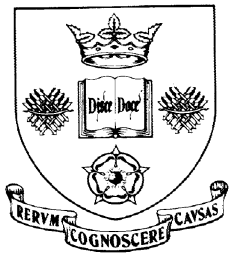
Monograph:
Caglayan, Mustafa, Mouratidis, Kostas and Saeidinezhad, Elham (2011) Monetary policy effects on output and exchange rates: Results from US, UK and Japan. Working Paper. Department of Economics, University of Sheffield ISSN 1749-8368

Sheffield Economic Research Paper Series 2011016

Sheffield Economic Research Paper Series

SERP Number: 2011016

ISSN 1749-8368



Mustafa Caglayan, Kostas Mouratidis and Elham Saeidinezhad

Monetary policy effects on output and exchange rates: Results from US, UK and Japan

June 2011

Department of Economics
University of Sheffield
9 Mappin Street
Sheffield
S1 4DT
United Kingdom
www.shef.ac.uk/economics

Monetary Policy Effects on Output and Exchange rates: Results from US, UK and Japan*

Mustafa Caglayan†
Department of Economics, University of Sheffield, UK
Kostas Mouratidis
Department of Economics, University of Sheffield, UK
Elham Saeidinezhad
Department of Economics, University of Sheffield, UK

May 21, 2011

Abstract

We investigate the effects of "contractionary" monetary shocks by imposing sign restrictions on the impulse responses of macroeconomic variables up to six months while allowing industrial production and exchange rate to be completely determined by the data. We show that i) the effect of an adverse monetary policy shock on industrial production is ambiguous; ii) there is price puzzle for Japan and UK which we conjecture as an outcome of excessive bank lending and poor regulation but not of passive monetary policy; iii) there is delayed overshooting puzzle for Japan and the exchange rate puzzle for the UK and the US.
JEL: C3, E1, E3
Key words: monetary shocks, business cycles, exchange rate puzzle, price puzzle, vector autoregression

*We would like to thank Phillip Arestis and Alessandro Flamini for their comments on earlier drafts of this paper.
†Corresponding author; University of Sheffield, Department of Economics, 9 Mappin Street, Sheffield, S1 4DT, UK. e-mail: mcaglayan@sheffield.ac.uk, Tel: 0114 22 23320

1 Introduction

The fundamental theoretical and empirical question in monetary economics centers on understanding whether money and monetary policy have any impact on real economic activity. To that end monetary economists have been particularly interested in investigating the validity of the benchmark theories focusing on the impact of monetary policy shocks that lead to economic fluctuations. In their analysis, they often resort to using a vector autoregressive (VAR) framework, developed by Sims (1980), to describe and understand the behavior of prices, monetary aggregates, interest rates and output, as well as to conduct policy experiments.

The popularity of VAR approach can be attributable to the fact that these models validate dynamic stochastic general equilibrium (DSGE) models under certain sign restrictions.[1] In fact, it is well known that linear or log linear approximations of Markovian DSGE models around the steady state yields VAR(1) solutions which are complicated functions of the underlying preference, technology and policy parameters.[2] Hence, extracting meaningful results from a reduced form VAR is a difficult task and requires cross-equation restrictions which should be credible and uncontroversial. In general, to solve the identification problem in the model, researchers impose constraints either on the short run or the long run impact of monetary shocks on macroeconomic variables. There are two main approaches to solve the identification problem. The first approach, followed by Sims (1988), Bernake and Blinder (1992) and Bernake and Mihov (1998) among others, requires a recursive identification scheme known as the Cholesky decomposition where policy shock affect output with a lag. The second approach (see Blanchard and Quah (1989) and Gali (1992) among others) achieves identification by imposing zero restrictions on the long-run impact of monetary disturbances.

However, the identification of structural economic shocks based on zero restrictions has been repeatedly stressed in the VAR literature that this approach has various shortcomings. Cooley and Leroy (1985) argue that identification based on the Cholesky decomposition is unsatisfactory because this approach is not consistent with the DSGE models. Canova and Pina (1999) show that DSGE models do not imply the recursive structure imposed by the

[1] More concretely, Ireland (1999) show how a real business cycle model can be written as a VAR(1). The first order conditions of a DSGE model and log-linearisation around the steady state lead to a system of rational expectation (RE) model. Also note that conventional solution of RE models using Blanchard and Kahn (1980) method gives a VAR(1).

[2] See, for instance, Leeper, et al. (1996) Christiano et al. (1999) and Canova (2007) who summarize the developments of VAR models and empirical findings.

Cholesky decomposition. Cooley and Dwyer (1998) show that the long-run restrictions used by Blanchard and Quah (1989) rely on weak instruments and lead to unreliable conclusions concerning the differentiation of permanent shocks from transitory shocks. Further research (see Chari et al (2005), Giordani (2004) and Benati and Surico (2009) points out that for a certain class of DSGE models VARs are unable to trace out both the true dynamics of state variables and the true shocks even if the appropriate identification restrictions were used. This is so because the log-linearization of these models leads to a VARMA data generating process (DGP).[3] If one of the roots of the MA component is large then a finite order VAR would not necessarily capture the true DGP. However, Canova (2006) and Canova and Cambetti (2010) show that when VAR method is properly used then the true DGP can be properly recovered.

Given the criticism regarding the use of zero restrictions in identifying parameters of a VAR structure and the fact that DSGE models do not exhibit zero restrictions, researchers began to use sign restrictions to validate DGSE models. This reasoning is due to the observation that a log-linearized DGSE model rarely delivers zero restrictions to extract structural shocks, they contain many sign restrictions which could be used to identify the model (see Canova (2007) page 138).

In this paper, taking into account the developments in the field, we investigate the impact of monetary shocks for three developed countries considering a Bayesian structural VAR model as suggested by Uhlig (2005) and Mountford and Uhlig (2009). This methodology identifies structural monetary shocks by imposing sign restrictions on the impulse responses of (some) variables while allowing some other variables to be completely determined by the data. This approach is useful because it avoids some of the identification problems that arise in the traditional structural VAR models. In our case, we impose no restrictions on the responses of industrial production and exchange rate to monetary policy shocks as they are the key variables of interest in this study and we want the data to determine their path. Our dataset covers the period between January 1988 to December 2009 on a monthly bases and collected for the UK, the US and Japan.

It is worth stressing at this point that although most of the results in the

[3]Benati and Surico (2009) using a three-equation New-Keynesian model show that if there is a structural change in the policy rule (i.e., from passive to active) then a VAR analysis will detect this as the variance of the shocks has changed. However, Benati and Surico (2009) can be criticized on the grounds of omitted variable problem which induces biased coefficients and overestimated variance of shocks. To that end, Canova (2006) states that an augmented VAR including a proxy of the omitted variable (i.e. expected inflation), may uncover the true DGP.

