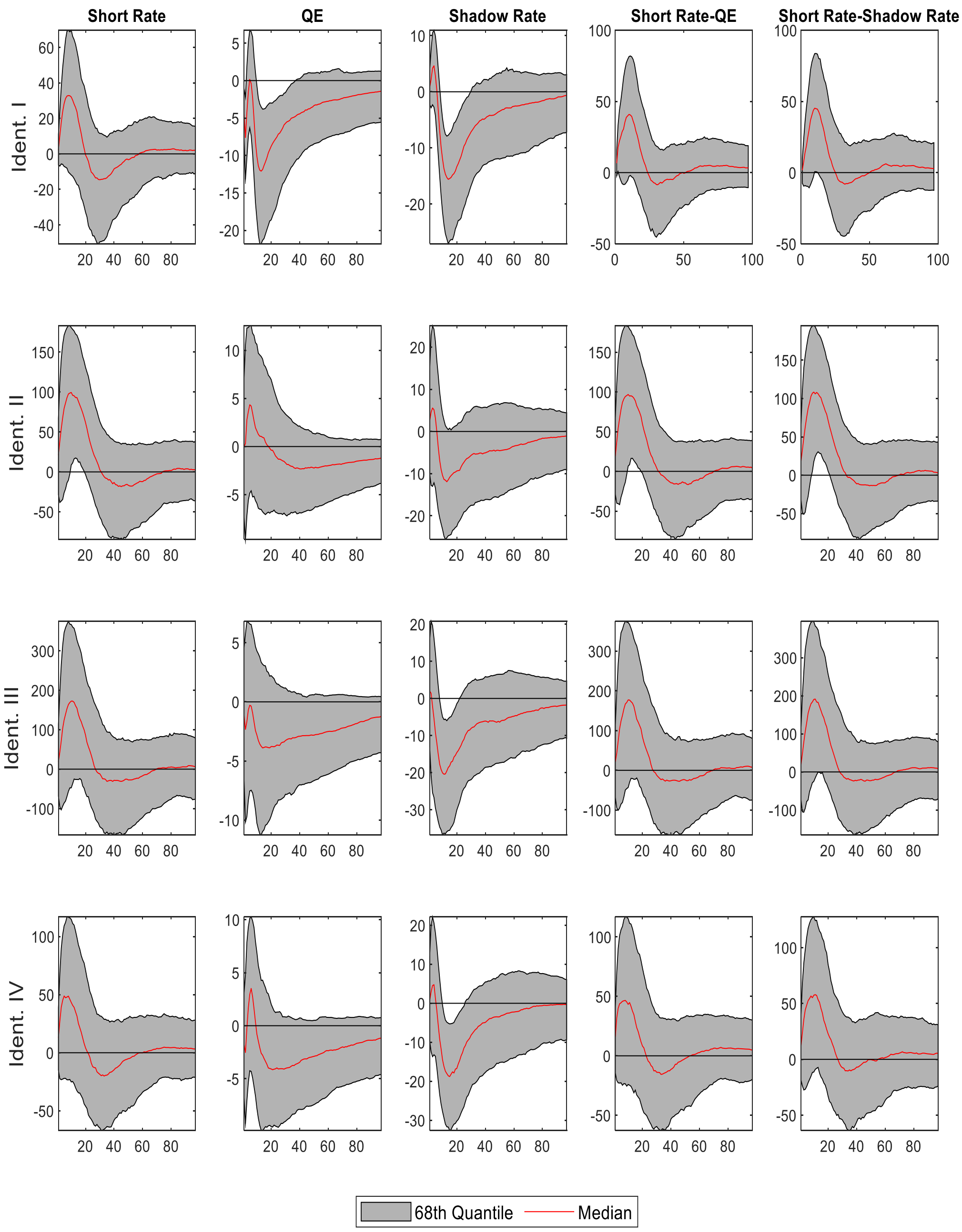
Note: This figure shows impulse responses of the ICE BOFA EM CORP Spread to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the ICE BOFA EM CORP Spread impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the ICE BOFA EM CORP Spread impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the ICE BOFA EM CORP Spread than conventional monetary policy.

Figure 12: Impulse response of the UK credit to households to GDP ratio to various monetary policies



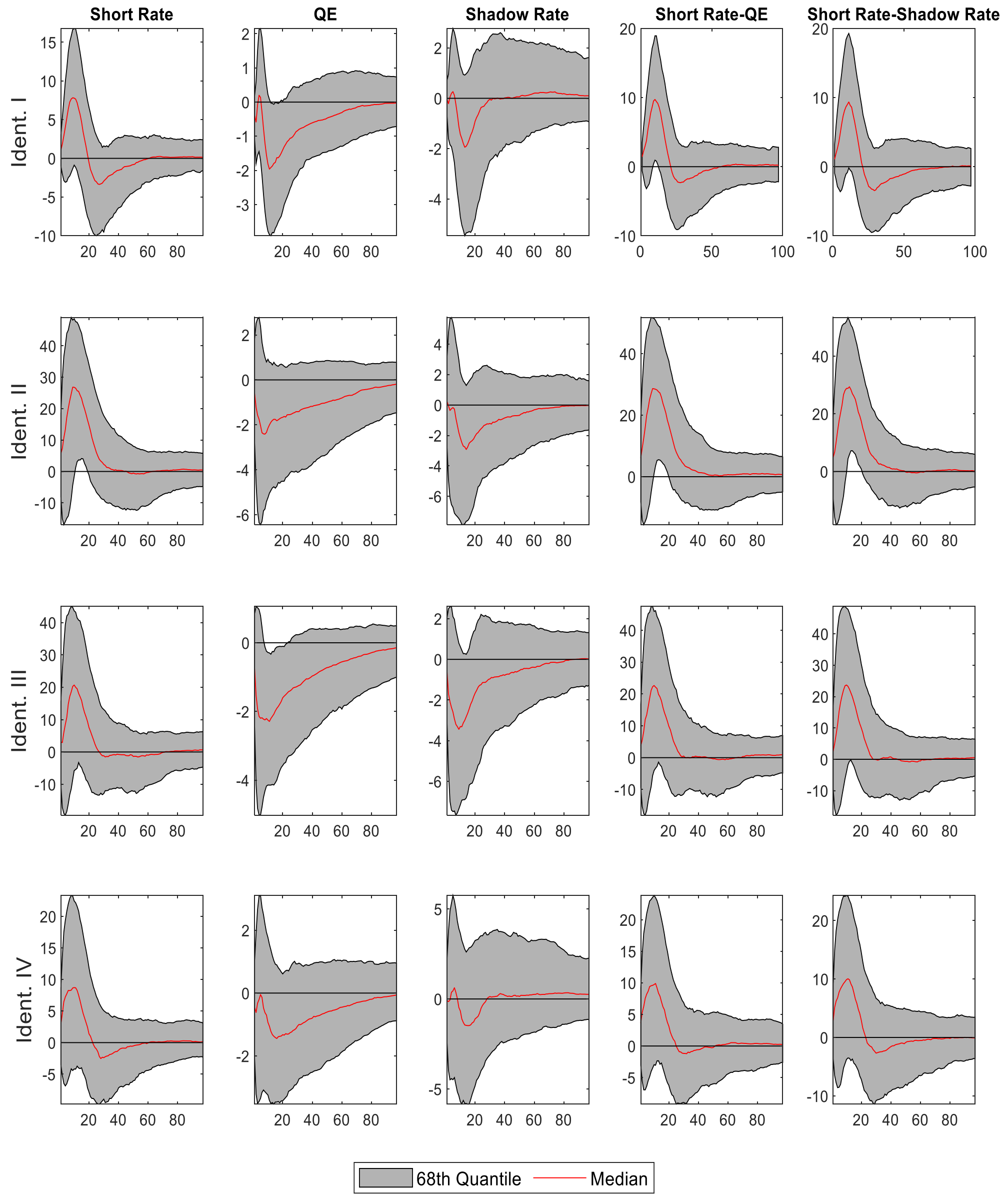
Note: This figure shows impulse responses of the UK's credit to households to GDP ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the credit to households to GDP ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the credit to households to GDP ratio impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 13: Impulse response of the UK credit to non-financial sector to GDP ratio to various monetary policies



