

論 文

Japanese Monetary Policies and Spillovers to Asia: A Global VAR Approach

Robert DEKLE*

Abstract

I examine the impact of Japanese expansionary monetary policies on its Asian neighbors through the lens of the global vector autoregression model. In the short-run, I find that more stimulative Japanese monetary policies—as measured by an increase in Japanese base money—negatively impacts on the GDPs of Korea, China, and Thailand. In the medium- and longer-runs, the expansion of Japanese base money has a positive effect on the GDP of Thailand, no effect on China, and a somewhat negative effect on the GDP of Korea.

JEL Codes: F36, F32, F35

Keywords: International Spillovers, Unconventional Monetary Policies

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日本の金融政策とアジアへの波及： グローバル VAR モデルによるアプローチ

Robert Dekle

〈要旨〉

本稿では、日本の拡張的金融政策がアジアの近隣諸国に与える影響について、GVAR (Global Vector Autoregression Model) を用いて検証している。分析の結果、マネタリーベースの拡大を日本の景気刺激的な金融政策ショックと定義するならば、これは、短期的に韓国、中国、タイの GDP を押し下げる効果があることが分かった。一方で、中長期的にみると、タイの GDP にはプラス、中国の GDP には中立、韓国の GDP には若干のマイナスの影響がみられる。

JEL 分類コード：F36, F32, F35

キーワード：国際的波及効果、非伝統的金融政策

1 . Introduction

Since the financial crisis of 2009, many countries have embarked on extremely loose monetary policies. Short-term interest rates have been cut to zero, and central banks have purchased government bonds and other assets in massive quantities. These measures that expanded Central Bank balance sheets are collectively called "Quantitative Easing" policies. While many studies have examined the impact of quantitative easing policies on the domestic Japanese economy (Hoshi, 2014; Rogers and Wright, 2014), few studies have analyzed the manner in which quantitative easing policies have affected Japan's neighboring economies are scarce.

One of the few studies examining spillover effects on neighboring countries is that by Dekle and Hamada (2015). The authors examine how monetary shocks in Japan and in the U.S. affect each other. Furthermore, they examined short-term interest rate and base money changes in Japan and in the U.S. to investigate how GDP growth rates and inflation rates in each country are affected. The authors use a sequence of two-country nonstructural vector autoregression (VARs) to show, the effects of changes in short-term interest rates and monetary base stocks. They find that an expansionary monetary policy in the U.S. appreciates the Japanese yen and impacts Japanese GDP for approximately three quarters, after which point Japanese GDP began to grow, owing to the expansion of U.S. GDP. An expansionary Japanese monetary policy has a small negative effect on the U.S. economy in the short-run, because of the appreciation of the dollar, and a small positive effect on U.S. GDP growth in the long-run, because of the expansion of Japanese GDP, which stimulated U.S. exports to Japan.

However, changes in Japanese monetary policies are expected to primarily affect Japan's smaller or closer in neighbors such as Korea, China, and Thailand. The impact of Japan's monetary policy on the U.S. economy, while not negligible, cannot be as large as its impact on Japan's Asian neighbors, given the relative sizes of Japan and the U.S. and the geographical proximity of Korea, China, and Thailand to Japan.

As a follow-up to Dekle and Hamada (2015), I examine the effects of an expansion in Japanese monetary policy on the economies of Japan's Asian neighbors, specifically on Korea, China and Thailand, both in the short-run and in the long-run. I choose Korea because of its proximity to Japan, China was chosen because of its current size, and

Thailand, because of its Southeast Asian location, and complementary trade structure with Japan.

Loose monetary policies in Japan can affect the economies of Japan's neighboring Asian countries in several ways. If the policy causes the yen to depreciate relative to Japan's partner currencies, then the trade positions of Japan's partner countries will be affected, damaging the GDP growth prospects of these countries. However, in the medium-run, if a loose monetary policy causes capital to flow from Japan to these partner countries, then that may help raise their investment, asset prices, and GDP. In the even longer run, an increase in Japanese GDP owing to looser monetary policies may help raise the GDPs of the partner countries by growing their exports to Japan.

I examine the impact of Japanese expansionary monetary policies on its neighbors through the mechanism of the global vector autoregression model (the Global GVAR), as advanced by Pesaran, Schuerman, and Weiner (2004). The standard Vector Autoregression (VAR) approach as pioneered by Chris Sims is a way of summarizing time series data such as GDP, inflation, interest rates, exchange rates, and other variables. Once a pattern in these variables are established through estimation, then counterfactuals can be performed by impulse response analysis. For example, we can examine the impact of a cut in Japanese short-term interest rates on Japanese GDP (Kim and Roubini, 2000).

However, when we have more than one country, in a typical VAR analysis, all the variables in the other countries have to be included in the estimation of the model in each country, resulting in inadequate observations to perform the estimation. For example, let us summarize the relations among the following four variables: short-term interest rates, GDP, inflation, and exchange rates among Japan, Korea, and China. If we have only one country, we would need to estimate a 4×4 variable VAR system. With three countries, however, we would need to estimate a 12×12 variable VAR system, or obtain coefficient estimates for 144 variables. Given the lengths of conventional quarterly time series data, we would quickly run out of observations to estimate the three country model.

As described below, the GVAR approach imposes strong restrictions on the usual VAR model so that enough parsimony can be achieved in the estimation. In the estimates below, I use the GVAR Toolbox Program 2.00 (2014) to estimate a 26-country model. While the data are available from 1979Q1-2013Q1, the estimation and calculated impulse responses mainly use the sample 1990Q1-2013Q1. The key to

the GVAR modelling approach is the inclusion of own-country variables along with the foreign variables, to deal with the common factor dependencies that exist in the world economy. Since the included foreign variables are the same for all the countries, the foreign variables will be the common factor.

