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Global Shocks and the Japanese Economy: Structural Changes in the 1990s

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Jun-ichi Shinkai

Specially Appointed Researcher, Osaka School of International Public Policy (OSIPP)

Akira Kohsaka

Professor, Osaka School of International Public Policy (OSIPP)

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【Abstract】This paper analyzes how those global shocks as foreign business cycles and exchange rate realignments affect the Japanese economy and whether there are structural changes in the transmission mechanism of these shocks in the recent period by using a VAR model. This paper finds that, since the 1990s the impact of exchange rate changes on the Japanese economy has become smaller and/or insignificant. But the spillover effect of business cycles in U.S. and Europe turns out to have become larger and that from East Asia, once being small and insignificant, become large and significant in the 2000s. To sum up, the Japanese economy has appeared to re-couple with the world and regional business cycles in the recent period.

Correspondence author: Akira Kohsaka, OSIPP, Osaka University, 1-31 Machikaneyama-cho, Toyonaka, Osaka 560-0043, Japan. Email: kohsaka@osipp.osaka-u.ac.jp. We gratefully acknowledge financial support from the Japan Society for the Promotion of Science program, grant-in-aid for Scientific Research (20223003). The earlier version of this paper was presented at the 11th International Convention of the East Asian Economic Association, 15-16 November, 2008, Manila.

1. Introduction

After World War II, the Japanese economy as well as many others was affected strongly by U.S. business cycles. This relationship has been expressed as "When U.S. sneezes, Japan catches cold." But recently there has been a lot of talk on business cycle decoupling between U.S and other developed countries (IMF 2007). That is, spillover effects of U.S. business cycles are said to have weakened. As of now, U.S. has suffered from the collapse of residential price bubbles, the resulting fall of profits in financial and other corporate firms and expected serious recession ahead. If U.S. and Japanese business cycles are decoupling it is likely that U.S. recession doesn't have much impact on Japan.

It has been also pointed out that the impact of exchange rate changes on the real economy has declined. The impact depends not only on the responsiveness of export and import volumes to relative price changes between domestic goods and foreign goods, but also on the responsiveness of import prices to exchange rate changes. If the responsiveness of import prices to exchange rate changes is small, both the relative price levels and volumes of export and import do not change much. Then there will be little expenditure switching effect with respect to real exchange rates. In fact, Campa and Goldberg (2002) reported that the responsiveness of import price to exchange rate changes is falling among OECD countries. If the impact of exchange rate changes on the real economy has declined, the yen appreciation doesn't worsen her real economy much. Again, in fact, Otani, Shiratsuka and Shirota (2003) and Miyao (2003) showed the decline of impact of exchange rate changes in Japan.

This paper examines the impact of such global shocks as foreign business cycles and exchange rate changes on the Japanese economy by using a VAR model. Our empirical model includes both spillover (expenditure changing) effects of foreign GDP and relative price (expenditure switching) effects of exchange rates. Thus we can analyze the relative price effect of exogenous yen appreciation[1] separately from the spillover effects of exogenous global as well as foreign recessions.

This paper has two objectives. First, we examine whether we can detect structural changes in the

[1] Depreciation could have positive effects on inflation and/or business cycles. When the Bank of Japan decreased nominal interest rates to zero in the latter half of the 1990s, real interest rates did not fell due to deflation. Then Krugman (1998) suggested inflation targetting because inflation could reduce real interest rates. Svensson (2001) focused on exchange rate policy for inflation, and suggested yen depreciation policy that aims at inflation targeting and temporal yen peg simultaneously.

transmission mechanism of these global shocks in the Japanese economy during the recent period. In particular, we analyze whether we can find evidence of business cycle decoupling between foreign economies and Japan and also we analyze whether we can find evidence of the reduced impact of exchange rate changes on the real economy. Second, we examine the relative effects of foreign business cycles across such regions as U.S., Europe and East Asia. We are interested in whether there are changes in relative contribution among regional business cycles to the Japanese economy in the recent period, particularly through deepening market integration in the regions.

We have four main findings. First, the impact of global and external business cycles on the Japanese economy has witnessed some structural changes in the past three decades. But it is NOT decoupling, but re-coupling, namely, while we cannot detect strong evidence for spillover effects of external business cycles on Japan in the 1980s, we have significant positive spillovers in the most recent decade, i.e. the 2000s.

Second, parallel with structural changes in global business cycle spillovers, their impacts both from US and Europe have been actually strengthened in the most recent period. Note, however, we find that they were already significant in the case of Europe in the 1980s, but this is not that clear in the case of US, somewhat puzzlingly. Most interesting finding here is that East Asia has started to show very significant positive spillover effects of business cycles on Japan in the 2000s, in contrast to the 1980s and early 1990s with almost no spillovers.

Third, the impact of expenditure switching through exogenous exchange rate changes on the real economy has also appeared to witness structural changes in the past three decades. In fact, we ensured the reduced pass-through which has been often discussed by now. Namely, although we can see some significant expenditure switching effects of exogenous changes in real exchange rates in the 1980s, we found that they have become very insignificant particularly since the mid-1990s. In other words, we detect structural changes in the transmission mechanism of such global shocks as business cycles and relative prices, the former of which becoming significant and the latter insignificant.

Fourth, the impacts of exogenous business cycles and relative price changes on domestic inflation demonstrate again asymmetric structural changes over time. External business cycles have begun to have positive impacts on inflation, while real exchange rate changes become insignificant in affecting negatively on inflation.

The remainder of the paper is organized as follows. Section 2 overviews the literatures of business cycles among countries and exchange rate pass-through. Section 3 describes empirical model and data for the empirical exercise and shows the results of estimation in section 4. Section 5 and 6 analyzes time variation of the effects of global shock and regional effects respectively. Section 7 analyzes the magnitude of effects using variance decomposition. Section 8 is robustness analysis. Section 9 concludes.

2. Related Literature

We deal with two types of global shocks in this paper. The first shock is business cycles in foreign countries. A business cycle has an international spillover effect through trade channels. IMF (2007) analyzes by using VAR whether U.S. and European recessions have effects upon Latin America and whether U.S. and Japanese recessions upon East Asia. Recessions in U.S. and Europe negatively affect Latin America, where the effect of U.S. being stronger than that of Europe, while U.S. and Japanese recessions affecting East Asia as well. Baxter and Kouparitsas (2005) investigated the determinants of business cycle linkages. Bilateral trade, geographical distance between countries, and being both developed countries or both developing countries, are important for a business cycle linkage, but industrial structure and membership of a currency union are not important factors. IMF (2007), Stock and Watson (2005) and Helbling and Bayoumi (2003) pointed out the importance of common international shocks for a business cycle linkage. The business cycle linkage between U.S. and other foreign countries depend on the magnitude of common international shocks such as an oil shock, while the idiosyncratic shocks in foreign countries have spillover effects weaker than common international shocks (IMF 2007).

