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# ASSET SUBSTITUTION IN RESPONSE TO LIQUIDITY DEMAND AND MONETARY POLICY: EVIDENCE FROM THE FLOW OF FUNDS DATA IN JAPAN\*†

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We empirically investigate asset substitution of economic sectors in response to either liquidity demand or monetary policy shock, using the Japanese flow of funds data. Our interest is in responses of portfolio items of six sectors, financial institutions, central government, public corporations and local government, corporate business, personal, and overseas. It is reasonable to identify both shocks in liquidity demand and monetary policy, using recursive VAR models where the variable ordering is the real GDP, the GDP deflator, the commodity price index, the call rate, the monetary base and each balance-sheet variable. We interpret that structural innovations in the monetary base as liquidity demand shocks and those in the call rate as monetary policy shocks. The responses to either the monetary-policy or liquidity demand shocks are different among sectors, among the transaction items, and between the periods before and after the bubble. Among the sectors, the personal sector exhibits the delayed responses, which are consistent with the limited participation model. The transaction items of the corporate business sector show vivid responses to the shocks. Between the two sub-periods, the stocks held by the financial institutions show the clearly different responses.

*JEL classification:* E52; G21; G32

*Keywords:* Asset substitution; liquidity; monetary policy; flow of funds; identification; VAR model

## 1. Introduction

The interaction between monetary policy and balance-sheet adjustments has been the issue of interest in monetary theory (see Kashyap and Stein (1994) for an earlier survey and Christiano, Eichenbaum and Evans (1999) for a more recent one). In particular, financial accelerator models (e.g. Bernanke and Gertler, 2001) imply that fluctuations of *bank loans* are amplified by monetary policy, which affects collateral values or net worth of financially constrained firms. Another monetary theory of limited participation models (e.g. Lucas (1990), Fuerst (1992), Christiano and Eichenbaum (1992)) assumes that *household sector* would make a financial choice especially in *deposit* holdings, based on imperfect information prior to monetary policy announcement. The portfolio commitment faces households with liquidity constraints, generating imperfect price adjustments, and as a result, real effects of monetary policy. The other related strand of the monetary theory is on corporate liquidity management (e.g. Holmstrom and Tirole

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† We greatly appreciate discussions with Akira Kohsaka (Osaka University) and Kazuo Ogawa (Osaka University). This paper was written in 2004 but we find it still contains valuable information. Thus, we decided to publish the paper as it is.

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(1998)). In a three-period model where an aggregate liquidity shock occurs at the intermediate period, *corporations* need publicly-supplied liquidity so that liquidity can be loosened (tightened) when the aggregate liquidity shock is high (low). The liquidity demand suggests a rationale for *government debt* management.

Our interest is broader than these monetary theories that focus on a specific sector of banks, households or firms, or a specific balance-sheet item of bank loans, deposits or government bonds. We intend to explore responses of 6 transaction items of 6 different sectors to liquidity demand and monetary policy shocks.

Monetary policy supplies financial intermediaries with liquidity, relaxes liquidity constraints on different sectors, and leads to an increase in demand for less liquid assets. The asset substitution from liquid assets to illiquid ones can cause a decrease in nominal interest rate, following the conventional Keynesian proposition of Tobin (1947). However, VAR approach to the “liquidity effects” of monetary policy on nominal interest rate presents a puzzle in the sense that a relationship between innovations in monetary base and nominal interest rate is highly uncertain and usually of positive sign (e.g. Gordon and Leeper (1992)). Some more recent studies (Strongin (1995); Kasa and Popper (1997); Bernanke and Mihov (1998); Shioji (2000)) suggest that in order to resolve the liquidity puzzle, we have to incorporate into VAR models a part of the endogenous money supply, which means accommodative money supply to liquidity demand. Taking into account effects of the endogenous money supply, shocks identified as of exogenous money supply can have negative influence on nominal interest rate. This paper follows the empirical strategy of identifying both unexpected changes in liquidity demand and exogenous changes in monetary policy stance, by using simple recursive VAR models.

We have two reasons for analyzing the liquidity problems discussed above in the Japanese economy. First, under the “zero interest rate policy (ZIRP)” (Ueda (2001) for an overview with practical perspectives) since 1998, there has been a macroeconomic state of excessive liquidity. The current account deposits held by the financial condition, interest rates of the Japanese government bonds (JGB) have been lowered down to 0.9% in spite of the over-issuance up to 31.9% of the GDP per annum (Takeda and Yajima (2004) for the JGB markets during the ZIRP). Under such an excess liquidity including liquid assets such as the government bonds, however, there are serious concerns about what is happening when the ZIRP is lifted in the near future. What will be purchased or sold in the financial market in response to a change in monetary policy stance? Is there a possibility of recurrent asset price bubbles as experienced in the second half of the 1980s? Our estimate of portfolio responses to monetary policy will be instructive for these questions.