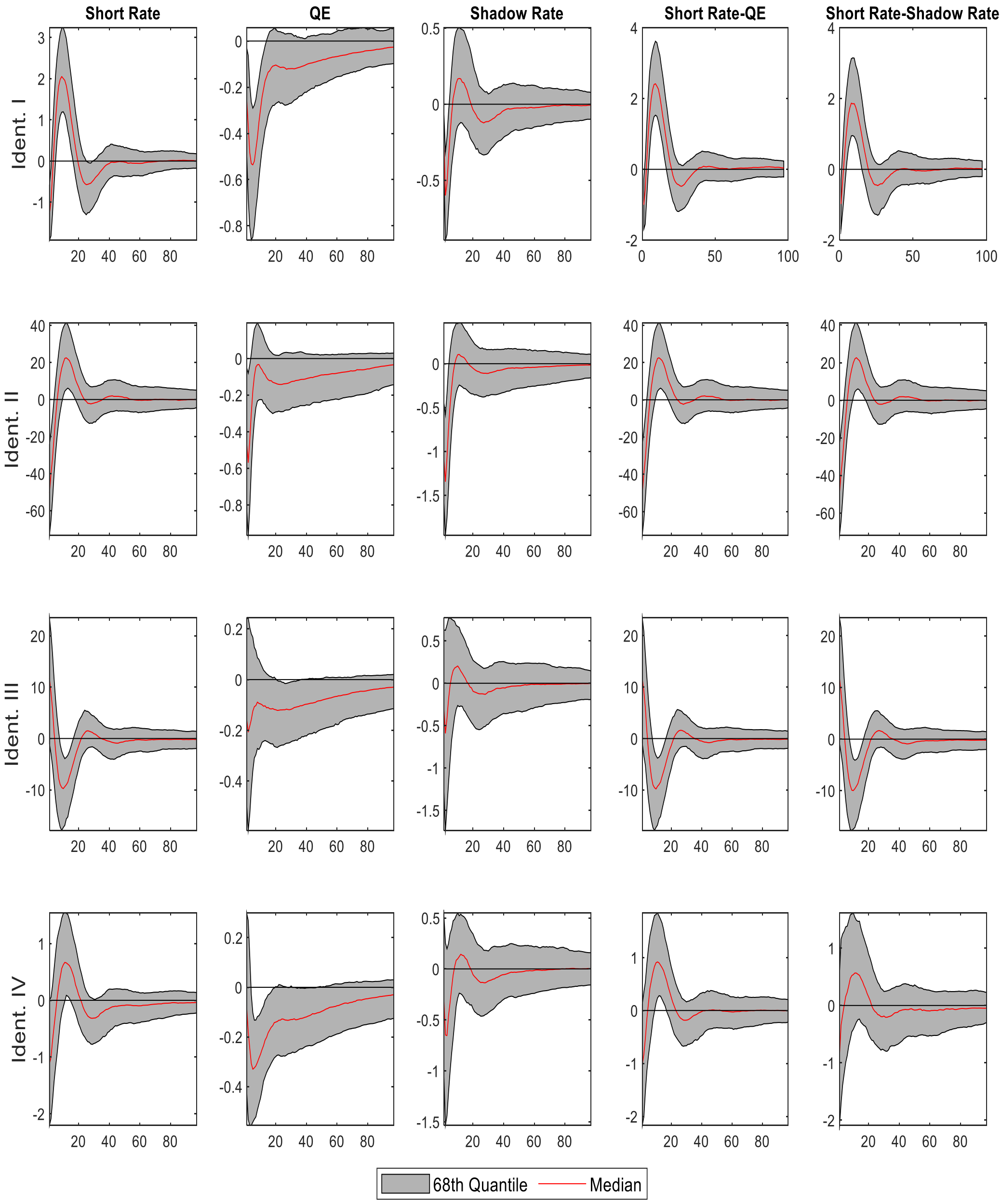
Note: This figure shows impulse responses of the UK's credit to non-financial sector to GDP ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the credit to non-financial sector to GDP ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the credit to non-financial sector to GDP ratio impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 14: Impulse response of the UK Credit to GDP Gap to various monetary policies



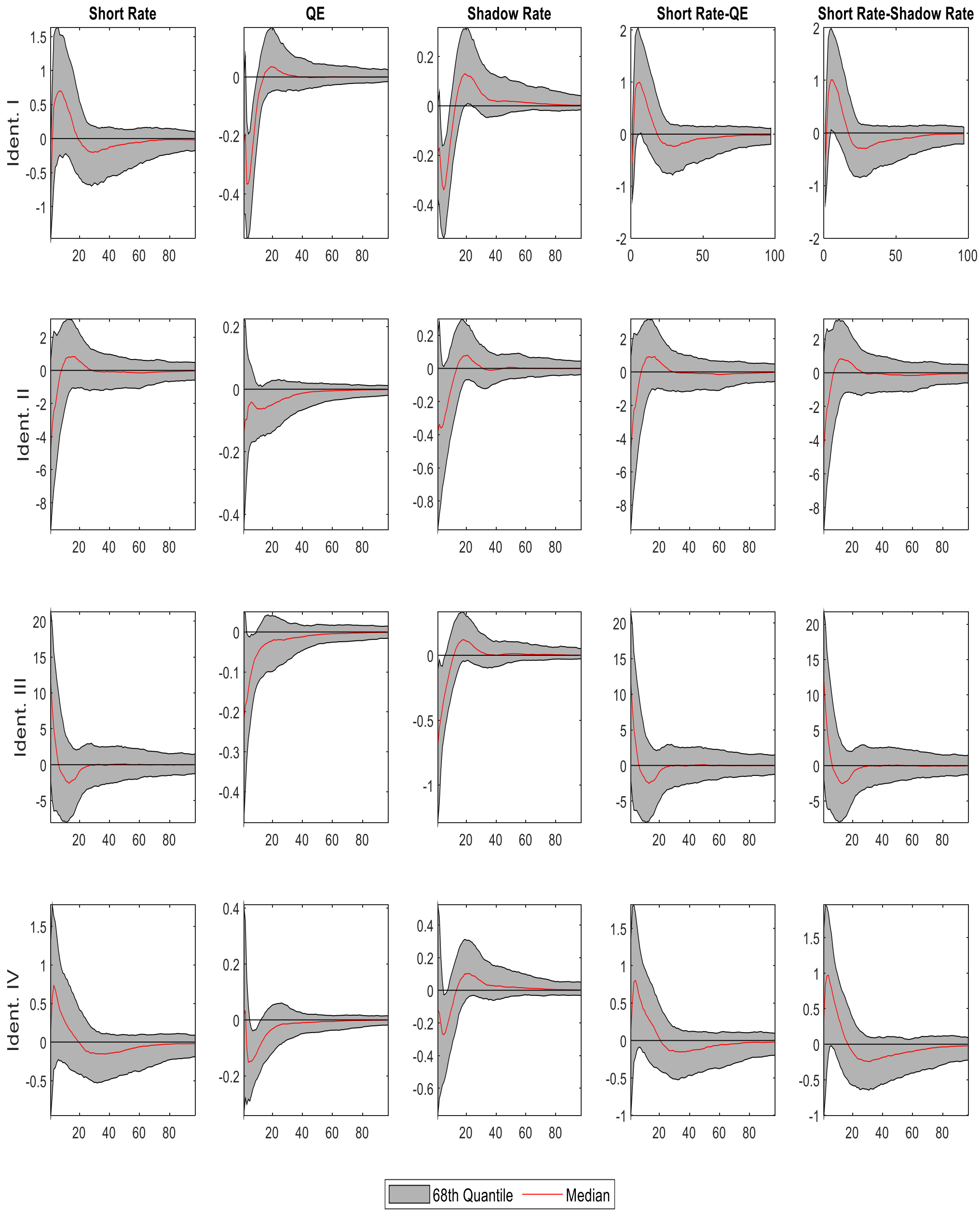
Note: This figure shows impulse responses of the UK Credit to GDP Gap to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the Credit to GDP gap impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the Credit to GDP Gap impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 15: Impulse response of the UK BAA spread to various monetary policies



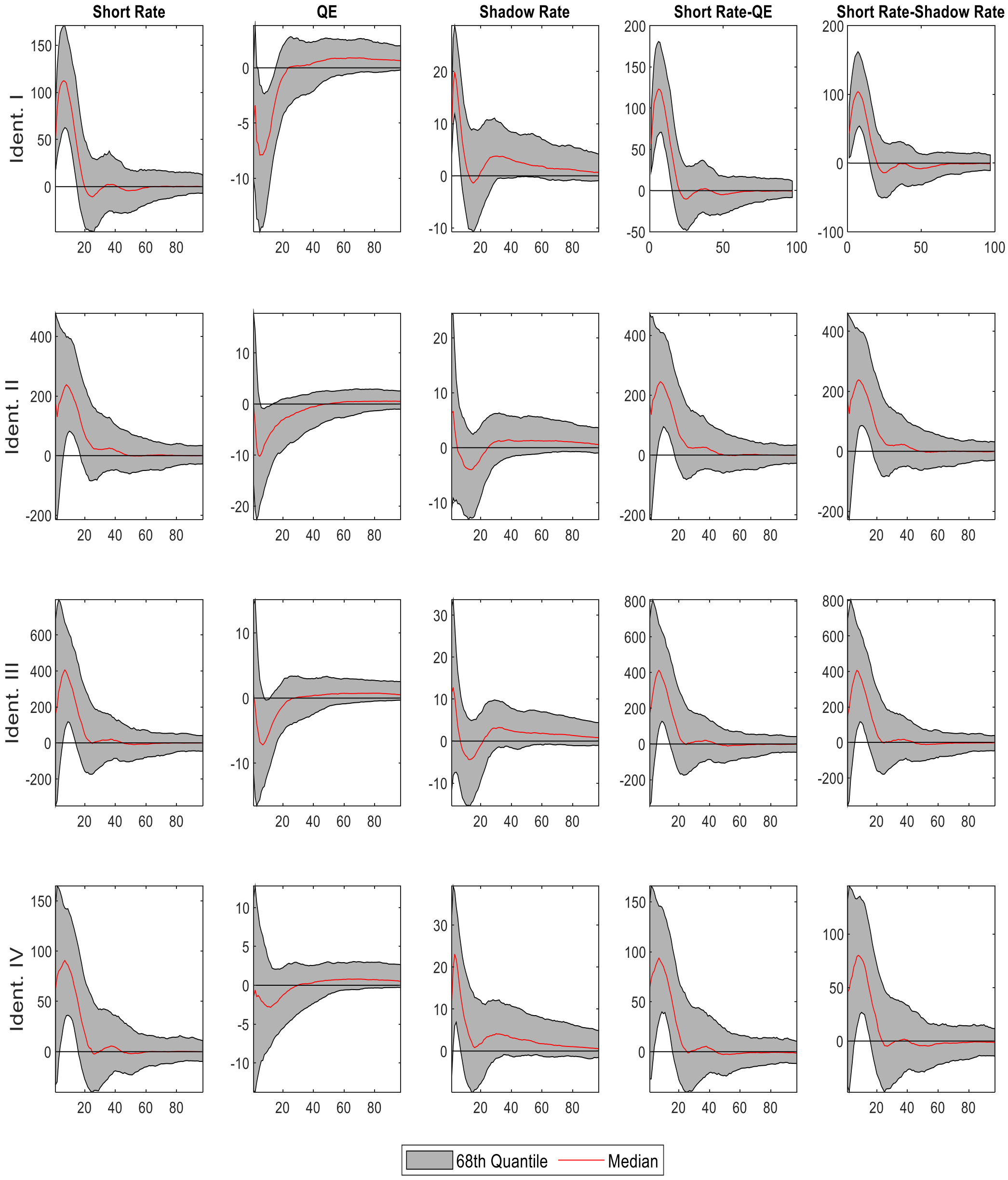
Note: This figure shows impulse responses of the UK BAA spread to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the BAA spread impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the BAA spread impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 16: Impulse response of the UK VIX to various monetary policies



