Not all international monetary shocks are alike for the Japanese economy

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\textbf{A B S T R A C T}

This paper examines the influence of monetary aggregates shocks in the U.S., China and the Euro area on Japan. China’s monetary expansion has significant effects on Japan’s economy that are quite different from those of the U.S. and Euro area. In line with the implications of the Mundell–Fleming model when there are capital controls in place, Chinese monetary expansion is found to primarily affect Japan through trade. The income absorption effect of China’s monetary expansion is substantial for Japan. China’s monetary expansion results in significant increases in Japan’s industrial production, exports and inflation, and decreases in the trade-weighted yen. After 24 months, monetary shocks in China forecast 20% of the variation in Japan’s real trade balance. In contrast, U.S. monetary expansion results in contraction in Japan’s industrial production, exports and trade balance (expenditure-switching). Monetary expansion in the Euro area does not significantly affect Japan. Structural vector error correction models and a factor-augmented model are estimated to establish robustness of results.

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1. Introduction

In the intertemporal models of Svensson and Van Wijnbergen (1989) and Obstfeld and Rogoff (1995) monetary expansion within a large economy decreases real interest rates around the world and promotes aggregate demand worldwide. Work on exploring the impact of monetary expansion in a large economy on other economies has naturally focused on the role of the U.S. in the international transmission of monetary shocks. Evidence for this mechanism and that monetary changes in the U.S. have implications for other economies has been demonstrated in the literature on the diffusion of monetary shocks.\textsuperscript{2}

In this paper we examine the influence of monetary aggregates shocks in the U.S., China and the Euro area on Japan. The subject is important because China is a large fast growing economy and monetary shocks in China may have different effects on other economies than monetary shocks in the U.S. The topic is also valuable because the potential for big effects on income through a fall in Japan’s interest rate caused by positive monetary shocks in a large open economy, such as the U.S. or the Euro area, are precluded, because Japan’s interest rate is already at low levels. Examination of the effect of changes in international monetary aggregates on Japan’s economy is informative since over the period of analysis these variables capture quantitative easing, something that interest rates, already at low levels, are unable to do.\textsuperscript{3}

In the Mundell–Fleming model, monetary policy expansion results in beggar-thy-neighbour effects under flexible exchange rates. Monetary expansion leads to currency depreciation and an improving trade balance through expenditure-switching, with the implication of falling incomes in other countries. The improvement in the trade balance and the fall in foreign income might be mitigated by the income-absorption effect (increased income in the inflating country leading to increased demand for imports). China has enjoyed such spectacular growth in recent years relative to the U.S. and the Euro area that the income absorption effect

\textsuperscript{2} A number of papers have examined the effect of U.S. monetary policy shocks on other economies. Kim (2001) and Canova (2005) find that monetary expansion in the U.S. causes economic expansion in the non-U.S. G-6 and in Latin America by lowering interest rates across these economies. In examining the role monetary policy of the non-U.S. G7 economies Grilli and Roubini (1995) demonstrate that it is important to control for U.S. monetary policy. Di Giovanni and Shambaugh (2008) find that high interest rates in a major country depress the domestic economy of a country that ties its exchange rate to that of the major country. Kazi et al. (2013) find that with regard to the influence of US monetary policy, unexpected change in the Federal Funds Rate influences output in most OECD countries.

\textsuperscript{3} Quantitative easing (QE) has been applied in Japan before and since the global financial crisis in 2007. Since the global financial crisis, quantitative easing has been used by the U.S. and the Euro area.

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of China's monetary expansion might be different in degree than that of monetary expansion by the U.S. and the Euro area. Within the Mundell–Fleming framework, the presence of extensive capital controls in China suggests that Chinese monetary expansion affects other economies primarily through trade.

A structural vector error correction model (SVEC) is used to examine international monetary transmission to Japan from U.S., China and the Euro area. We also explore the robustness of our analysis with several different specifications including the use of structural factor-augmented error correction model (SFAVEC). It is found that over 1999:1–2012:12 China’s monetary expansion has significant effects on Japan’s economy that are quite different from those of the U.S. and Euro area. The influence of China’s monetary expansion on Japan is through the effect of China’s growth on increased demand for imports and China’s exchange rate policy. China’s monetary expansion is associated with significant increases in Japan's industrial production, decreases in the trade-weighted yen and increases in Japan’s real exports. Monetary shocks in China forecast 20% of the variation in Japan’s real trade balance and 10% of real exports at the 24 month horizon.

In contrast, U.S. monetary expansion significantly lowers Japan's exports and industrial production. Monetary expansion in the Euro area does not significantly affect Japan's exports and industrial production. Japan’s real trade balance worsens with monetary expansion in the U.S. Results are robust across a number of differently specified structural vector error correction models and also to estimation by a factor-augmented vector error correction model.

In the next section recent developments in monetary aggregates and Japanese trade are briefly discussed. The methodology and the model for the study of the international monetary effects on Japan are presented in Section 3. The empirical results are discussed in Section 4 and checks for the robustness of results are presented in Section 5. The results are discussed in Section 6.

2. Background on the G4

The growing importance of China’s money supply for global liquidity is illustrated in Fig. 1. In Fig. 1, the log of M2 money supplies expressed in U.S. dollars in China, U.S., and Japan (the G4) over 1996:01–2012:12 is presented. By 2012M2 in China exceeds that in the U.S., the Euro area, and in Japan. China’s nominal M2 (in USD) increased on average by 19.5% per year from 1996 to 2011. The behaviour of China’s nominal GDP is also strongly upward over the period, increasing on average (in U.S. dollars) by 15% per year (not shown in Fig. 1).

Developments in trade between the U.S., China and the Euro area on the one hand with Japan on the other are presented in Figs. 2, 3 and 4. The dramatic increase in trade between China and Japan, in absolute terms and relative Japan’s total trade with all nations is illustrated in Figs. 2 through 4. In Fig. 2, the ratio of exports plus imports between China and Japan to total exports plus imports for Japan rises from 8.5% in 1999 to 20% in 2012. Over the same period, the ratio of exports plus imports between the U.S. (Euro area) and Japan to total exports plus imports for Japan falls from 27% (16%) in 1999 to 13% (9%) in 2012. The rise in China's influence in trade is particularly marked with regard to Japan's imports. In Fig. 4, Japan's imports from China, the U.S., and the Euro area relative to total Japanese imports were 21.5%, 8.5%, and 9%, respectively, in 2012, compared to 13%, 22%, and 13%, respectively, in 1999. As a market for Japanese goods China has also become much more important, with China absorbing more Japanese exports than the U.S. and far more than the Euro area over 2009–2012.

