School of Oriental and African Studies University of London

DEPARTMENT OF ECONOMICS WORKING PAPERS

No.139

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August 2004

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Transmission channels of capital flow shocks: why Korean crisis was so severe

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Abstract

The Asian crisis highlighted the vulnerability of emerging market economies faced by sudden capital flow reversals. An important question that has critical implications for crisis management is how negative shocks in capital inflows were transmitted to economic activities, transforming financial instability into fully-fledged crises. Using VARs, this paper analyzes the transmission mechanism of capital flow shocks during the Korean crisis of 1997-98. Although it is commonly believed that severe economic contractions were caused by credit crunch, the analysis suggests that the major constraint for production was a steep rise in prices of imported inputs due to sharp exchange rate depreciations.

JEL Classification: C22; C32; F31; F32; F41

Keywords: Capital flow shocks; Current account adjustments; VAR; Crisis; Korea.

1. Introduction

The Asian crisis of 1997-98, along with other recent crises, has highlighted the vulnerability of emerging market economies when faced with "sudden stops" of capital inflows.[1] A sudden reversal of capital inflows caused by an abrupt shift in market sentiments necessitated a rapid improvement in current account through the adjustments of real exchange rate and domestic spending. The resulting adjustments turned out to be disorderly, leading to severe output contractions in the Asian crisis countries.

One of the most fundamental issues that has critical implications for policy responses to sudden stops is the transmission mechanism of capital flow shocks; that is, how the negative

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[1] See Calvo and Reinhart (2000) for the empirical analyses of sudden stops episodes including the Asian crisis. Kaminsky, Reinhart, and Végh (2003) identify the factors that bring about "fast and furious" financial contagion, which appear to have played a critical role in triggering the sudden stops in Korea.

shocks in capital inflows are transmitted to economic activities, transforming the initial financial instability into a fully-fledged economic crisis. In this regard, many analysts emphasize the adverse balance-sheet effects of exchange rate depreciation: with an extensive currency mismatch in the balance sheets of domestic financial institutions, the sharp exchange rate depreciation following the capital flow reversals induces severe credit crunch, causing a disruption in economic activities the Asian economies.[2]

Emphasizing the detrimental impact of credit crunch on economic activities, some go further to suggest that the first priority in crisis management should be averting disruptions in financial intermediation to minimize the risk of deep recessions.[3] Given that there is a trade-off between supporting financial systems through monetary easing and stabilizing exchange rates via monetary tightening, it is implied in this view that exchange rate stability might need to be compromised for the support of the financial system.[4]

It is, however, important to recognize that there are multiple channels through which capital flow shocks could be transmitted to economic activities. For example, the large exchange rate depreciation following the sudden stop of capital inflows could have had substantial adverse impacts on economic activities through a rise in prices of intermediate and capital goods in an economy where the supply of these goods depends heavily on imports. In addition, the tightening of fiscal and monetary policy in response to the capital flow reversals might have a large contractionary effect on aggregate demand.[5] Hence, a reduction in the availability of credit might not be the dominant factor that depressed economic activities.

Taking the Korean crisis as an example, this paper examines how the negative shocks in capital inflows can be transmitted to economic activities and seeks to identify the factors that explain the severe economic contractions by using vector autoregressions (VARs). The VAR

[2] See, among others, Goldstein (1998; 2002), Eichengreen (1999), Mishkin (1999), and Kenen (2001).

[3] See, for example, Stiglitz and Greenwald (2003).

[4] It should, however, be noted that these two objectives may be compatible when capital controls are effectively imposed.

[5] Radelet and Sachs (1998a, b) and Furman and Stiglitz (1998) emphasize the perverse effects of monetary and fiscal tightening requested by the IMF programmes.

approach was chosen for two major reasons. Firstly, VARs allow the placement of minimum restrictions on how capital flow shocks affect economic activity. With restrictions relatively independent of particular hypotheses, the estimated impulse response functions and historical decompositions will help distinguish between competing explanations for the transmission mechanism of capital flow shocks. Secondly, VARs explicitly recognize the simultaneity between the variables. This is a major advantage because the direction of causality between the variables is not necessarily obvious in advance. For example, a decline in domestic credit supply may be the result of an endogenous response to the economic contraction, rather than its cause.

The remainder of the chapter is organized as follows: Section 2 analyses various transmission channels for capital flow shocks. Section 3 describes the empirical methodology. Section 4 presents empirical results. Section 5 summarizes the main empirical findings and discusses their policy implications.

2. Transmission channels of capital flow shocks

2.1 Disorderly current account adjustments

The Asian crisis was unique in several aspects. The crisis suddenly erupted in the countries where the underlying fundamentals were generally robust. There was no obvious conflict between fiscal policies and fixed exchange rates which has been the central element of the traditional balance-of-payment crisis. Although the weakness of domestic financial systems and the presence of moral hazard created by implicit government guarantees had been the sources of vulnerability in Asian economies, there was little sign to indicate the market was anticipating a crisis in well advance.[6] The reversal of capital flows occurred quite abruptly, reflecting a sharp shift in market sentiments associated with creditor panic and contagion.[7]

[6] Radelet and Sachs (1998a) present and discuss these data.

[7] Radelet and Sachs (1998a b) emphasize the central role of creditor panic and contagion in triggering the Asian crisis. Choe et al. (1999) and Kim and Wei (2002) find evidence of herd behaviour among foreign investors during the Korean crisis. Goldstein (1998) argues that the Thai crisis served as a “wake-up call” for foreign investors to reassess the creditworthiness of Asian borrowers, generating contagion effect. Van

Another distinct feature of Asian crisis was its severity. The real GDP contracted by about 7 to 13 percent in Indonesia, Korea, and Thailand within a single year. The component of GDP that contributed most to the contraction of real GDP was gross fixed investment, whose contribution ranged from -7.3 to -15.2 percent points (Table 1). The negative contribution of private consumption was also large in Thailand and Korea.

Hence, in order to understand why the Asian crisis was so severe, it is essential to identify the factors that contributed to the large decline in domestic spending, notably private consumption and investment.

A deep economic contraction appears to have been associated with *disorderly current account adjustments* where both the real exchange rate deprecation and the reduction in domestic spending were excessively sharp. In fact, a substantial part of exchange rate depreciations following the collapse of the de facto dollar pegs was reversed after the stability in foreign exchange markets had been restored in the crisis countries. Importantly, the sharp exchange rate depreciations seem to have had substantial contractionary effects on domestic economic activities at least in the short run; otherwise the depreciations should have helped in avoiding severe economic contractions through the expansions of net exports.

So why did the deprecations have severe contractionary effects on the economy, rather than stimulate it? Many analysts argue that the severe economic contractions were caused mainly by the adverse balance-sheet effect of exchange rate depreciation: with an extensive currency mismatch in the balance sheets, the sharp exchange rate depreciations might have significantly reduced the net worth of financial and non-financial firms, resulting in a severe credit crunch.[8] This in turn could have depressed economic activities if firms had not been able to obtain funds necessary to finance their investment and production at affordable costs, or even at any cost.

Although such possibility cannot be denied in theory, it is not clear whether there was actually an economy-wide credit crunch. A reduction in domestic credit could result from a fall

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Rijckeghem and Weder (200) and Kaminsky and Reinhart (2001) find evidence of contagion effect through bank lending channel during the Asian crisis.

[8] See footnote 2.

in credit demand on the borrower's side due to economic slowdown, rather than a decrease in credit supply. Although there have been several studies that examine the extent of credit crunch in the Asian crisis countries, the results are somehow mixed.[9] Above all, the existing studies provide little evidence regarding the extent to which the reduction in the availability of credit had contributed to the severe economic contractions. It should be emphasized that there is a large gap between finding evidence of a credit crunch and claiming that a credit crunch was the primary cause for sharp contractions.

2.2 Minsky model

To identify the factors that explain the sharp economic contraction during the crisis, we need to understand how the negative shocks in capital inflows could be transmitted to economic activities, particularly to investment. To this end, Hyman Minsky's model of investment determination provides a useful framework. Drawing primarily on Keynes's "General Theory",[10] Minsky developed a model of investment determination focusing on the relationships between finance, asset value, and investment.[11] Using this model, he showed how instability in financial markets could develop and interact with real economic activities.

In the Minsky model, the determination of investment depends primarily on three factors: the demand price for capital assets, the supply price of investment goods (plant and equipment), and financial conditions. Capital assets are expected to yield cash flows in the form of gross profits. The demand price for capital assets is determined by the capitalization of expected cash flows. The capitalization ratio depends primarily on the liquidity embodied in the assets and the value

[9] Ghosh and Ghosh (1999) estimate credit demand and supply functions and find little evidence of credit rationing in the sense of excess demand for credit in the Asian crisis countries. Ding, Domaç, and Ferri (1998) consider the combination of increases in the yield spreads between bank loans and risk-free assets as the evidence of credit crunch and claim to find such evidence in all Asian crisis countries. Using firm-level survey data, Dollar and Hallward-Driemeier (2000) and Hallward-Driemeier (2001) find little evidence to suggest that a reduction in the access to credit was the most severe problem for the business activities in the Asian crisis countries.

[10] John Maynard Keynes, *The General Theory of Employment, Interest and Money* (1936)

[11] See Minsky (1975), Chapter 5 and Minsky (1986), Chapter 8.

placed on liquidity by the investors.

The supply price of investment goods is determined mainly by production costs, such as labour, other inputs, and financing. The financing for production is typically short-term and therefore these costs primarily depend on short-term interest rates.