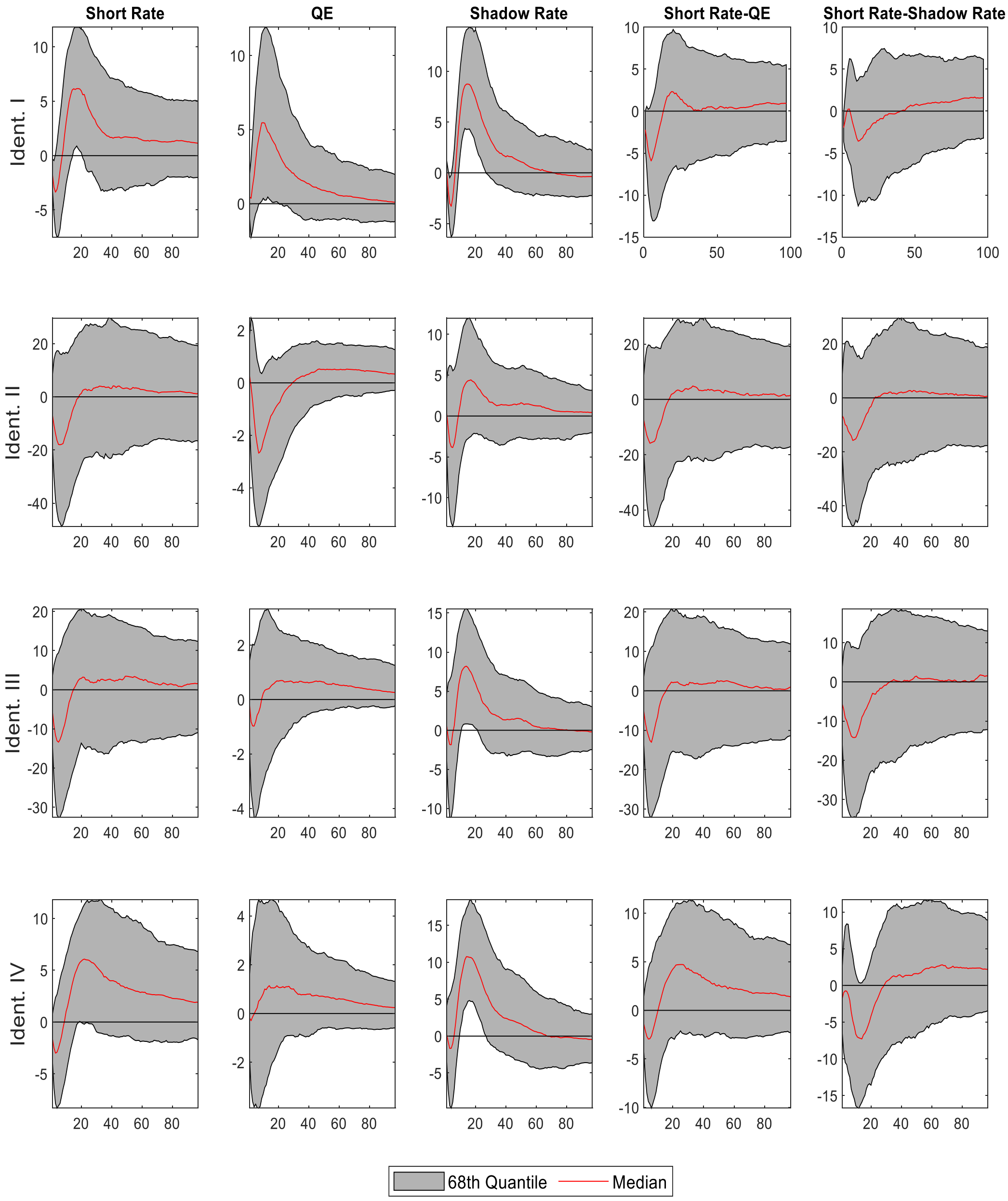
Note: This figure shows impulse responses of the UK VIX to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the VIX impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the VIX impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 17: Impulse response of the UK Price to Earnings Ratio to various monetary policies



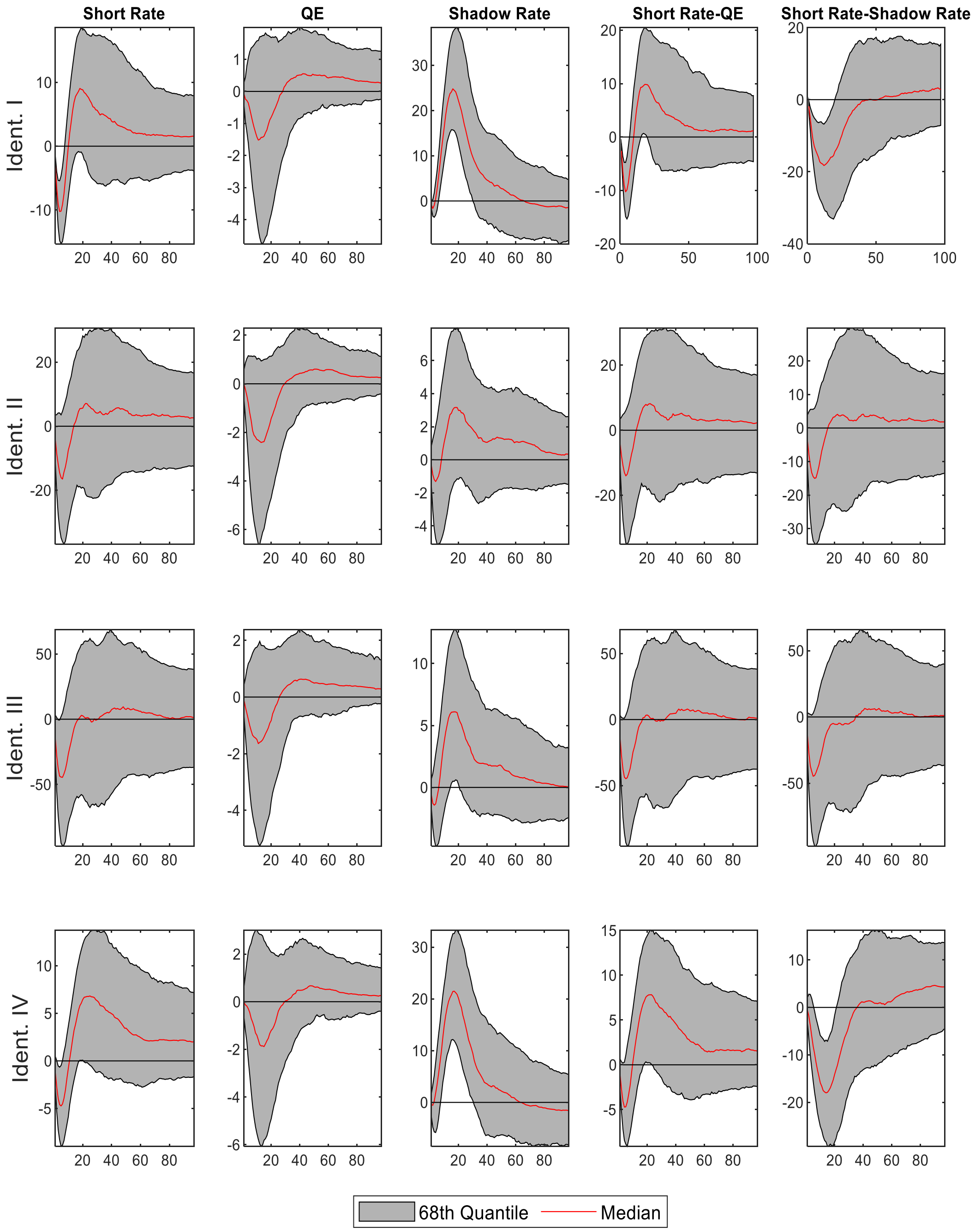
Note: This figure shows impulse responses of the UK's Share Price to Earnings ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the Share Price to Earnings ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the Share Price to Earnings ratio impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 18: Impulse response of the UK House Price to Income ratio to various monetary policies