Indices of the nominal trade-weighted index for the yen and renminbi/dollar and renminbi/yen exchange rates are shown in Fig. 5 with all indices being set at 100 at the start of the sample in January 1999. Prior to 2005 the renminbi was pegged to the U.S. dollar. Since July 21, 2005, the value of renminbi has been determined with regard to a basket of currencies among which the dollar has been preeminent. Ma and McCauley (2011) find that over 2006 to 2008 the renminbi strengthened slightly within a narrow band against a basket of major currencies. Over an extended period from 2008 to 2010, the renminbi/dollar rate did not vary from 6.8. Cai et al. (2012) and Fang et al. (2012) show that post 2005, consideration of the parity of the exchange rate of the renminbi against the U.S. dollar dominates the influence of the other currencies in determining the overall value of the renminbi (the other currencies include the Euro, Japanese yen and South Korean won). Granville et al. (2011) find that China’s exchange rate policy is relatively unimportant relative to the price of China’s imports in influencing price levels in the G3.

In Fig. 5 there is a tendency for the renminbi/dollar exchange rate to fall since 2005 as the U.S. dollar weakened against other currencies. The renminbi/yen exchange rate has risen and fallen over 1999–2012, with an index value in December 2012 of 97.925 just over 2% below the value in January 1999. Despite this small adjustment of the renminbi/yen exchange rate, the nominal trade-weighted index for the yen has risen over 1999–2012 with an index value of 121.285 in December 2012. Thus, by the end of 1999–2012 the yen has risen on a trade-weighted basis and has fallen slightly against the renminbi. In line with the rise in the trade-weighted value of the yen, the end of 1999–2012 the U.S. dollar has weakened against the yen. The dollar/yen index (not shown) stands at 130.072 in December 2012 (compared to 100 in January 1999).

References

Goodfriend and Prasad (2007) reason that capital controls provide room for monetary policy independence in China. During the fixed exchange rate period from 1998 to 2005, Sun (2009) finds that China operated an independent monetary policy. There has been considerable work on China in recent years. Cheng and Zhang (2012) construct a general equilibrium monetary model to study China–US trade and find that an appreciation in China’s currency would reduce consumption in the US and reduce China’s trade surplus. Whalley and Wang (2011) in a trade model show that the effects of Renminbi appreciation on trade flows can be substantial. Wang et al. (2014) find that China’s money and output show bidirectional time-varying Granger causality, supporting the position that monetary expansion can influence output in China.
Over the period of this study, 1999:1–2012:12, up until 2005 China operated a dollar peg and since 2005 the renminbi has floated in a narrow margin around a fixed base rate defined with reference to a basket of major currencies with undisclosed weights. Throughout the period China has had extensive capital controls in place. In the Mundell–Fleming model with imperfect capital mobility, sterilization actions under a fixed exchange rate permit an independent monetary policy for as long as foreign exchange reserves permit.\(^5\) China’s financial markets are still segmented, including relative to Japan, and this point is addressed within the Mundell–Fleming framework.

In models of the international transmission of monetary shocks discussion of effects on interest rates plays a large role. The Federal Funds rate for the U.S. and the central bank discount rates for China, Japan, and the Euro area are reported in Fig. 6. The discount rate in Japan is at extremely low levels over 1999–2012. The Federal Funds rate for the U.S. has been close to zero since late 2008.

3. Methodology

The impact of a monetary expansion in the U.S., Euro area and China on the Japanese economy is analysed by constructing a structural vector error correction model.

3.1. The variables and data

The variables in the basic model are introduced here. The international variables are the United States (U.S.) monetary aggregate M2 in U.S. dollars (US M\(_2\)), Euro area monetary aggregate M2 in U.S. Dollars (EU M\(_2\)), the Chinese monetary aggregate M2 in U.S. dollars (China M\(_2\)), and oil prices in U.S. dollars (OP). The interest rate for the U.S. (US IR\(_t\)), Euro area (EU IR\(_t\)) and China (Ch IR\(_t\)); the consumer price index (CPI) for the U.S. (US CPI\(_t\)), Euro area (EU CPI\(_t\)) and China (Ch CPI\(_t\)); the industrial production for the U.S. (US IP\(_t\)), Euro area (EU IP\(_t\)) and China (Ch IP\(_t\)).

The domestic variables for Japan include the short-term interest rate (Japan IR\(_t\)), the Japanese monetary aggregate M2 in U.S. dollars (Japan M\(_2\)), the Japanese consumer price index (Japan CPI\(_t\)), the Japanese industrial production (Japan IP\(_t\)), the Japanese nominal and real trade-weighted index (TW\(_t\)), and nominal and real indices for Japanese exports (J Ex), imports (J Im) and trade balance (J Tb).

In extensions of the benchmark model to examine the robustness of results additional variables will be introduced including U.S. dollar indices for global energy prices and global commodity prices, and principal components for interest rates, industrial productions and consumer price indices of the Euro area, the U.S. and China.

M2 is chosen as the measure of monetary aggregate since it is the broadest monetary aggregate available for these four largest economies for the full period 1999:1 to 2011:12 (e.g., Chinese M3 data is not available). Kozluk and Mehrotra (2009) and Johansson (2012) use M2 as the measure of China’s monetary policy. Fan et al. (2011) report that M2 is the key variable for the conduct of monetary policy in China.

The monetary aggregates over the period of analysis capture quantitative easing. Given that interest rates are at low levels, central banks...
have introduced quantitative easing (increasing the monetary base and money supply by buying securities) in an attempt to increase lending and liquidity.6 A short-term interest rate and M2 is included among the variables for Japan. Nakashima and Saito (2012) examine alternative functional forms for money demand in Japan and find that an interest rate semi-elasticity function form is stable for demand for M1 and for M2 plus certificates of deposit.7

The data are monthly from 1999:1 to 2012:12. The sample period is determined by the availability of M2 data for the Euro area with the creation of the European Central Bank and by the observation that the People’s Bank of China started concentrating on balance sheet adjustment for the conduct of monetary policy in 1998 (Johansson, 2012). G4 monetary aggregates and industrial production indexes, Japan’s CPI and short-term interest rate (discount rate), and oil price (West Texas Intermediate crude oil price) data are from the Federal Reserve of St. Louis (FRED). An all commodity price index (U.S. dollar index) is from the World Bank and an index for all energy prices (U.S. dollar index) is from the International Monetary Fund. Japan’s nominal and real trade weighted yen exchange rate, nominal and real exports and imports and the real trade balance are from Central Bank of Japan.8 Monetary aggregates M2 are measured in nominal terms in line with Kim and Roubini (2000) and Koray and McMillin (1999). U.S. dollar amounts are used because the global oil price and commodity price index are U.S. dollar indices.