The demand for investment depends basically on the price of capital assets. But the *effective* demand for investment is influenced by financial conditions. This is because the internal funds are often not sufficient to finance investment, so the availability of external finance constrains the demand for investment. In the Minsky model, the financial conditions are represented by "borrower's risk" and "lender's risk".[12] The borrower's risk and lender's risk reflect the subjective valuation of the required "margin of safety", which affects the extent to which the investment is financed externally, or more generally, the debt-capital ratio of borrowers. The borrower's risk is not reflected in any objective costs, but it lowers the effective demand price for capital assets. By contrast, the lender's risk is reflected in the financial contracts in the form of higher interest rates, shorter terms to maturity, a requirement to pledge specific assets as collateral, and restrictions on dividend payouts and further borrowing.

Minsky's model suggests that negative shocks to capital inflows can be transmitted to economic activities through various channels.

The first channel is a reduction in the availability of domestic credit. With an extensive currency mismatch in the balance sheets, the sharp exchange rate depreciation following the capital flow reversals might have caused a rise in debt-capital ratio of financial institutions and/or firms. This could have caused an increase in lenders' risks, leading to a tightening of credit conditions and a decline in credit supply.

The second channel is a rise in the supply price of investment goods. The depreciation might have increased the production costs of investment goods because the import content ratio is generally high in the Asian economies. A rise in production costs would have shifted the supply curve upwards, leading to a reduction in investment.

The third channel is a rise in interest rates. In an attempt to stem massive capital outflows and

[12] The terms "borrower's risk" and "lender's risk" also appear in Keynes's *General Theory* (p.144).

stabilize exchange rates, the Asian crisis countries tightened monetary policy. A rise in interest rates might have substantially increased the financing costs of investment goods, shifting the supply curve upwards. Furthermore, a higher interest rate might also have affected investment adversely through: (1) raising the value of liquidity and thereby reducing the capitalization ratio; (2) weakening the cash flow positions of firms and therefore increasing both borrowers' and lenders' risks.

Finally, the heightened uncertainty in the wake of financial turmoil might have had a substantial adverse impact on business confidence. This could have had a negative effect on firms' expected return to capital assets. It could also have adversely affected their subjective valuation of the capitalization ratio by diminishing risk appetite. Due to these effects, the demand for capital assets could have declined, shifting the demand curve downwards.

In addition to these channels, there are several others through which capital flow shocks could have adversely affected economic activities. For example, a reduction in the availability of foreign trade credit for import could have had a negative effect on investment whose import content was high. Similarly, the limited availability of foreign trade credit could have constrained exports.

It is also important to recognize that some of the channels described above might have been relevant to private consumption. For example, a reduction in the availability of domestic credit for households might have adversely affected their spending. Also, a heightened uncertainty could have had negative effects on consumer confidence. Finally, the tightening of fiscal policy requested by the IMF-supported programme could have exacerbated economic downturn through reducing aggregate demand.

3. VAR model

Corresponding to the possible transmission channels identified above, the following variables, together with output, were included in the basic VAR model: real capital inflows, real exchange rate, real corporate borrowing, real fiscal surplus, real interest rate. The confidence channel is captured by the independent shocks in output. All variables are measured in real terms because,

in terms of the impact on real economic activities, it would be the real variables that matter.[13]

3.1. Data

Output: This variable is measured by seasonally adjusted real GDP, divided by the trend real GDP to eliminate trends.[14]

[Source] National Accounts

Real capital inflows: This variable is defined as the difference between the overseas sector's total fund utilization and total fund raising excluding foreign exchange holdings, as measured by flow of funds accounts, deflated by the GDP deflator and divided by the trend real GDP to eliminate trends.

[Source] Bank of Korea *Flow of Funds Accounts*, IMF *International Financial Statistics*

Real exchange rate: This variable is defined as the year-on-year changes (changes over the previous four quarters) of real exchange rates.[15] Assuming that the law of one price holds for traded goods, the real exchange rate in foreign currency terms is defined as[16]

$$q = \log(NEER) + \log(CPI_k) + \log(PPI_f) \quad (1)$$

where CPI_k is Korea's consumer price index (CPI), PPI_f is the foreign producer price index (PPI), *NEER* is Korea's nominal effective exchange rate in terms of the foreign currency. As a proxy for the prices of non-traded and traded goods, Korea's CPI and foreign PPI were used respectively because CPI contains both traded and nontraded goods while PPI is heavily

[13] In the following analysis, it is assumed that the Korean crisis was initially triggered by capital flow reversals, rather than speculative attacks on the currency. The assumption is consistent with the fact that the scope of speculative attacks was limited in Korea at the time of crisis because of the tight restrictions on forward transactions on the Korean won and the absence of a future market (Hahm and Mishkin 2000).

[14] The trend real GDP is obtained by filtering the series using the Hodrick-Prescott procedure.

[15] The year-on-year change was used instead of the level of real exchange rates to obtain white noise residuals in the equation for the real exchange rate.

[16] This definition of the real exchange rate is often referred to as the internal real exchange rate. Alternatively, the real exchange rate can be defined as the ratio between foreign price levels and domestic price levels measured in a common currency. Such a definition of real exchange rates is called the external real exchange rate. See Hinkle and Nsengiyumva (1999) for the discussions on the definition and measurement of real exchange rates.

weighted with traded goods.

The foreign PPI is defined as the weighted average of PPI in Korea's major trading partners, namely the United States, Japan, and the European Union (EU). The weights are computed using the share of Korea's trade with these regions.[17] As a proxy for the PPI of the EU, the PPI of Germany is used. The nominal effective exchange rate is defined as the weighted average of the bilateral exchange rate against the US dollar, Japanese yen, and German mark. The same weights as those for the foreign PPI are used for the calculation. The bilateral exchange rate against the German mark is used as a proxy for the exchange rate against the EU.[18]

[Source] IMF *International Financial Statistics* and *Direction of Trade Statistics*

Real corporate borrowing: This variable is defined as the sum of the borrowing by the business sector from financial institutions (loans) and security (commercial paper corporate bonds) markets, as measured by flow of funds accounts, deflated by the GDP deflator and divided by the trend real GDP to eliminate trends.[19]

[Source] Bank of Korea *Flow of Funds Accounts*, IMF *International Financial Statistics*

Real fiscal surplus: This variable is a proxy for the stance of fiscal policy and defined as the difference between the government sector's total fund raising and total fund utilization (nominal fiscal surplus), as measured by flow of funds accounts, deflated by the GDP deflator and dived by the trend real GDP. To eliminate the seasonality, the fourth order of moving average of nominal fiscal surplus is used.

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[17] The weights are 0.45 for the United States, 0.35 for Japan, and 0.2 for the EU. These weights are computed by dividing each region's trade share (the sum of the share of exports and imports) by the sum of these trade shares. The trade share of the Western Hemisphere is also added to that of the United States since most of the developing countries in this region used to peg to the dollar and still tend to focus mainly on the dollar. The trade share is computed using the trade data of 1993 drawn from the IMF *Direction of Trade Statistics*.

[18] The bilateral exchange rate against the German mark after 1999Q1 when the euro was introduced is computed using the market rate of the euro and the fixed conversion rate for the German mark (1euro = 1.95583 mark).

[19] The borrowing from security markets is also included because a bulk of corporate bonds issued by Korean firms carries bank guarantee (Chopra et al. 2002). Accordingly, the availability of credit through the corporate bond market might also have been affected by banks' lending capacity.

[Source] Bank of Korea *Flow of Funds Accounts*, IMF *International Financial Statistics*

Real interest rate: This variable is defined as the overnight call rate less the inflation rate of the GDP deflator over the previous four quarters.

[Source] IMF *International Financial Statistics*

3.2. Unit root test

The data span the period 1980Q1 to 2000Q4. The unit root test indicates that half of the levels of the variables are nonstationary (Table 2). Accordingly, the first difference of the variables is used in the regressions. In the case of output, however, the quarterly growth rate of real GDP is used instead of the first difference of detrended GDP defined above to obtain white noise in the equation for the output. The unit root test indicates that all these transformed variables are stationary, as shown in the table. Using these variables, a VAR model is estimated from 1981Q3 to 2000Q4 using five lags of each variable.[20] The five-lag is selected because this is the smallest number of lags necessary to obtain white-noise residuals in all equations.[21]

3.3. Identification

The interactions among the variables in the VAR system can be examined using the estimated impulse response functions. The Choleski decomposition is employed to identify the orthogonalized shocks using the ordering: real fiscal surplus, real capital inflows, real exchange rate, output, real interest rate, and real corporate borrowing. The ordering determines the level of exogeneity of the variables and a shock in a particular variable has a contemporaneous effect on the variables ordered after that particular variable but not on those ordered before it.

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[20] The starting date of 1981Q3 reflects the need to accommodate transformations of the underlying data and lags in the VAR.

[21] It is possible that there are cointegration relationships between the levels of the variables. To examine this, Johansen's (1988, 1991, 1995) full information maximum likelihood approach was used. Although the test indicated the existence of multiple number of cointegration relationships, none of them seemed to have particular economic meanings consistent with standard economic theories when normalized with regard to output. For example, it was suggested that a rise in real interest rates was associated with an increase in output in the long run.

The ordering is chosen on the basis of the speed with which a particular variable responds to current changes in other variables, with real fiscal surplus assumed to be the least responsive, followed by real capital inflows, real exchange rate, output, real interest rate, and real corporate borrowing. The ordering of real capital inflows reflects the assumption that push factors predominate over pull factors in the short run.[22] The real exchange rate is ordered after real capital inflows and before output and real interest rate because Korea's exchange rates were heavily managed and the current account balance was a particularly important policy target.[23]

3.4. Extensions

To further investigate the transmission mechanism of negative shocks in real capital inflows, the basic VAR model is extended in two ways. Firstly, to analyze the sensitivity of major expenditure components of real GDP to shocks in real capital inflows and real exchange rate, output (i.e., real GDP growth rate) is decomposed into two parts: the contribution of particular components to real GDP growth and the remainder (i.e., the sum of contributions of the remaining components).[24] The former is ordered after the latter and before real interest rate.