Stock and Watson (2005) and Helbling and Bayoumi (2003) pointed out that, compared to the 1960s and 1970s, business cycles in G7 countries were not linked to each other in the 1980s and 1990s due to a reduced magnitude of common international shocks, but that the spillover effects of domestic shocks have been intensified by trade expansion and financial development. Also, Stock and Watson (2005) reported that a decline of business cycle linkages within G7 countries in the 1980s and 1990s was due to a reduction of common international shocks except for Japan, and due to a structural change in transmission mechanism of shocks in the case of Japan. That is, they suggest that Japanese business cycles were dominated more by domestic shocks and regional shocks

than by international shocks. By analyzing business cycle linkages among U.S., Japan, China and other East Asian countries McKinnon and Günther (2003) reported that Japanese business cycles strongly affect East Asian countries.

The second type of shock we focus on is exchange rate changes. Various factors such as business fluctuations and policy changes can affect exchange rates. Above all, changes of international investors' perceptions and sentiments affect international capital flows and thus exchange rates. Exchange rates as a relative price between two currencies affect trade volumes. Through the expenditure switching effect currency depreciation is expected to give a boost to a domestic economy.

This effect of exchange rate changes, however, depends on the degree of exchange rate pass-through. If exchange rate change affects import prices one-to-one (pass-through is perfect), the effect is strong. Conversely, if exchange rate changes affect import prices only partially (pass-through is imperfect or partial), the effect is weaker because exchange rate changes do not affect relative prices much. Recent researches revealed that exchange rate pass-through in advanced economies tended to decline[2]. Campa and Goldberg (2002) reported that exchange rate pass-through declined in 15 of 25 OECD countries after 1990s. In the case of Japan, Otani, Shiratsuka and Shirota (2003) showed that the pass-through declined in both macroeconomic and industrial levels. The decline of pass-through implies that the expenditure switching effect become less effective. In fact, Miyao (2003) found that the yen fluctuation affected export and import volumes before the mid-1980s, but it did not afterwards. It suggests that in Japan the impact of exchange rate changes on the real economy declined probably because of structural changes in trade patterns occurred through the 1980s to 1990s[3].

3. Estimation Model and Data

We use a structural vector autoregressive (VAR) model for estimation. The variables we estimate are foreign gross domestic product (FGDP), Japanese yen real effective exchange rate (REER),

[2] Campa and Goldberg (2005) surveyed recent studies on exchange rate pass-through.

[3] Kimura (2006) pointed out that international production and distribution networks are being formed in East Asia. After the Plaza agreement, Japanese corporations moved factories to East Asian countries and constructed a distribution network of parts, components and products. Partly because the significant part of international trade is intra-firm transactions, import prices tend not to reflect exchange rate fluctuations as before and the pass-through to import prices declined.

Japanese inflation rate (INFL), and. Japanese gross domestic product (GDP). The sample period is from 1980Q1 to 2007Q4.

FGDP is a total GDP of 14 principal trade partners of Japan in 2005 calculated from *Direction of Trade Statistics* of IMF[4], as GDP index (2000 year = 100) multiplied by real GDP in constant 2000 US dollars. We obtained GDP index data from IMF's *International Financial Statistics* (IFS), and real GDP data in constant 2000 US dollars from World Bank's *World Development Indicators 2005*. FGDP covers Australia, Canada, China, Germany, Hong Kong, Indonesia, Korea, Malaysia, Netherland, Philippines, Singapore, Thailand, the United Kingdom and the United States[5]. Since there are no quarterly GDP data of China and Indonesia, of Malaysia before 1993 and of Thailand before 1990 in IFS, we generate quarterly GDP data from annual data from IMF's *World Economic Outlook Databases*. Japanese GDP is calculated as GDP index (year 2000 = 100) multiplied by real GDP in constant 2000 US dollars. INFL is the first difference of the logarithm of consumer price index. CPI and real effective exchange rates are obtained from the websites of Ministry of Internal Affairs and Communications and the Bank of Japan, respectively. GDP, FGDP and INFL are seasonally adjusted. All variables are logarithm differences multiplied by 100.

In order to check the stationarity of variables that we use in the model, we implemented the augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. Lag numbers in ADF test is determined by AIC. Table 1 reports the results of ADF test and PP test. For the level variables, both tests reveal that for all variables the null hypotheses of presence of unit roots cannot be rejected at 5 percent level. On the other hand, for the first differences both tests rejected the null hypotheses for all variables. Therefore, we interpreted those variables as being first order integrated I(1).

＜Table 1 here＞

Moreover, in order to test if there is a cointegration vector in our model because all variables are I(1), we implemented the Engel-Granger test, the Johansen test and the Gregory-Hansen test. Table 2 reports their results. All the tests couldn't show that there is a cointegration vector in our model.

[4] We obtained Japanese export data from *Direction of Trade Statistics* of IMF. The export share of 15 countries with Taiwan amounted to 81% of the total.
[5] Although Taiwan is the fourth largest share in Japanese exports, it is not included in FGDP because her real GDP data in constant 2000 US dollars is not available in WDI.

Therefore, we will use first differenced VAR in the next section.

＜Table 2 here＞

Based on Sims (1980) we impose a recursive constraint for identification of structural VAR. Then, the order of variables is important because higher order variables are assumed to affect lower order variables contemporaneously and lower order variables to affect higher order variables with lags. In our model, we assume a small country model that foreign variables are of higher order. Among domestic variables, we assume that GDP is most endogenous. Therefore, we adopted the order of FGDP, REER, INFL, and GDP. Lag numbers in the VAR model is determined by AIC.

4. Empirical Results

In this section we will verify the validity of our model. For this purpose we focus on the responses of domestic variables to the shocks from foreign GDP and real effective exchange rate of yen. Figure 1 shows the cumulative impulse responses of a VAR model with 4 variables.

＜Figure 1 here＞

The first column of Figure 1 shows the responses of all variables to a FGDP (foreign output) shock. A positive foreign ouput shock causes real yen appreciation, domestic inflation to rise and domestic output (GDP) to increase. Thus, foreign business cycles have spillover effects to Japan.

The second column of Figure 1 shows the responses to a yen real appreciation shock. Foreign GDP tends to increase, domestic inflation to fall and domestic GDP to decline, though the GDP response is not statistically significant. Thus, although the appreciation shock suppresses domestic inflation, possibly through declining import prices, we cannot detect a significant expenditure switching effect here.