VAR literature are consistent with the economic theory, Sims (1992) using a recursive identification approach observed a positive relationship between prices and interest rate.[4] Sims argues that the price puzzle is possibly an artifact of the omitted variables problem. In other words, because the central bank has more information concerning expected inflation than a researcher can incorporate in a VAR model, the finding that interest rate rises in response to expected high inflation can only be explained due to the omission of a fundamental variable from the model. Recently, Castelnuovo and Surico (2010) show that price puzzle is the by-product of a passive monetary policy with respect to inflation. More concretely, if a central bank accommodates instead of fighting inflation, that is if a central bank follows a passive policy, then this would generate indeterminate multiple equilibria and expectations become self-fulfilling. Thus, high inflationary expectation will be fulfilled by a passive monetary policy leading to expectation for even higher inflation. This implies that the Sims' argument is correct only when monetary policy is passive.

Our empirical findings can be summarized as follows. First, similar to Uhlig (2005), we find that a "contractionary" monetary policy shock, does not necessarily lead to a fall in real GDP. For instance, in the US, we find that the real industrial output growth stays positive for the entire 5 year period following a contractionary monetary shock. In Japan the real industrial production growth does not respond much to the monetary shock for several months but then it slightly increases after the middle of the second year following the shock; however, this response is small and negligible. In contrast, the real industrial production growth in the UK declines for the entire period following the negative shock. Second, although the response of prices is tainted due to the sign restriction, it is interesting to note that we do observe the price puzzle for the UK and Japan when we consider the full sample. We conjecture that the price puzzle in these two countries is not an outcome of passive monetary policy but it is related to excess bank lending over the period prior to the financial crises. Third, when we inspect the behavior of real exchange rates, we observe delayed overshooting in Japan and the exchange rate puzzle in the UK and in the US.[5, 6]

The remainder of the paper is organized as follows. Section 2 explains the methodology, section 3 provides information on the data and illustrates

[4]Eichengreen et. al. (1992) named this anomaly as a "price puzzle".

[5]For all the countries the real exchange rate is measured with respect to the US dollar whereas the real exchange rate for the US is measured against the SDR. All real exchange rate variables are drawn from the International Financial Statistics (IFS).

[6]Scholl and Uhlig (2008) report the presence of the exchange rate puzzle for US-Germany, US-UK, US-Japan.

the results of the VAR analysis in terms of impulse responses and variance decomposition. Finally, Section 4 offers some concluding observations.

2 The Bayesian VAR model and identification

We empirically investigate the impact of a contractionary monetary policy shock on the economy especially that on output and exchange rate. We construct a VAR system that consist of real industrial production, exchange rate, money market rate, total reserves and consumer price index and follow the identification approach suggested in Uhlig (2005) by imposing sign restrictions. By construction, the growth rate of real industrial production and that of the real exchange rate are the focus of interest and we do not impose any sign restrictions on these variables. However, we restrict the impulse responses of monetary and price variables to identify monetary policy shocks.

2.1 VAR model

Consider the reduced form VAR model:

$$\begin{aligned} Y_t &= \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + ... + \Phi_p Y_{t-p} + \epsilon_t \quad (1) \\ &= \Phi(L) Y_t + \epsilon_t \quad (2) \end{aligned}$$

where Y_t is a $n \times 1$ vector of data at time t, $\Phi(L)$ is a polynomial in the lag operator L of order p and ϵ_t is the error term. Identification of economically meaningful shocks requires a sufficient number of restrictions on the underlying structural model. For instance, let $u_t = A^{-1}\epsilon_t$ is a $n \times 1$ vector of independent structural shocks such that:

$$E(uu') = \Sigma_u = I_n$$

where I_n is an identity matrix of order n and A is an $n \times n$ matrix. Identification of u_t requires the researcher to impose $n(n-1)/2$ restrictions on matrix A. In the VAR literature this is done through the recursive ordering of variables:

$$\begin{aligned} \Sigma_\epsilon &= E(\epsilon_t, \epsilon_t') \quad (3) \\ &= AA' \end{aligned}$$

where A is the Cholesky factor of Σ_ϵ.[7]

2.2 Sign-Restriction Approach

Instead of using the standard approach which we briefly discussed above, Uhlig (2005) and Mountford and Uhlig (2009) achieve the identification of the VAR model by imposing sign restrictions on the impulse responses of a group of variables. These two papers demonstrate that any impulse vector $a \subseteq R^n$ can be restored if there exists an $n-$dimensional vector q of unit length such that that $a = \tilde{A}q$ where $\Sigma_\epsilon = AA' = \tilde{A}\tilde{A}'$, and $\tilde{A}$ is the lower triangular Cholesky factor of the covariates matrix, Σ_ϵ. Note that $\widetilde{A} = AQ$ where Q is an $n \times n$ orthogonal matrix.

According to Uhlig (2005) the estimation and inference can be implemented as follows. A prior of the Normal-Wishart for $(\widehat{\Phi}(L), \widehat{\Sigma}_\epsilon)$ can be constructed and the posterior draws are obtained from the Normal-Wishart for $(\widehat{\Phi}(L), \widehat{\Sigma}_\epsilon)$. After estimating $\Phi(L)$ and Σ_ϵ from the posterior draws, we draw $\widehat{q}_j$ from a uniform distribution, divided by its length. Then, we construct a candidate impulse response vector $\widehat{\alpha}_j = \tilde{A}\widehat{q}_j$ and compute its impulse responses by:

$$r_s = [I - \widehat{\Phi(L)}]^{-1}\widehat{\alpha}_j \tag{4}$$

where r_s is the vector of the impulse responses at horizon s. We account for only those draws of $\widehat{q}_j$ where the sign restrictions are not violated. We repeat this procedure until we obtain 1000 draws which satisfy the sign restrictions. Next, using these draws we construct the error bands.

The advantage of using sign restrictions to identify policy shocks is that results are not affected by the ordering of the variables. That is changing the order of the variables in a system would not render any difference in the observed impulse response functions. In addition Bayesian VAR (BVAR) is not subject to parameter uncertainty. This is so because the BVAR allows us to compute the reduced-form parameters and the impulse vector simultaneously.

3 Data and Results

In this section, we present our results that we generate using the pure sign-restriction approach. We carry out our analysis using monthly data which

[7]Recursive identification imposes short-run restrictions based on an ad-hoc ordering. This method was used by Sims (1986). Alternatively, Blachard and Quah (1989) identified structural shocks by imposing $n(n-1)/2$ long-run restrictions on $C(1) = [I - \Phi(1)]^{-1}$.

covers the period between January 1988 and December 2009 for the US, the UK and Japan. We compare and examine the results gathered from these three countries to understand how monetary policy shocks affect output, exchange rate and prices. Our empirical model is similar to that of Bernanke and Mihov (1998) and it is well studied in the literature. Our investigation makes use of real industrial production, commodity price index, total reserves, the real exchange rate and short-term interest rate. The data on the interest rate are taken from line 60b of the *International Financial Statistics*. Data for total reserves are taken from line 12 of the same source and it represents total reserves minus gold. Data on the consumer price index (CPI) and the industrial production are extracted from lines 64 and 66, respectively. Last but not least, the real effective exchange rate is taken from line 42. Note that the real effective exchange rates of the UK and Japan are measured with respect to the US dollar. The real exchange rate for the US is given with respect to the SDR. Given the definition of the real exchange rate series, an increase indicates a real depreciation whereas a decline indicates a real appreciation. We use the logarithmic first difference of each variable in our VAR system with the exception of the short-term interest rates which is used in levels.