Secondly, the importance of each transmission channel represented by a particular variable is examined by rerunning the VAR with that particular variable exogenized; that is, excluding the chosen variable from the VAR but including its lags as exogenous variables.[25] By doing so, it is possible to block any responses within the VAR that pass through particular variables. For example, if the impulse response of output to the shocks in real capital inflows is lowered significantly when real corporate borrowing is exogenized, it indicates that the domestic-credit channel is an important conduit for the transmission of shocks in real capital inflows.

Finally, the past changes in output are decomposed into the parts explained by the shocks in

[22] Push factors refer to the conditions in international capital markets that influence the supply of capital, while pull factors refer to domestic conditions that affect the attractiveness of investing in particular countries (Calvo et al., 1996; Das, 2003)

[23] See Rhee and Song (1999).

[24] The contribution of private consumption, for example, is defined as the change in private consumption from the previous quarter divided by the GDP in the previous quarter.

[25] The methodology adopted here follows closely the approach employed by Bayoumi (2001).

each variable. This so-called historical decomposition will help identify the major factors that explain the sharp economic contraction during the crisis.

4. Results

4.1. Impulse responses

The impulse responses of output estimated using the basic model are shown in Figure 1. The graph (a) of the figure, for example, reports the impulse responses of output to a one-standard deviation shock (one-unit shock, hereafter) in real fiscal surplus, together with the response of real fiscal surplus to its own shock. These responses refer to the accumulated effects of one-unit shocks on the variables, which are obtained by the summation of the coefficients of impulse response functions. All the variables are measured in such a manner that a change of 0.01 represents a one- percent change in the relevant variable.[26]

As can be seen from the figure, an increase in real fiscal surplus and real interest rate lowers output, demonstrating the adverse impact of the tightening of macroeconomic policies on output. Interestingly, the impact of real interest rate wears off gradually after five quarters, while that of real fiscal surplus has a long-lasting effect. The output declines by about 0.3 percent in response to a one-unit shock in real fiscal surplus over four quarters, while it declines by about 0.5 percent in response to a one-unit shock in real interest rate over the same period.

Both the negative shocks in real capital inflows and real exchange rate have a relatively large adverse effect on output.[27] In response to a negative one-unit shock in real capital inflows (i.e., a decline in capital inflows), the output declines by about 0.4 percent on impact and 1.5 percent over four quarters. In response to a negative one-unit shock in real exchange rate (i.e., depreciation in real exchange rates), the output declines by about 0.7 percent on impact and 1.6 percent over four quarters. The adverse impact of exchange rate depreciations appears to reflect the effect of the Korean crisis in 1997-98. Also, the decline in output in response to the negative

[26] In the case of real interest rate, this is achieved by dividing the percentage value by 100.

[27] Note that the signs of real capital inflows and real exchange rate are reversed in the figure, so that an increase in the values imply a decline in real capital inflows and depreciation in real exchange rate.

shocks in real capital inflows seems to reflect the adverse impact of exchange rate depreciations since the negative shocks in real capital inflows induces real exchange rate depreciations (see Figure 2).

Finally, the positive shocks in real corporate borrowing have a significant positive effect on output. In response to a one-unit shock in real corporate borrowing, the output increases by about 0.6 percent over four quarters. The result suggests that a decline in the availability of credit could be an important cause for economic contractions.

4.2. The response of GDP components

The negative response of output to exchange rate depreciations is rather counterintuitive because exchange rate depreciations would induce a rise in net exports provided the Marshall-Lerner condition holds.[28] The observed decline in output therefore suggests that there may be a reduction in domestic spending that offsets the rise in net exports and/or the expansion of exports is constrained by some factors.

Figure 3 and 4 report the impulse responses of the growth contribution of GDP components to a one-unit negative shock in real exchange rate and real capital inflows, respectively. As expected, the contribution of net exports responds positively to the negative shocks in real exchange rate. The contribution of net exports also increases in response to the negative shocks in real capital inflows. Importantly, these increases in the contribution of net exports arise mostly from a positive contribution of imports, that is, a reduction in imports. The contribution of exports is either small or negative in the short run. For example, negative shocks in real exchange rate lower the contribution of exports by about 0.01 percent on impact, while raising the contribution of imports by about 0.8 percent. Similarly, a decline in the contribution of exports in response to the negative shocks in real capital inflows is more than offset by the positive contribution of imports.

[28] The Marshall-Lerner condition is the sufficient condition for a devaluation of exchange rates to improve the balance of trade. It requires the sum of the demand elasticity of imports and exports to be greater than unity in absolute value.

The decline in the contribution of exports in response to the negative shocks in real exchange rate appears to reflect a high import content of Korea's exports.[29] According to IMF (2000), the share of import goods used for the production of export goods in Korea was about 37 percent in 1997. The real exchange rate depreciation therefore could adversely affect exports through increasing the production costs of export goods. Likewise, the decline in the contribution of exports in response to the negative shocks in real capital inflows may also be due to an increase in the production costs of export goods as the result of real exchange rate depreciations.

However, it is also possible that the decline in the contribution of exports arises from a reduction in the availability of foreign trade credit. Indeed, the observed response pattern of the contribution of exports to the shocks in real exchange rate differs markedly from that to the shocks in real capital inflows. The decline in the contribution of exports in response to the shocks in real exchange rate is relatively small and short-lived and it is more than offset by a significant rise in the contribution of exports over the long run. By contrast, there is a long-lasting decline in the contribution of exports in response to the shocks in real capital inflows. These results suggest that there may be other channels, such as a decline in the availability of foreign trade credit, through which the shocks in real capital inflows affect exports other than exchange rate depreciations.

In contrast to the contribution of net exports, the contribution of private consumption and that of gross fixed investment respond negatively to the negative shocks in real capital inflows and real exchange rate. In response to negative shocks in real capital inflows, the contribution of private consumption declines by about 0.3 percent on impact and 1.0 percent over four quarters, while the contribution of gross fixed investment declines by about 0.3 percent on impact and 1.0 percent over four quarters. In response to the negative shocks in real exchange rate, the contribution of private consumption declines by about 0.5 percent on impact and 1.1 percent over four quarters, while the contribution of gross fixed investment declines by about 0.005

[29] An alternative explanation for the negative response of exports to depreciations in the short run is the presence of so-called J-curve effect. However, as far as the small-country assumption holds for Korea and so that it faces given world prices (in foreign currencies) for exports and imports, the J-curve effect will not be significant.

percent on impact and 0.5 percent over four quarters.

4.3. Transmission channels of capital flow shocks

We now turn to the question of how capital flow shocks can be transmitted to economic activities. The relative importance of various transmission channels was examined by rerunning the VAR with the corresponding variable exogenized, as described above. The impulse responses of output to the negative shocks in real capital inflows with particular variables being exogenized are shown in Figure 5a. The vertical distance between the base case (Case A) and other cases measures how much the impact of shocks in real capital inflows is reduced by exogenizing particular variables. In other words, the importance of particular transmission channels represented by the exogenized variables can be assessed by the relative size of the vertical distance.

As can be seen from the figure, output declines considerably less in the short run when real exchange rate is exogenized, suggesting the importance of imported-input channel (Case B). Exogenizing real exchange rate reduces the adverse impact of negative shocks in real capital inflows by about 21 percent over two quarters, 22 percent over four quarters, and 24 percent over five quarters. However, the vertical distance between the base case and Case B starts to narrow after five quarters, indicating that the importance of this channel declines over time.

The corporate-borrowing channel also appears to be important, though there seems to be a considerable time lag in the transmission of the shocks in real capital inflows through this channel (Case C). Exogenizing real corporate borrowing lowers the adverse impact of negative shocks in real capital inflows by about 5 percent over two quarters, 14 percent over four quarters, 22 percent over eight quarters, and more than 40 percent over eleven quarters. The observed time lag might reflect the offsetting effect of Bank of Korea's liquidity support to domestic banks at the early stage of the crisis.[30]

On the other hand, there are only small changes in the impact of shocks in real capital inflows

[30] According to Jeanne and Wyplosz (2001) the liquidity support to Korean financial institutions between June 1997 and June 1999 reached nearly 7 % of GDP.

when real fiscal surplus and real interest rate are exogenized, suggesting that the fiscal policy channel and the interest rate channel are much less important conduit (Case D and E). Importantly, even when both real exchange rate and real corporate borrowing are exogenized, the output still declines by about 0.9 percent over four quarters, which is more than half of the output decline under the base case. This suggests that other channels, namely foreign-trade-credit and confidence channels are also important.

It should be noted that changes in exchange rates might also affect the credit supply by financial institutions through the balance-sheet effect. If that is the case, part of the vertical distance between the base case and Case B may capture the impact of shocks in real capital inflows transmitted through the domestic-credit channel. To investigate this, the impulse response function of output to exchange rate shocks was re-estimated by exogenizing real corporate borrowing. As shown in Figure 5b, exogenizing real corporate borrowing makes little difference to the response of output in the short run, though it reduces the adverse impact on output significantly over the long run. There seems to be a considerable time lag for exchange rate variations to affect financial institutions' credit supply through the balance-sheet effect. This result, together with the above findings, suggests that the imported-input channel dominates over the domestic-credit channel in the transmission of shocks in real capital inflows in the short run.