The third column shows the responses to a domestic inflation shock. Japanese inflation has no impact on foreign as well as domestic GDP and the real effective exchange rate appreciates slightly, but not in a statistically significant way. Thus, the domestic inflation shock does not affect the other variables.

The fourth column shows the responses to a Japanese GDP shock. Japanese GDP does not affect foreign GDP even in the long run. While an increase of Japanese GDP is often presumed to have spillover effects to foreign countries, we find no such effects.[6] The real effective exchange rate does not respond to Japanese GDP shock, but domestic inflation rises significantly.

We examined the estimated results of our 4-variable VAR model. The impacts of a foreign GDP shock as well as a real effective exchange rate shock on domestic variables are not only consistent with expected spillover effects and expenditure switching effects discussed in section 2, but also reasonably interpreted. Thus, we can safely use this VAR model in the following sections.

5. Structural Changes

In this section, we will examine possible structural changes in the transmission process of the global shocks. First, we divide the sample period into two subsample periods of 1980Q1-1993Q4 and of 1994Q1-2007Q2. When we estimate VAR models, we implicitly assume no structural changes during the sample period. Even if there are structural changes, VAR models cannot catch such changes and estimate only an average effect over the whole sample period. Therefore, we use the same VAR model over subsample periods in order to detect possible structural changes in global linkages.

Figure 2 reports the impulse responses of domestic inflation and GDP to the foreign GDP shock (upper panel) and the real exchange rate shock (lower panel). The first column shows the results for the former subsample period of 1980Q1-93Q4 and the second column shows those for the latter subsample period of 1994Q1-2007Q2.

＜Figure 2 here＞

As to the foreign GDP shock, it has no impact on domestic inflation in the former subperiod, but significantly positive impact in the latter subperiod. The foreign GDP shock has positive impact on domestic GDP in both subperiods, though statistically less significant in the latter subperiod. As to the yen real appreciation shock, it has strong negative impact on domestic inflation in both

[6] Rather Figure 1 suggests a negative impact of the domestic GDP shock on FGDP, although being insignificant, which appears puzzling.

subperiods. But, the shock has significantly negative impact on domestic output only in the former subperiod, and no impact in the latter.

In other words, according to the estimation results over the two subsample periods, we found that the foreign GDP shock has recently gained positive impact on domestic inflation, but that the yen appreciation shock has recently lost negative impact on domestic output. We did not detect structural changes in the positive impact of the foreign GDP shock on domestic output, nor in negative impact of the yen appreciation on domestic inflation.

Next, we investigate a variation of impacts of global shocks in more detail by implementing rolling estimations over 19 ten-year subsample periods. Figure 3 reports the impulse responses of domestic inflation and output to the foreign GDP (upper panel) and real exchange rate shocks (lower panel). It shows only 3 representative results out of 19 in total. The first column is the results for the subsample period of 1980Q1-89Q4, the second column for 1990Q1-99Q4, and the third column for 2000Q1-07Q2.

＜Figure 3 here＞

It is apparent that the magnitude and significance of the impact of the foreign GDP shocks vary across subsample periods. The foreign GDP shock has a positive impact on domestic output consistently in the 1980s and early 1990s, but not always significantly. But when including the years of 1997-99, domestic output show no response at all. After 1999, however, the foreign GDP shock regains a positive impact on domestic output. In particular, the estimation results that include the years of 2000-01 show significantly positive spillover effects, which is consistent with the assertion by Helbling and Bayoumi (2003) that common international shock occurred in the years of 2000-01 and business cycles in G7 are linked together. We must note, however, that the positive impact of the foreign output on domestic output is not coherent across subsample periods. The positive spillover can be found only for the recent subsample periods, which is not always significant, though.

The magnitude and significance of the impact of yen appreciation shock also vary across subsample periods and the estimation results are different from those with the two subsample periods. In the analysis with the two subsample periods, the appreciation shock has negative impact on domestic inflation in both subsample periods. But under the rolling estimation analysis, the impact of

the appreciation shock on inflation tends to lose significance as time passes and almost disappear in the 2000s. On the other hand, although the yen appreciation shock had consistently negative but weak impact on domestic output in the 1980s and early 1990s, it appears to lose impact on domestic output in the 2000s.

Weakening impacts of the exchange rate shock on domestic variables is consistent with the declining exchange rate pass-through to import prices since the 1990s. As stated above, the smaller pass-through implies that exchange rate changes affect the relative price level less so that the expenditure switching effect doesn't work well. The less export and import volumes respond to exchange rate changes, the less domestic output responds to them as well. Also, the declining exchange rate pass-through to import prices means declining pass-through to consumer prices[7]. The less import prices respond to exchange rate changes, the less domestic inflation respond to them as well[8]. These results of ours are consistent with the findings on the declining exchange rate pass-through by Campa and Goldberg (2002) and Otani, Shiratsuka and Shirota (2003) and with the finding on the weakening expenditure switching effect by Miyao (2003).

6. Regional Effects

In this section, we will analyze the spillover effects of regional output shocks by estimating the same VAR model where foreign GDP is divided into three regions, i.e. U.S. (US), Europe (EU) and East Asia (EA). Considering possible structural changes, the model is estimated over the two sub sample periods as well as the rolling 10-year subsample periods[9].

Figure 4 shows the impulse responses of domestic inflation and output to regional output shocks

[7] Generally, exchange rate pass-through to consumer prices tends to be smaller than that to import prices. Import goods constitute only part of consumer goods, and transport costs and wages through distribution channels are added to import goods before final sales.

[8] Taylor (2000) pointed out that exchange rate pass-through to consumer prices declined because inflation was low and steady all over the world in the 1990s. Low inflation reduces a room of price changes by exporters because competitive goods prices are fixed due to more intense competition among firms. So they cannot pass through exchange rate changes to goods prices.

[9] Before estimation, we tested stationarity of U.S., EU and EA GDP variables and cointegration in the model. Unit root tests reveal that the level variables do not reject the null hypothesis of presence of unit roots at the 5 percent level and the first difference variables reject the null. Therefore, we interpreted those variables as first order integrated I(1). Also, the models with US and EU GDP rejected the null of cointegration vector. But, as to the model with EA GDP, while the Johansen test rejected the null, other two tests didn't reject it. Therefore, we estimate models by using differenced VAR here.

over rolling 10-year subsample periods. Only three out of 19 periods are illustrated. The first column is for the period of 1980Q1-89Q4, the second column for 1990Q1-99Q4, and the third for 2000Q1-07Q2.