3.2. Unit root and cointegration

The assumption of the VAR/VEC model requires that all variables in the model must be stationary, or that the linear combinations of non-stationary but cointegrated variables must be stationary. In Table 1 all variables in the model are shown to be first difference stationary.9 For robustness of the analysis, results in Table 1 are presented for both the Augmented Dickey–Fuller (ADF) test, where the null hypothesis is that the variable has a unit root, and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test, where the inverse null hypothesis is tested.10 In line with the quantity theory of money, we test for cointegration relationships among the (log of the) variables prices, money and output for the Japanese economy. Swanson (1998), Bachmeier and Swanson (2005) and Garratt et al. (2009) find evidence of this long-run relationship.

In Table 2, cointegration among the log of Japanese prices (CPI), money (M2) and income (industrial production) is tested using the Johansen cointegration test under different assumptions such as the inclusion of linear and quadratic trend and intercept. Results consistently show that there is a cointegration vector among these variables during the period 1999:1 to 2012:12. Consequently, a SVEC model using an error correction term (ECT) among the log of prices, money and output is preferred, allowing the short and long-term properties of the data to be captured.

3.3. Model and identification strategy

The SVEC model can expressed as:

$$B_0X_t = \beta + \sum_{i=1}^{j} B_i X_{t-i} + \lambda ECT_{t-1} + \sum_{i=1}^{j} \rho_i Z_{t-i} + \epsilon_t$$

where $j$ is the optimal lag length, determined by the Schwarz information criterion (SIC) in this case two lags are selected. $X_t$ is a vector of endogenous variables. $Z_t$ is a vector of country-specific exogenous variables. $B_i$, $\lambda$, and $\rho_i$ are the matrices of coefficients to be estimated. $\epsilon_t$ is the vector of structural changes, which is serially and mutually independent.

The vector $X_t$ can be expressed as:

$$X_t = \begin{bmatrix} \Delta \log(M2_1), \Delta \log(EU M2_1), \Delta \log(CPI_1), \Delta \log(IP_1), \Delta \log(TW1) \end{bmatrix}.$$  

The error correction term ($ECT_t$) is given by:

$$ECT_t = \log(Japan CPI_t) - \alpha - \psi \log(Japan IP_t) - \gamma \log(Japan M2_t).$$

The vector of the country-specific exogenous variables is defined as:

$$Z_t = \begin{bmatrix} US IR_t, EU IR_t, CH IR_t, \Delta \log(US CPI_t), \Delta \log(EU CPI_t), \Delta \log(CH CPI_t) \end{bmatrix}.$$  

We use the industrial production, CPI and the interest rate of China, of the U.S. and of the Euro area as exogenous variables. The variables growth in US M2, Euro area M2 and China M2 appear in the list of exogenous

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6 Quantitative easing has been used because the official nominal short-term interest rates for monetary policy are low and extraordinary actions are believed to be called for. The U.S. Federal Reserve announced QE1 in late November 2008, QE2 in November 2010, and QE3 on 13 September 2012. The European Central Bank has been buying covered bonds, a form of corporate debt. The Bank of Japan announced enormous expansions its asset purchase programme in October 2011 and on April 4, 2013. The latter event is likely to lead to a doubling of the money supply.

7 Nagayasu (2007) uses reserve money as the measure of monetary policy since interest rates have fallen to low levels and finds that monetary expansion depreciates the yen but that this does not seem to expand real growth. Fujiwara (2007) investigates the effect of real balances (real M2 plus certificates of deposit) on real activity in Japan, given that interest rates are at extremely low levels, and finds that money has only a small direct effect in Japan. Hosono (2006) examines in detail the bank balance sheet mechanism by which monetary policy is transmitted in Japan.

8 The yen’s trade-weighted index is calculated using the weighted geometric average of the yen’s exchange rates against 15 major currencies. The weights are based on the average of Japan’s relative exports to trading partners. The real trade balance is defined by the Bank of Japan as real exports minus real imports denominated in 2010 prices, indexed so that for the base year 2010 the real trade balance is equal to 100.

9 Note that Japanese interest rate is not included in the table because the interest rate is already expressed in percentage. Interest rate is widely used in the macroeconomic literature without further transformations.

10 Results are also supported by the Dickey Fuller GLS (DF-GLS) and the Phillips-Perron (PP) which are available upon request.
variables. With industrial production and the interest rate of China, of the U.S. and of the Euro area taken as exogenous, shifts in the demand for money in China, the U.S. and the Euro area are isolated. Thus, shifts in the foreign money variables in Eq. (1) reflect changes in the supply of money.

Non-recursive contemporaneous restrictions are preferred in this study in line with Sims and Zha (1995), Kim and Roubini (2000) and Kim (2001). In particular our identification scheme is based on Kim and Roubini (2000), to the extent possible. Restrictions are only imposed in the contemporaneous matrix $B X_t$ as:

$$
B X_t = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & -\phi_4 & 0 & 0 & -\phi_7 & -\phi_{10} \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & -\phi_7 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & -\phi_8 & -\phi_4 & -\phi_5 & -\phi_6 & -\phi_{10} & 1 \\
\end{bmatrix}
$$

In this system, the three international monetary aggregates, the U.S., Euro area and Chinese M2 and oil prices are treated as contemporaneously exogenous assuming some information delay from international to domestic variables. Consistent with Kim and Roubini (2000), and following Sims and Zha (1995), the central bank reaction function (the fourth equation in system 4) only responds contemporaneously to domestic monetary aggregates, nominal exchange rate and oil prices as information regarding other variables are not available within a month.

In the fifth line of the Eq. (5) restrictions are in line with Kim (1999 and 2001) and Kim and Roubini (2000), implying that demand for real money depends on both real income and nominal interest rate. Or more generally in the setup in Eq. (5), nominal demand for money a function of real income and interest rate and CPI. Restrictions in both the inflation and output equations (sixth and seventh equation respectively) are standard in the economic literature assuming that oil prices affect these variables in the same period, as oil is crucial inputs for many sectors.11 Kim and Roubini (2000), Kim (1999) and Kim (2001) treat oil prices and/or commodity prices as contemporaneously exogenous. The exchange rate equation is affected contemporaneously by all other variables as international exchange rate operators may arbitrage daily with all available information.

To evaluate the transmission mechanisms from the international monetary variables to the Japanese economy, we follow Kim (2001) in adding one variable at the time to the system presented in Eqs. (1)–(5). These variables will include Japanese real exports, real imports and real trade balance.

3.4. Test of stability, heteroskedasticity and stability condition

To test for autocorrelation the residual serial correlation LM test is carried out and p-values results estimated. The null hypothesis of no serial correlation cannot be rejected at conventional levels for the model set out in Eqs. (1) to (4) and for the alternatives specifications introduced later. Therefore autocorrelation does not seem to be a problem in these models. Results are also confirmed by both the VAR residual cross-correlation (correlograms) and by theVAR residual Portmanteau test for autocorrelation.