4.4. Historical decomposition

Finally, historical decompositions are used to identify the factors that explain the sharp economic contraction during the crisis period. The decomposition of the actual path of output implied by the VAR model is shown in Figure 6a and 6b. The past movements in output is decomposed into the parts explained by the shocks in real fiscal surplus (fiscal policy shocks, hereafter), real capital inflows (capital flow shocks, hereafter), real exchange rate (exchange rate shocks, hereafter), output (independent shocks, hereafter), real interest rate (interest rate shocks, hereafter), and real corporate borrowing (corporate borrowing shocks, hereafter).

It is apparent from the figure that there was a marked change in the strength of correlation

between output and capital flow shocks, as well as between output and exchange rate shocks. The correlation coefficient between output and capital flow shocks was 0.27 during the period before the crisis (1990Q1-1997Q3), while it was 0.89 during the period after the onset of the crisis (1997Q4-2000Q4). Similarly, the coefficient between output and exchange rate shocks rose from -0.40 to 0.83 after the onset of the crisis. By contrast, the correlation coefficient between output and corporate borrowing shocks dropped from 0.30 to -0.12.

The stronger correlation between output and capital flow shocks or exchange rate shocks after the onset of the crisis appears to reflect the change in Korea's exchange rate regime; that is, a shift from a de facto dollar peg to a floating rate regime in late 1997. With a higher variability in exchange rates under a floating rate regime, exchange rate shocks, as well as capital flow shocks through their effect on exchange rates appear to have had a larger impact on Korea's economic activities that depend heavily on foreign trade.

The historical decompositions show that the output decline in 1997Q4 can be attributed mainly to the negative capital flow shocks and exchange rate shocks. As shown in Table 3, there was a large outflow of short-term loans to banks in 1997Q4. At the same time, a sharp depreciation in exchange rates had led to a steep rise in import prices (16.7 percent year-on-year basis). By contrast, the other shocks, namely fiscal policy-, independent-, interest rate-, and corporate borrowing shocks all had a positive effect on output, offsetting part of the large adverse impact of capital flow shocks and exchange rate shocks.

Most of the sharp output decline in 1998Q1 can be explained by capital flow shocks, exchange rate shocks, and independent shocks. Remarkably, import prices rose by more than 50 percent in 1998Q1, reflecting the sharp exchange rate depreciation. As shown in Table 3, there was a sharp reduction in the inflow of foreign trade credit in 1998Q1, suggesting the importance of the foreign-trade-credit channel. The large impact of independent shocks seem to have reflected the deterioration in consumer and business confidence because of the heightening of the economic uncertainty in the wake of the crisis. Despite the tightening of fiscal and monetary policies as requested by the IMF-supported programme in response to the crisis, the adverse impact of fiscal policy shocks and interest rate shocks were small. Likewise, the corporate

borrowing shocks had only a limited negative impact on output.

The output decline in 1998Q2 can also be explained mostly by capital flow shocks, exchange rate shocks, and independent shocks. Interestingly, fiscal policy shocks had a positive impact on output, probably reflecting the easing of fiscal stance in accordance with the revision of the fiscal target in the IMF programme.

Table 4a shows the size of individual shocks and their ratio to the total shocks (the sum of individual shocks) over the period 1997Q4-1998Q2.[31] On average, the largest adverse impact came from exchange rate shocks, accounting for about 38 percent of total shocks over this period. The second largest impact came from capital flow shocks, accounting for about 36 percent of total shocks. It is, however, important to note that a significant part of capital flow shocks might have been transmitted through the imported-input channel: as seen earlier, about 20 percent of capita flow shocks were transmitted through this channel over two quarters. Taking this into account, it seems that a rise in imported input prices following the sharp depreciation was the most important factor to explain the sharp economic contraction during the crisis.

The direct impact of capital flow shocks, notably a decline in the availability of foreign trade credit might also have been a major factor. The impact of independent shocks was also relatively large, accounting for about 26 percent of total shocks. On the other hand, both interest rate shocks and domestic credit shocks had only a marginal adverse effect, while the impact of fiscal policy shocks was on average slightly positive over the period.

While a decline in the availability of domestic credit does not seem to have been the primary cause for the sharp contractions, it might have been a significant constraint on the economic recovery during the post-crisis period. As shown in Table 4b, the corporate borrowing shocks had an adverse impact on output throughout 1999 except in the second quarter. On average, the corporate borrowing shock was the only major negative contributor in 1999 and it offset more than one-fifth of the sum of the positive contributions by other shocks.

[31] The sum of individual shocks is not equal to actual output because there is an intercept term in the VAR.

5. Concluding remarks

The main findings of the above analysis can be summarized as follows:

Firstly, the impulse response analysis shows that negative shocks in real capital inflows and real exchange rate have large adverse impacts on output, which appear to reflect the effect of the Korean crisis in 1997-98. The output declines result largely from the negative responses of private consumption and gross fixed investment. While there is a positive contribution of net exports, it is more than offset by the negative contribution of domestic demand. Moreover, a rise in net exports arises mostly from a decline in imports. The contribution of exports is either small or even negative in the short run.

Secondly, reflecting a high dependence on imports for the supply of intermediate and capital goods in Korea, a significant part of capital flow shocks appears to be transmitted to economic activities through the imported-input channel in the short run. The domestic-credit channel, however, seems to dominate over the imported-input channel in the long run. The foreign-trade-credit channel and the confidence channel also might be important.

Thirdly, historical decompositions suggest that a rise in prices of imported intermediate and capital goods following the sharp exchange rate depreciations might have been the most important factor to explain the sharp economic contraction during the Korean crisis. A reduction in the availability of foreign trade credit and the deterioration in consumer and business confidence could also have been major factors. Contrary to what is widely believed, the analysis of this paper has found little evidence to suggest that the decline in the availability of domestic credit was the primary cause for the severe contraction during the crisis period. There is, however, some evidence that a decline in the availability of credit might have been a significant constraint on the economic recovery during the post-crisis period.

Finally, the analysis has also found little evidence to suggest that the tightening of macroeconomic policies was primarily responsible for the severe contraction during the Korean crisis. The overall effects of fiscal policy and interest rate shocks were broadly neutral over the crisis period.

The policy implications of these findings are clear: in order to prevent financial instability from being developed into a fully-fledged economic crisis, stabilizing exchange rates would be critically important; sharp economic contractions might not be avoided by domestic credit expansions alone unless the exchange rate stability is achieved. This would be particularly true for a small open economy like many East Asian economies where economic activities depend heavily on foreign supply of intermediate and capital goods.

It should, however, be emphasized that stabilizing exchange rates is not equivalent to sustaining unsustainable exchange rates: once a non-temporary reduction in capital inflows occurs for whatever reasons, the adjustments in real exchange rates and domestic spending will become unavoidable. In such a case, the priority in exchange rate management should be placed on avoiding excessive exchange rate fluctuations. This is important because capricious variations of floating exchange rates tend to result in what Frankel (1996) called the "overshooting of the overshooting equilibrium" in an environment of high economic uncertainty resulting from the crisis. Under such circumstances, foreign exchange markets are likely to be distorted seriously by "noise trading" which could cause substantial deviations of exchange rates from their fundamental values.[32]

Moreover, the risk of excessive exchange rate fluctuations is generally much higher in emerging market economies where the long-term value of their national currencies tends to be deemed not as stable as that of major currencies and thus market expectations on their exchange rates are often not regressive. Therefore, the government's adequate exchange rate management aimed at stabilizing market expectations in an environment of high uncertainty would be important to avoid severe economic contractions arising from the contractionary effects of exchange rate deprecations.

However, the recent dramatic increase in the mobility of global capital flows has increasingly

[32] Jeanne and Rose (2002) develop a model of noise trading which shows how exchange rate determinations can be distorted by the prevalence of noise trading and how the market entry of noise traders is endogenously determined. Kinkyo (2004a) analyzes Korea's real exchange rate dynamics during the crisis of 1997-98 and present evidence to suggest that there was a substantial degree of overshooting of overshooting equilibrium in the midst of the crisis.

undermined the ability of emerging market economies to manage their exchange rates. A grater risk of sudden stops of capital inflows and associated Asian-type crises is likely to make capital flows to emerging market economies more volatile and thus greatly increase the difficulty of maintaining the targeted exchange rate. Confronted with such challenge, one possible solution would be to employ some institutional mechanisms that help reduce excessive volatility in capital flows and exchange rates. Options might include the imposition of restrictions and taxes on capital and foreign exchange transactions.

Another solution would be to improve access to supplemental financing that would enhance the capacity of national governments to deal with destabilizing market pressures against their currencies. Establishing regional exchange rate arrangements that involve effective financing facilities would serve such a purpose.[33] With the enhanced ability to stabilize exchange rates, emerging market economies would better deal with panic-driven capital flow reversals, which could otherwise result in economic disaster.

Acknowledgements

The author wishes to thank Jerry Coakley, Laurence Harris, Machiko Nissanke, and Graham Smith for very useful comments and suggestions.

[33] Nissanke (2003) discusses the case for the "two-tier Tobin tax" originally proposed by Spahn (1995; 1996) as an instrument to enhance the manageability of exchange rates in developing countries. In a similar vein, Kinkyo (2004b) argues the case for regional exchange rate arrangement in the context of East Asia.