We built our VAR model allowing for 12 lags in the logarithmic difference form of the series with the exception of the short-term interest rates which is used in levels. To achieve identification of the VAR system, we impose that the response of inflation and growth of total reserves would not increase and that of money market rate would not decrease for the first six months following the monetary policy shock; i.e. $s = 6$.

3.1 General Observations

We have three sets of key results. The first set is about the effect of monetary policy shocks on real output. We find that a negative monetary policy shock does not necessarily lead to a contractionary effect on real industrial production. It is possible that the ambiguous effect of monetary policy on economic growth is related to the response of the financial sector to changes in monetary policy. Given our observations, it appears that transparency and a well behaving financial sector can restore the confidence in the economy so that the uncertainty surrounding the future economic growth and inflation can be deflated to a large extent. More specifically, our findings suggests that sunspots are not necessarily generated due to the implementation of passive monetary policies but due to the actions of a poorly regulated financial sec-

tor.[8] Hence, it might be more important to (re-)institute a well functioning financial system prior to meddling with the monetary policy to achieve full economic recovery.

Second, when we consider the full data, we do find evidence for the presence of the price puzzle for the UK and Japan. Evidence of the price puzzle begs an answer to the question on the underlying factors that generate this indeterminancy. Although, Castelnuovo and Surico (2010) argues that the indeterminacy is due to violation of the "Taylor principle"[9] their suggestion is not consistent with the adoption of inflation targeting by the BoE or the inflation averse policies followed by the BoJ.[10] We conjecture that the mechanism that generated sunspots both in the UK and in Japan was related to the excess bank lending that took place before the periods of crisis that both countries went through. A sharp increase in bank-lending accompanied by poor bank regulation can easily lead to speculation and mal-investment. Under such circumstances a crisis can easily spiral into poor economic conditions as both countries experienced. We show that this anomaly disappears once the periods of crises are removed from the analysis. It seems that without establishing a well functioning and a well regulated financial sector, it would be hard to achieve economic recovery.

Our third set of results relates to the behavior of the real exchange rates of the countries in our sample. We find that the reaction of exchange rates to monetary policy shocks is not identical across all three countries. In particular, there is evidence of a delayed overshooting puzzle for Japan.[11] In contrast, for the UK and the US we find evidence for the exchange rate puzzle; depreciation of the real exchange rate in response to the contractionary monetary policy.

It is worth noting that within the framework of a typical delayed overshooting model, as demonstrated in empirical studies including that of Eichen-

[8]This conjecture perhaps does not correspond to the US reaction to monetary policy shocks due to its size and the way it is governed.

[9]The Taylor principle states that if the coefficient of inflation in the standard Taylor rule is smaller than one, then the rational expectations model has multiple equilibria and the expectations become self-fulfilling.

[10]Lubik and Schorfheide (2004) argue that the association of indeterminacy with passive monetary policy is model specific. Dupor (2001) shows that in a continous time model with endogenous investment passive monetary policy is consistent with determinancy. However, in the New-Keynesian widely used in the literature to analyse the monetary transision mechanism of interest rate shocks, passive monetary policy is the generated mechanism of indeterminancy.

[11]Essentially, this means a desecration of the uncovered interest parity (UIP) condition which is called as the 'forward discount puzzle'. It is important to note though that there could be a forward discount puzzle even with no delayed overshooting.

baum and Evans (1995) and Grilli and Roubini (1995, 1996), the value of exchange rate overshoots its long-run level in response to a monetary shock and reaches its peak after one to three years rather than instantaneously as the Dornbush's overshooting model suggests.[12] Hence there is a critical disagreement between the standard theory and the baseline evidence regarding the effects of monetary policy shocks on the behavior of exchange rates.[13] Recently, Faust and Rogers (2003) argue that the delayed overshooting is an artifact of the recursive identification scheme. In particular, they show that there is no evidence of delayed overshooting model once mild sign or shape restrictions are imposed to identify monetary policy shocks. Yet, Scholl and Uhlig (2008) restore the delayed overshooting puzzle by imposing sign restrictions on the impulse response functions.

3.2 Empirical Results

Figures 1 to 7 show the impulse responses for Japan, the UK and the US to a "contractionary" monetary policy shock for different sample periods. Figures 1, 4 and 7 plot the impulse responses for the full sample for each country, respectively. Figures 2 and 3 presents the impulse responses of Japan to a contractionary monetary policy when we use shorter periods as we investigate the role of crises. We follow a similar strategy regarding the effects of crises periods for the UK on the response of variables to monetary policy shocks. In particular Figures 5 and 6 depict the response of the UK economy as we exclude the periods of EMS currency crisis and the recent financial crisis.

The Case of Japan
When we inspect Figure 1, we observe that a contractionary monetary policy shocks have unclear effects on the real industrial production of Japan. Real industrial production growth does not respond to the shock for the first two and a half years after which it starts to increase. Overall, the reaction of industrial production growth in Japan is around the baseline level suggesting that a contractionary monetary shock does not create large fluctuations in industrial production. Evidence that adverse monetary shock is not an important source of fluctuation in Japan's economy is consistent with the

[12]The delayed overshooting puzzle is also named as the forward discount puzzle due to a violation of uncovered interest rate parity. It is worth noting that a forward discount puzzle might exist even if there is no delay overshooting. See also Leeper et. al. (1996), Clarida and Gali (1994) and Kim (2001).

[13]Dornbusch's (1976) famous overshooting model, which predicts that an increase in the domestic interest rate relative to the foreign interest rate leads to an immediate appreciation followed by a depreciation of the domestic currency to its long-run equilibrium level.

fact that Japanese monetary authorities faced nearly-zero interest rates for most of the period that we explored in this study. Thus, when the economy experiences a recessionary shock, monetary authorities cannot stimulate the demand by decreasing interest rate since the nominal interest rate cannot go below zero. Put it differently, zero bound interest rate reduces the effectiveness of monetary policy; should the economy face a shock on aggregate supply or demand, monetary policy cannot be used to return the economy back to its equilibrium.[14]

We next turn to examine the behavior of consumer prices**.** By construction inflation cannot increase in the first 6 months following the negative monetary policy shock. But then inflation begins to exhibit an increasing trend; although inflation remains below the baseline level for almost two years, it becomes positive and increases for the rest of the period. On average there is mild evidence of the price puzzle which might be an artifact of omitted variables problem as suggested by Sims (1992) and Castelnuovo and Surico (2010). In particular, Castelnuovo and Surico (2010) argue that in a New-Keynesian model the omitted variable problem is the by-product of a passive monetary policy which leads to indeterminacy. Indeterminacy, as Lubik and Schorfheide (2004) stress, is an outcome where policy shocks are not uniquely identified and sunspots become important in generating business cycles and affecting the equilibrium. Hence, structural VAR models (SVAR) would be misspecified should one mistakenly omit forward-looking variables such as expected inflation. Under such circumstances, monetary policy shocks will not be identified properly.