This paper is organized as follows. Section 2, describes the main hypothesis to be tested. Section 3, describes the GVAR methodology in more detail. Section 4, discusses some of the literature to empirically identify recent Japanese quantitative easing policies. Section 5 presents the results from the impulse responses (from the GVAR estimates). Section 6, quantifies from the impulse response, the likely magnitudes of the effects of the recent expansions in Japanese base money on Japanese, Korean, Chinese, and Thai GDP. Section 7 concludes the paper.

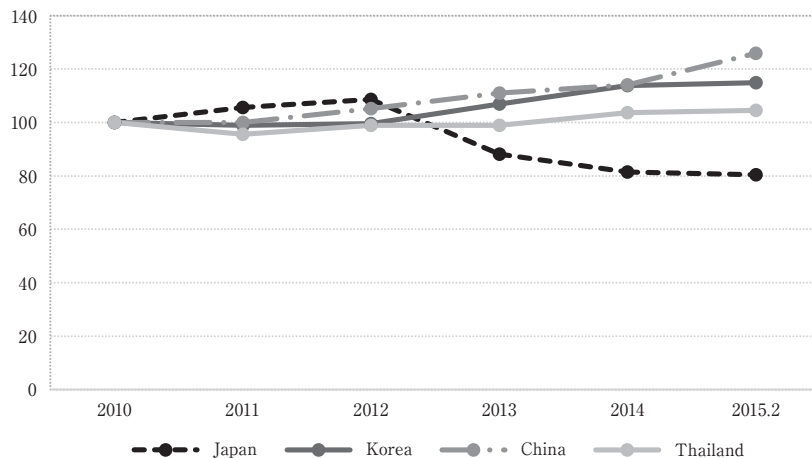
2. Hypothesis

My main hypothesis is that in the short-run, the expansionary monetary policies in Japan will depreciate the yen, and appreciate the currencies of Japan's partner countries in Asia, resulting in a decline in trade balances and the GDP growth rates of Japan's Asian partner countries. However, in the longer run, the expansion in Japanese GDP caused by the Japanese expansionary monetary policy will increase the GDPs of Japan's partner countries.

Before I move to the formal testing of these hypothesis using the GVAR approach, I take a quick look at the data. Following Prime Minister Shinzo Abe's election, announcements about the expansion of the Japanese monetary base began to appear in late 2012. Figure 1 depicts the trends in the nominal effective exchange rates (NEER) of Japan, Korea, China, and Thailand from 2010 to the second quarter of 2015¹. We can see that the Japanese NEER appreciated slightly from 2010 to 2012, after which it depreciated sharply by about 25 percent. The timing of this depreciation accords well with the announcements of the monetary base expansions. Meanwhile, the Korean NEER has appreciated by 10 percent from 2012, while the Chinese NEER appreciated by about 20 percent. The Thai NEER appreciated slightly. While many economic shocks such as GDP changes, natural disasters, such as the Tohoku earthquake, and other shocks affect nominal exchange rates, the prospects of a rapid

¹ The NEER are from the IMF, *International Financial Statistics*.

Fig. 1 : Nominal effective exchange rates



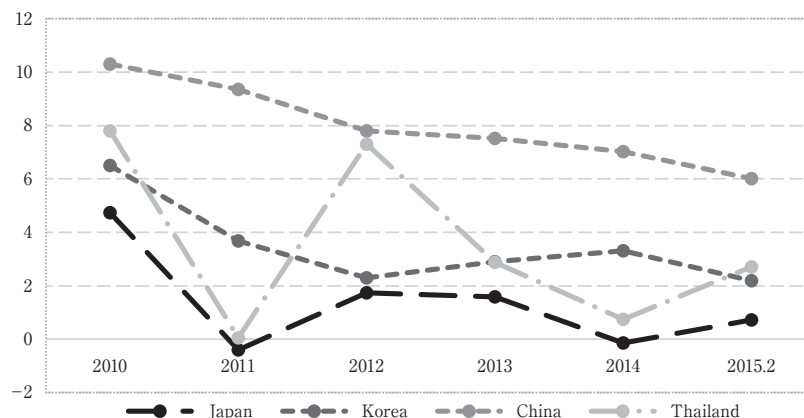
increase money supply in Japan (relative to its trading partners) from late 2012 has contributed to the sharp depreciation of the yen.

The Japanese merchandise current account fell from 108 billion dollars in 2010 to -4.5 billion dollars in 2011 mainly because of the effects of the earthquake, which raised materials and energy imports needed for the reconstruction (not depicted here to save space). Japan's merchandise current account recovered to -3 billion dollars by 2015Q2. While part of this recovery may be related to the weaker yen, the other part may be related to the recovery of the Japanese economy and the fall in global commodity prices. Since 2014, both the Korean and Chinese merchandise current accounts fell relative to their GDPs. However, given the many other shocks hitting these economies, it is difficult to ascribe how much their stronger NEERs impacted the Korean and Chinese current account deteriorations.

The start of the Japanese monetary announcements coincided with a weak period of Japanese growth owing to the effects of the 2011 Tohoku earthquake. Consequently, Japanese real GDP growth was slightly negative in 2011 (see Figure 2) but rebounded between 2012 and 2015Q2 (except for 2014). From the data, it is difficult to see how the rebound in Japanese GDP growth contributed to growth in Korea and China since the growth in these countries has actually deteriorated. After falling in 2012, Korean real GDP growth began to rebound in 2013, but fell sharply in 2015. Chinese real GDP growth has been declining steadily from 2010 from over 10 percent to under 7 percent by 2015Q2. Thai GDP, on the other hand, has tracked Japanese GDP well.

Given that graphically, it is difficult to test my hypothesis that recent Japanese

Fig.2 : Real GDP growth rates



recent monetary policies have negatively impacted its neighbors in the short-run, while having a positive effect in the longer run, I adopt the more sophisticated statistical (GVAR) methodology to evaluate the effects of Japanese monetary shocks on the GDPs of its Asian neighbors.