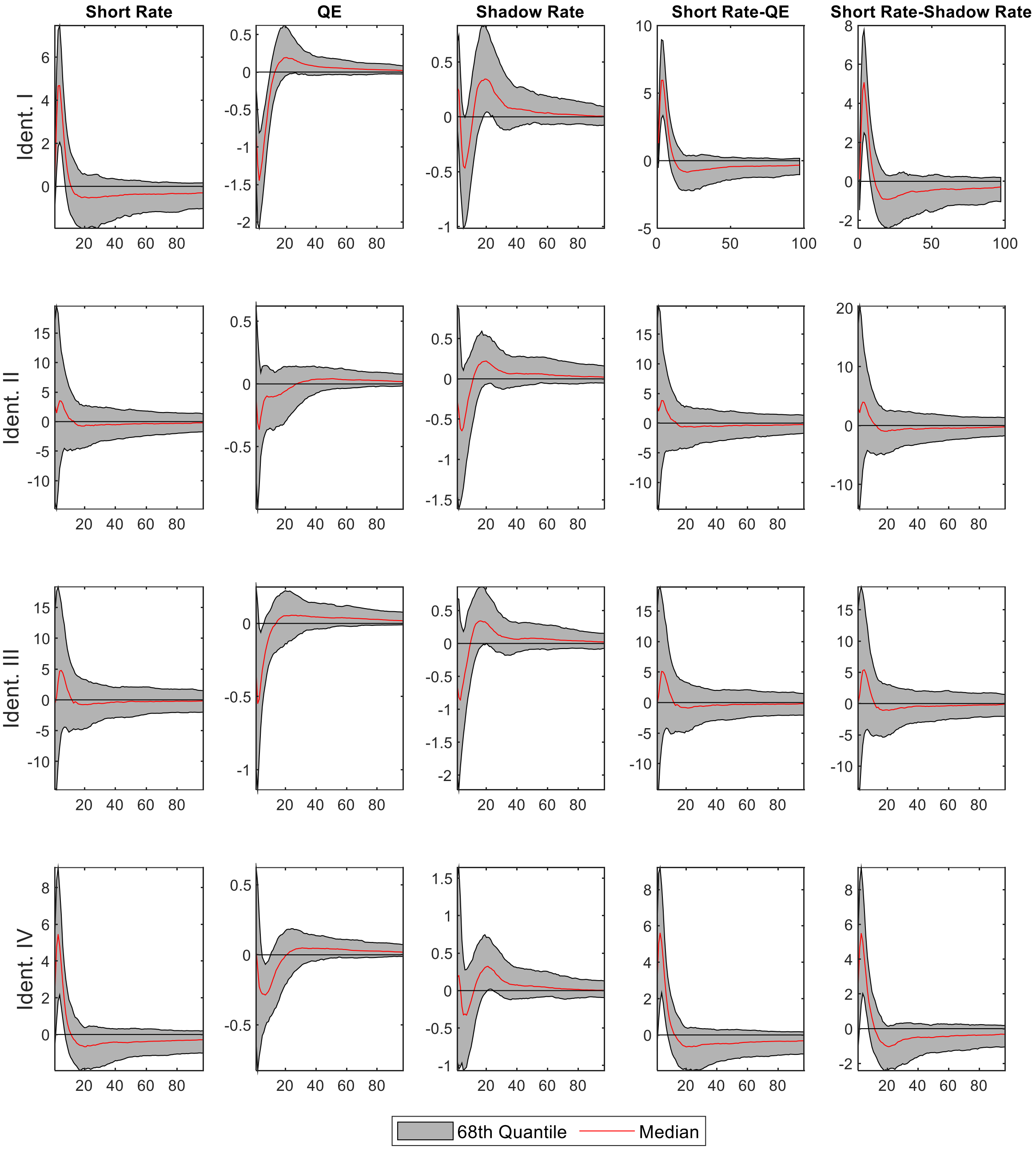
Note: This figure shows impulse responses of the UK's House Price to Income ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the House Price to Income ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the House Price to Income ratio impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the House Price to Income ratio than conventional monetary policy.

Figure 19: Impulse response of the UK House Price to Rent ratio to various monetary policies



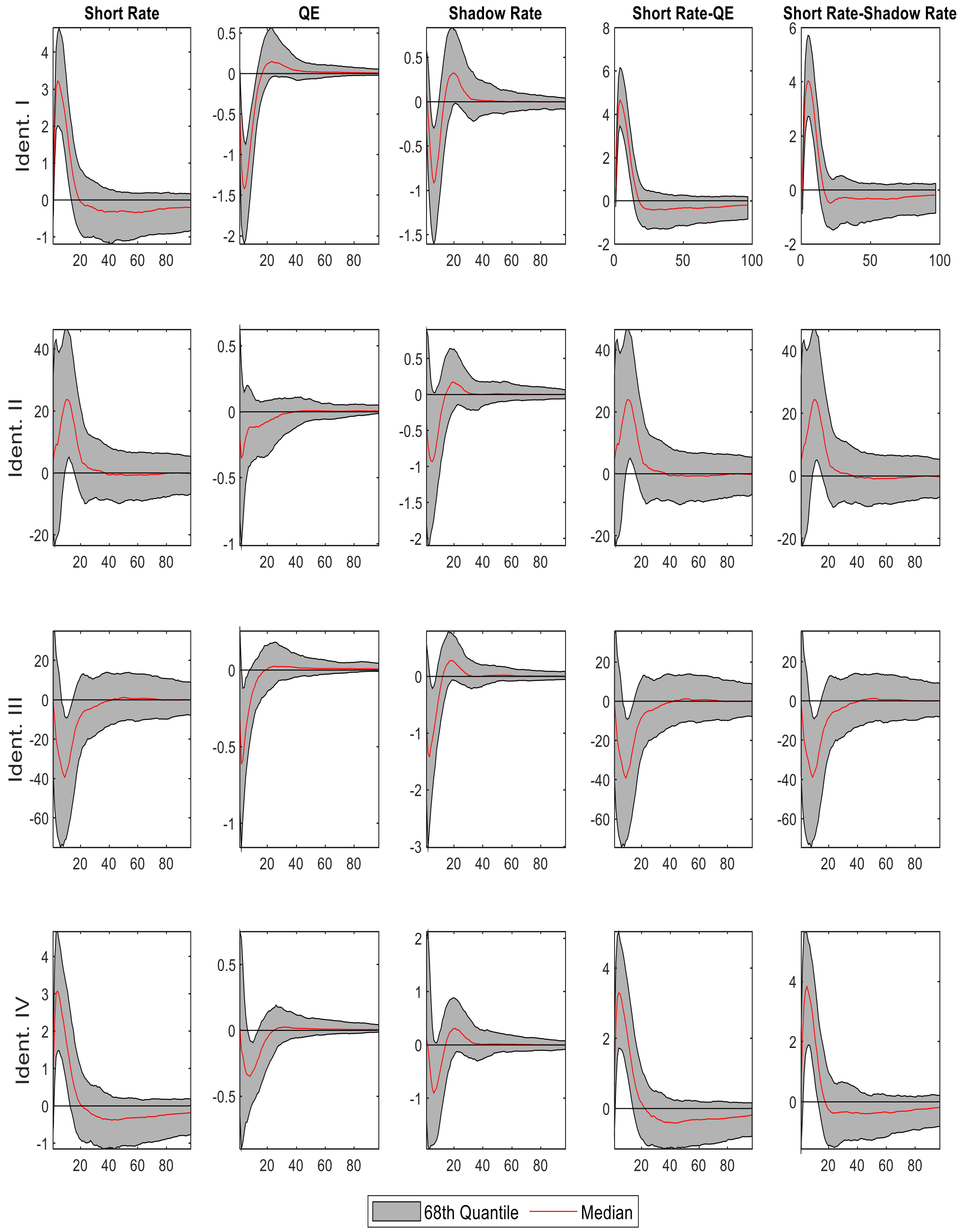
Note: This figure shows impulse responses of the UK's House Price to Rent ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the House Price to Rent ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the House Price to Rent ratio impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the House price to Rent ratio than conventional monetary policy.

Figure 20: Impulse response of the EMBIG Spread to various UK monetary policies



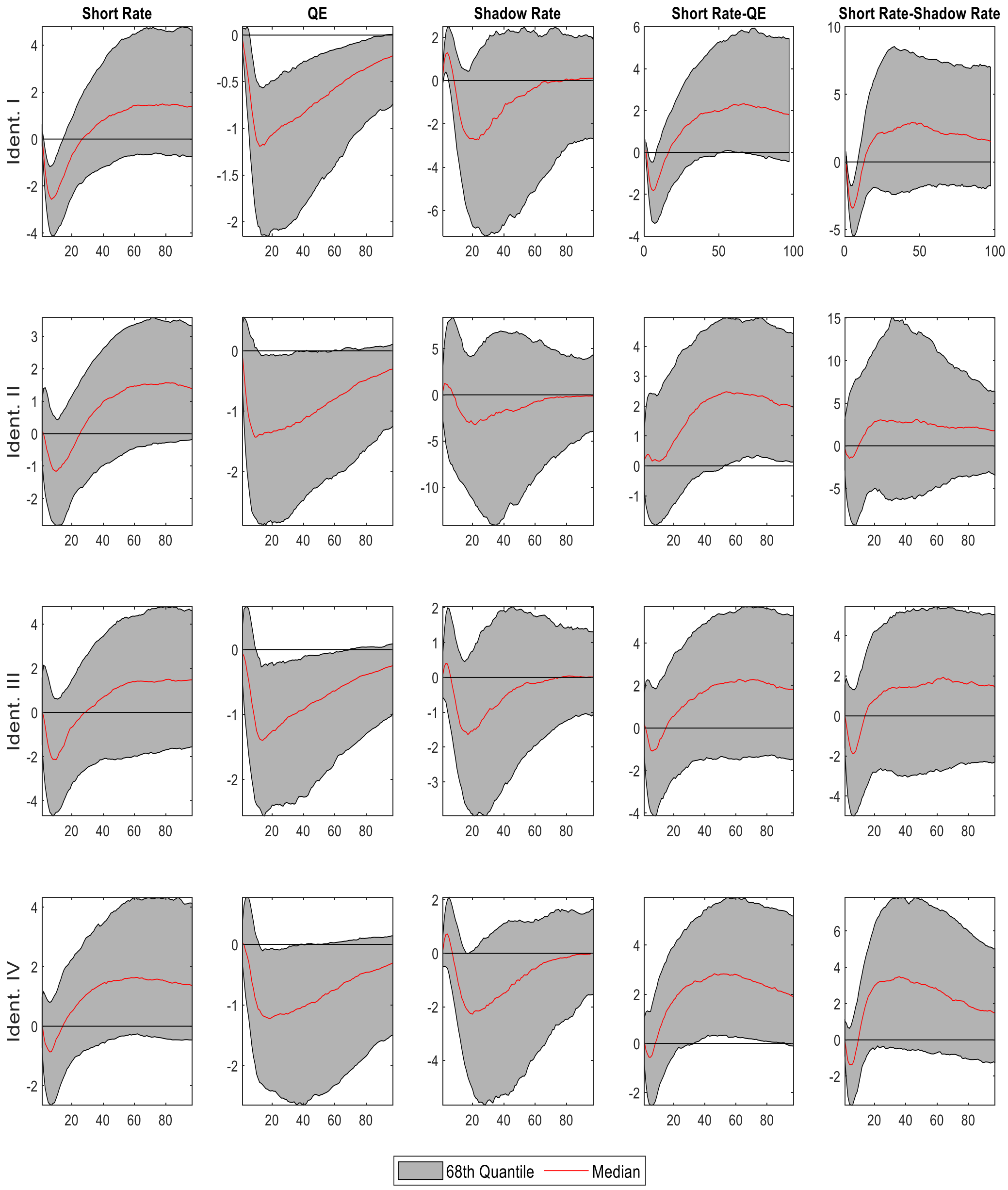
Note: This figure shows impulse responses of the EMBIG Spread to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the EMBIG Spread impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the EMBIG Spread impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the EMBIG Spread than conventional monetary policy.