We presume that the price puzzle is surfacing here due to the economic crises that Japan went through over the late 1980s and early 1990s. In particular, recall that the bank of Japan (BoJ) during this period followed an expansionary monetary policy to mitigate the impact of Yen's appreciation in order to comply with the 1985 Plaza Accord. The expansionary monetary policy, along with the current account surplus, led to excess liquidity in the financial system fueling financial assets and real estate prices. During this period, the Japanese monetary policy authorities were also concerned about the possibility that inflation would surge as a consequence of the developments in the economy. To counteract a potential surge in inflation, BoJ doubled the bank rate. Yet, they were then slow to reduce it. The increase in the bank rate exerted a negative impact on real estate and stock prices resulting in an increase in the number of loan defaults. The negative impact

[14]Baba et al. (2004) show that although the ratio of money base to GDP doubled after 1995, deflation has persisted. They also argue that evidence of recession and deflation was due to the low and even negative growth rate of bank loans.

of loan defaults on the economy was further exacerbated as Japanese banks ended up with the final bill in the form of bad loans. The damage was done: bad loans, continuous increases in the number of defaults and reduction in real estate and stock prices paved way to a deflationary environment making demand side policies ineffective.

Given the negative and protracted nature of the crises in Japan, we conjecture that the presence of the price puzzle could be due to excess lending and poor banking regulation that was in effect prior to the financial crisis. To provide evidence to our conjecture, we generate the impulse responses for the post-crises period so that we can circumvent the indeterminacy possibly induced by the inclusion of this period in the analysis. Figure 2 depicts our observations for the 1992-2009 period. When we concentrate on the behavior of prices, we see that although prices fall and remain below zero for the whole period there is still a tendency in prices to increase following the third year. Once we exclude the 2007-09 period from the analysis the price puzzle disappears fully. However, as Figure 3 shows, while the reaction of the other variables do not change, it now appears that the adverse monetary shock has a negative effect on industrial production growth.

When we turn to analyze the movements in the real exchange rate, we observe in Figure 1 that the Japanese Yen appreciates following the monetary policy shock for a year and then settles around its baseline as the value of the currency does not appear to change much (although there is some evidence of depreciation following a year and a half of the shock, this is very mild). Thus, there is evidence of delayed overshooting following the contractionary monetary policy shock. However, the delayed overshooting in Japan might be a mirror response to the price puzzle. More specifically, exchange rate initially appreciates to mitigate the effects of expected inflation and then depreciates. Once we exclude the periods of financial crises the delayed overshooting disappears.

The case of the UK

We next inspect the results for the UK. Figure 4 plots the impulse responses of the variables when we use the full data. In general, we observe that the industrial production growth falls following a contractionary monetary policy shock. However, this drop is not too large. As expected, inflation initially falls due to the restriction that we impose for the first 6 months. Afterwards inflation increases reaching a peak by the end of the first year while it remains above the baseline for the rest of the period. Yet, the deviation of inflation from the baseline is negligible after the four years following the shock.

Similar as in the case of Japan, the positive relation between inflation and interest rate could be due to the fact that the UK economy went through

a period of crises in early 90s. In this period, in conjunction with the German unification and the subsequent contractionary monetary policy that Germany implemented, the UK economic outlook deteriorated and unemployment increased substantially. However, to reduce unemployment, the British government could not stimulate economic growth by devaluating the British pound because the UK was a member of the ERM. The option for the UK, at that time, were either to opt out of the ERM and achieve higher economic growth by devaluing the domestic currency or to remain in the ERM and suffer a severe recession. The market bet in favor of the former option leading to a speculative attack on the British pound in September 1992. Given this panorama of the UK economy, it appears that the devaluation expectations and the subsequent inflation expectations could as well be the underlying mechanism for the price puzzle that we observe in the data. To test for this possibility, we repeat the analysis concentrating on the post 1992 EMS currency crises period to remove the immediate effects of this period of uncertainty. As in the case of Japan, we also estimate the impulse responses by excluding the recent financial crisis. Figures 5 and 6 which cover the period between 1995-2009 and 1995-2007, respectively, provide evidence supporting our explanation that the price puzzle disappears once periods of crises are removed from the data.

Our results are consistent with Benati (2008) who using a time-varying coefficient structural VAR (TVC-SVAR) shows that there is a violation of the "Taylor principle" during the entire decade of the 80s. The UK joined the ERM on October 1990 and opt out of the ERM in September 1992. The long-run coefficient on inflation is estimated to fluctuate between 0.7 and 0.8 before the UK joined the Exchange Rate Mechanism (ERM). During the ERM, the interest rate differential between the UK and Germany declined from 2.3 to 0.4 (see Gross and Thygesen 1998). In line with the empirical regularities, Benati (2008) estimates a temporary decrease in the long-run coefficients on inflation and output growth during the ERM period. However, after the introduction of inflation targeting in October 1992, following the suspension of the EMS membership, the long-run coefficients on inflation and output increased substantially, reaching 1.4 and 0.9, respectively. This observation suggests that the "Taylor principle" is not violated over the period following the introduction of inflation targeting to the current financial crisis. To put it in other words, although there was a violation of the "Taylor principle" before the EMS crisis, this was not the case for the period prior to the recent financial crisis.

The behavior of the British pound exhibits an interesting reaction to monetary policy shocks. We observe that the real exchange rate depreciates after a contractionary monetary policy shock in all three graphs providing

evidence in favor of an exchange rate puzzle which might be consistent with the presence of a price puzzle. More specifically, within the Frankel's (1979) overshooting model an increase in the interest rate will lead to depreciation only if the expected inflation is higher than nominal interest rate.[15] This explanation accords with the observations in Figure 5 where the depreciation of real exchange rate becomes explosive after two years following the monetary policy shock.

The Case of the US

Finally, we concentrate on the behavior of the US economy to a contractionary monetary policy shock. Figure 7 shows our observations. The reaction of the US economy to a monetary policy shock has been studied by several researchers including Uhlig (2005), Scholl and Uhlig (2008) and it is pleasing to see that our findings in general align with theirs. We observe that the industrial production growth in the US increases at first and then falls towards the baseline supporting Uhlig (2005) that a contractionary monetary policy does not necessarily lead to a contraction in the economy. When we turn to observe the behavior of prices, we see that inflation falls for the first six months reflecting the restrictions that we impose. Furthermore, inflation remains below the baseline for most of the time and it does not appear to have a tendency to increase although it exhibits some cyclicality.

Similar to the UK, the real US dollar, which is measured against the SDR, exhibits the exchange puzzle: the US dollar depreciates following a contractionary monetary policy shock. This might be due to a forward discount puzzle where violation of uncovered interest rate parity (UIP) is driven by the existence of forward risk premium. Here, the risk premium implies that the forward premium is higher than the expected devaluation. This result along with the behavior of other variables in our VAR are in line with Scholl and Uhlig (2008) and Fratzscher at al. (2010) who found strong evidence for a forward discount premium in four developed countries.