3 . The GVAR Model

The GVAR model was first introduced in Pesaran, Schuermann, and Weiner (2004). It was originally developed in the aftermath of the 1997 East Asian financial crisis to quantify the effects of changing macroeconomic conditions. Although a few large global macroeconomic models existed at the time, they were difficult to use for simulation analysis. The existing models were often incomplete and did not present a closed, global system. The GVAR model was specifically developed to fill this gap in modelling and simulation analysis.

The initial version of the GVAR model was quite basic, contained only 11 countries, and did not include interest rates, either short-or long-term. The version of the GVAR model presented below is based on the study by Dees, di Mauro, Pesaran, and Smith (2007) which included 26 countries, and contained a full set of financial variables, such as short-and long-term interest rates and the value of the equity market.

The international transmission of business cycles take place through several channels. It can be through common global shocks such as global commodity prices and technology shocks. However, it is likely that even when all global shocks are considered, there could be strong policy and trade spillover effects among countries.

The spillover of monetary policies such as a decrease in say U.S. short term interest rates may have negative spillover effects on the GDPs of Japan and other countries, depreciating the dollar and impacting the competitiveness of the exports of other countries.

The transmission channels among countries are complex. For example, a fall in U.S. interest rates may slow the Japanese economy, by appreciating the yen. The slowdown in the Japanese economy could hurt the economies of Korea and China, leading to a slowdown of exports from the U.S. to Asia overall, with negative feedback effects on the U.S. economy.

Given these complex transmission mechanisms, quantitative analysis of say, the spillover effects of a fall in Japanese short-term interest rates requires a practical, yet general modelling framework for the quantitative analysis of the relative importance of different shocks and channels of transmission. In modern macroeconomics, the default is the stochastic dynamic general equilibrium model, but such models work well for at most two countries. Other *ad hoc* models with more than two, and in fact, many countries exist, but they are essentially static models with questionable dynamics. We need to have some reasonable dynamics to answer the question: what is the impact over time of a Japanese monetary expansion on Japanese and neighboring Asian countries?

In this paper, I use the GVAR model that combines a non-structural VAR model with an individual country error-correction model. This model includes domestic variables (say, of Japan) and country-specific foreign variables that are constructed to match the international trade and financial linkages of the country in question. In this case, the model includes Japan's foreign trade linkages with other countries as foreign variables.

The GVAR model allows for complex interactions/interdependencies at the national and international levels. Most importantly, it handles the “curse of dimensionality” by postulating that most of the foreign variables are weakly exogenous. This weak exogeneity assumption is the key feature of GVAR, since it allows country models to be estimated individually.

In other words, the objective is to model a number of country-specific macro-economic variables such as real GDP, inflation, base money, interest rates, and exchange rates collected in the vector, x_t over time, $t=1, 2, \dots, T$, and across the $N+1$ countries. Given the general nature of global interdependence, it is obviously desirable

to treat all the country-specific variables x_{it} and global variables endogenously. However, such an attempt is impossible because of the “curse of dimensionality.” In a typical time-series, there are simply not enough observations to estimate all of the parameters. To get around this, the GVAR framework imposes weak exogeneity on the foreign country-specific and global variables. It assumes that an individual country, with the exception of the U.S., is a “small” country with respect to the rest of the world. These assumptions can be stated algebraically as follows.

For country i , consider the structure :

$$x_{it} = a_{i0} + a_{i1}t + \phi_{i1}x_{i,t-1} + \phi_{i2}x_{i,t-2} + y_{i0}x_{i,t}^* + y_{i1}x_{i,t-1}^* + y_{i2}x_{i,t-2}^* + u_t \quad (1)$$

Where x_{it} is a k by 1 vector of domestic variables, x_{it}^* is a k^* by 1 vector of foreign variables, and u is a serially uncorrelated and cross-sectionally weakly dependent process. Foreign-specific variables are computed as a weighted average of the corresponding domestic variables of all countries, with the weights also being country-specific, that is, $x_{it}^* = \sum_{j=0}^N w_{ij}x_{ij}$, where w_{ij} , $J=0, 1, \dots, N$ are a set of weights such that they add up to unity. The weights are meant to capture the importance of country j for the i th economy. The weights may reflect, for example, trade linkages depending on the purpose of the modelling exercise. Note that the set of foreign variables can differ from the domestic variables. For example, in my model, the variable real base money (nominal base money divided by the CPI index) appears instead of the short-term nominal interest rate only for Japan.

In the actual estimation, (1) is estimated in error-correction form so that all variables are stationary. For ease of exposition, let the vector x_{it} refer to Japan (J) and include only two variables, base money, m_{jt} , and real GDP, y_{jt} . (1) can be re-written as follows :

$$\Delta m_{jt} = c_{jt} + \alpha_{jt}(\beta_m m_{jt} + \beta_y y_{jt} + \beta_x' x_{it}^*) + \delta'_{j1} \Delta x_{it}^* + \theta_{j1} \Delta m_{j,t-1} + \mu_{j1} \Delta y_{j,t-1} + u_{1t}$$

For the second equation for Japan, Δy_{jt} , the right-hand side explanatory variables are identical. The term in the parentheses above refer to the long run cointegrating relationships among Japanese base money, real GDP, and the vector of foreign variables.

The two equations for Japan can be estimated jointly, conditional on the vector of foreign variables Δx_{it}^* for all other countries i . As mentioned, an important assumption of the GVAR approach is that the vector of foreign variables is weakly exogenous. The

foreign variables are weighed by their relative trade with Japan. Given the weak exogeneity assumption, the foreign variables enter as contemporaneous variables.

More generally, for my purposes, x_{it} , for i =Japan, will include Japanese real GDP, Japanese real base money, real exchange rates (against the U.S. dollar), real equity prices, and nominal long-term (10 year) interest rates. The foreign variables include the weighted averages over the other 25 countries of the same variables (except that we substitute short-term interest rates for base money for countries other than Japan).