To test for heteroskedasticity, the VAR residual heteroskedasticity test is performed. In this test, all possible combinations of error term products are used as dependent variables. The null hypothesis of no heteroskedasticity cannot be rejected at 5% level for the joint hypothesis of all combinations for our models. The White heteroskedasticity test either using no cross terms and cross terms also confirms the previous results. Therefore, the hypothesis of heteroskedasticity in our models is discounted.

The stability condition for the VEC model, with r co-integrating equation and k endogenous variables, requires that at most k-r roots should be equal to unity, while the other roots must lie inside the unit root circle.12 Consequently, the inverse roots of the characteristic AR polynomial test are performed for each model. These tests find that this condition is satisfied for all model presented in this investigation.

3.5. Summary of methodology

In summary, a structural vector error correction model is used as the benchmark model to analyse the impact of a monetary expansion in the U.S., Euro area and China on the Japanese economy. This model builds on Kim and Roubini (2000) and uses a mix of stationary and non-stationary variables to incorporate the co-integration relationship among non-stationary variables. The selection of variables and identification restrictions in the model is based on Sims and Zha (1995) and Kim and Roubini (2000) to the extent possible given that the effects of U.S., Euro area and China monetary policy shocks on the Japanese economy are the focus of the analysis.

4. The empirical results

4.1. The impulse response effects of the structural monetary shocks

Fig. 7 shows the dynamic response (or impulse response function) of the Japanese short-term interest rate, M2, consumer price index, industrial production index, oil price index, and the nominal effect trade-weighted yen exchange rate, in the SVEC in Eqs. (1)–(5) to impulse...

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11 These restrictions have been also been used by Gordon and Leeper (1994), Sims and Zha (2006), Christiano et al. (1999) and Kim (1999).

12 For more detail see Enders, Applied Econometric, p. 266.
response to monetary shocks in China, the U.S. and the Euro area. The dashed lines represent a one standard error confidence band around the estimates of the coefficients of the impulse response functions. The first, second, and third columns show the responses of Japanese variables to structural innovations in China M2, Euro area M2, and U.S. M2, respectively.

4.1.1. The effect of shock to China M2

In the first row in Fig. 7, the short-term Japanese interest rate rises significantly and Japan’s M2 tends to fall with positive shocks in M2 in China. This response is consistent with the effects of China’s M2 being expansionary for the Japanese economy. In the third row in Fig. 7, a positive shock to China’s M2 results in a rise in Japan’s CPI that is statistically significant after three months. The magnitude of the rise in the CPI is gradually increasing. This effect on the CPI will be seen to be connected with the outcome of shocks to China’s M2 on oil and commodity prices.

Japan’s industrial production is positively and significantly impacted by positive shocks to China’s M2. This result will be related to the effect on Japan’s real exports of shocks to China’s monetary aggregate. The effects of shocks to China’s M2, on international oil price are shown in the fifth row in Fig. 7. A positive innovation in China’s M2 has a statistically significant positive effect on oil prices that rapidly builds up over four or five months and then gradually increases in magnitude over 20 months. A positive shock in China’s M2 has a statistically significant negative effect on the nominal trade-weighted yen from impact. This effect would raise the price of imports in Japan and reinforce the effect on the Japanese consumer prices of the effect positive innovations in China’s M2 on the U.S. dollar price of oil.

The significant effect of shocks to China’s M2 on the nominal trade-weighted yen exchange rate requires further discussion. A rise in China’s M2 facilitates domestic growth in China and increases China’s demand for imports. The currencies of the countries supplying imports to China experience upward pressure. To stabilize the pegged exchange rate, China intervenes in the foreign exchange market and sells foreign currency. The net effect of these actions on the nominal trade-weighted yen exchange rate depends on the mix of imports, and the mix of foreign currencies sold in the foreign exchange market. The latter will be influenced by the weights assigned to currencies in the reference basket of major currencies to which the renminbi is allowed to float within a narrow margin. It is found as an empirical result that the net effect of China’s actions following a positive innovation in China’s M2 is a decrease in the nominal trade-weighted yen exchange rate.

4.1.2. The effect of shock to Euro area M2

In column 2 of Fig. 7, the short-term Japanese interest rate does not respond significantly to an innovation in Euro area M2. Japan’s M2 tends to rise with positive shocks in M2 Euro area. Japan’s CPI and industrial production are not significantly affected by shocks in Euro area M2. A positive shock in Euro area M2 has a positive effect on oil prices, but the effect is small and only marginally statistically significant. A positive shock in Euro area M2 has a negative effect on the nominal trade-weighted yen, but the effect is only statistically significant in the fourth month. Monetary expansion in the Euro area does not significantly affect Japan.

4.1.3. The effect of shock to U.S. M2

The short-term Japanese interest rate falls significantly to innovations in the U.S. M2. This latter result is consistent with a defensive response by the U.S. that weakens the dollar and makes Japanese goods more expensive in the U.S. In the second row of Fig. 7, Japan’s M2 tends to fall with a positive shock in M2 in the U.S. In Fig. 7, a positive shock to U.S. M2 results in a fall in Japan’s CPI that becomes statistically significant after seven months. In the fourth row in Fig. 7, Japan’s industrial production is negatively and significantly impacted by positive innovations in U.S. M2. These results will be related to the effect on Japan’s real exports of shocks to each of the countries’ monetary aggregates. A shock in U.S. M2 has a statistically insignificant effect on global oil prices. The response of the nominal trade-weighted Japanese yen exchange rate to a positive shock to U.S. M2 is initially positive (the value of the yen is increased) but is not statistically significant. U.S. monetary expansion results in contraction in real activity in Japan, or the dominance of an expenditure-switching effect.

4.2. Responses of Japan’s trade variables to monetary shocks

The impact of monetary shocks originating in the U.S., China and the Euro area on Japanese trade variables will be now examined. Following a procedure in Kim (2001) the Japanese real exports, real imports and real trade balance are now added one variable at a time as an additional variable in the SVEC system in Eqs. (1)–(5). The first, second, and third columns in Fig. 8 show the responses of Japanese variables to an impulse response in China M2, Euro area M2, and U.S. M2, respectively.

A positive shock to China’s M2 significantly expands Japan’s real exports in Fig. 8. The rise in Japan’s real exports builds up rapidly over
five or six months and then persists. The effects of shocks to China M2 on Japan’s real imports are not statistically significant. Japan’s real trade balance shows a statistically significant large positive response to positive shocks in China’s M2. In Fig. 8 a positive shock in China’s M2 has a statistically significant negative effect on the real trade-weighted yen that persists. This is consistent with large positive increase in Japanese real exports attendant on depreciation of trade-weighted yen following a positive shock in China’s M2 and with Japan’s real imports being price inelastic. Kim (2001) and Huang et al. (2014) argue that capital controls in China imply that the means by which Chinese monetary expansion impacts other economies is through trade, a view confirmed by our analysis of effects for Japan.