＜Figure 4 here＞

Figure 4 suggests that the impulse responses to U.S. and Europe shocks are similar to those to the global output shock in Figure 3. Namely the spillover effects were positive in the 1980s and early 1990s and disappeared when included the period of 1997-99 and significantly positive again in the 2000s. And then, more precisely, while the spillover effects of Europe were statistically significant in the 1980s, earlier 1990s and 2000s, those of U.S. were significant only in the 2000s. Thus, we can sum up that the business cycles of U.S. and Europe have stronger positive spillover effects to Japan in the 2000s.

The impulse response of domestic output to an East Asia GDP shock differs from those to U.S. and Europe shocks. East Asia has no spillover effect on Japan in the 1980s and earlier 1990s but has significantly positive effect in the later 1990s and 2000s. Thus, we find that the Japanese business cycles have become linked to East Asia more than before since the mid 1990s.

There are two possible reasons for those structural changes. First, the trade structure changed in Japan. In fact, Kimura (2006) pointed out that trade between Japan and East Asia grew rapidly through the establishment of international production and distribution networks. We presume that this changing regional trade structure intensifies a business cycle linkage between Japan and East Asia.

Another reason is simply the rapid economic growth in East Asia. During the years of 1985-2003, while U.S. and Europe became 1.7 times and 1.5 times larger in terms of constant 2000 US dollar, respectively, East Asia became 3.5 times larger in size[10]. As a result of this rapid economic growth, East Asia has become a principal export market to Japan and East Asian business cycles have had significant positive spillover effects on Japan in the 2000s.

While Stock and Watson (2005) pointed out that Japan was de-linked to other G7 countries in the 1990s due to a change of her transmission mechanism to shocks, our results implies that Japan has

[10] We used the data for 2003 that is available and latest in WDI.

been linked to East Asia since the latter half of the 1990s.

Note that the impulse responses of domestic inflation are different across regions. Figure 4 shows that, while shocks in U.S., Europe and East Asia didn't have positive impacts on inflation in the earlier period, they affect inflation in the later period[11]. Thus it implies that business cycles in those regions have come to affect Japanese inflation. Furthermore, the results of rolling VAR estimation reveal that the impact of U.S. shock on inflation appeared in the later 1990s and that of East Asia appeared in the 1990s, but then the former disappeared in the 2000s. On the other hand, Europena shock had positive impact on inflation in the 1990s only. Thus we can say that foreign business cycles, particularly East Asia, have positive impacts on domestic inflation in the 2000s. Again, we verified that the impacts of foreign business cycles effects differ by region and vary over time.

7. Variance Decomposition

So far, we analyzed the direction and significance of the effects of foreign business cycles and exchange rate shocks on Japanese inflation and output. In this section, using variance decomposition we analyze the relative magnitude of its effects in their total variances.

Figure 5 shows variance decompositions of inflation and GDP to REER shock in rolling VAR. We used the value after 10 quarters from shocks occurred.

＜Figure 5 here＞

Figure 5 suggests that the relative magnitudes of exchange rate shocks on inflation and GDP has a declining trend though varying across sample periods,. The magnitudes on inflation are an average of 30% in former of 1980s, declined to about 20% in the latter of the 1980s and the 1990s. Moreover, in the 2000s those are below 10%. The magnitudes on GDP are an average of 20% in the 1980s, temporary rose to about 30% because excessive appreciation of yen rate in 1995 depressed real economy. Thereafter, though the magnitudes are over 10% in the latter of the 1990s, those are below 10% in the 2000s. Therefore, it is apparent that the effect of exchange rate on real economy has declined in its relative magnitude.

Figure 6 shows variance decomposition of GDP to FGDP and regional shock in rolling VAR.

[11] The impact of European output shock was not significant.

Similarly to Figure 5, we used the value of 10 quarters from shocks occurred.

＜Figure 6 here＞

Figure 6 illustrates that the relative contribution of FGDP shock on domestic GDP volatility varies largely and there are two humps the former of which is in midst of 1980s and the latter in the late of 1990s. Particularly, the second hump imply that the spillover effect from foreign output has risen lately. The contribution of East Asia rises in the latter half of the 1990s. It appears that the Japanese economy has been affected almost equally by the three regions recently.

8. Robustness Check

In this section, we will report the results of robustness checks on our basic 4-variable VAR model. First, we estimate two VAR models with 5 variables including money supply (M2CD) and government expenditure (GOV) respectively. The results are similar to those of the 4 variable VAR models.

Since different ordering of variables might generate different results, next, we test alternative orderings. First, we assume inflation as the most endogenous variable, i.e. as (FGDP, REER, GDP, INFL), second, real effective exchange rate as the most exogenous as (REER, FGDP, INFL, GDP) and third, we replace domestic output and foreign output as (REER, GDP, FGDP, INFL). The results from these different orderings turned out to be similar to those of the original ordering.

Finally, we estimate two additional VAR models in order to incorporate the third country effects. First, we estimate a model with 5 variables including both U.S. and non-U.S. FGDP, i.e. as (US, nonUS-FGDP, REER, INFL, GDP), and, second, a model with 4 variables including all regional GDPs as (US, EU, EA, GDP). The results of these models are again similar to those of the original basic model. Thus, we confirmed the robustness of our basic results obtained so far.

9. Conclusion

We examined the effects of both foreign output shock and exchange rate shocks on Japanese domestic output and inflation by using a VAR model. Our empirical analysis reveals several interesting points.

First, while the Japan's linkage to global, U.S. and European business cycles seems to have disappeared in the 1990s, these business cycles are, in fact, confirmed to have strong positive spillover effects on Japan in the 2000s. The linkage might have declined because there were relatively less common international shocks during the 1990s. In particular, Japan was affected not by U.S. and European cycles but by domestic shocks and regional shocks in East Asia then. But, actually in the recent period or the 2000s, business cycles in U.S. and Europe generate significantly positive spillovers on Japanese output, implying that there is no such thing as *decoupling* at least recently in the case of Japan. Considering increasing integration through both product and capital markets, it is very likely that we will have more common international shocks and that business cycle linkages among countries will be more intensified, generating larger spillover effects of global shocks.

Second, East Asia has become far more important than before for Japanese business cycles. Business cycles in East Asia had little impact on Japan in the 1980s and early 1990s, but have had strong positive spillover effects since the mid 1990s. At least one of the basic reasons is the remarkably intensified linkage between Japan and East Asia through rapid and deep product market integration. We must note here that such strengthened business cycle linkage increases the importance of the third country effect, which is very relevant in discussing the impacts of the current U.S. recession. Business cycle linkage between U.S. and Europe is stronger than that with Japan on one hand, and East Asian exports depend on U.S., Europe and Japan in addition to their intra-regional trade on the other. In particular, Chinese exports depend heavily on U.S. If U.S. recession spillovers to Europe and East Asia, the impact of U.S. recession on Japan will be stronger because the main final markets for Japan will slow down. Thus, considering such third country effects through Europe and East Asia, it is very likely that the U.S. recession have serious negative spillover effects on Japan.