[15] Frankel's overshooting model suggests that the deviation of exchange rate form its equilibrium value depends on the real interest rate differential:

$$s_t = \overline{s} - \frac{1}{\theta}[(i_t - \Pi) - (i_t^* - \Pi^*)]$$

where s_t is the current exchange rate, $\overline{s}$ is the equilibrium exchange rate i_t, is domestic nominal interest rate, i_t^* is foreign nominal interest rate, Π is the long-run domestic inflation rate and Π^* is the foreign long-run inflation rate.

3.2.1 Evaluation of the Results

Our results have strong policy implication for all there countries but mainly for those which experience the price puzzle: the UK and Japan. Throughout the period under investigation, although both Japan and UK attempted to defuse contraction in their economies by implementing monetary and fiscal policy tools to boost demand, both countries failed to achieve their goals. Following the financial crises of the late 80s, the BoJ reduced the rate of interest to zero and kept it at that level as the government increased its expenditures to stimulate the economy. There was a reluctance to use a quantitative easing, because even when Japan experienced deflation, BoJ was averse to possible future inflation. Similarly, the recent financial crisis that erupted in the USA forced the BoE to reduce the bank rate to unprecedented low levels while, different from the BoJ, increasing the money supply to support the demand side of the economy.

When we turn to observe the reaction of the Labour government which was in power during the 2007-2009 financial crises, we see that the government implemented expansionary fiscal policies and strived hard to convince governments in continental Europe and the US to do the same. In contrast, the subsequent Tory—Lib-Dem coalition government that took power in 2010 restructured the fiscal policy to achieve a medium to long-term reduction of fiscal deficit and national debt. Under the current situation it is debatable that the two sets of (conflicting) policies implemented by the BoE and the government will push the country to its long-run growth path rather than to a low equilibrium where growth will be too slow for a protracted period into the future. More concretely, given that the monetary policy had limited impact on the demand side as experienced in Japan, USA and the UK[16], the coalition government might have been too quick to attempt to reduce government expenditures to keep the public expenses in check. This complete reversal of the UK fiscal policy may have further undesirable consequences as inflation in 2011 is on the rise as a result of increases in fuel and wholesale commodity prices inducing inflation expectations of the public.

Furthermore, the presence of the price and exchange rate puzzles implies that sunspots could have significant effects on the business cycle. In particular, it may be the case that pessimism about the future economic circumstances might have introduced further negative feelings on the effectiveness of monetary policy in Japan and in the UK. Although the earlier research has shown that the price puzzle or sunspot is a by-product of passive

[16]Quantitative easing did not lead to inflation in Japan in the past. During the recent crises, although both FED and BoE injected substantial amounts of cash into the financial system, the rate of inflation in both countries did not change.

monetary policy, our observations for the UK and Japan are not consistent with this view. The reason is that over the period of investigation and importantly during the financial crisis, monetary policy makers in both countries played a very active role. Given the evidence, we suggest that the underlying factor to sunspots is excessive bank lending and poor bank regulations. In Japan banks kept funding its customers before the financial crises as long as the borrower was able to provide a collateral in the form of real estate. This strategy worked well while the real estate prices were stable or increased over time and the economy was not overheated as the asset bubble formed which eventually happened in Japan in the 1990s and in the USA in 2007. However, once the bubble burst this practice imposed immense negative effects both on financial and real economic sector. In the case of the UK, Haldane et al. (2007) show that UK banks increased their unsecured exposures along with UK households secure debt to figures around 32% of UK bank's total lending. Haldane at al. (2007) also explain that households were very sensitive to adverse shocks and there were signals of stress with the number of personal insolvencies sharply increasing before the 2007-2009 financial crises.

It is also worth stressing that in the UK the price puzzle might have been the mirror response of the exchange rate puzzle and vice-versa. More specifically, expected depreciation of pound fuels expected inflation and expected inflation further increases expected depreciation. The fundamental question is why there was an expected depreciation or an increase of expected inflation in the first place. Is it due to bad policy or due to bad lack? In our view it is due to a combination of both for the UK and due to bad policy in Japan. Although in both countries the driving force behind expected inflation was excess lending prior to the crises, the new element in the 2007-2009 financial crisis is the increases in commodity prices and oil prices that happened concurrently. Under such circumstances policy makers have to identify which part of expected inflation is generated by supply shocks (i.e. oil price, food prices etc.) and which part of inflation is generated by sunspots. The latter in both countries was a result of poor bank regulation which after the crisis led to an uncertain economic environment undermining the effectiveness of monetary and fiscal policy concerning the future economic growth. Our results suggest that any decision to increase the interest rate by the BoE should be associated with demand factors that affects expected inflation. However, expected inflation is due either to supply shocks or to bad policy prior to the recent financial crisis. Thus, an increase in interest rate will not only undermine future economic growth but it might also issue wrong signals concerning the credibility of BoE monetary policy committee.

As a final step of our empirical study we perform a variance decomposition analysis. Table 1 shows the variance decomposition of all variables for

all three countries in response to an interest rate shock. We can see that movements in monetary policy is responsible for a small fraction of the state variables' movements in any of these countries. More concretely, monetary policy explains at about 20 percent of the variability of any of the variables included in the VAR system. Last but not least within each group of countries the variance decomposition is relatively the same.

4 Conclusion

In this paper we investigate the impacts of monetary policy shocks on output, exchange rate and prices using data from the UK, the US and Japan. We carry out our investigation implementing an agnostic identification method recently proposed by Uhlig (2005). In this framework, to achieve identification we impose sign restrictions on domestic short-term interest rates, prices and total reserves for the first six months following the contractionary shock. We apply no restrictions on real exchange rate and output so that the impulse responses of these variables are completely determined by the data. Regarding the restrictions that we impose, we follow the conventional wisdom and assume that a contractionary monetary policy shock does not lead to a fall in domestic short-term interest rates, does not increase domestic prices and does not increase total reserves. We have three sets of observations.

First, the response of real output to adverse monetary policy shocks is ambiguous in a way that in most cases it does not have a significant impact on output as the response can be positive as well as negative. Therefore, we cannot be as comfortable as before when commenting on the impact of a contractionary monetary shock on the output.