The version of the GVAR adopted for my estimation and used in the impulse responses below has, 26 countries, estimated over the period 1990Q1–2013Q1. It is well-known that VAR estimations (of which the GVAR specifications are a special case) are plagued by numerous expectational, regime, and structural shifts. While the data to estimate the model are available from 1979Q1–2012Q1, as shown below, this long period results in some peculiar impulse responses. For example, the effect of monetary loosening in Japan on GDP was found to be more than two times greater in China than in Japan. This is probably because China went through such enormous growth and structural change during this entire period. While today China is twice as big as Japan, during the early 1980s, China was less than 1/10th the size of Japan. Thus, while on average, over the 1979–2013 period, shocks in Japan had large spillover effects on China, today shocks in Japan should have much smaller effects on China today.

Thus, in calculating impulse responses from Japanese shocks to China today, it is better to estimate the GVAR on a more recent sample, say from 2005. However, such a late start date results in a limited number of time series observations, which makes efficient estimation difficult. Thus, I start my estimation of GVAR in 1990Q1 to have a long enough series of observations, while minimizing structural changes in the sample of countries.

For all the countries, the GVAR model includes the following variables : real GDP, CPI inflation, real equity prices, the real exchange rate against the U.S. dollar, the nominal long-term (10 year) interest rate, and a monetary policy variable. The monetary policy variables are the level of real base money (for Japan) and the short-run nominal interest rate (for the other countries). The weights reflect the share of the country's trade (imports plus exports/total imports plus exports) with another country. The quarterly data used to estimate the 26-country model are from Rebucci et. al. (Inter-American Development Bank), except for Japanese base money, which are

from the Bank of Japan web page.

The estimates of the error-correction form for the change in Japanese real GDP are depicted in Table A1. These are estimates in the context of the full GVAR model with 5 variables and 26 countries. Note that if all the estimates for Japan are depicted, there will be other columns for the changes in CPI inflation, real equity prices, the real exchange rate against the U.S. dollar, the nominal long-term interest rate, and real base money. (They are not depicted to save space.) In addition, in the full GVAR results, there will be columns for all 6 variables for all the 25 other countries.

Table 1: Estimates of the error-correction representation of Japanese GDP (in GVAR)

Coefficient Estimates	
Dependent Variable: Japanese Change in GDP, Ch (GDP)	
Constant	0.16
<i>Japanese Lagged Variables</i>	
Ch (GDP, -1)	0.16
Ch (CPI, -1)	0.025
Ch (Equity, -1)	0.01
Ch (Real Exch., -1)	-0.22
Ch (Real Base Mon., -1)	-0.21
Ch (Long Interest, -1)	0.019
<i>Foreign Contemporaneous Variables, * Denotes trade weighted foreign variables for the other 25 countries.</i>	
Ch (GDP*)	0.68
Ch (CPI*)	0.061
Ch (Equity*)	0.01
Ch (Real Exch. Rate*)	0.022
Ch (Short Interest*)	-0.44
Ch (Long Interest*)	-1.95
<i>Japanese Cointegrated Variables</i>	
GDP	1
CPI	0.00044
Equity	-0.069
Real Exch	-0.053
Real Base Mon.	-32.78
Long Interest	28.41
<i>Foreign Cointegrated Variables are not depicted to save space.</i>	

Sample: 1990Q1 to 2012Q1

4. Identifying Japanese Monetary Policy (Quantitative Easing) Shocks

Quantitative easing policies affect the real economy in several ways. The official view among central banks appears to be that such policies raise real economic growth by reducing long-term (10-year) nominal interest rates and raising long-term inflation expectations, thereby stimulating the economy by reducing long-term real interest rates². The Bank of Japan (2015) officially says that the quantitative easing policies of the Abe administration are aimed at to increase long-term inflation expectations and lowering long-term bond yields. Examining the policy effects from January 2013 to December 2014, the Bank of Japan finds that 10-year yields declined by 0.3 percent and inflation expectations over the long-horizon increased by 0.5 percent, resulting in a decline in real interest rates by 0.8 percent.

This ability of Japanese quantitative easing policies to reduce long-term real interest rates is echoed by Hausman and Wieland (2014). They perform an event study for Japan, and find that the package of Abenomics announcements from late 2012 to mid-2013, mainly regarding monetary policies, increased long-run inflation expectations by 1 percent and led to a negligible decline in 10-year bond rates, resulting in a 1 percent decline in real interest rates.

Others take a broader view of the channels of Japanese quantitative easing policies. Fukuda (2015) use an event study approach and focusses on the effects of Abenomics announcements on nominal yen exchange rates and the stock market. He finds that most of the moves in nominal exchange rates and in the yen stock market happened after markets were closed in Japan, suggesting that most of the market participants moving the foreign exchange and stock markets were foreigners. Hausman and Wieland (2014) also find that Abenomics announcements had large effects on depreciating the yen. Honda and Kuroki (2003) not only find a strong link in the late-1990s between short-term interest (call) rates in Japan and long-term 10-year interest rates but also between short-term interest rates and the Japanese stock market. They use econometric techniques to find that a 1 percent surprise cut in call

² In the U.S., Krishnamurthy and Vissing-Jorgensen (2011) examine the effects of the Federal Reserve's purchases of long-term Treasuries and other long-term bonds in two distinct periods, 2008-2009 (QE1) and 2010-2011 (QE2). They find, using an event study approach, that 10-year Treasury yields fell by about 1 percent at the end of the series of QE1 announcements. The effects of the QE2 announcement were estimated to be smaller, reducing 10-year yields by about 25 basis points.

rates result in a 60-basis point decline in long-term market interest rates and a 3 percent increase in the Japanese stock market. Thus, Japanese actual monetary policies and policy announcements appear to depreciate the yen and raise the value of the Japanese stock market.

In this paper, I take the view that Japanese quantitative easing policies in the last few years were mainly achieved by the expansion of Japanese base money. This was the assumption of Dekle and Hamada (2015). I examine how the increase in Japanese base money has affected the Japanese economy and the economy of its Asian neighbors. Furthermore, I examine the transmission channels of the expansion of Japanese base money—whether the expansion of Japanese base money works through a decline in long-term real interest rates, a depreciation in the real yen, or an increase in stock market values. I examine these transmission channels of base money to GDP growth, both domestically, within Japan, and internationally, to Japan’s Asian neighbors.