Third, the effects of exchange rate changes on real economy have declined, mainly because of declining exchange rate pass-through to import prices and ultimately to consumer prices in the recent period. Yen appreciation caused domestic output slowdown and disinflation in consumer prices in the 1980s. But such expenditure switching effects of exchange rate changes have become less powerful in the 1990s and worked no more towards the 2000s. This implies that depreciation does not lead to demand recovery, nor appreciation to slowdown. In other words, exchange rate

management, if ever, cannot be used for stabilization purposes. Even if the Bank of Japan could depreciate yen exchange rate, it would need very large depreciation for Japan's recovery, which may not be acceptable for political economic reasons.

Finally, the positive impact of foreign business cycles on domestic inflation has become significant in the 2000s. Foreign business cycles used to have little impact on domestic inflation in the 1980s, but especially those of East Asia have had positive effects since the 1990s. Note that this is additional spillover effects on Japan.

We have shown that Japanese business cycles have become more affected by foreign shocks and that exchange rate changes have lost adjustment abilities in the 2000s. This implies that the Japanese policy authorities have had to face with more uncontrollable shocks coming from abroad, without the help of external adjustment through exchange rate changes. In particular, foreign business cycles not only in U.S. and Europe but also in East Asia have come to affect Japan and, moreover, their effects spillover to domestic inflation as well as output.

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Table 1: Unit Root Tests

	ADF	PP
Level		
GDP	−1.64	−1.21
FGDP	−2.28	−2.24
REER	−0.85	−1.13
CPI	−0.90	−2.31
First difference		
⊿GDP	−3.44**	−9.04***
⊿FGDP	−6.23***	−6.33***
⊿REER	−8.99***	−9.12***
⊿CPI	−3.52***	−7.61***

This table reports the results of a unit root test. ADF denotes Augmented Dickey-Fuller test and PP denotes Phillips-Perron test. The tests include constant term and trend in level and only constant term in first difference. *, **, *** denote respectively that the hypothesis that the variable contain unit root can be rejected at 10%, 5%, 1% level of significance.

Table 2: Cointegration Tests

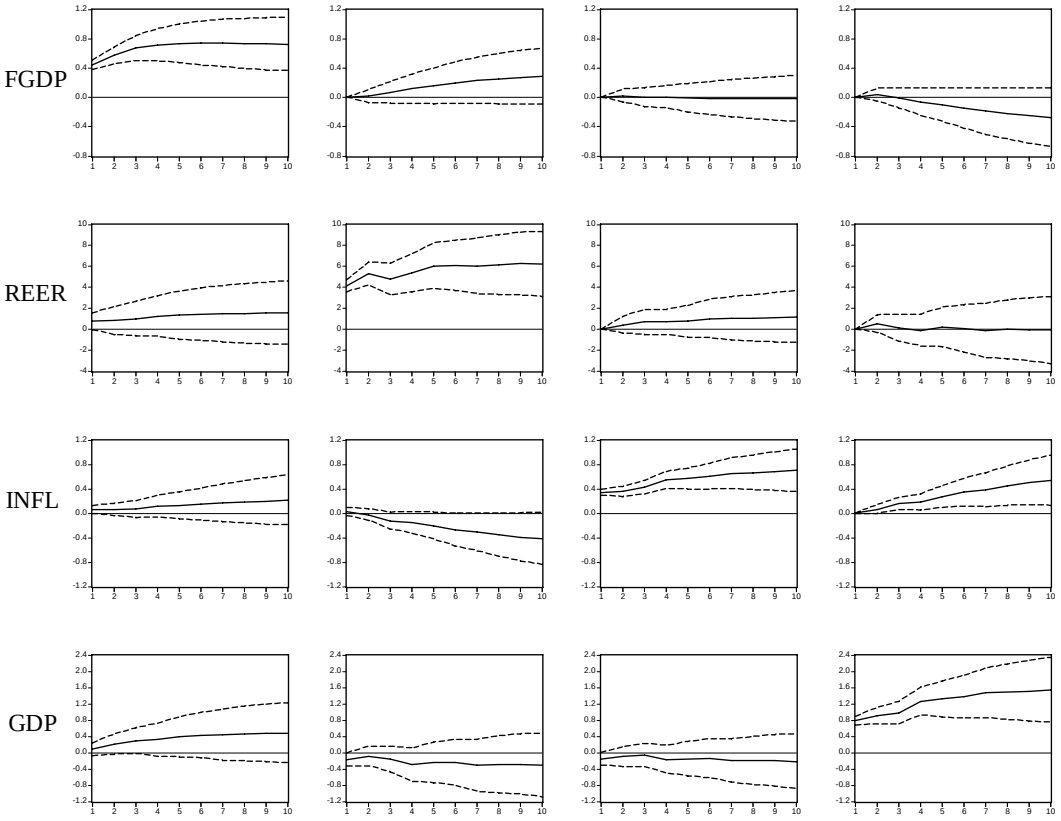
	EG	JOH	GH
(FGDP, REER, INFL, GDP)	-2.51	25.64	-3.63

This table reports results of cointegration tests in our VAR model with FGDP, REER, INFL and GDP. EG denotes Engel-Granger test, JOH denotes Johansen maximum eigenvalue test and GH denotes Gregory-Hansen test. The tests include 4 lags. *, ** denote respectively that the hypothesis that there are cointegration vector in the model can be rejected at 5%, 1%. We used critical value in MacKinnon (1991) for EG test, in Osterwald-Lenum (1992) for JOH test and in Gregory-Hansen (1996) for GH test as follows.