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Table 1
Contributions to real GDP growth in Indonesia, Korea, and Thailand

[Indonesia] (% points)

	1996	1997	1998	1999	2000
Private consumption	5.9	4.9	-3.9	3.2	2.6
Public consumption	0.2	0.0	-1.1	0.0	0.5
Gross fixed investment	4.3	2.7	-10.6	-4.8	3.8
Inventory investment	-2.6	-0.6	-2.2	-0.6	-2.0
Net exports	0.0	-2.2	4.8	3.0	0.1
Exports	2.1	2.1	3.1	-11.3	3.9
(less) Imports	2.0	4.3	-1.7	-14.3	3.8
Real GDP growth rate: %	7.8	4.7	-13.1	0.8	5.0

Note: GDP is calculated by summing up the expenditure components.

[Korea]

	1996	1997	1998	1999	2000
Private consumption	3.9	1.9	-6.4	5.6	4.1
Public consumption	0.8	0.1	0.0	0.1	0.0
Gross fixed investment	2.7	-0.8	-7.3	1.1	3.1
Inventory investment	0.6	-2.0	-5.5	5.4	-0.2
Net exports	-1.1	5.7	12.5	-1.0	3.1
Exports	3.4	6.7	5.1	7.0	9.5
(less) Imports	4.5	1.1	-7.4	8.0	6.5
Real GDP growth rate: %	6.8	5.0	-6.7	10.9	9.3

[Thailand]

	1996	1997	1998	1999	2000
Private consumption	3.2	-0.7	-6.3	2.3	2.6
Public consumption	1.0	-0.2	0.3	0.3	0.2
Gross fixed investment	3.0	-8.7	-15.2	-0.7	1.1
Inventory investment	-0.7	-0.7	-2.2	2.3	1.1
Net exports	-2.3	8.6	13.4	0.9	-1.1
Exports	-2.6	3.0	3.8	5.0	10.1
(less) Imports	-0.3	-5.6	-9.6	4.1	11.2
Real GDP growth rate: %	5.9	-1.4	-10.5	4.4	4.6

Source: National Accounts

Table 2
Unit root test

	Level		First difference
	No trend	Trend	
Output	-4.6548 (3) [-2.8981]	-3.0183 (0) [-3.4666]	-7.6161 (0) [-2.8986]
Real capital inflows	-3.4851 (1) [-2.8981]	-3.4428 (1) [-3.4666]	-8.2805 (2) [-2.8986]
Real exchange rate	-2.8824 (4) [-2.8981]	-2.8584 (4) [-3.4666]	-7.4811 (3) [-2.8986]
Real corporate borrowing	-2.5333 (1) [-2.8981]	-2.6531 (1) [-3.4666]	-8.9356 (2) [-2.8986]
Real fiscal surplus	-1.3851 (0) [-2.8981]	-1.8315 (0) [-3.4666]	-8.7674 (0) [-2.8986]
Real interest rate	-4.4920 (0) [-2.8981]	-4.5867 (0) [-3.4666]	-10.1430 (0) [-2.8986]

Note:

1. The figures are augmented Dickey-Fuller (ADF) statistics.
2. Numbers in the parentheses are the order of augmentations for the ADF test. The order is selected on the basis of the Schwarz Bayesian criterion.
3. Figures in the brackets are the 95 percent critical value for the test computed using the response surface estimates given in MacKinnon (1991).
4. In the case of output, the quarterly growth rate was used instead of the first difference of detrended real GDP.

Table 3
The development of balance of payments in Korea (1997Q3-1998Q4)

Millions of US dollars

	1997Q3	1997Q4	1998Q1	1998Q2	1998Q3	1998Q4
Current account	-2052.6	3961.6	10712.5	11007.3	9744	8901.1
Financial account	762.5	-9782.8	-1357.4	2223.5	-2777.1	-1456.8
Direct investment	-660.8	-211.8	-32	553.6	662.1	-510.9
Portfolio investment	5443.9	428.2	3805.9	567.7	-3877.5	-2374.3
Assets	80.4	2514	1214.4	-1166.1	-84.6	-1550.4
Liabilities	5363.5	-2085.8	2591.5	1733.8	-3792.9	-823.9
Equity securities	753.5	-1410.5	2753.9	-15.3	-195.7	1313.3
Other investment	-4020.6	-9999.2	-5131.3	1102.2	438.3	1428.4
Assets	-1933.6	-7402.7	-1070.3	1586.5	3048.8	3127.8
Liabilities	-2087	-2596.5	-4061	-484.3	-2610.5	-1699.4
Trade credits	-264.6	-2478.2	-5569.9	-1297.4	-234.9	6.7
Loans	-1742.8	-683.1	2178.4	752.2	-2182.5	-2256
Monetary authorities	0	11117	4028.3	1870.3	972.3	-1857.7
General government	-11.1	4905.3	3012.9	9.7	43.1	1581
Banks	-1035	-11007.6	-3354.7	-550.3	-2182.8	-481.3
of which: short-term	-2104.1	-11780.3	-2972.1	-7262.6	-1815.4	-200.1
Other sectors	-696.7	-5697.8	-2087.8	1411.8	-705.2	-1411
of which: short-term	-1343.2	-6407.4	-2526.1	-2647.2	-558.1	-827.2
Currency and deposits	-132.3	-889.9	-106.1	63.3	171.3	549.8
Other liabilities	52.7	1454.7	-563.4	-2.4	-364.4	0.1
Net errors and omissions	2600.1	9980.1	-9357	-11262	-5543.8	-4812.2
Reserve assets (-: increase)	-1165.4	-4028.7	51.4	-2318.1	-1358.1	-2568.4

Source: Bank of Korea *Balance of Payments Statistics*

Table 4a

The size of individual shocks and their ratio to total shocks (1997Q4-1998Q2)

	Fiscal policy	Capital flow	Exchange rate	Independent	Interest rate	Corporate borrowing	Total shocks	Actual output
1997Q4	0.0047	-0.0162	-0.0201	0.0034	0.0064	0.0043	-0.0177	0.0000
	-26.4%	91.8%	114.0%	-19.2%	-36.1%	-24.1%	100.0%	
1998Q1	-0.0039	-0.0234	-0.0243	-0.0262	-0.0074	-0.0036	-0.0889	-0.0715
	4.4%	26.3%	27.4%	29.5%	8.3%	4.1%	100.0%	
1998Q2	0.0030	-0.0108	-0.0084	-0.0136	-0.0033	-0.0013	-0.0344	-0.0156
	-8.6%	31.5%	24.4%	39.4%	9.6%	3.7%	100.0%	
Average	0.0013	-0.0168	-0.0176	-0.0121	-0.0014	-0.0002	-0.0470	-0.0290
97Q4-98Q1	-2.7%	35.8%	37.5%	25.8%	3.1%	0.5%	100.0%	

Note: The sum of individual shocks is not equal to actual output because there is an intercept term in the VAR.

Table 4b

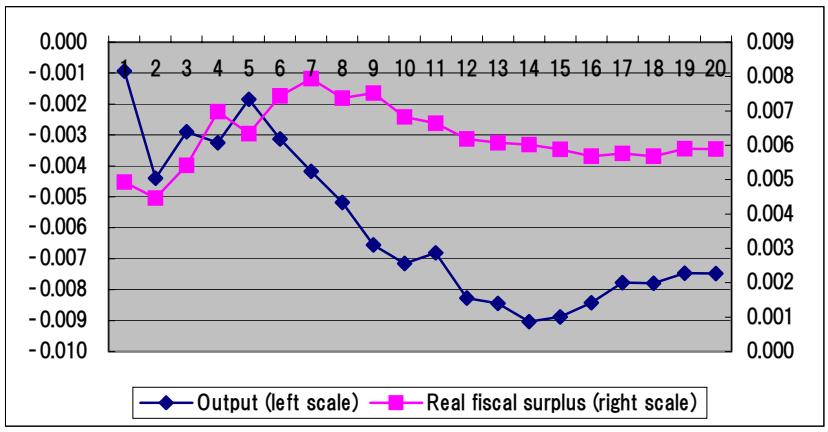
The size of individual shocks and their ratio to total shocks (1998Q3-1999Q4)

	Fiscal policy	Capital flow	Exchange rate	Independent	Interest rate	Corporate borrowing	Total shocks	Actual output
1998Q3	-0.0016	0.0022	-0.0088	-0.0027	0.0012	-0.0024	-0.0121	0.0060
	13.2%	-18.7%	72.8%	22.4%	-9.6%	19.8%	100.0%	
1998Q4	-0.0013	0.0116	0.0064	-0.0106	0.0010	-0.0014	0.0057	0.0255
	-22.4%	203.5%	113.2%	-187.1%	17.4%	-24.6%	100.0%	
1999Q1	0.0014	0.0106	0.0079	0.0083	0.0061	-0.0100	0.0244	0.0404
	5.9%	43.6%	32.5%	34.0%	25.0%	-41.0%	100.0%	
1999Q2	0.0024	0.0042	0.0043	-0.0016	0.0027	0.0037	0.0157	0.0341
	15.1%	26.8%	27.3%	-10.0%	17.1%	23.7%	100.0%	
1999Q3	0.0007	0.0063	0.0043	-0.0012	0.0030	-0.0066	0.0065	0.0238
	10.3%	97.2%	66.5%	-19.2%	46.4%	-101.2%	100.0%	
1999Q4	-0.0058	0.0020	0.0094	0.0112	0.0002	-0.0005	0.0166	0.0337
	-34.8%	12.3%	56.8%	67.5%	1.5%	-3.3%	100.0%	
Average	-0.0003	0.0058	0.0065	0.0042	0.0030	-0.0033	0.0158	0.0330
99Q1-99Q4	-0.9%	45.0%	45.8%	18.1%	22.5%	-30.4%	100.0%	

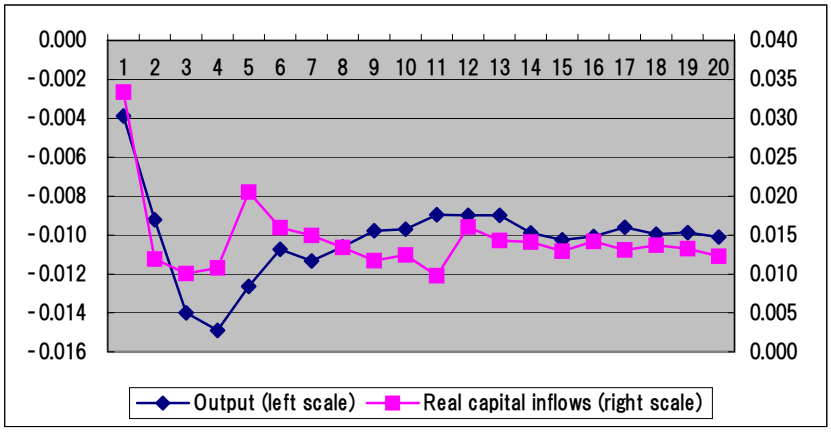
Note: The sum of individual shocks is not equal to actual output because there is an intercept term in the VAR.