Figure 21: Impulse response of EM CORP Spread to various UK monetary policies



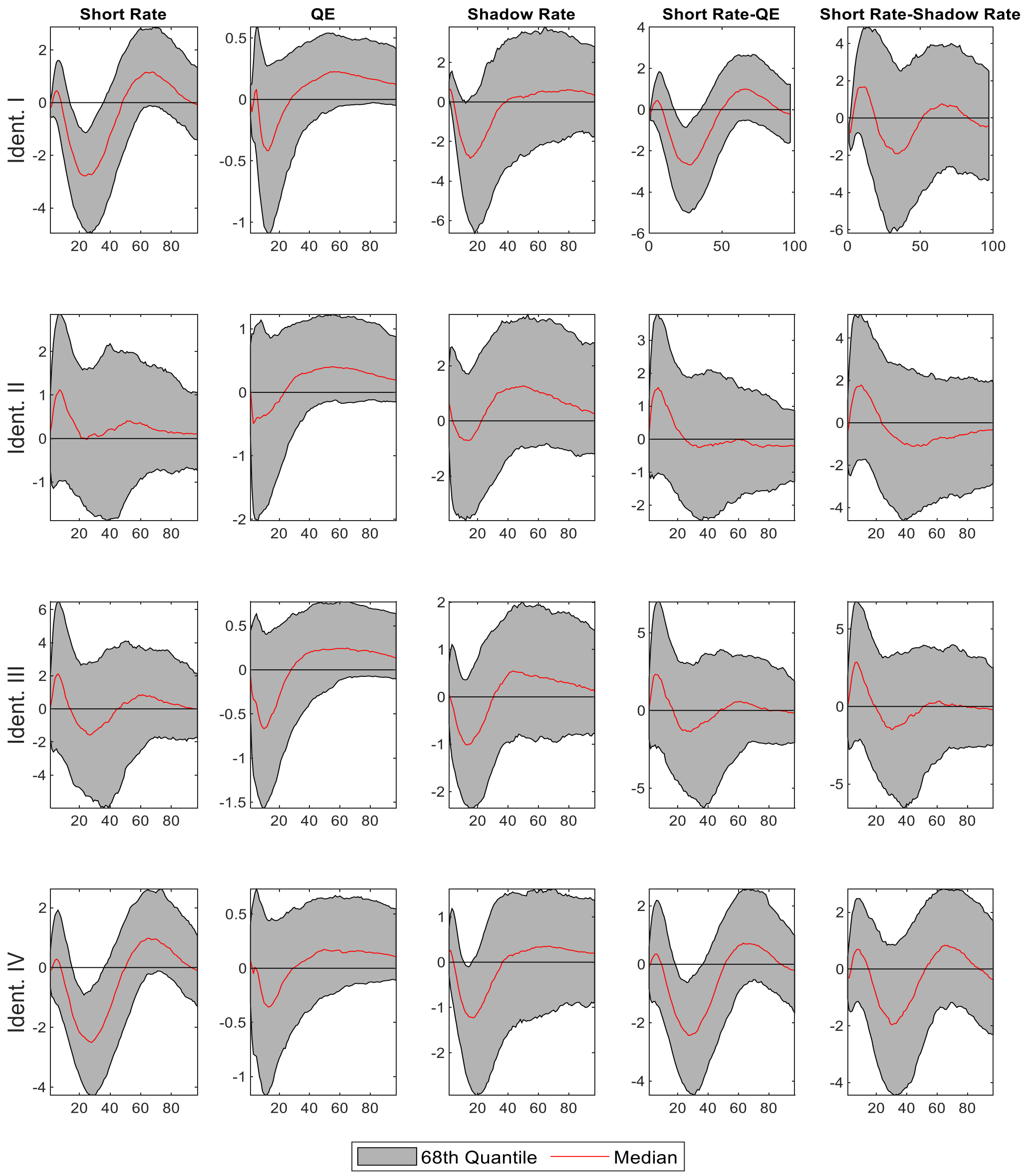
Note: This figure shows impulse responses of the ICE BOFA EM CORP Spread to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the ICE BOFA EM CORP Spread impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the ICE BOFA EM CORP Spread impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the ICE BOFA EM CORP Spread than conventional monetary policy.

Figure 22: Impulse response of the US private credit to household to GDP ratio to various monetary policies



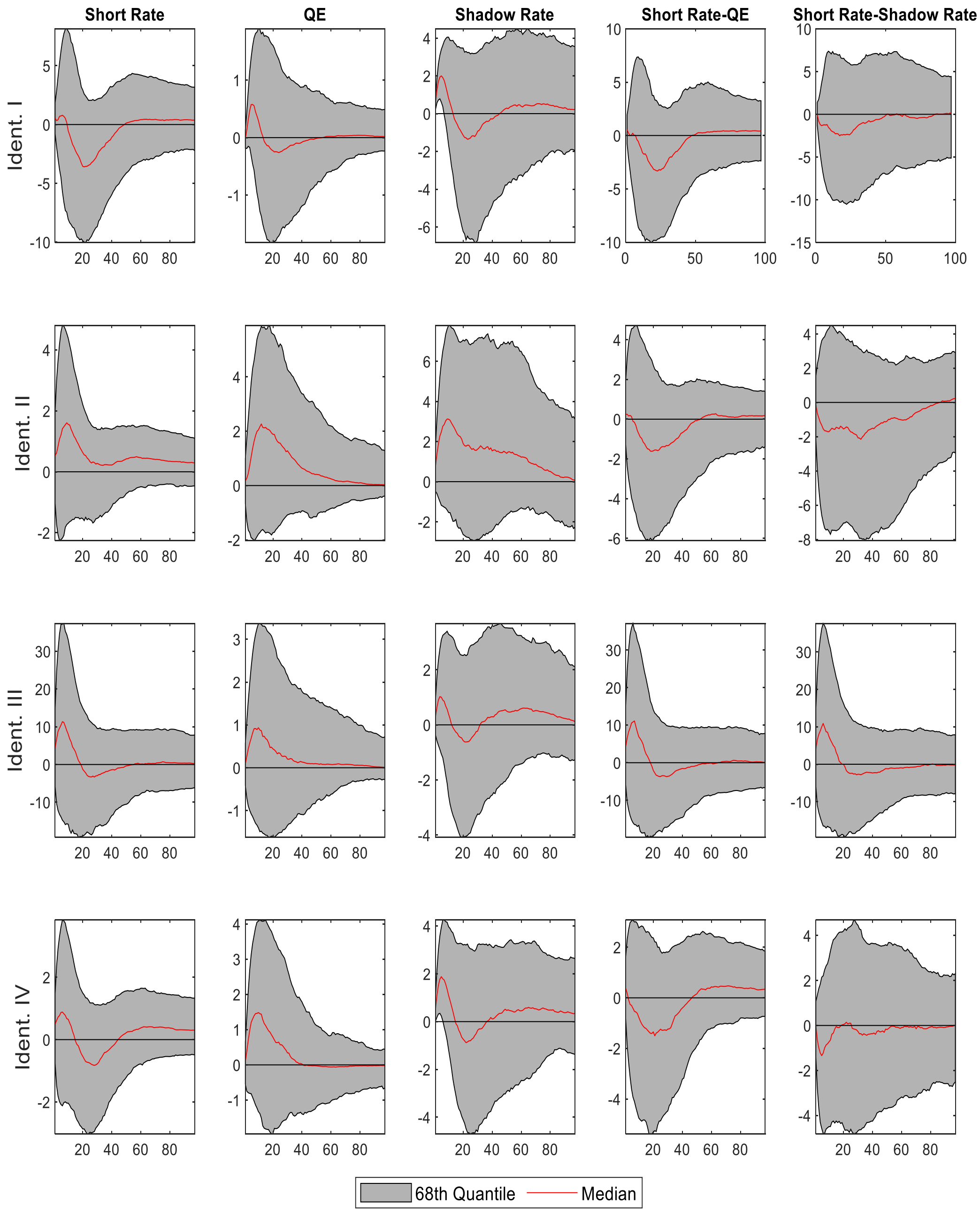
Note: This figure shows impulse responses of the US private credit to household to GDP ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the private credit to household to GDP ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the private credit to household to GDP ratio impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 23: Impulse response of the US private credit to PNFC to GDP ratio to various monetary policies