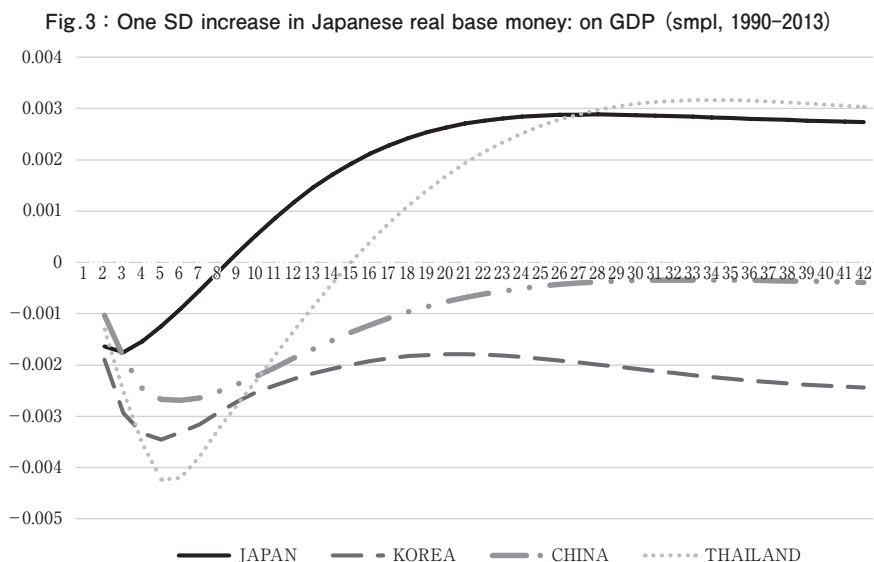
5. Results

5.1 Impulse Response Analysis

I first estimated the entire GVAR model over 26 countries, and calculated their Generalized Impulse Responses (Pesaran and Shin, 1998)³. As mentioned above, I characterize Japanese monetary policy as a change in base money. In fact, I use the log of Japanese nominal base money minus the log of the Japanese CPI index as the measure of Japanese monetary policy. This is because until the late 1990s, Japan had higher inflation rates than today, and during this period, the Bank of Japan partly expanded its base money supply to accommodate this rise in prices. In recent years, CPI inflation rates in Japan have been negligible, so the increase in log real base money has essentially reflects the expansion in nominal base money. As mentioned, the GVAR is estimated for a sample from 1990Q1–2013Q1^{4,5}.

³ The Generalized Impulse Responses (GIR) is an alternative to the orthogonalized impulse responses. The orthogonalized approach requires the impulse responses to be computed with respect to a set of orthogonalized shocks, while the GIR approach considers shocks to individualized errors and separates out the effects of the other shocks using the observed distribution of all shocks. Unlike the OIR, the GIRF is invariant to the ordering of the variables and the countries in the GVAR model.

⁴ We also attempted a somewhat more formal method to settle on the sample period. From 1979Q1 to 2013Q1, we estimated the model repeatedly shortening the sample size by five years each time the



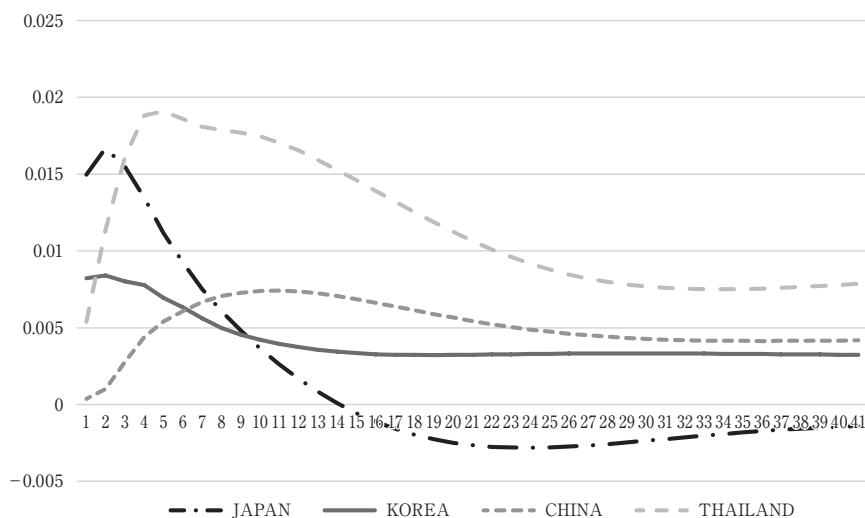
In Figure 3, I depict the impulse response functions of a one standard deviation (SD) increase in Japanese base money on the GDPs of Japan, Korea, China, and Thailand. Here a one SD increase in log real base money means a 4.0 percent increase in the level of real base money.

From the impulse responses, I find that a real base money increase of this magnitude lowers Japanese GDP by 0.2 percent on impact. The impact on Japanese GDP growth turns positive in eight quarters, and reaches a peak of 0.3 percent of GDP by 22 quarters. Korean GDP falls by 0.3 percent on impact and remains lower by 0.2 percent of GDP for over 40 quarters. Chinese GDP, after initially falling by 0.2 percent, returns to its original long-run level by 22 quarters. Thai GDP, after sharply falling by 0.4 percent, rises rapidly and increases by 0.3 percent of GDP by 28 quarters. From the impulse responses, I see a pattern wherein GDP of all countries first falls and then rises over time. Japanese and Thai GDPs increase in the medium-run. Korean GDP falls in the medium-run, and Chinese GDP is unchanged.

model was estimated. Estimating the model that include data before the early 1990s resulted in very large effects for monetary base shocks, and convergence was sometimes difficult to achieve. Therefore, we decided to use the sample only since 1990.