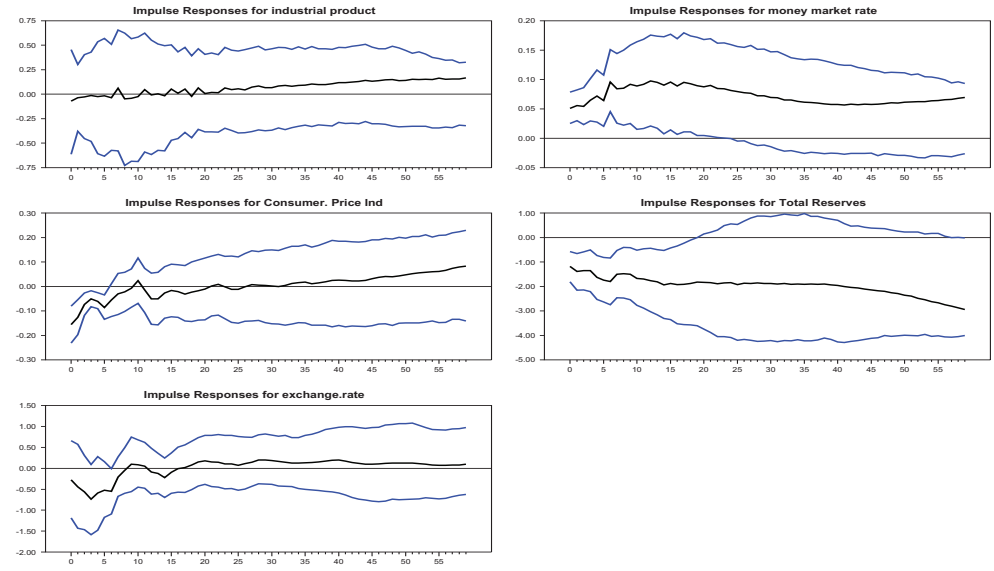
Second, we observe price puzzle for Japan and UK when we use the full sample period during which both countries experienced 2 two distinct periods of crises including the recent 2007-2009 financial crises. We argue that the price puzzle is an artifact of excess lending and poor banking regulations. Excess lending prior to financial crises created inflationary expectations which in the case of UK have been further enhanced by depreciation of the home currency. In other words, we conjecture that the price puzzle in Japan and the UK is not a by-product of passive monetary policy, as the central banks were active through out the sample period, but rather it is an outcome of the poor regulation of the banking system which led to a lending boom and inflationary expectations. Our results suggest that the appropriate tool to satisfy market expectations and to restore public confidence is through increasing the transparency of banking system and introducing a better financial regulatory system.

Third, we show that the exchange rate puzzle occurs in the UK and the US while we observe the delayed overshooting for Japan. Empirical evidence suggests that in Japan exchange rate responds to mitigate expected inflation while in the UK and the US exchange rate response accommodates expected inflation.[17]

Last but not least, the results in this paper suggest that monetary policy shocks can explain only a small part of the variation in output and prices. Quantitatively, monetary policy shocks seem to have a negligible effect on exchange rate fluctuations as well as output, in contrast to some of the literature.

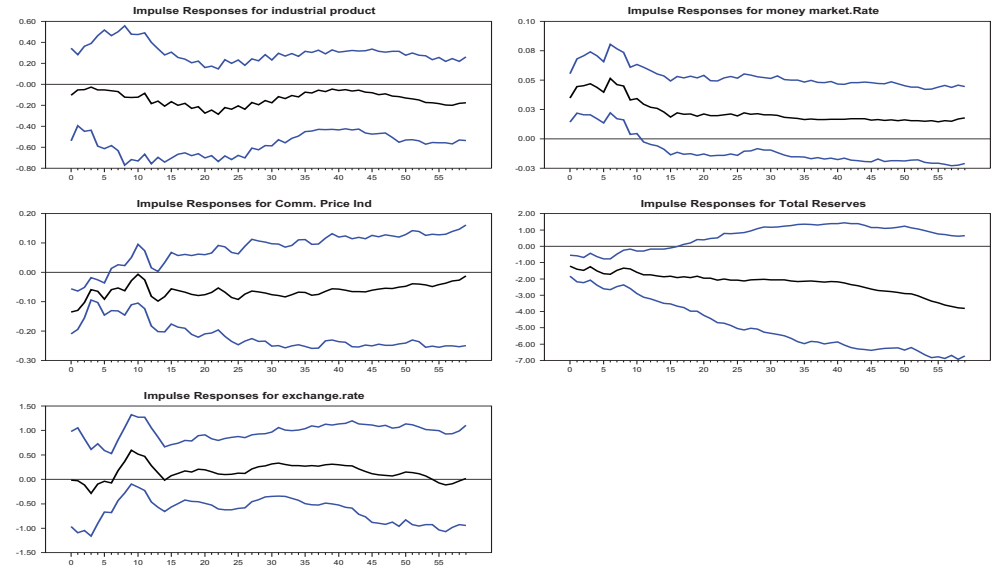
[17]In an attempt to explain empirical findings of delayed overshooting theoretical research such as Gourinchas and Tornell (1996, 2002) argue that delayed overshooting is the by-product of learning the current state and the intrinsic dynamic if interest rate reaction to monetary shocks.

Figure 1: Japan: Full Sample (1988-2009)



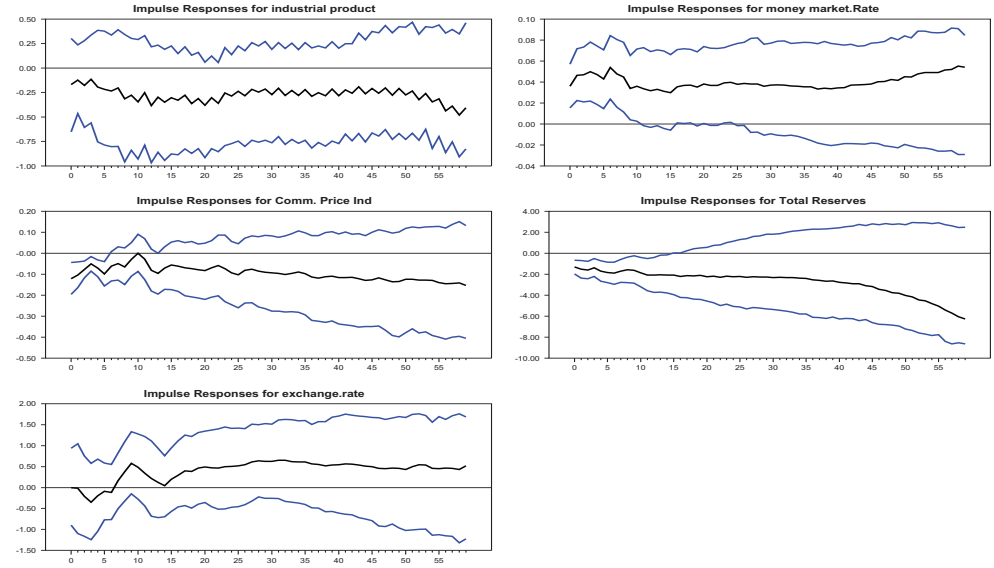
Impulse Responses with Pure-Sign Approach