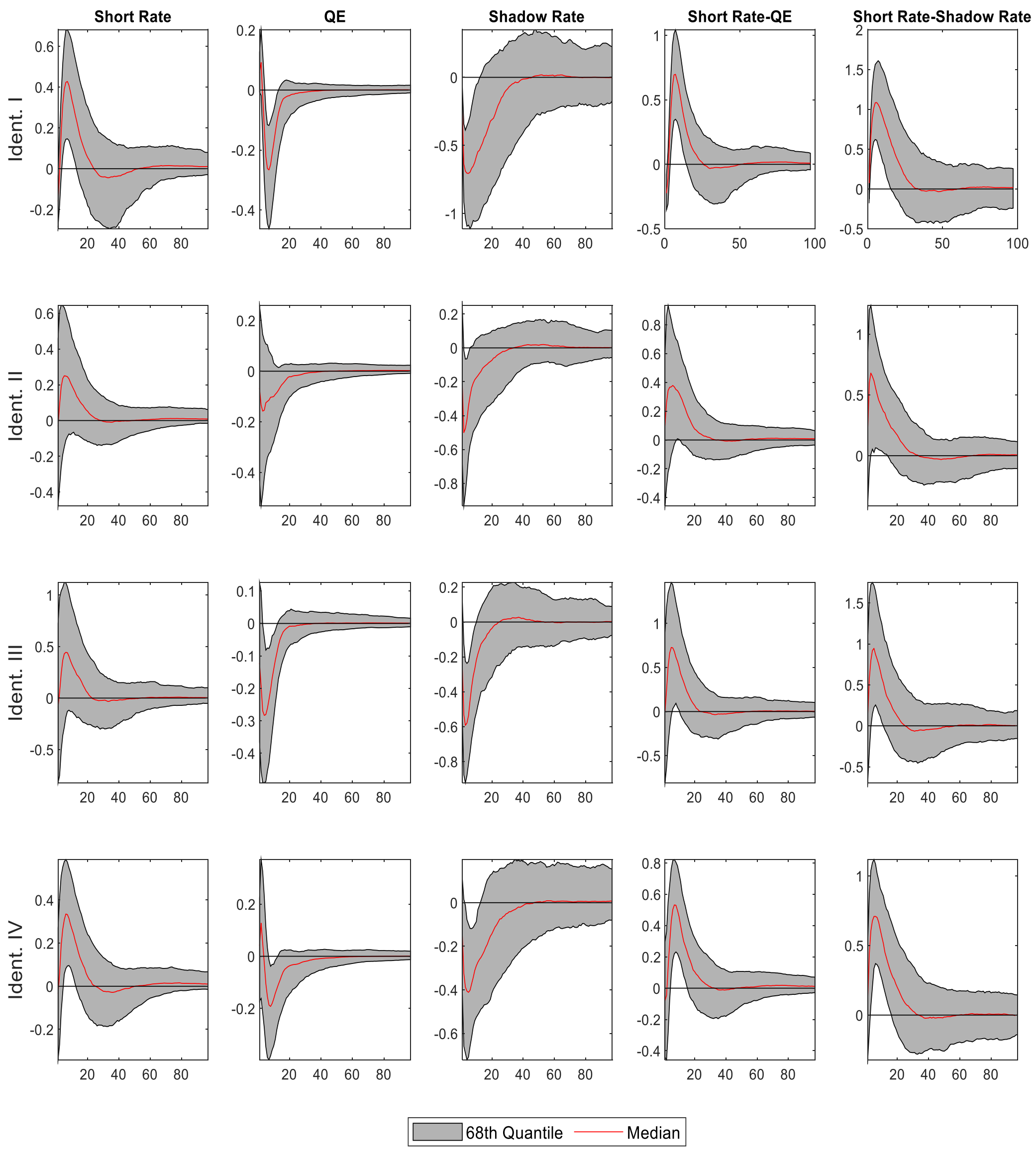
Note: This figure shows impulse responses of the US's private credit to PNFC to GDP ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the private credit to PNFC to GDP ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the private credit to PNFC to GDP ratio impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 24: Impulse response of the US private Credit to GDP gap to various monetary policies



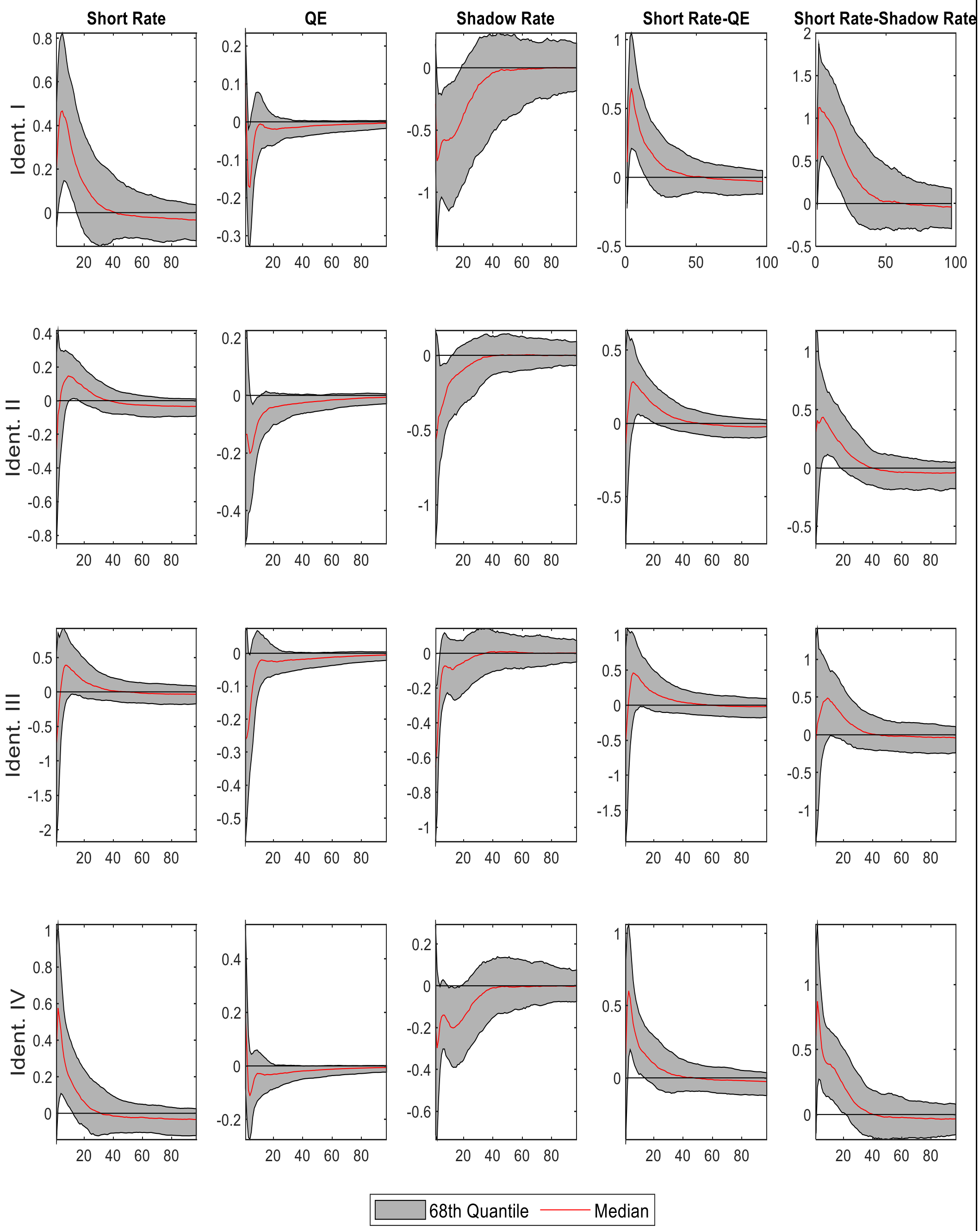
Note: This figure shows impulse responses of the US's private Credit to GDP gap to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the private Credit to GDP gap impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the private Credit to GDP gap impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 25: Impulse response of the US BAA spread to various monetary policies