⁵ As part of settling on the final sample by first estimating the GVAR over subsamples, I have estimated the GVAR on a subsample starting from 2000. This is the period excluding the Asian currency crisis of the late 1990s. The sample size from this period was simply too short to obtain stable estimates. I obtained better estimates by estimating the model from the 1970s to 1995, again excluding the Asian currency crisis years. However, this sample period excluded much of Japan's experience with quantitative easing in the early 2000s and the early 2010s, so was not appropriate for the purposes of this paper.

Fig.4 : One SD Increase in Japanese real base money: response of real exchange rate against U.S. dollar

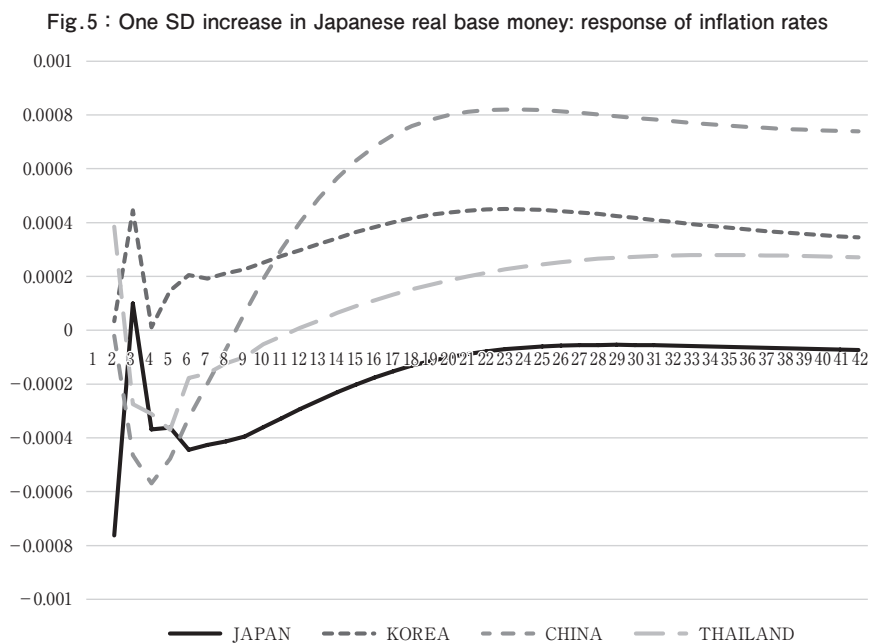


I next examine the effects of Japanese monetary expansion on real exchange rates, inflation, real equity The values, and long-term nominal interest rates. In Figure 4, I depict the changes in each country’s currency against the U.S. dollar in response to the increase in Japanese base money. Until about three quarters, the Japanese yen depreciates the most against the U.S. dollar, so the yen is depreciating against all other Asian currencies. The yen depreciation upon impact is quite large—1.5 percent. By the fourth quarter, the yen starts appreciating against the Thai Baht, and by the ninth and eleventh quarters, the yen is appreciating against the RMB and the won. Thus, we can see that the yen starts depreciating against the Baht within a year and starts depreciating against the won and the RMB in two to three years.

It is well-known that in the real world, China, and to a much lesser extent Korea and Thailand, peg their currencies against the U.S. dollar. In the GVAR model, while nominal pegs are allowed, real exchange rates are assumed to be flexible⁶. In addition, in the GVAR model, all currencies are defined in terms of the U.S. dollar (in real terms). Therefore, when the yen depreciates against the U.S. dollar and Asian currencies depreciate less against the U.S. dollar, the yen is effectively depreciating against the Asian currencies (as mentioned in the previous paragraph).

In Figure 5, a one SD increase in base money has almost no effect on the long-run

⁶ Thus, the model allows for the pegging of nominal exchange rates against the U.S. dollar.



inflation rate in Japan (in fact, inflation rates fall slightly in Japan). The spillover effects on inflation in Japan’s neighbors are also small. A one SD increase in Japanese real base money raises Chinese inflation by 0.08 percent. Thus, we can say that the expansionary effects of an one SD increase in Japanese base money on inflation in all of the countries are negligible.

That the increase in Japanese base money has no effect on the Japanese inflation rate in the long run is somewhat surprising. It should be recalled that the GVARs were estimated on a sample starting in 1990. The period from 1990 to today is a period of generally low Japanese inflation, despite it being a period of monetary loosening, especially from the late 1990s. The reasons for low Japanese inflation are many. They include a host of phenomena associated with “secular stagnation” such as low physical and R & D investment, low TFP growth owing to complete “catch-up” with Western technology, and the rapid aging of the population. These phenomena have negatively affected Japanese consumer psychology, leading to low and downwardly rigid inflationary expectations. As in the study by Dekle and Hamada (2015), we showed that Japanese monetary expansions have not increased Japanese inflationary expectations and actual inflation rates.

In Figure 6, I depict the response of real equity prices (nominal equity prices divided by the CPI index). Equity prices of Japan, Korea, and Thailand all rise very sharply⁷. A

Fig. 6 : One SD increase in Japanese real base money: response of real equity prices