Figure 2: Japan: Post Financial Crises? 1992-2009



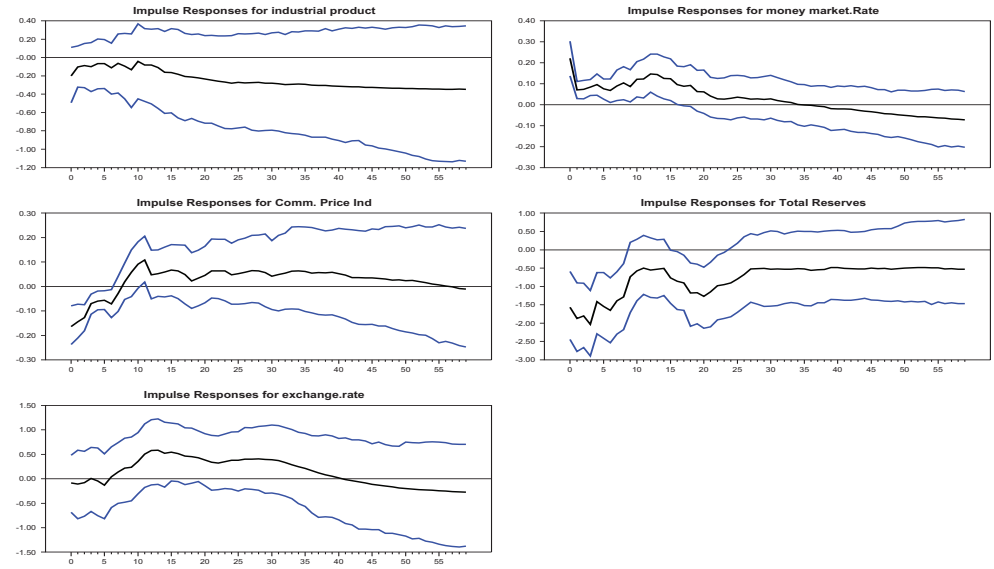
Impulse Responses with Pure-Sign Approach

Figure 3: Japan: 1992-2007



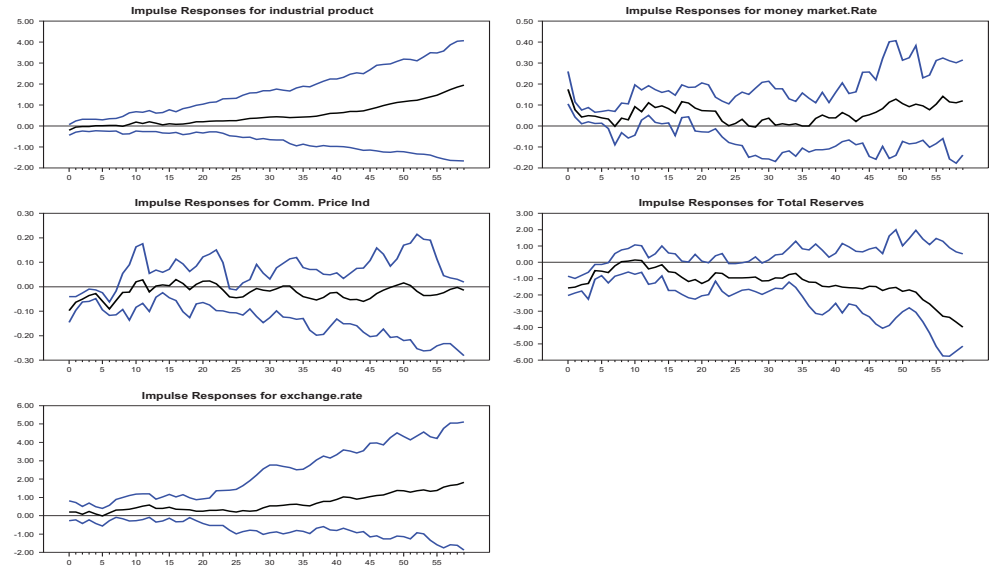
Impulse Responses with Pure-Sign Approach

Figure 4: The UK: Full Sample (1988-2009)



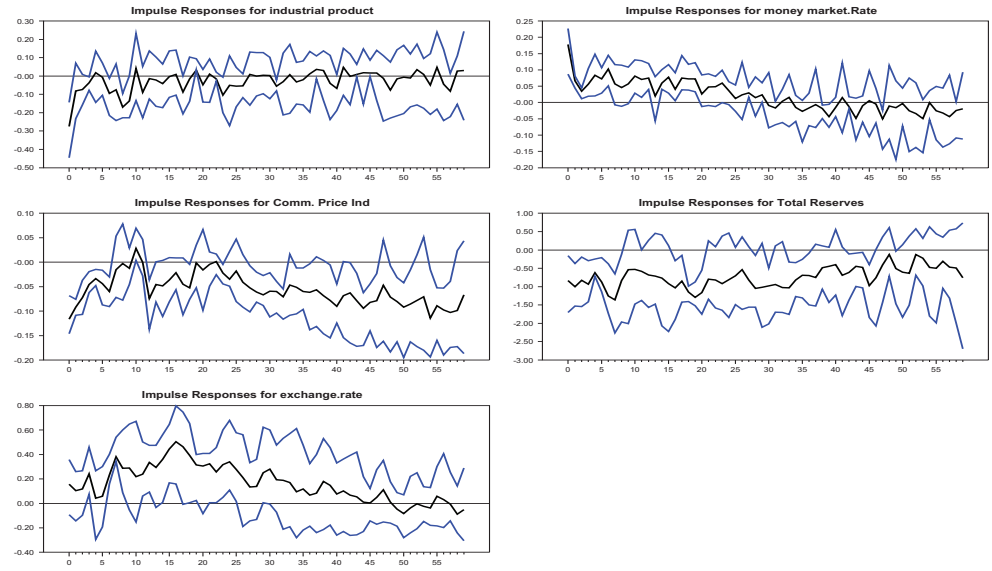
Impulse Responses with Pure-Sign Approach

Figure 5: The UK: Post ERM Crises (1995-2009)



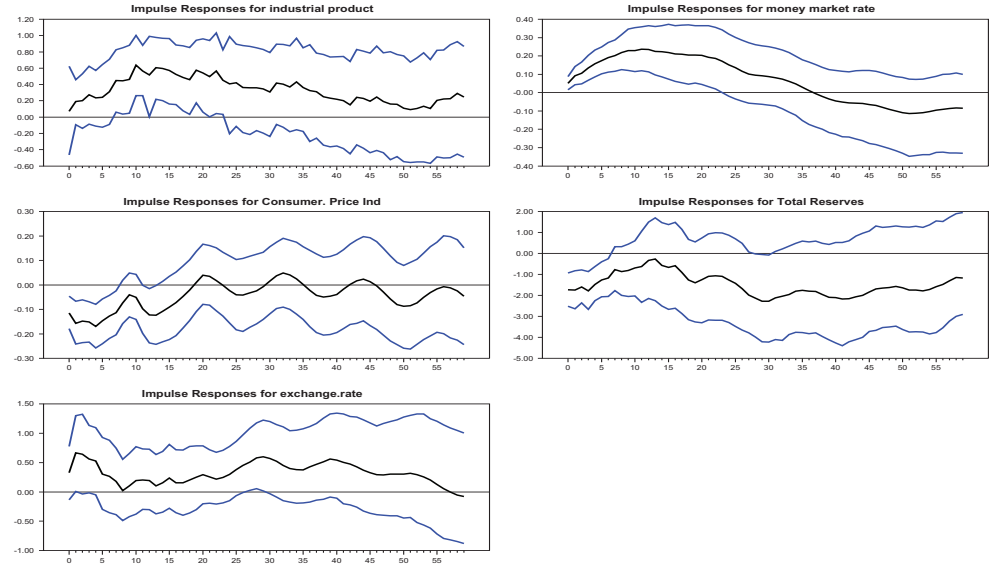
Impulse Responses with Pure-Sign Approach

Figure 6: The UK: Post ERM Crises (1995-2007)



Impulse Responses with Pure-Sign Approach

Figure 7: The US



Impulse Responses with Pure-Sign Approach

Table 1: The variance decomposition

Fraction of Variance for IP Growth	6 month	12 month	24 month
Japan	10 %	14 %	16 %
United States	10 %	14 %	16 %
United Kingdom	11 %	17 %	20 %
Fraction of Variance for Inflation			
Japan	22 %	21 %	20 %
United States	15 %	20 %	18 %
United Kingdom	18 %	22 %	23 %
Fraction of Variance for Exchange Rate Growth			
Japan	11 %	13 %	17 %
United States	16 %	20 %	22 %
United Kingdom	12 %	15 %	20 %

References

[1] Baba, N., Nishioka S., Oda N., Shirakawa M., Ueda K, and Ugai H., 2005. Japan's deflation, problems in the financial system and monetary policy. BIS Working Paper No. 188.