Fig. 1. Impulse responses of output to shocks in other variables

(a) Real fiscal surplus

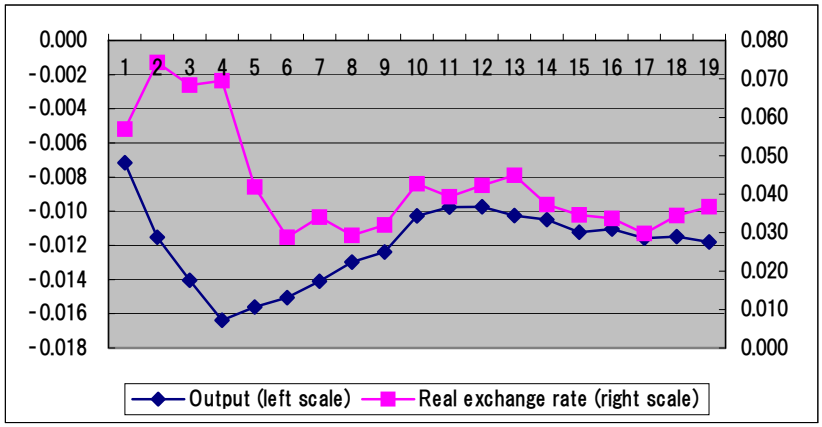


(b) Real capital inflows



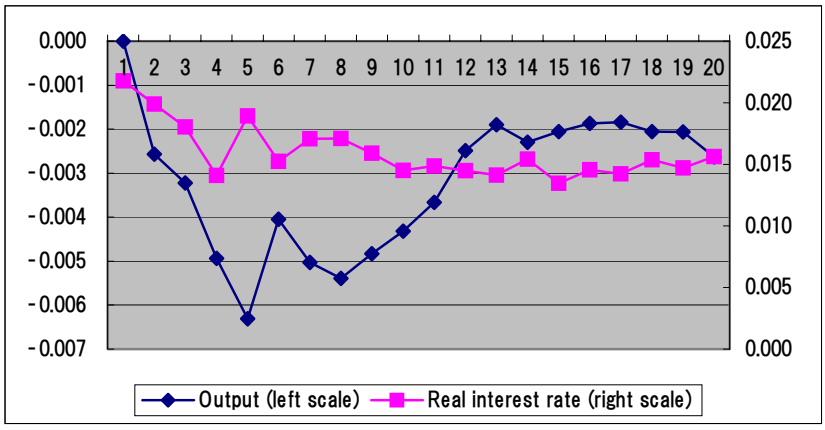
Note: The sign of real capital inflows is reversed, so that an increase in the value indicates a decline in real capital inflows.

(c) Real exchange rate



Note: The sign of real exchange rate is reversed, so that an increase in the value indicates the deprecation of real exchange rate.

(d) Real interest rate



(f) Real corporate borrowing

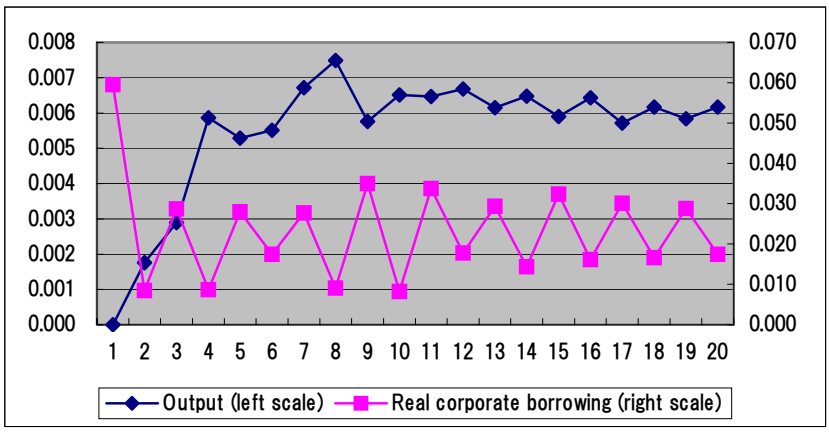
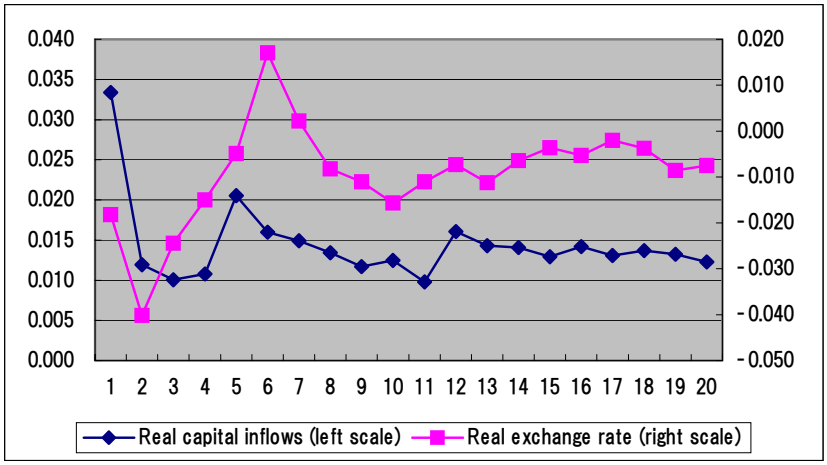


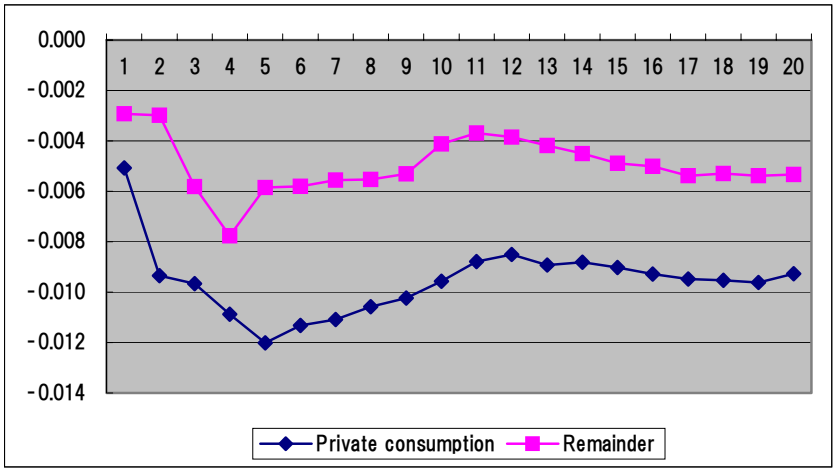
Fig. 2. Impulse responses of real exchange rate to negative shocks in real capital inflows



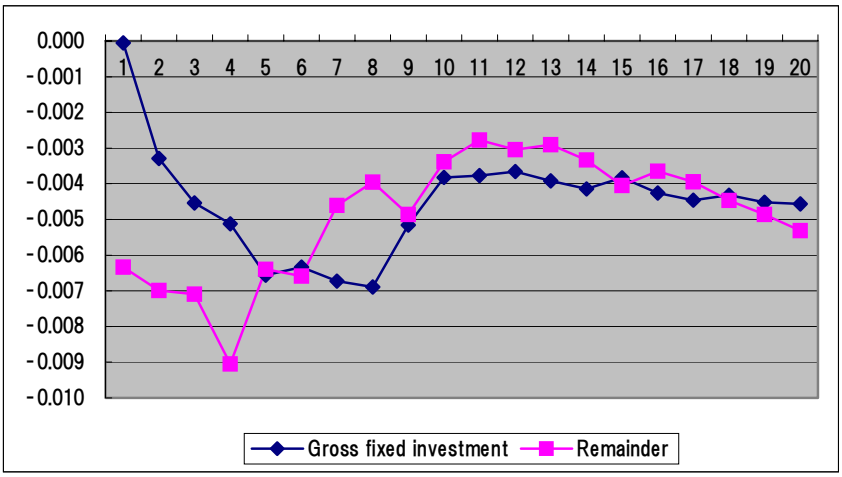
Note: The sign of real capital inflows is reversed, so that an increase in the value indicates a decline in real capital inflows

Fig. 3. Impulse responses of GDP components to negative shocks in real exchange rate