A positive shock in Euro area M2 does not significantly impact Japan’s real exports, and has a small negative effect on Japan’s real imports that is statistically significant in months 3 through 6 following the shock. A positive shock in Euro area M2 has a significant positive impact Japan’s real trade balance, but the effect is smaller than that observed from shocks to China M2.

A positive shock to U.S. M2 has statistically significant negative effects on Japan’s real exports and on Japan’s real imports in Fig. 8. A positive shock to U.S. M2 has a statistically significant negative effect on Japan’s real trade balance. The response of the real trade weighted Japanese yen to positive shocks to U.S. M2 is not statistically significant.

The results of U.S. monetary expansion for Japan can be contrasted with those obtained by Kim (2001) for the flexible exchange rate period 1974–1996. Kim (2001) finds that monetary expansion in the U.S. causes a reduction in interest rates and boom in the non-U.S. G-6 (in that GDP and industrial production increase in those countries). The trade balances of the non-U.S. G-6 with the rest of the world are not significantly affected by U.S. monetary expansion, indicating that income–absorption is important. Kim (2001) concludes that the boom in non-U.S. G-6 is due to the fact that the stimulative effect of the decline in non-U.S. G-6 interest rates attendant on U.S. monetary expansion. Grilli and Roubini (1995), Canova (2005), Di Giovanni and Shambaugh (2008), and Kazi et al. (2013) also find that monetary expansion in the U.S. occasions a stimulative effect on other economies through precipitating declining interest rates.

The results for the effects of U.S. monetary expansion on Japan over 1999–2012 are very different from those reported for the period 1974–1996 during which positive U.S. monetary shocks have expansionary
effects on the Japanese economy. Potential reasons for this difference in results include the U.S. economy not being as dominant as it once was, that the Japanese economy has been in depressed state for an extended period, and that the potential for big effects on income through a fall in Japan’s interest rate being precluded by Japan’s interest rate being already at low levels.16

4.3. Variance decomposition results

An important question concerns how much of the variation in Japanese trade weighted yen, exports, imports, and trade balance is explained by China M2, Euro area M2 and US M2. Decomposition of the forecast error variance into components provides insight on the percent contribution of the structural shocks to the variation of important Japanese trade variables, and can validate the results of the impulse response functions (Cover and Mallick, 2012).

Table 4 panel reports the fraction of forecast error variance decomposition (FEVDs) of Japan’s real exports. China M2, Euro area M2 and US M2 each make statistically significant contributions to forecasting the variation in Japan’s real exports that vary substantially in size. The contribution of China’s M2 explains only 2.56% of the variation in Japan’s real exports in the first month, but a statistically significant 10.21% of the variation in Japan’s real exports at the sixth month horizon. This fraction remains constant thereafter and is 10.25% at the 24 month horizon. In contrast, the Euro area M2 and US M2 each make much smaller contributions (of the order of 2.09% to 3.70%) to forecasting the variation in Japan’s real exports, that only become statistically significant at either the 12th or 24th months.

With regard to forecasting the variation in Japan’s real imports, China M2, Euro area M2 and US M2 explain only 2.68%, 2.58% and 1.31%, respectively, at the 24 month horizon. Only China M2 and Euro area M2 contributions to forecasting the variation in Japan’s real imports at the 24 month horizon are statistically significant.

In Table 4 the fraction of forecast error variance of Japan’s real trade balance at the 24 month horizon due to China M2, Euro area M2 and US M2, are 19.82%, 0.01% and 12.03%, respectively.17 The contributions by both China M2 and US M2 are statistically significant. In Table 4, China M2 explains a statistically significant 7.94% of forecast error variance of Japan’s real traded weighted value of the Japanese yen at the 24 month horizon. Euro area M2 and US M2 forecast much smaller fractions of variance of real trade weighted Japanese yen at 24 months. Only 2.90% and 1.16% forecast error variance of real trade weighted value of the Japanese yen at the 24 month horizon for Euro area M2 and US M2, respectively.18

16 Ono (2006) argues that Japan’s stagnation and decline in the marginal utility of consumption relative to that of liquidity is associated with appreciation of the yen relative to dollar, and decline in home output and increase in foreign output.

17 The first difference in Japan’s real trade balance does not exhibit autocorrelation, hence the low value of own variable contribution to the fraction of forecast error variance of Japan’s real trade balance after the first month.

18 Results on variance decomposition for Japan’s exports, imports, trade balance and trade weighted value of the yen do not differ greatly on whether these variables are in nominal or real terms, probably owing to the flatness of the Japanese consumer price index over the period of analysis.

---

**Table 1**

<table>
<thead>
<tr>
<th>Endogenous variables</th>
<th>Variables</th>
<th>ADF</th>
<th>KPSS</th>
<th>First difference</th>
<th>ADF</th>
<th>KPSS</th>
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</thead>
<tbody>
<tr>
<td>log(US M2)</td>
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<td>1.79***</td>
<td>1.08***</td>
<td>0.09</td>
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<td></td>
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<tr>
<td>log(China M2)</td>
<td>0.37</td>
<td>1.62***</td>
<td>2.94***</td>
<td>0.73*</td>
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<td></td>
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<tr>
<td>log(EU M2)</td>
<td>0.30</td>
<td>1.24***</td>
<td>1.28***</td>
<td>0.25</td>
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<td></td>
</tr>
<tr>
<td>log(J M2)</td>
<td>0.33</td>
<td>1.35***</td>
<td>1.28***</td>
<td>0.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>log(J CPI)</td>
<td>-2.24</td>
<td>0.94***</td>
<td>-2.76***</td>
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<td></td>
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<tr>
<td>log(J IP)</td>
<td>-2.52</td>
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<td>log(US IP)</td>
<td>-2.43</td>
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<tr>
<td>log(J NTWI)</td>
<td>1.71</td>
<td>0.58**</td>
<td>-9.15***</td>
<td>0.08</td>
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</tbody>
</table>

Notes: The variables are US M2, China M2, Euro area M2 (EU M2), Japan M2 (J M2), Japan consumer price index (J CPI), Japan industrial production (J IP), global oil price (OP), and nominal trade weighted exchange rate index of the Japanese yen (foreign/domestic (J NTWI)). The null hypothesis for the Augmented Dickey–Fuller (ADF) test is the variable has a unit root and the null hypothesis for the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test is the variable is stationary. The first difference of the series is indicated by Δ. The lag selection criteria for the ADF is based on Schwarz information Criteria (SIC) and for the KPSS is the Newey–West Bandwidth. ***, **, * indicates rejection of the null hypothesis at 1%, 5% and 10%, levels of significance.