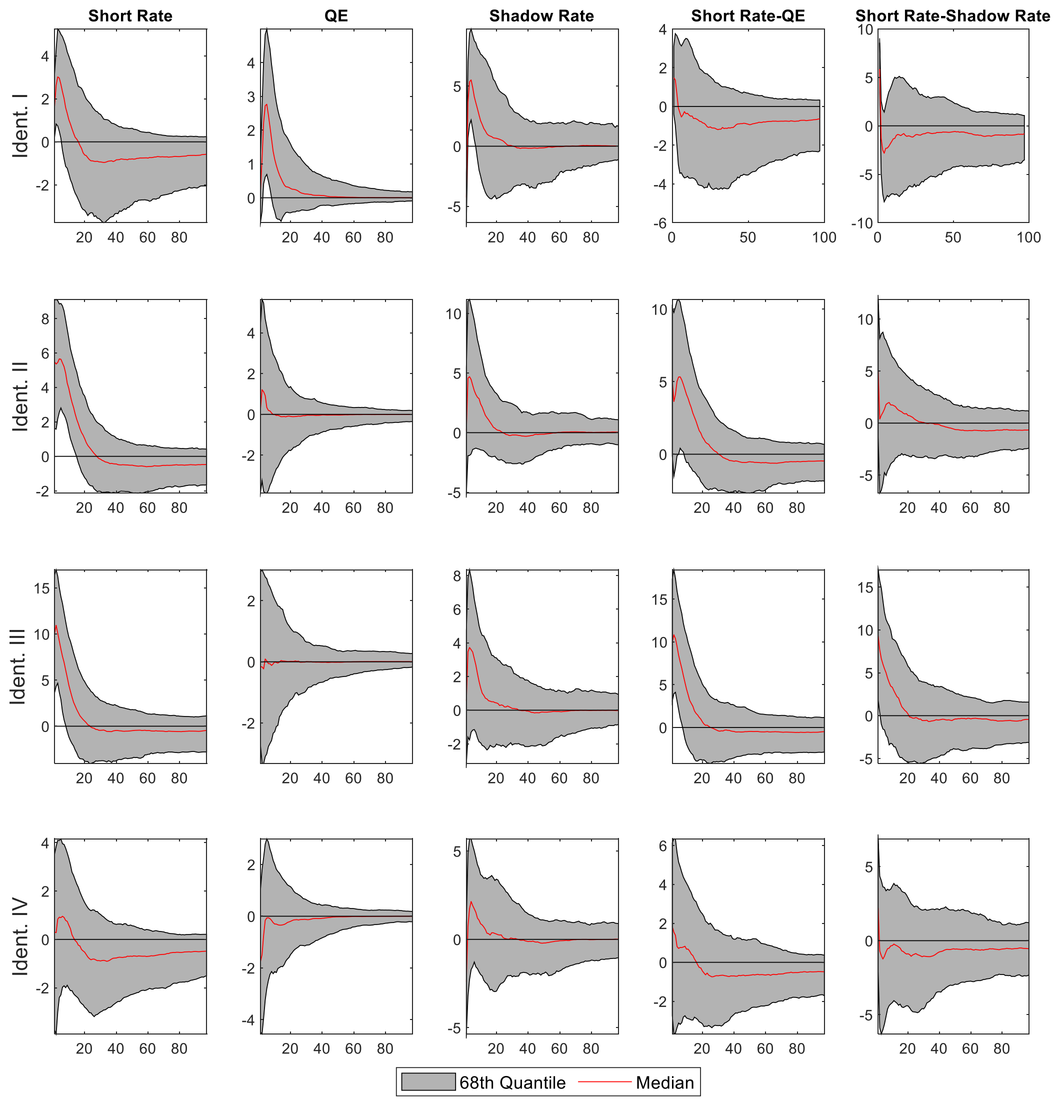
Note: This figure shows impulse responses of the US BAA Spread to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the BAA spread impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the BAA spread impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 26: Impulse response of the US VIX to various monetary policies



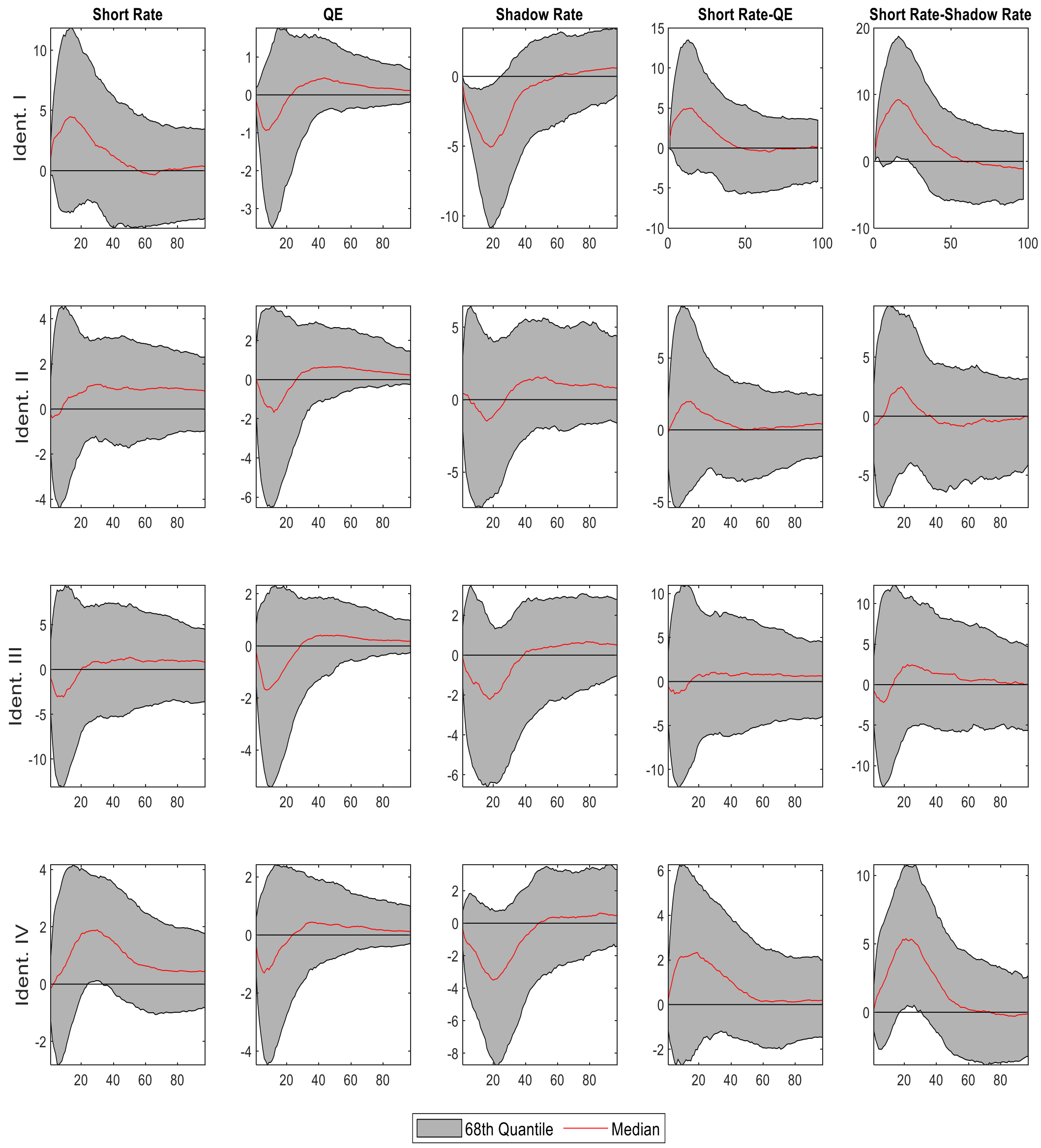
Note: This figure shows impulse responses of the US VIX to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the VIX impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the VIX impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 27: Impulse response of the US Price to Earnings Ratio to various monetary policies



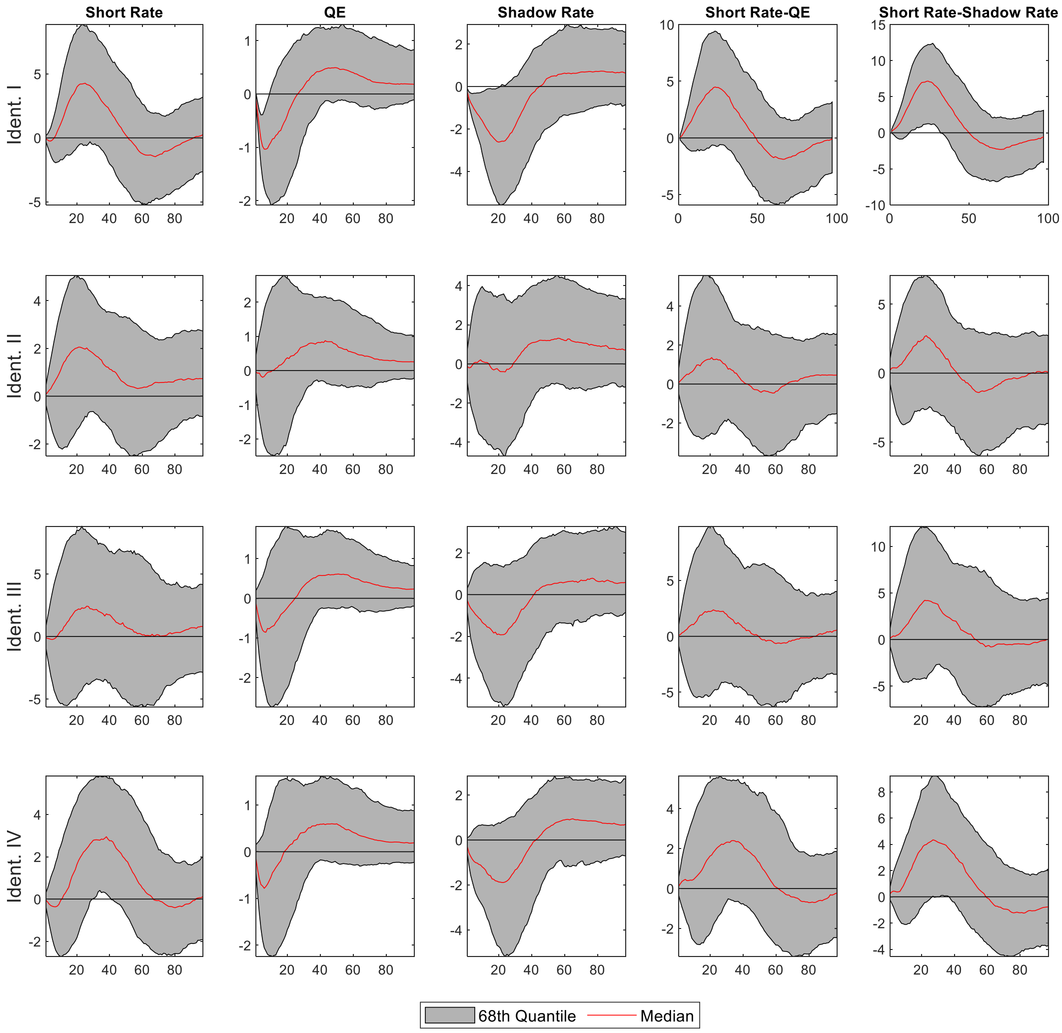
Note: This figure shows impulse responses of the US's Share Price to Earnings ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the Share Price to Earnings ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the Share Price to Earnings ratio impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the price to earnings ratio than conventional monetary policy.