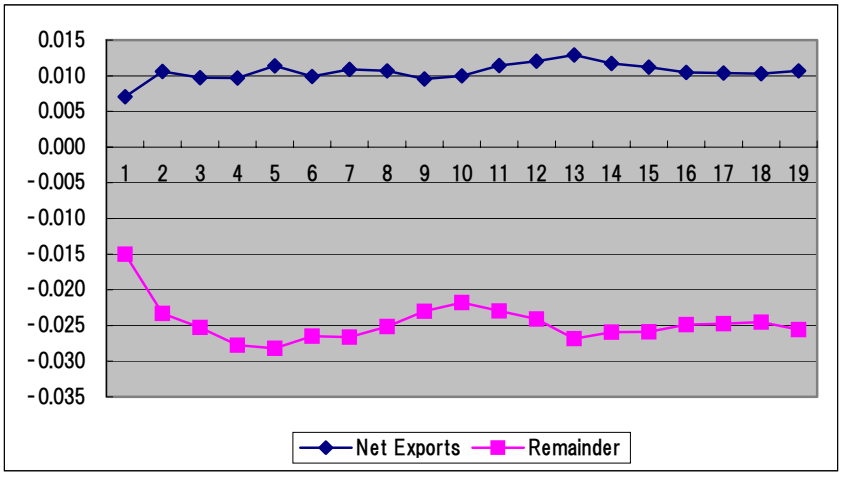
(a) Private consumption



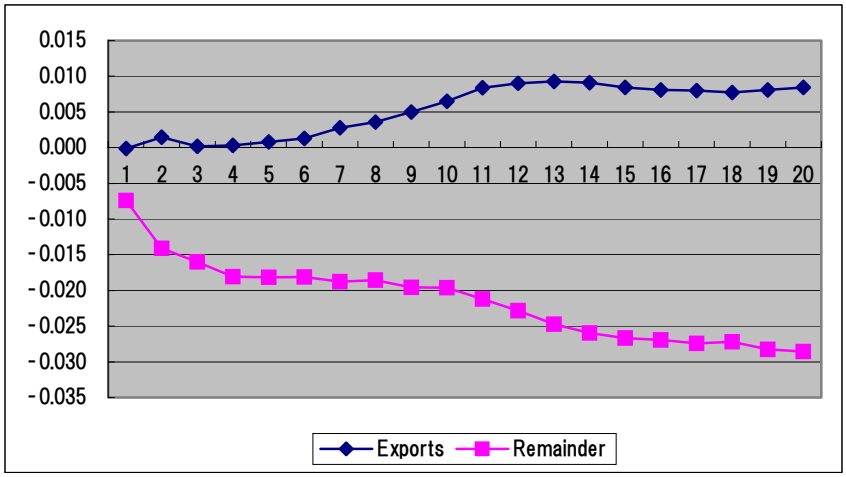
(b) Gross fixed investment



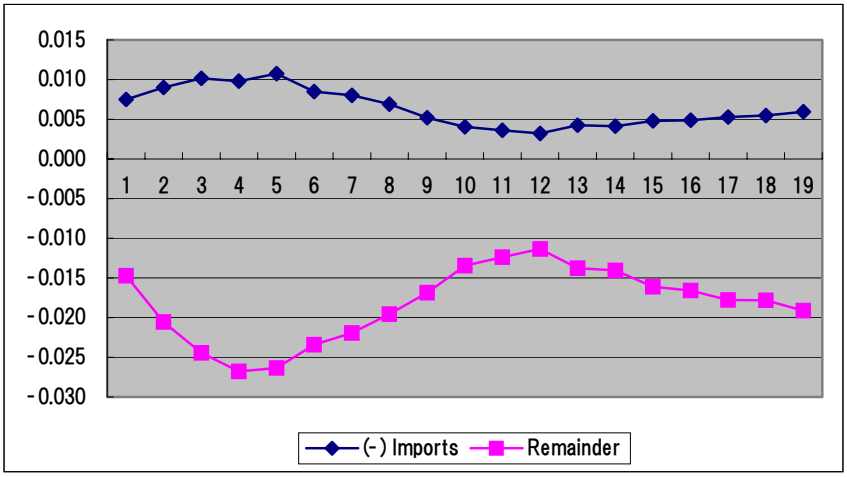
(c) Net exports



(d) Exports



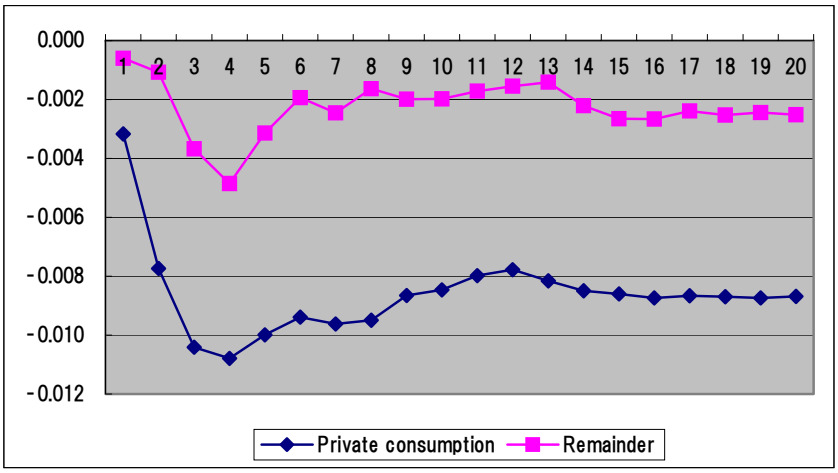
(e) Imports



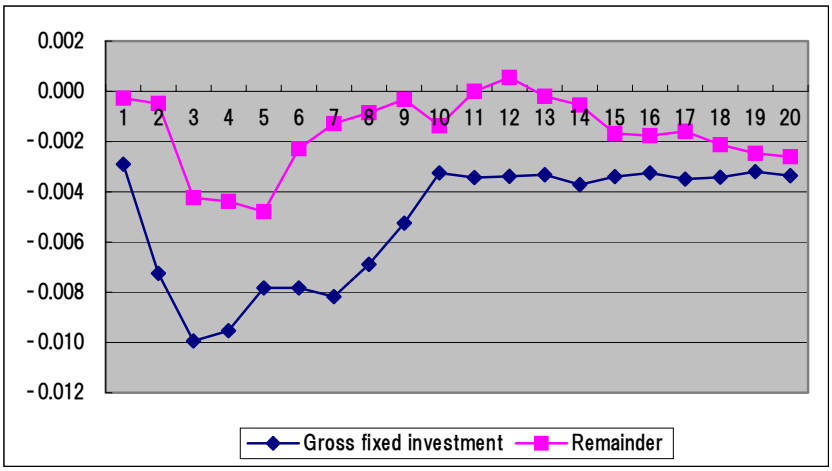
Note: The sign of the contribution of import is reversed, so that an increase in the value indicates a decline in imports.

Fig. 4. Impulse responses of GDP components to negative shocks in real capital inflows