---

**Table 2**

<table>
<thead>
<tr>
<th>Variables: log(J IP), log(J M2), log(J CPI)</th>
<th>Data trend</th>
<th>None</th>
<th>None</th>
<th>Linear</th>
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<th>Quadratic</th>
<th>Intercept</th>
<th>Trend</th>
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</thead>
<tbody>
<tr>
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<td>No trend</td>
<td>No trend</td>
<td>Intercept</td>
<td>No trend</td>
<td>Intercept</td>
<td>Trend</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Trace</td>
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<td>1</td>
</tr>
<tr>
<td>Max-Eig</td>
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<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Notes: *Critical values based on MacKinnon et al. (1999).
5. Robustness checks

In this section several changes are made to the model in Eqs. (1) through (5) to examine the robustness of results. These modifications include variation in lag length, alternative contemporaneous restrictions, different global commodity and energy price indices, the impact of the global financial crisis, changed interactions between foreign and domestic variables, and comparison of results from a structural factor-augmented vector error correction (SFAVEC) model.

5.1. Lag length

First, we check the sensitivity of our results to the lag selection strategy for the autoregressive process in the SVEC model from Eqs. (1) to (5). In our benchmark estimation (model described in Section 3.3), we used 2 lags based on the Schwarz information criterion. An alternative popular lag selection strategy is to use the Akaike Information Criterion (AIC). In our model this criterion selects 3 lags. We re-estimate the model using 3 lags and report results in Fig. 9. Results are very similar with 3 lags to results obtained from the benchmark model with 2 lags. In Fig. 9 standard error bands around the impulse response function are not shown because of the large number of results being reported.

5.2. Contemporaneous restrictions

Different contemporaneous restrictions could potentially lead to changes in results. Given that in this investigation we are introducing the use of different international monetary aggregates, it is sensible to consider the use of different international monetary aggregates, it is sensible to examine the robustness of results. These modifications include variation in lag length, alternative contemporaneous restrictions, different global commodity and energy price indices, the impact of the global financial crisis, changed interactions between foreign and domestic variables, and comparison of results from a structural factor-augmented vector error correction (SFAVEC) model.

In Eq. (6), all monetary aggregates (international and domestic) contemporaneously affect each other. In Eq. (7), the international monetary aggregates (in addition to Japan’s M2) affect contemporaneously the trade weighted Japanese yen. The log likelihood ratio test for over-identified restrictions supports the restrictions selected in Eq. (5) (with highest p-value from the Chi-square distribution). In Table 3, the log likelihood ratios for over-identification test p-values are reported for the three models shown in Eqs. (5), (6) and (7). The highest p-value for over-identification test restriction is for our model of choice in Eq. (5), indicating that the restriction cannot be rejected at a higher significance level than for the other models. The models based on the restrictions in Eqs. (6) and (7) are re-estimated and results are obtained that are very similar to results obtained from the benchmark model in Eq. (5). The results for the model based on Eq. (7) are reported in Fig. 9.

5.3. Global commodity and energy price indices

In modelling macroeconomic interaction for an economy, Dedola and Lippi (2005) utilize a commodity price index rather than oil price index. Impulse response results from using a global commodity price index (or a global energy price index) instead of oil price in the SVEC system described in Eqs. (1) to (5) are very similar to those already reported in Fig. 7. In Fig. 9 the response of global commodity price index is reported when this index replaces oil price in the Eqs. (1) to (5). The response of global energy price index to the international monetary shocks is not reported to avoid cluttering the figures.

A positive innovation in China’s M2 has a statistically significant positive effect on global commodity prices that rapidly builds up over four or five months and then persists. A positive shock in Euro area M2 has positive and statistically significant effects on global commodity price that persists. A shock in U.S. M2 has a statistically significant effect on global commodity oil prices in the first month and the effect thereafter is statistically insignificant.

5.4. Global financial crisis

Several aspects of the behaviour of macroeconomic variables have interesting characteristics during the global financial crisis (GFC). Perri and Quadrini (2011), for example, document unprecedented business cycle synchronization among the developed countries during the last two quarters of 2008.\(^{19}\) China is not included in their analysis and did not experience the recession that was so marked among the developed countries. To investigate whether recognition of the global financial crisis affects results in our analysis, we introduce an exogenous dummy variable that takes the value 1 from July 2008 to December 2008 and 0 otherwise into Eq. (1). The model benchmark model with the restrictions in Eq. (5) and inclusive of the dummy variable for the GFC is estimated. Results are analogous to outcomes obtained from the benchmark model without the variable for the GFC. The results for the model with the GFC variable are reported in Fig. 9.

5.5. Interaction among foreign and domestic economies

In Eq. (1), non-Japanese (foreign) industrial productions and non-Japanese interest rates are taken as exogenous. Consequently the model restricts interaction between non-Japanese industrial productions and interest rates and with the variables in the (Japanese) domestic economy. In this section we use foreign industrial productions and interest rates in the model as endogenous variables, so as to

\(^{19}\) Perri and Quadrini (2011) find that the last two quarters of 2008 stands out in the post-war era in terms of GDP falling by so much and in all countries G7 countries (the U.S., Japan, Germany, U.K., France, Italy and Canada). The correlation of GDP movements among the developed countries during the last two quarters of 2008 jumped from 0.3 to 0.7 and the sample standard deviation of the correlations fell from 0.19 to 0.09.
Fig. 7. Impulse responses of Japanese economic variables to one standard deviation innovations in China M2, Euro area M2, and U.S. M2. Notes: The variables are U.S. M2, China M2, Euro area M2 (EU M2), Japan M2, Japanese industrial production (Japan IP), Japanese consumer price index (Japan CPI), oil prices, short-term Japanese interest rate (Japan IR), nominal trade-weighted Japanese currency foreign exchange rate (Japan TWI). The confidence bands are obtained using Monte Carlo integration as described by Sims (1980), where 5000 draws were used from the asymptotic distribution of the VAR coefficient.
allow for interaction of foreign and domestic variables. To specify this alternative model we estimate a 15-endogenous-variable SVEC model where the U.S., Euro area and China interest rates (industrial productions) are placed ahead of (placed after) U.S., Euro area and China M2 aggregates in Eq. (5) in the same equation. In this model (non-Japanese), foreign variables only interact in the lag structure as the test for over identify restrictions confirms these variables as contemporaneously exogenous to the (Japanese) domestic variable.