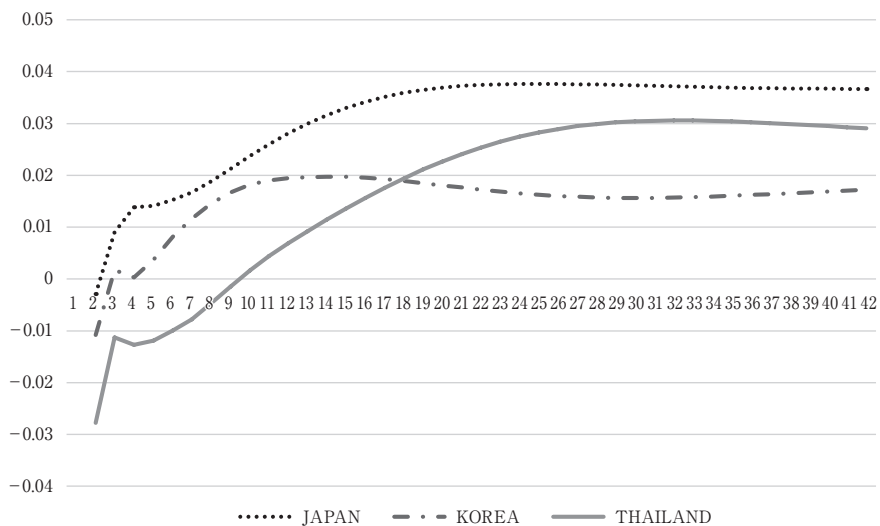
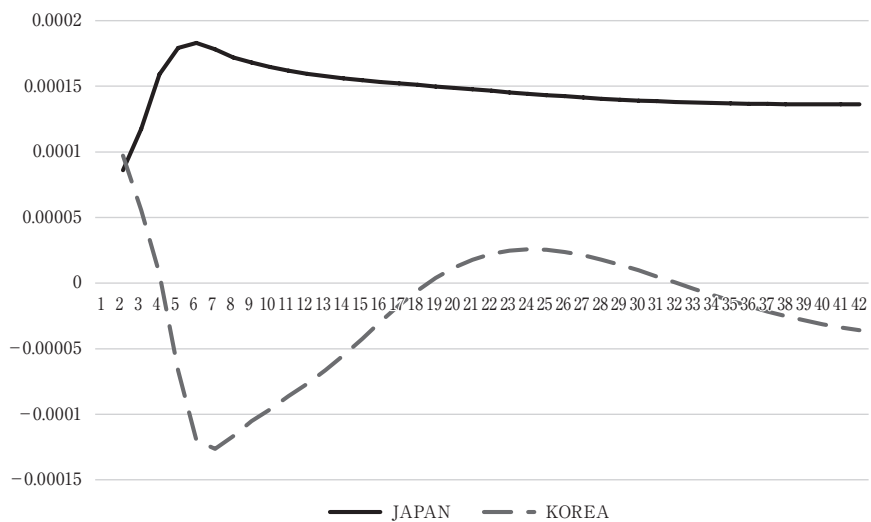


Fig. 7 : One SD increase in Japanese real base money: response of long-term interest rates



one SD increase in Japanese base money increases Japanese, Korean, and Thai equity prices by 4, 3, and 2 percent respectively.

Finally, in Figure 7, I depict the response of long-term nominal interest rates to a Japanese base money shock. Long-term interest rate data are available only for Japan

⁷ Chinese equity prices from 1990 are not available in the database.

and Korea. Japanese long-term interest rates increase ever so slightly—0.0015 percent in response to a one SD increase in Japanese real base money. Korean long-term interest rates zig zag, but the effects are small. Given that the impact of Japanese monetary expansions on inflation and nominal long-term interest rates are small, the impact of the monetary expansion on real long-term interest rates are also probably small

5.2 Transmission Mechanisms of Japanese Monetary Policy

Thus far, I have not elaborated on the mechanisms underlying the impact of an increase in Japanese base money on the GDPs of Japan and its neighbors (in Figure 3). The impulse responses depicted above, however, suggest that the positive transmission channel through the lowering of real long-term interest rates is probably negligible within Japan. In response to a shock to real base money, long-term interest rates in Japan actually rise (slightly) and inflation rates fall (slightly), increasing long-term real interest rates. In Korea, inflation rates rise and long-term interest rates generally decline in response to an expansion in Japanese base money, suggesting that Korean GDP may be stimulated somewhat by this decline in their long-term interest rate.

The sharp rise in equity prices in all countries in response to an increase in Japanese base money suggest that the equity channel could be important in raising Japan's GDP. As equity prices rise, the wealth of households increases and they increase their consumption, stimulating GDP. A rise in equity prices also lowers the cost of capital for firms, leading firms to invest more. Equity prices in Korea and Thailand also increase sharply in response to a rise in Japanese base money, suggesting that Japanese base money shocks may be transmitted to Korea's and Thailand's GDP through the rise in Thai and Korean equity prices⁸.

Finally, the fact that the Japanese yen first depreciates and then appreciates relative to the Asian currencies in response to Japanese base money shocks, implies that exchange rates could be an important conduit of Japanese quantitative easing policies on its Asian neighbors. The initial depreciation of the yen-vis-à-vis the Korean won

⁸ It may appear peculiar that Korean GDP is lower in the longer-run, despite the increase in Korean equity prices. My interpretation is that Korean GDP is lower in the long-run, because of the initial appreciation of the Korean won against the Japanese yen that damages Korean exports over the longer-run. The rise in Korean equity prices helps the recovery in Korean GDP over the long-run by stimulating Korean consumption and investment, but this stimulus is not quite enough to make Korean overall GDP positive.

(lasting more than 10 quarters, 2.5 years) may be what is lowering Korean GDP over the medium- and long-runs, given that the other two transmission mechanisms, long-term interest rates and equity prices, move in the direction of raising Korean GDP. That Korea is dependent on exports and that many of its export products compete with Japanese products suggests that Korea may be especially vulnerable to an appreciation of its currency against the yen.

6. Quantification

Armed with the impulse response functions, I can calculate the impact over the medium- and long-runs of Japan's recent increases in real base money on the GDPs of Japan and its neighbors. Since taking office in 2013, Prime Minister Abe has embarked on a massive loosening of base money to stimulate the Japanese economy. According to Hoshi (2014), between the end of 2012 and the end of 2014, the Bank of Japan at the start of 2013 laid out plans to increase the monetary base to 270 trillion yen, which is about 140 trillion yen larger than the monetary base at the end of 2012. This represented a 96 percent increase in the monetary base in the two years since the start of 2013.

In reality, the Bank of Japan expanded its monetary base from 132 trillion yen at the end of 2012 to 267 trillion yen at the end of 2014, an increase of about 100 percent, which is close to the announced increase at the end of 2012. Since the end of 2014, the Japanese monetary base has been expanding, reaching 344 trillion yen by November 2015.