[2] Benati, L., 2008, The "Great Moderation" in the United Kingdom" Journal of Money Credit and Banking, Vol. 40, pp.121-147.

[3] Benati, L. and Surico P., 2009, VAR Analysis and the Great Moderation," American Economic Review, vol. 99(4), pp. 1636-52

[4] Bernanke, B. and Blinder A., 1992. The federal funds rate and the channels of monetary transmission. American Economic Review. 82 (4), pp. 901–921.

[5] Bernanke, B. and Mihov I., 1998a. Measuring monetary policy. Quarterly Journal of Economics. 113 (3), pp. 869–902.

[6] Blanchard, O. and Kahn M., 1980. The solution of linear difference models under rational expectations. Econometrica. 48, 5, pp. 1305–1312.

[7] Blanchard, O. and Quah D., 1989. The dynamic effects of aggregate demand and supply disturbances. American Economic Review. 79, pp. 655–673.

[8] Canova, F., 2006. You can use VARs for structural analyses. A comment to VARs and the great moderation. mimeo, Universitat Pompeu Fabra.

[9] Canova, F., 2007. Methods for Applied Macroeconomic Research, Princeton: Princeton University Press.

[10] Canova, F., and Cametti, L., 2010, Do Inflation Expectation Matter? The Great Moderation Revisited, American Economic Journal, 2 (3), 2010, 183-205

[11] Canova, F. and Pina A., 1999. Monetary policy misspecification in VAR models. CEPR Discussion Paper No. 2333.

[12] Castelnuovo, E. and Surico P., 2010. Monetary policy, inflation expectations, and the price puzzle. The Economic Journal. 120(549), 1262–1283.

[13] Christiano, L., Eichenbaum M and Evans C., 1999. Monetary policy shocks: what have I learned and to what end. in: Woodford, M., Taylor, J.B. (Eds.), Handbook of Macroeconomics. North-Holland, Amsterdam, pp. 65–148.

[14] Clarida, R. and Gali J., 1994. Sources of real exchange rate fluctations: How important are nominal shocks. Carnegie-Rochester Series on Public Policy. 41, 1–56.

[15] Cooley, T. F., and Dwyer M., 1998. Business cycle analysis without much theory: A look at structural VARs. Journal of Econometrics 83, pp. 57–88.

[16] Cooley, T.F., and Leroy, S.F., 1985. Atheoretical macroeconometrics: A critique. Journal of Monetary Economics. 16(3), pp. 283–308.

[17] Dornbusch, R., 1976. Expectations and exchange rate dynamics. Journal of Political Economy. 84, pp. 1161–1176.

[18] Dupor, B., 2001. Investment and interest rate policy. Journal of Economic Theory. 98, pp. 85-113.

[19] Eichenbaum, M. and Evans C.L., 1995. Some empirical evidence of shocks to monetary policy on exchange rates. Quarterly Journal of Economics. 110, pp. 975–1010.

[20] Faust, J and Rogers J.H., 2003. Monetary policy's role in exchange rate behavior. Journal of Monetary Economics. 50, (7), pp. 1403–1622.

[21] Frankel, J., 1979, On the Mark: A theory of flaoting exchnage rates based on real interest rate differential. American Economic Review, 69, pp. 610-622.

[22] Fratzscher, M., Juvanel, L., and Sarno, L., 2010, Asset prices, exchnage rates and the current account. European Economic Review, 54, pp. 643-658.

[23] Gali, J. 1992. How well does the IS-LM model fit postwar US data. The Quarterly Journal of Economics. 107(2), pp. 709–738.

[24] Giordani, P., 2004. An alternative explanation of the price puzzle. Journal of Monetary Economics. 51 (6), pp. 1271–1296.

[25] Grilli, V. and Roubini N., 1995. Liquidity and exchange rates: puzzling evidence from the G-7 countries. Mimeo, Yale University.

[26] Grilli, V. and Roubini N., 1996. Liquidity models in open economies: theory and empirical evidence. European Economic Review. 40 (4), pp. 847–859.

[27] Gross, D., and Thygesen, N., 1998, European Monetary Integration: from the European Monetary System to European Moneatry Union, Longman.

[28] Haldane, A., Hall, S., and Pezzini, S., 2007. A new approach to assesing risks to financial stability. Bank of England, Financial Stability Paper No. 2.

[29] Kim, S., 2001. International transmission of U.S. monetary policy shocks: evidence from VARs. Journal of Monetary Economics. 48 (2), pp. 339–372.

[30] Ireland, P., 1999. Does the time-consistency problem explain the behavior of inflation in the United States. Journal of Monetary Economics. 44 (2), pp. 279–291.

[31] Leeper, E., Christopher S. and Zha T., 1996. What does monetary policy do. Brookings Papers on Economic Activity Series 2, pp. 1–63.

[32] Lubik, T., and Schorfheide F., 2004. Testing for indeterminacy: an application to u.s. monetary policy. American Economic Review. 94 (1), pp. 190–219.

[33] Mounford A., and Uhling, H. 2009. What are the effects of fiscal policy shock? Journal of Applied Econometrics. 24 (6), pp 960-992.

[34] Uhlig, H., 2005. What are the effects of monetary policy on output? Results from an agnostic identification procedure. Journal of Monetary Economics. 52(2), pp. 381–419.

[35] Scholl A. and Uhlig H., 2008. New evidence on the puzzles: Results from agnostic identification on monetary policy and exchange rates. Journal of International Economics. 76, 1, pp. 1–13.

[36] Sims, C., 1980. Macroeconomics and reality. Econometrica. 48, pp. 1–48.

[37] Sims, C., 1986. Are forecasting models usable for policy analysis. Minneapolis Federal Reserve Bank Quarterly Review Winter. pp. 2–16.

[38] Sims, C., 1992. Interpreting the macroeconomic time series facts: the effects of monetary policy. European Economic Review. 36, pp. 975–1011.

[39] Surico, P. and Castelnuovo E., 2010. Monetary policy, inflation expectations and the price puzzle. Economic Journal. 120 (549), pp. 1262–1283.