The model 15-endogenous-variable SVEC is estimated and impulse response results reported in Fig. 9. Impulse response results are similar to results obtained from the benchmark model in Eq. (5). Not shown are the much wider standards errors band around the impulse response functions from 15-endogenous-variable SVEC. The extra width is most likely owing to the loss of degrees of freedom with the addition of 6 endogenous variables in the model.

5.6. The SFAVEC model

Bernanke et al. (2005) propose a factor-augmented VAR (FAVAR) to identify monetary policy shocks, based on the work of Stock and Watson (2002) using principal components analysis to identify macroeconomics factors. A small number of variables in a VAR may not span the information set used by market participants which may include hundreds of data series. A set of factors can summarize large amounts of information about an economy and be included in a VAR.

In the literature, the international transmission mechanism of macroeconomic shocks has been studied using both FAVAR and global VAR (GVAR) models. We favour the use of a FAVAR model since a FAVAR is preferred when the number of domestic variables examined is large. In line with this view, Kamber et al. (2013) argue that in the GVAR while the country dimension is large, the number of variables which can be inspected in each domestic country is restricted.

Fig. 8. Impulse responses of Japanese real exports, imports, trade balance and trade weighted exchange rate to one standard deviation innovations in China M2, Euro area M2, and U.S. M2. Notes: The variables are U.S. M2, China M2, Euro area M2 (EU M2), Japan M2, Japan’s real exports (J Ex), Japan’s real imports (J Im), Japan’s real trade balance (J Tb), and real trade weighted exchange rate index of the Japanese yen (J TWI). The confidence bands are obtained using Monte Carlo integration as described by Sims (1980), where 5000 draws were used from the asymptotic distribution of the VAR coefficient.
The use of a FAVAR model measuring international macroeconomic transmission is strongly supported by the literature. Mumtaz and Surico (2009) use a FAVAR model to investigate the transmission of international shocks of other industrialized economies to the UK economy. Adopting a FAVAR approach, Eickmeler et al. (2011) study the international transmission of US financial shocks to nine major advanced economies. Mumtaz and Surico (2012) investigate the transmission of international inflation shocks to a domestic economy (the UK) using this framework. Kazi et al. (2013) examine the changing international transmission of the U.S. monetary shocks to OECD countries with a FAVAR approach.

Based on the Stock and Watson (2002) and Bernanke et al. (2005) models, we consider a structural factor-augmented vector error correction model (SFAVEC) as an alternative to the benchmark SVEC and as a further way of examining the robustness of results. Eq. (1) can be replaced by Eq. (8):

$$\beta_0 X_t = \beta + \sum_{i=1}^{I} B_i X_{t-i} + \lambda ECT_{t-1} + \sum_{i=1}^{I} \rho_i C_{t-i} + \epsilon_t$$  \hspace{1cm} (8)

where $C_i$ is a vector of the following factors:

$$FIR_t = [I_{IR}^{EU}, I_{IR}^{US}, I_{IR}^{CH}]$$ \hspace{1cm} (9)

In Eqs. (9) through (11), $FIR_t$, $FY_t$, and $FCPI_t$ are unique factors (principal components) for the interest rates, industrial production index, oil price index, and the nominal effect trade-weighted yen exchange rate, in the SFAVEC in Eqs. (2), (3), (5) and (8) to impulse response to monetary shocks in China, the U.S. and the Euro area. The dashed lines represent a one standard error confidence band around the estimates of the coefficients of the impulse response functions. Impulse response results are very similar to those in Fig. 7 for the benchmark SVEC (Eqs. (1) through (5)). One quantitative difference is the much larger positive impact of China’s M2 on Japan’s industrial production in the SFAVEC model. This finding reinforces the overall conclusion in the paper that expansion of China’s M2 generates a powerful income absorption effect for Japan.

5.7. The short-term model (SFAVAR)

In this section, we replicate the model in Section 5.6 in Eq. (8), but omitting the error correction term. In this way, only the short-term structure or structural factor-augmented vector autoregressive process (SFAVAR) is modelled. This extension is undertaken since, with a sample of fourteen years, the time period for the application of cointegration techniques may not be enough to effectively study the long run relationship among the variables. It should be noted however, that examination of

$$FY_t = [I_{IR}^{EU}, I_{IR}^{US}, I_{IR}^{CH}]$$ \hspace{1cm} (10)

$$FCPI_t = [CPI_{IR}^{EU}, CPI_{IR}^{US}, CPI_{IR}^{CH}]$$ \hspace{1cm} (11)

In Eqs. (9) through (11), $FIR_t$, $FY_t$, and $FCPI_t$ are unique factors (principal components) for the interest rates, industrial production index, oil price index, and the nominal effect trade-weighted yen exchange rate, in the SFAVEC in Eqs. (2), (3), (5) and (8) to impulse response to monetary shocks in China, the U.S. and the Euro area. The dashed lines represent a one standard error confidence band around the estimates of the coefficients of the impulse response functions. Impulse response results are very similar to those in Fig. 7 for the benchmark SVEC (Eqs. (1) through (5)). One quantitative difference is the much larger positive impact of China’s M2 on Japan’s industrial production in the SFAVEC model. This finding reinforces the overall conclusion in the paper that expansion of China’s M2 generates a powerful income absorption effect for Japan.
Fig. 9. Robustness analysis. Impulse responses to one standard deviation innovations in China M2, Euro area M2, and U.S. M2 for a range of SVEC models. Notes: Variables include short-term Japanese interest rate (Japan IR), industrial production (Japan IP), consumer price index (Japan CPI), oil prices, and nominal trade-weighted Japanese yen (Japan TWI). Impulse responses to one standard deviation innovations China M2, Euro area M2 (EU M2), and U.S. M2 shocks for different models including: benchmark model in Eq. (5), variation in lag length, alternative contemporaneous restrictions given in Eq. (7), for global commodity price instead of oil price, the inclusion of dummy variable for impact of the global financial crisis, and changed interactions between foreign and domestic variables. Confidence bands are not shown.
Fig. 10. SFAVEC model impulse responses to one standard deviation innovations in China M2, Euro area M2, and U.S. M2. Note: The variables are U.S. M2, China M2, Euro area M2 (EU M2), Japan M2, Japanese industrial production (Japan IP), Japanese consumer price index (Japan CPI), oil prices, short-term Japanese interest rate (Japan IR), nominal trade-weighted Japanese yen (Japan TWI). The confidence bands are obtained using Monte Carlo integration as described by Sims (1980), where 5000 draws were used from the asymptotic distribution of the VAR coefficient.