Critical Values	5%	1%
EG	-4.21	-4.83
JOH	27.07	32.24
GH	-5.28	-5.77

Figure 1: Impulse Responses over the Full Sample Period

(Variables: FGDP, REER, INFL, GDP)

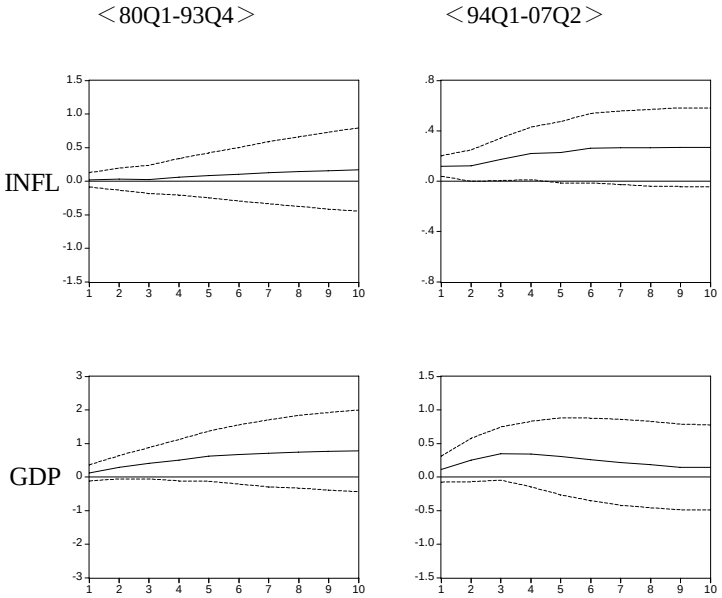


This figure shows impulse responses of VAR model with 4 variables. The left column shows impulse responses of each variable to FGDP shock, the second column shows impulse responses to REER shock, the third column shows impulse responses to INFL shock, the right column shows impulse responses to domestic GDP shock. Dotted lines are confidence bands of 2 standard deviations.

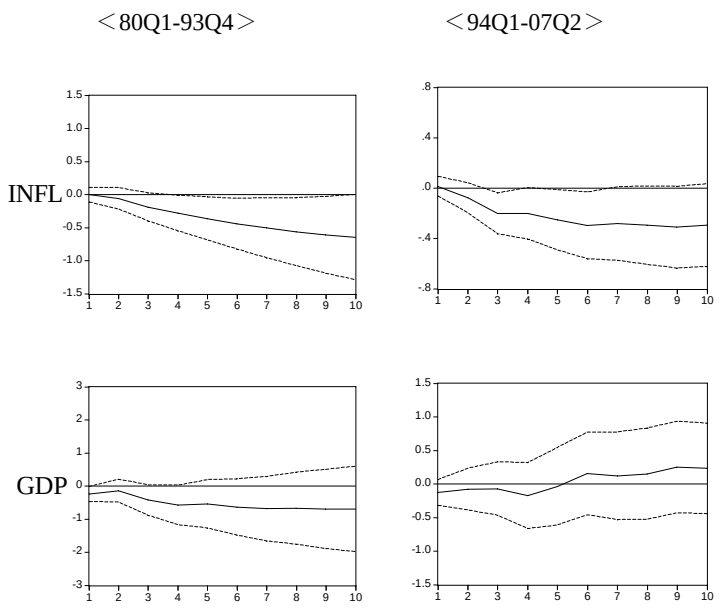
Figure 2: Impulse Responses over the Two Subsample Periods

(Variables: FGDP, REER, INFL, GDP)

A. FGDP shock

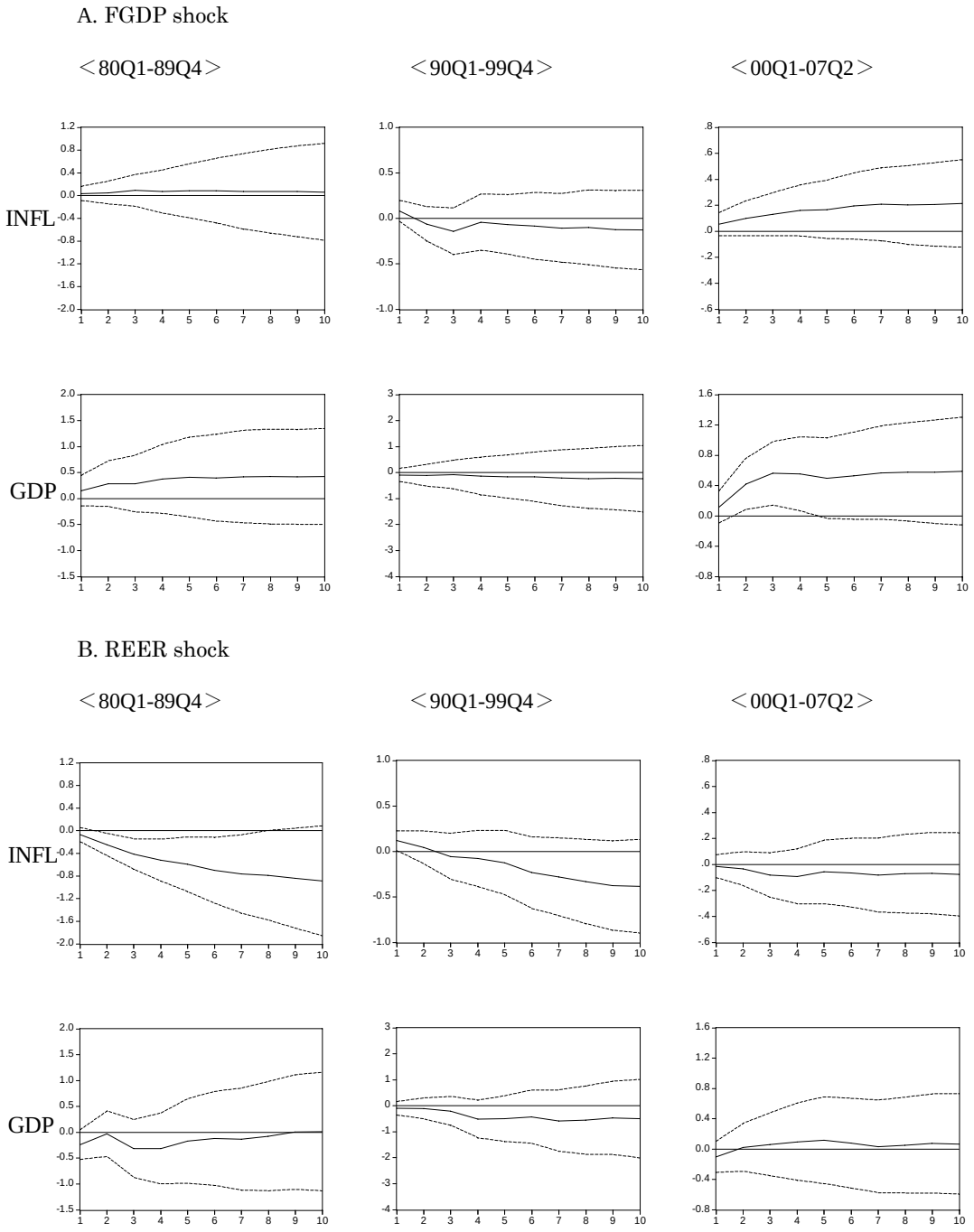


B. REER shock



This figure shows impulse response of INFL and GDP to FGDP shock and REER shock in sub samples analysis. The left column shows the results in 80Q1-93Q4, the right column shows the results in 94Q1-07Q2. Dotted lines are confidence bands of 2 standard deviations.