Figure 28: Impulse response of the US House Price to Income ratio to various monetary policies



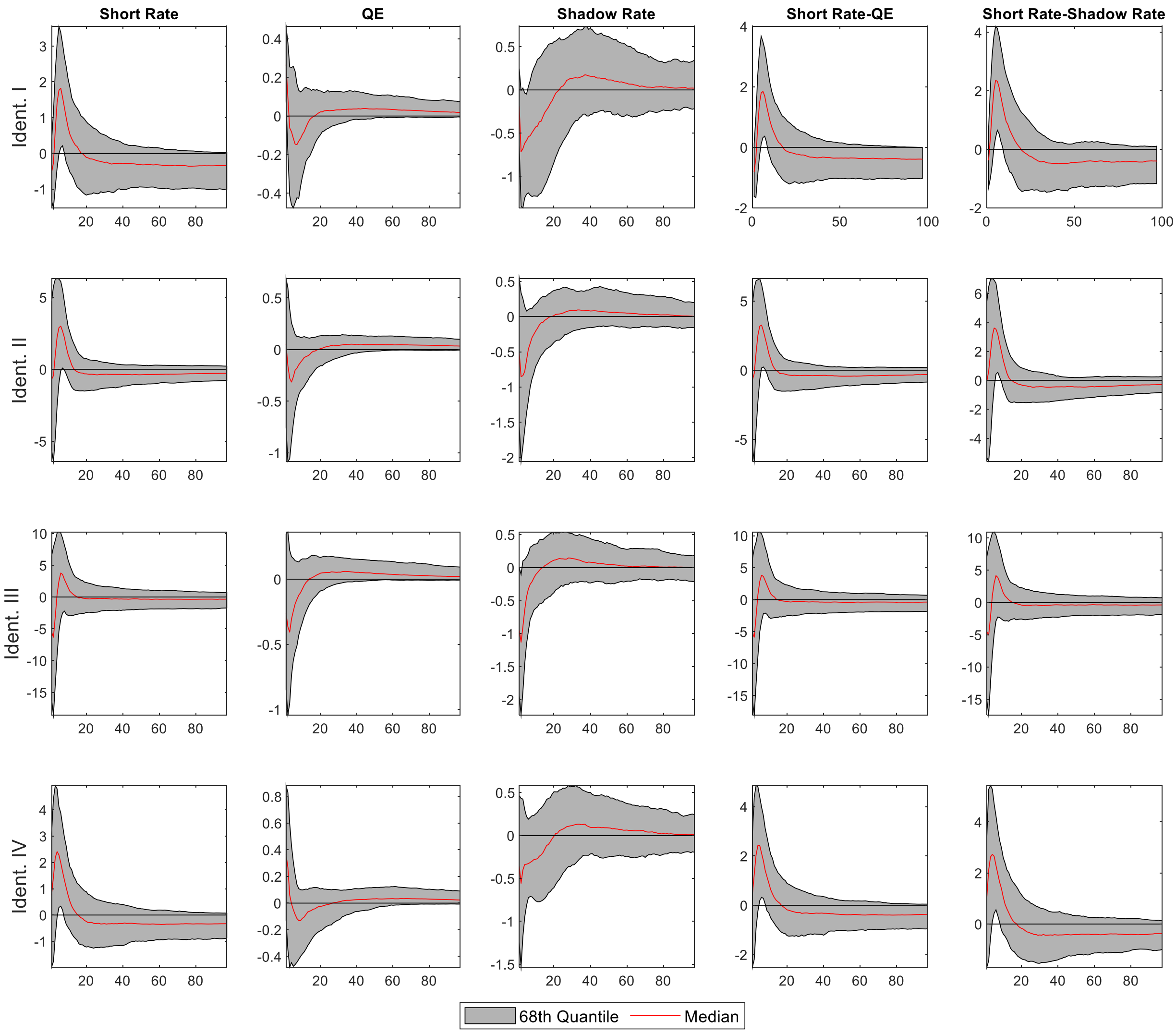
Note: This figure shows impulse responses of the US's House Price to Income ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the House Price to Income ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the House Price to Income ratio impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the House Price to Income ratio than conventional monetary policy.

Figure 29: Impulse response of the US House Price to Rent ratio to various monetary policies



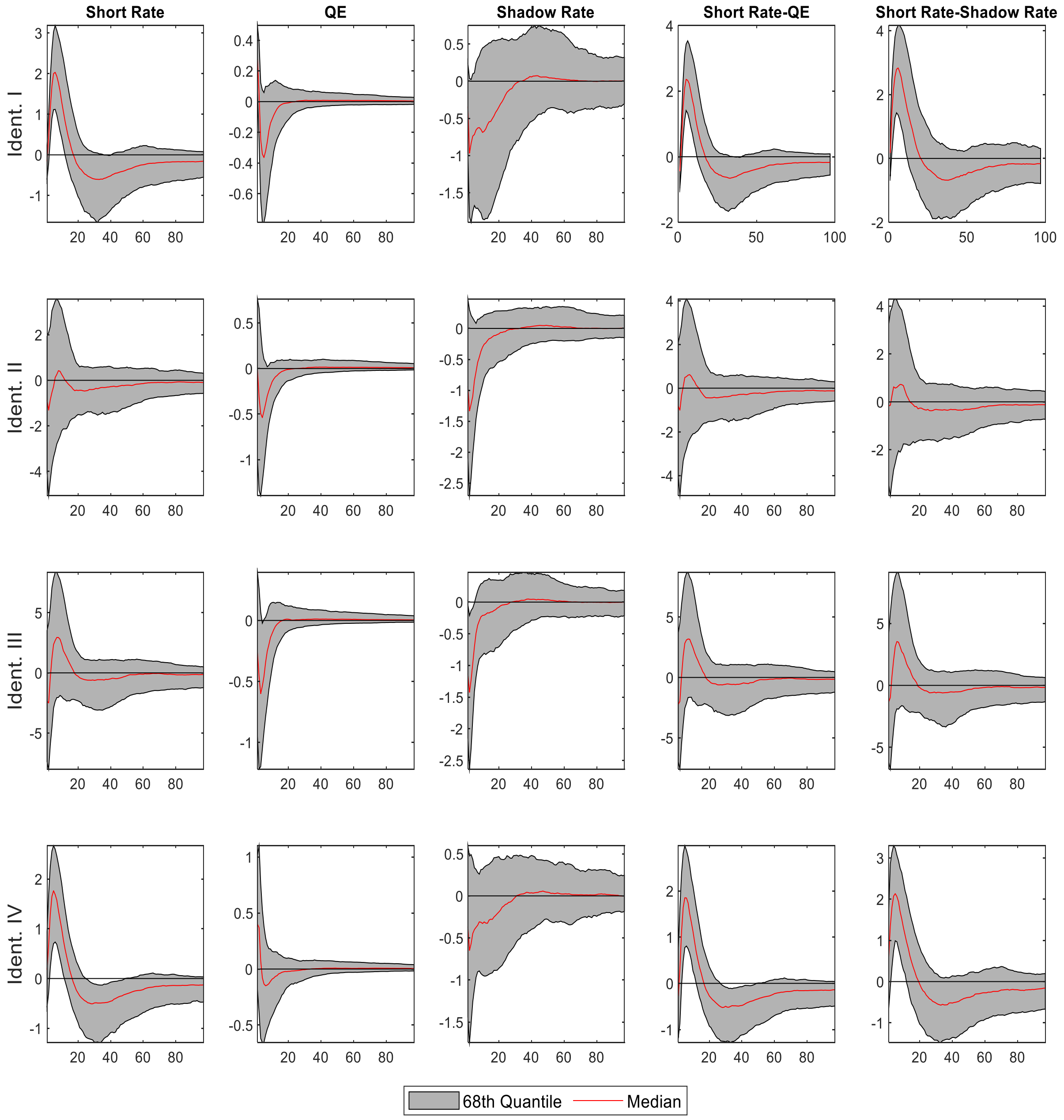
Note: This figure shows impulse responses of the US's House Price to Rent ratio to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the House Price to Rents ratio impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M7 1997 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the House Price to Rent ratio impulse response to a shock to the asset purchase announcement, estimated on data from M3 2009 to M5 2014, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the House Price to Rent ratio than conventional monetary policy.

Figure 30: Impulse response of the EMBIG Spread to various US monetary policies



Note: This figure shows impulse responses of the EMBIG Spread to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the EMBIG Spread impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the EMBIG Spread impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the EMBIG Spread than conventional monetary policy.

Figure 31: Impulse response of the ICE BOFA EM CORP Spread to various US monetary policies



Note: This figure shows impulse responses of the ICE BOFA EM CORP Spread to different monetary policies. To ensure that impulse responses are comparable across policies, all of them are standardised by the CPI inflation response. In other words, the impulse response shown is due to 1% rise in CPI inflation associated with a given monetary policy shock. The different rows indicate the four different identification schemes, all of which leave output and prices unrestricted. Column one, labelled 'Short Rate', shows the ICE BOFA EM CORP Spread impulse response to a shock to the short rate, the conventional monetary policy instrument, estimated on data from M1 1999 to M6 2007, with a BVAR with normal inverse-wishart prior. The second column, labelled 'QE' shows the ICE BOFA EM CORP Spread impulse response to a shock to the asset purchase announcement, estimated on data from M1 2015 to M2 2020, with a BVAR with normal inverse-wishart prior. The third column is almost identical to the second, other than we now use the shadow short rate as the unconventional monetary policy instrument. Columns four and five shows the impulses responses based on the differences in distribution between short rate and QE and short rate and the shadow rate, to examine if, for the same size inflation reaction, unconventional monetary policy has a larger impact on the ICE BOFA EM CORP Spread than conventional monetary policy.