In Fig. 11, we show cumulative impulse response functions from the SFAVAR model of the impact of monetary shocks in China, the U.S. and the Euro area to Japanese real exports, real imports, real trade balance and real TWI of the yen. These results from the SFAVAR model are for the most part similar to the results reported in Fig. 8 for the SFAVEC model. A difference between Fig. 8 and Fig. 11 is that the response of Japanese real imports to monetary shocks in China, the U.S. and the Euro area now exhibit much larger standard errors. We also replicate the impact of monetary shocks in China, the U.S. and the Euro area on the Japanese interest rate, M2, CPI, Industrial production, and on oil prices and the TWI of the yen. We find that results from the SFAVAR model are similar to the results reported in Fig. 7 for the SFAVEC model. To conserve space these results not shown and are available from the authors.

5.8. The great moderation and great recession periods

In this section, we examine the robustness of results with the inclusion of a dummy variable for the period of the great moderation. The period of the great moderation is followed by the great recession. These periods capture extraordinary events and the relationship between variables

![Fig. 11. SFAVAR model: Impulse responses of Japanese real exports, imports, trade balance and trade weighted exchange rate to one standard deviation innovations in China M2, Euro area M2, and U.S. M2. Notes: The variables are U.S. M2, China M2, Euro area M2 (EU M2), Japan M2, Japan’s real exports (J Ex), Japan’s real imports (J Im), Japan’s real trade balance (J Tb), and real trade weighted exchange rate index of the Japanese yen (J TWI). The confidence bands are obtained using Monte Carlo integration as described by Sims (1980), where 5000 draws were used from the asymptotic distribution of the VAR coefficient.](image-url)
may well change with consideration of the dummy variable. We follow Gadea-Rivas and Gomez-Loscos (2014), Williams and Taylor (2009) and Taylor (2011, 2012) and identify the end of great moderation period to be December, 2007. The balance of the data from January 2008 onwards, coincides with the definition of the great recession period in Gadea-Rivas and Gomez-Loscos (2014). The dummy variable with value 1 up to December 2007, and zero otherwise, captures the difference between the great moderation and great recession periods. The dummy variable is introduced into each equation in our SVEC, SFAVEC and SFAVAR models. In Table 5 the coefficients of the dummy variables are reported. In the first column the independent variable/equation are listed. In columns 2, 3 and 4, we show the coefficients for the dummy variable for the SVEC, SFAVEC and SFAVAR models, respectively. In general, the coefficients for individual equations are not statistical significant (or only marginally significant at 10% level in five cases and significant at 5% level in one case out of 27 cases). With the dummy variables in place, we re-estimate the cumulative impulse response functions for the SVEC, SFAVEC and SFAVAR models. We find that our results for cumulative impulse response functions with the dummy variable in the models do not appreciably change from the previously reported results without the dummy variable in the models. To economize on space these results are not reported and are available upon request.

6. Conclusions

Structural vector error correction and factor-augmented models are used to examine international monetary transmission to Japan from U.S., China and the Euro area. It is found that over 1999:1-2012:12 China's monetary expansion has significant effects on Japan's economy that are quite different from those of the U.S. and Euro area. Monetary expansion in China affects Japan primarily through trade. The income absorption effect of China's monetary expansion is substantial for Japan. Capital controls provide room for monetary policy independence in China even though the exchange rate is pegged (either to the U.S. dollar or to a basket of major currencies). In all models China's monetary expansion is associated with statistically significant increases in Japan's real exports, trade balance and industrial production, and with statistically significant decreases in the trade-weighted value of the yen. After 24 months, monetary expansion in China forecasts 20% of the variation in Japan's real trade balance.

In contrast, our results suggest that U.S. monetary expansion leads to a worsening in the Japanese real trade balance (the expenditure switching effect), with real exports falling more than real imports, and a fall industrial production. An income absorption effect (if any) does not offset expenditure switching. A statistically significant fall in the Japanese interest rate is associated with a positive shock in U.S. M2, but the impulse results overall suggest that U.S. monetary expansion has a depressing effect on the Japanese economy over the 1999–2012 period.

It is found that positive shocks to Euro area M2 are not significantly associated with movement in Japan's short-term interest rate, industrial production, inflation, or real exports. In response to positive shocks to Euro area M2 there is depreciation of the trade weighted yen and an improvement in Japan's real trade balance, but effects on Japanese trade are small compared to those from monetary expansion in China. Important developments such as the creation of the Euro area in 1999, the growing importance of the Chinese economy, and developments in trade and international finance have contributed to greater interconnectedness within the global economy over the last two decades. The four largest economies, of comparable size, the U.S., Euro area, Japan and China, currently comprise about 65% of the world economy. The policy implication of economic model in our paper is that Chinese and U.S. monetary expansion have noticeable and different impacts on the Japanese economy in recent years. Expansion of China's M2 generates a powerful income absorption effect. Consequently, policymakers, forecasters and modelers have to consider this issue when considering potential external influences in Japanese economy analyses and by extension economic and policy analysis of other countries.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.econmod.2015.10.019.

References


Table 5

SVEC, SFAVAR and SFAVEC models with dummy variables for the period of great moderation (January 1999 to December 2007).

<table>
<thead>
<tr>
<th>Model/equation</th>
<th>SVEC</th>
<th>SFAVEC</th>
<th>SFAVAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>US M2</td>
<td>0.0050 (0.0030)</td>
<td>0.0002 (0.0016)</td>
<td>0.0015 (0.0018)</td>
</tr>
<tr>
<td>EU M2</td>
<td>0.0128 (0.0072)</td>
<td>0.0071 (0.0038)</td>
<td>0.0104 ** (0.0052)</td>
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<tr>
<td>China M2</td>
<td>0.0016 ** (0.0011)</td>
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<td>0.0014 ** (0.0006)</td>
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<td>Japan IR</td>
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<td>Japan CPI</td>
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</tr>
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</tr>
<tr>
<td>OP</td>
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<tr>
<td>Japan IP</td>
<td>0.0003 (0.0003)</td>
<td>0.0035 (0.0025)</td>
<td>0.0015 (0.0027)</td>
</tr>
</tbody>
</table>

Notes: A dummy variable with value 1 up to December 2007, and zero otherwise, is introduced into each equation in the SVEC, SFAVEC and SFAVAR models. The variables are US M2, Euro area M2 (EU M2), China M2, Japan M2, Japan consumer price index (CPI), Japan industrial production (IP), global oil price (OP), and nominal trade weighted exchange rate index of the Japanese yen (foreign/domestic) (Japan TWI). The coefficients of the dummy variables are reported with standard error in parentheses. * and ** indicate statistical significance at 10%, 5% level of significance.

20 Whether the results on China’s monetary expansion for Japan would be observed with respect to China’s monetary expansion for other advanced economies is unclear. The empirical outcome would depend in part on the response of the relevant exchange rate and exports to monetary expansion in China. However, as long as China’s capital controls remain in place, the primary way in which monetary expansion in China would affect other advanced economies is likely to be through trade.