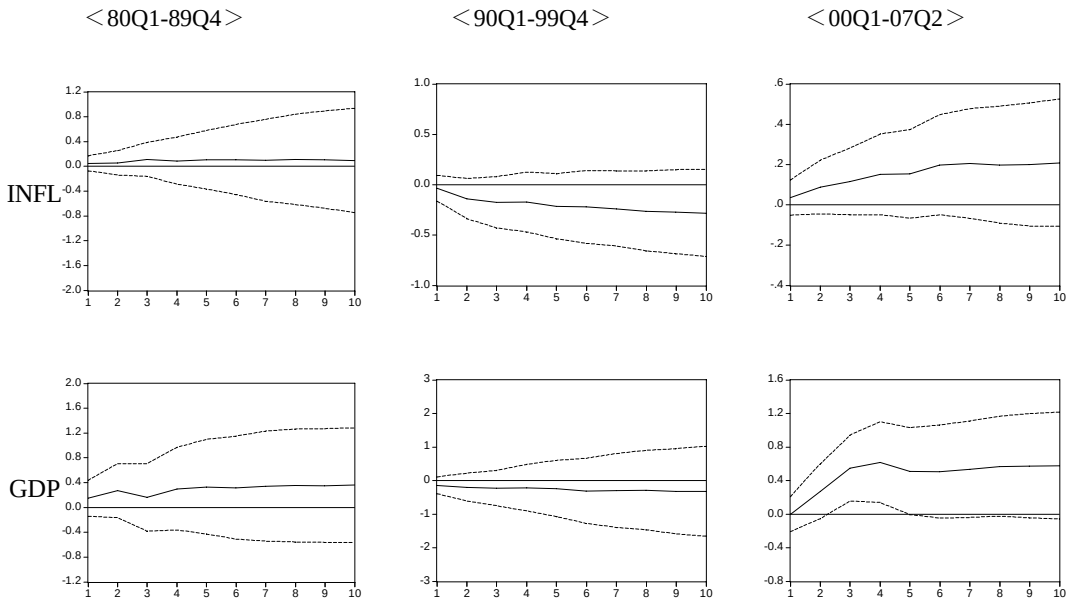
Figure 3: Impulse Responses in Rolling VAR



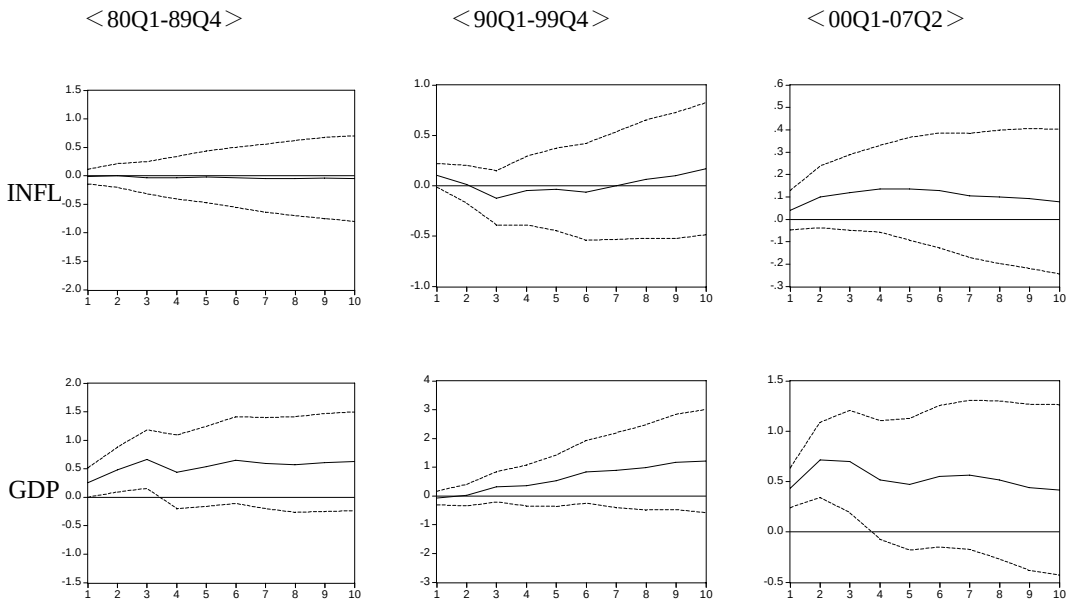
This figure shows impulse response of INFL and GDP to FGDP shock and REER shock in rolling VAR. We show representative 3 out of 19 results in rolling VAR. The left column shows results with 80Q1-89Q4, the center shows results with 90Q1-99Q4, the right shows results with 00Q1-07Q2. Dotted lines are confidence bands of 2 standard deviations.

Figure 4: Impulse Responses by Region in Rolling VAR

A. GDP shock in U.S.



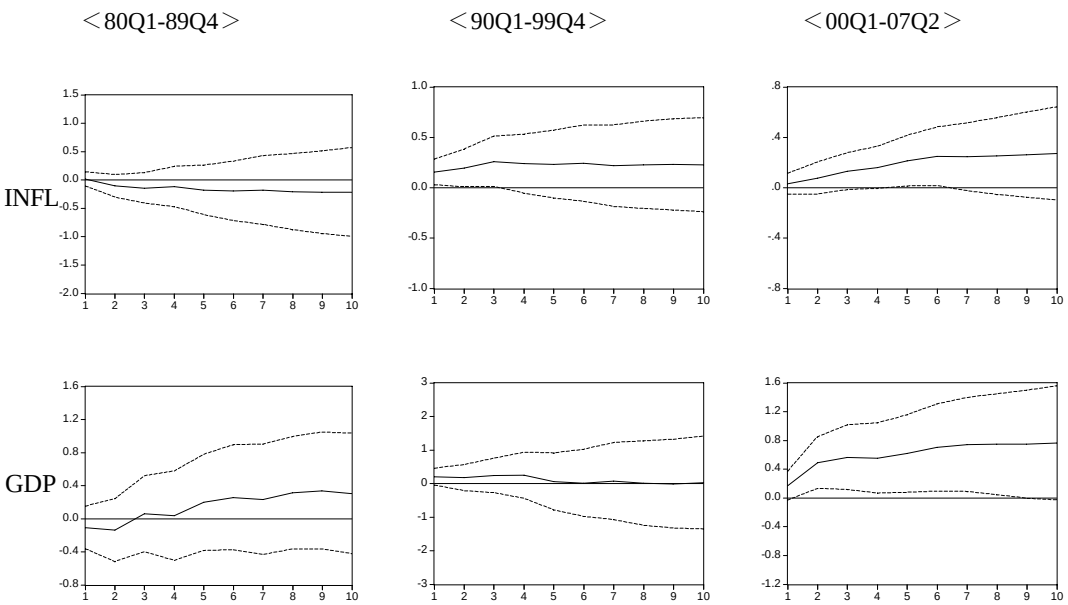
B. GDP shock in Europe



This figure shows impulse response of INFL and GDP to GDP shock in U.S., Europe and East Asia in rolling VAR. We show representative 3 out of 19 results in rolling VAR. The left column shows results with 80Q1-89Q4, the center shows results with 90Q1-99Q4, the right shows results with 00Q1-07Q2. Dotted lines are confidence bands of 2 standard deviations.