The spirit of the impulse response analysis arising from the GVARs is to calculate the response of say Japanese GDP to a shock in Japanese base money. Assuming that people were surprised at the Abenomics/Bank of Japan announcements of the expansion of base money at the end of 2012, the Abenomics announcements represented a shock to base money of 140 trillion yen or 96 percent (over the December 2012) over two years (eight quarters). (I assume negligible inflation so that the change in real base money would be the same as the change in nominal base money.) Since a one SD shock to Japanese base money represents a four percent shock in one quarter, over eight quarters, a one SD shock represents a cumulative shock of 32 percent. Therefore, the Abenomics announcement in late 2012 would represent a three SD shock to base money ($96/32$) over two years.

According to the impulse response functions calculated above, a one SD shock to Japanese base money will initially decrease the GDPs of Japan and its neighbors. In the medium-to long-runs (up to 42 quarters), the GDPs of all the countries recover but is never in the positive range for Korea and China. The long-run elasticities of GDP to a one SD shock to in Japanese base money for Japan, Korea, China, and Thailand are 0.3 percent, -0.2 percent, 0 percent, and 0.3 percent respectively. Thus, the three SD shock to Japanese base money will increase Japanese GDP by 0.9 (0.3×3) percent per year in the long-run (after 22 quarters), decrease Korean GDP by 0.6 (-0.2×3) percent per year, have no effect on China (0×3), and raise Thai GDP by 0.9 (0.3×3) per year. Owing to the massive increase in Japanese base money, these are large long-run positive effects on Japanese and Thai GDP.

7. Conclusions

As in many multicountry models of this type, the results of this paper are provisional.

One of the main drawbacks of the GVAR model is that it is not structural and lacks explicit dynamic macroeconomic underpinnings. The GVAR model is designed to give — in long-enough data samples — reasonable multipliers for the effects of macroeconomic shocks, such as monetary shocks, on home and foreign GDPs and other variables.

While multicountry models such as the IMF Multimod model (21 countries) have better microeconomic underpinnings, it is unclear whether the Multimod and related models are fully solved outside of the long-run equilibrium, which makes the Multimod no more credible than the dynamic analysis that I present here using the GVAR.

Thus, at a minimum, the GVAR estimates in this paper should provide a reasonable summary of the patterns in the data, the response of Japanese and foreign GDPs, real exchange rates, inflation rates, real equity prices, and long-term interest rates to a shock to Japanese base money. The results of this exercise are somewhat, but not entirely supportive of my hypothesis that Japanese monetary expansions, while negatively impacting Japan's Asian neighbors in the short-run, will have a positive effect on the long-run. While Thai GDP expands, Chinese GDP remains unchanged, and Korean GDP declines for a horizon as long as 40 quarters.

These results, however, assume unchanged foreign monetary policies. If Korea, for example, also expanded its monetary policies, Korea can also increase its GDP in the

medium-to long-runs. This leads to the possibility of Nash equilibria in international monetary games or competition (see Hamada, 1985). In such equilibria, that home country expansionary monetary policies have negative spillovers on other countries is not wrong from an economic welfare standpoint; it does not violate the Pareto optimality criterion. According to the Pareto optimality criterion, the welfare of partner countries cannot be improved without harming home country welfare. Thus, Pareto optimality represents a sort of equilibrium where all countries are about as well off as they can be, given their relative choices in monetary policies. As Hamada (1985) and Dekle and Hamada (2015) indicate, Pareto optimal outcomes can certainly be achieved with the type of negative monetary spillovers estimated above between Japan and Korea.

References

- Bank of Japan Review (2015), "Quantitative and Qualitative Monetary Easing: Assessment of Its Effects in the Two Years since its Introduction."
- Dekle, R. and K. Hamada (2015), "Japanese Monetary Policy and International Spillovers," *Journal of International Money and Finance*, 428-451.
- Dees, S., di Mauro, F., Pesaran, M.H., Smith, L.V. (2007). "Explaining the International Linkages in the Euro Area: A Global VAR Analysis," *Journal of Applied Econometrics*, p.1-38.
- Fukuda, S., (2015), "Abenomics: Why Was it So Successful in Changing Market Expectations," *Journal of Japanese and International Economies*, p.1-20.
- GVAR Toolbox 2.0 (2014). <https://sites.google.com/site/gvarmodelling/gvar-toolbox>
- Hamada, K. (1985), *The Political Economy of International Monetary Interdependence*. MIT Press.
- Hausman, J. and J. Wieland (2014), "Abenomics: Preliminary Analysis and Outlook," *Brookings Papers on Economic Activity*, 1-63.
- Hoshi, T., (2014), "Can Abenomics Restore Japan's Growth?. In *Macroeconomics Proceedings, Nomura Foundation*.
- Kim, S. and N. Roubini, (2000), "Exchange Rate Anomalies in Industrial Countries: A Solution with a Structural VAR Approach," *Journal of Monetary Economics*, 45, 561-586.
- Krishnamurty, A. and A. Vissing-Jorgenson (2011), "The Effects of Quantitative Easing on Interest Rates: Channels and Implications of Policy," *Brookings Papers on Economic Activity*, 215-287.
- Kuroki, Y. and Y. Honda, (2006), "Financial and Capital Market Responses to Changes in the Central Bank's Target Interest Rates: the Case of Japan," *Economic Journal*, 812-842.

- Pesaran, M.H., and Y. Shin, (1998). “Generalized Impulse Response Analysis in Linear Multivariate Models,” *Economics Letters*, 58, 17-29.
- Pesaran, M.H., Schuermann, T., and S.M. Weiner, (2004). “Modelling Regional Interdependencies Using a Global Error Correcting Macroeconometric Model,” *Journal of Business and Economic Statistics*, 22, 129-162.
- Rogers, J. and J. Wright, (2014), “Evaluating Asset Market Effects of Unconventional Monetary Policy: A Cross Country Comparison,” manuscript, Federal Reserve Board.