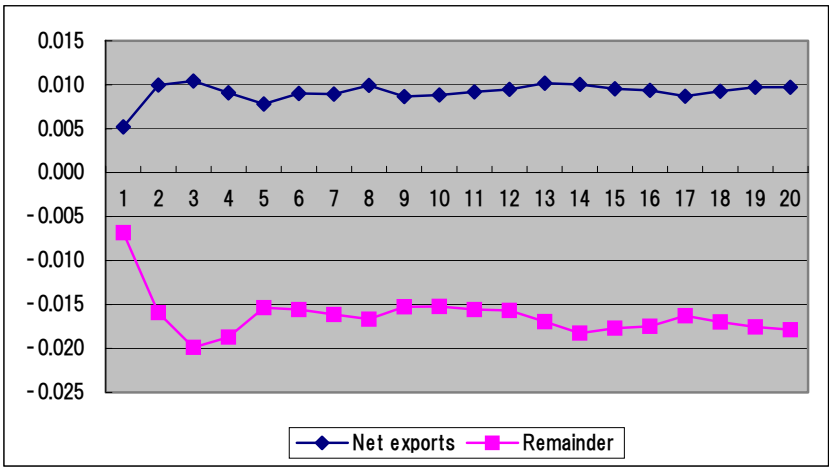
(a) Private consumption



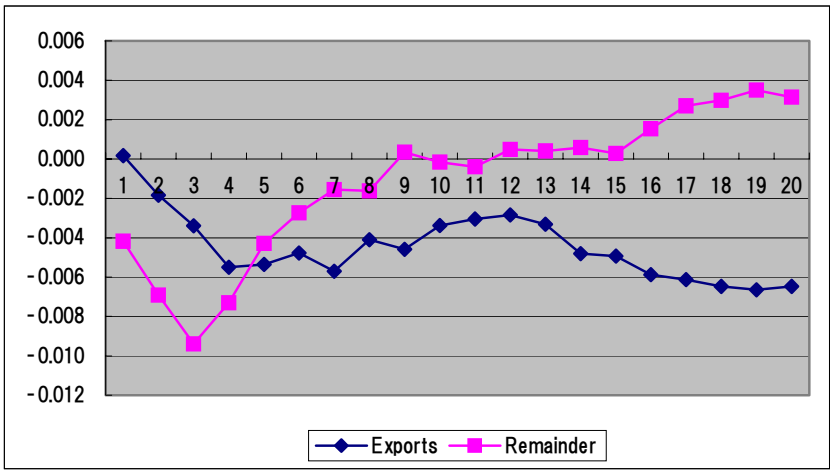
(b) Gross fixed investment



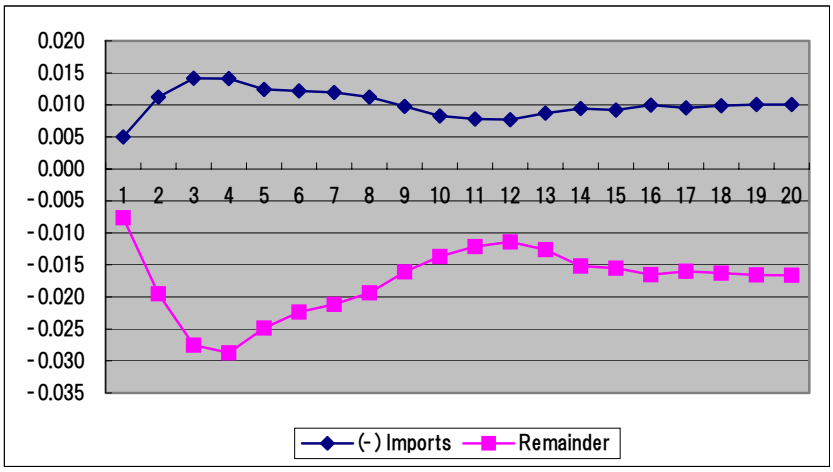
(c) Net exports



(d) Exports

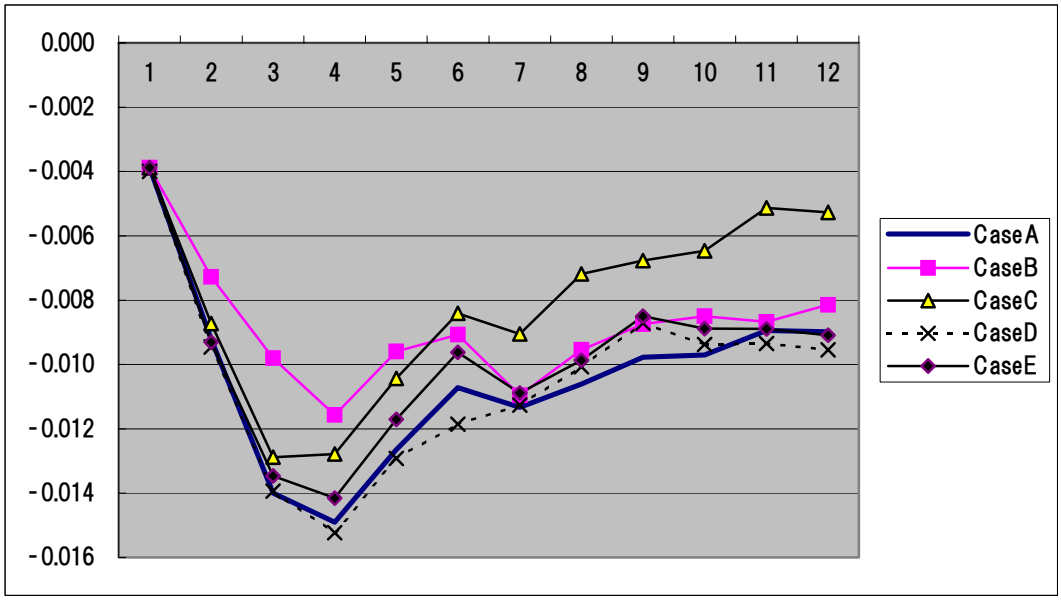


(e) Imports



Note: The sign of the contribution of import is reversed, so that an increase in the value indicates a decline in imports.

Fig. 5a. Impulse responses of output to negative shocks in real capital inflows in various cases



Note: Case A; Base case, Case B; Exogenizing real exchange rate,
Case C; Exogenizing real corporate borrowing,
Case D; Exogenizing real fiscal surplus, Case E; Exogenizing real interest rate

Fig. 5b. Impulse responses of output to negative shocks in real exchange rate in two cases

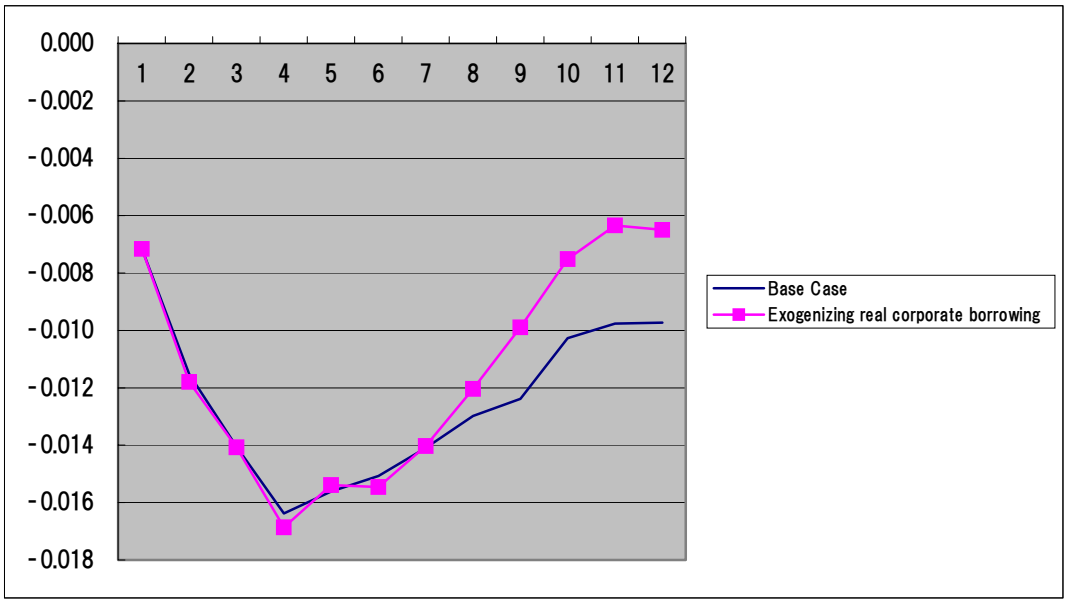


Fig. 6a Output decompostions (1990Q1-2000Q4)

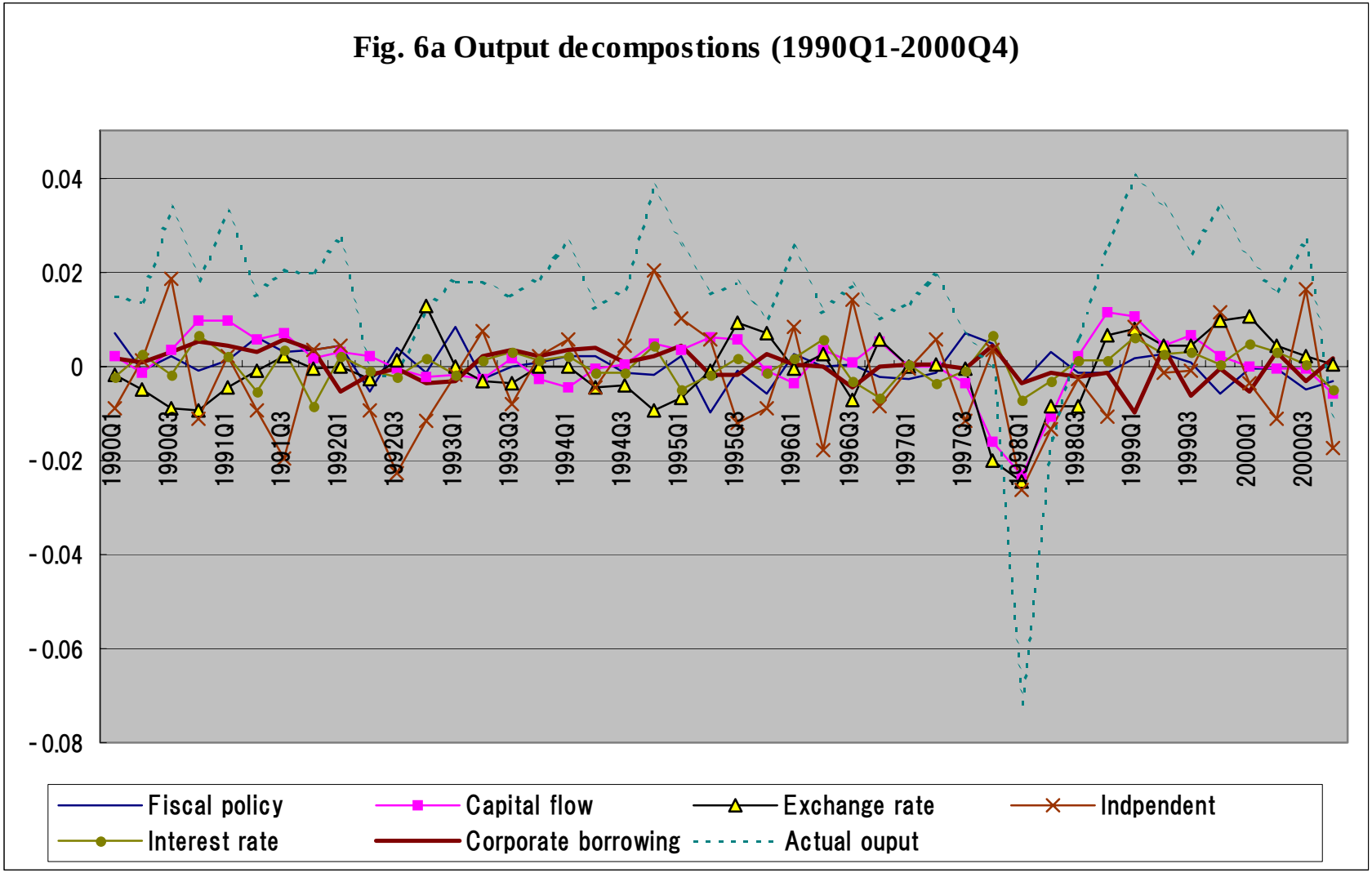


Fig.6b. Output decompostions (1997Q1-2000Q4)