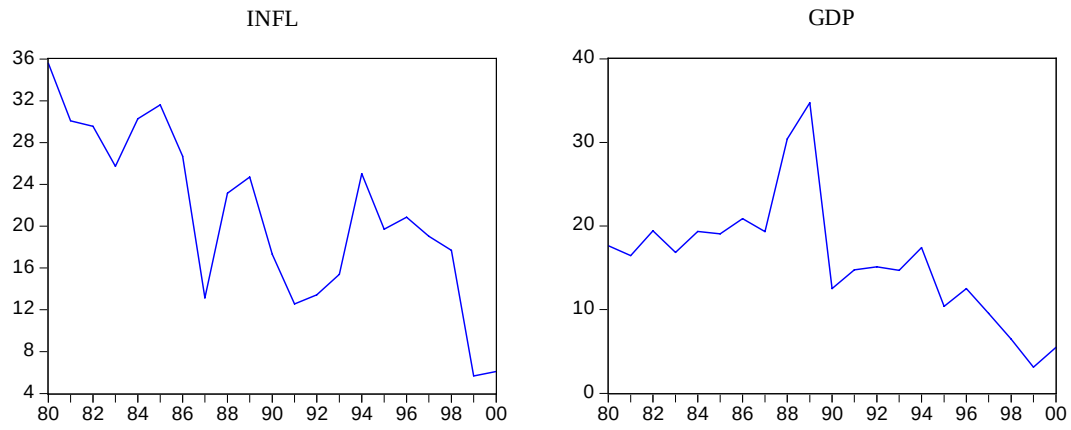
Figure 4: Impulse Responses by Region in Rolling VAR

C. GDP shock in East Asia



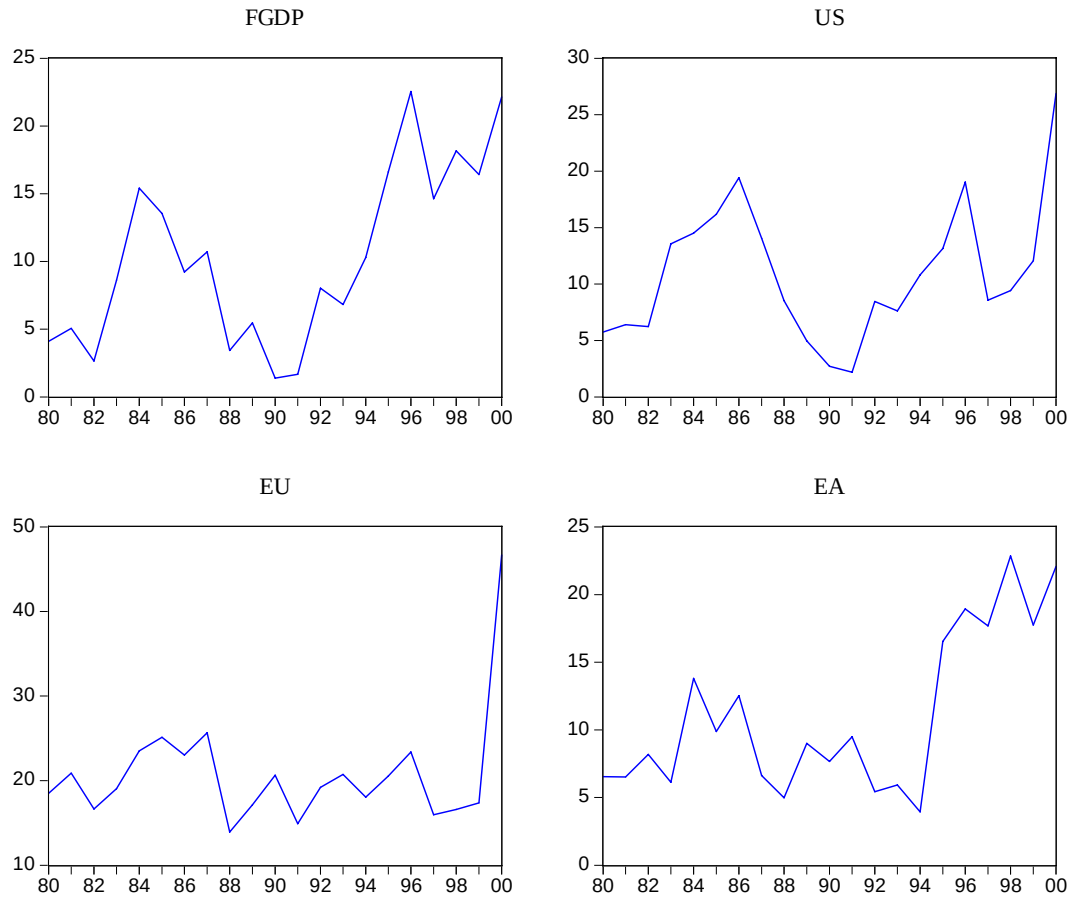
This figure shows impulse response of INFL and GDP to GDP shock in U.S., Europe and East Asia in rolling VAR. We show representative 3 out of 19 results in rolling VAR. The left column shows results with 80Q1-89Q4, the center shows results with 90Q1-99Q4, the right shows results with 00Q1-07Q2. Dotted lines are confidence bands of 2 standard deviations.

Figure 5: Variance Decomposition to REER shock in Rolling VAR



This figure shows variance decomposition of INFL and GDP to REER shock in rolling VAR as a percentage share of the total variance. We used values at 10 quarters after shocks. A horizontal axis shows start year of sample periods in Rolling VAR.

Figure 6: Variance Decomposition of GDP to foreign GDP shocks in Rolling VAR



This figure shows variance decomposition of GDP to FGDP and regional shock in rolling VAR as a percentage share of the total variance. We used values at 10 quarters after shocks. A horizontal axis shows start year of sample periods in Rolling VAR.