Second, if the first concern of us is appropriate, should the Bank of Japan (BOJ) adopt asset prices as another policy target? The bank has been accused of underestimating the serious negative effects of asset price bubble on real activities. BOJ economists reexamined the appropriateness of BOJ’s past policy in the bubble era and discussed that it was focused on preventing sharp appreciations of the Japanese yen relative to the US dollar (Okina, Shirakawa and Shiratsuka (2001)). Bernanke and Gertler (1999, 2001) dealing with asset-price targeting in the financial accelerator model, show that asset-price targeting can destabilize the equilibrium inflation rate and can cause sunspot equilibria at the worst. However, the destabilization effect on

inflation might depend on whether targeted assets are available as collaterals or not, or whether they consist in net worth of corporations. This paper will contribute to the debate on the asset-price targeting.

Based on these motivations, this paper analyzes effects of a liquidity demand shock and an exogenous change in monetary policy stance in identified VAR models following Christiano, Eichenbaum and Evans (1996).

## 2. Overview of the balance-sheets in Japan

This section overviews the chronological developments of the balance sheets of sectors in the Japanese economy. At first, we focus on the financial surplus/deficit, or the I-S balance of the sectors in the economy based on the Flow of Funds data. There are six sectors: financial institutions, central government, local governments, corporation, personal, and the overseas. Next, we look at the balance sheet adjustments in the corporate business sectors, based on the Corporate Business Statistics (Hojin-Kigyo-Tokei). Thirdly, we offer bird-eye views of the flow of funds in the entire economy in three periods: pre-bubble, bubble, and post bubble periods.

### 2.1 Financial surplus/deficit

Figure 1 shows the seasonally-adjusted real financial surplus/deficit of all sectors in the economy. There are significant volatilities but the trends can be observable. Let's focus on those sectors which exhibit clear trends. First, the central government was in deficit from the late 1970s to the early 1980s. Then, it was in the surplus from the late 1980s to the beginning of the 1990s, the “bubble” period. Deficit followed afterwards. This time, the deficit expanded progressively. The local governments and the governmental corporations have had the similar fluctuations in their deficits/surpluses.

Second, the private corporation sector exhibited quite a different movement. It experienced a deficit until the mid-1990s. This deficit expanded in the “bubble” period, but started to shrink after 1990. Then, it experienced a surplus since the mid-1990s. This was a totally new phenomenon and the surplus expanded. It was apparent that the corporations redeemed their loans and reduced their debts.

Third, the personal sector experienced a surplus through the period depicted in the Figure. But, there were significant changes in this sector, too. The surplus expanded until the mid-1990s but it was unchanged or even shrank since then. In fact, the Japanese household saving rate, which had been known for its high level, has started to decline significantly since the mid-1990s.

Fourth, the overseas sector had been a deficit sector in the period depicted in Figure 1. There were two exceptions; one during the first oil embargo and another during the second oil embargo. Its deficit showed an expanding trend since the beginning of the 1980s till the late 1980s. However, the trend disappeared since then, though large swings remained. The Japanese external surplus shrank in the “bubble” period.

### 2.2 Balance sheet adjustments in the corporate sector

We have seen that the corporate sector has recently become a surplus sector. This trend reflects

its balance-sheet adjustment; it has been reducing the debt. Figure 2 shows the total amount of the interest-bearing debt with its ratio to the total cash flow. The debt has decreased since 1999. That timing might seem rather late; some economists pointed that the debt of the worst performing sectors like construction and retail industries had been growing until then. The debt might have decreased a bit earlier unless the 1997-98 crises had not happened. The debt-cash flow ratio exhibits similar fluctuations. It started to decrease a bit earlier but the downward trend was also interrupted by the 1997-98 crises. Afterwards, it restarted to decrease.

### 2.3 Characteristics of the flow of funds in different periods

The pattern of the funds flow in the financial markets changed dramatically. To see this, we depicted Figure 3, which summarizes the information in the flow of funds data. Figure 3-A shows the pattern in the fiscal year 1984, a year in the pre-bubble period. We consider this pattern as the benchmark.

Figure 3-B shows the pattern in the fiscal year 1990, a year in the bubble period. Compared with the pre-bubble benchmark, the flows from the private financial institutions to the corporate business sector were about 50% larger in both loans and stocks/bonds. The deposits from the personal sector to the private financial institutions are more than doubled. On the other hand, the flows to the governmental sectors were smaller. The monetary base supplied by the Bank of Japan was much smaller.

Figure 3-C is the pattern in the fiscal year 1998. It is almost the reverse of Figure 3-B. The flows to the corporate business sector from the private financial institutions shrank. The deposits from the personal sectors to the private financial institutions are back to the 1984 benchmark level. On the other hand, the flows to the governmental sectors were increased. The Bank of Japan bought a huge amount of the government bonds and supplied a huge amount of monetary base.

## 3. Econometric methodology

### 3.1 Liquidity puzzle

Though our interest is in the different responses of the disaggregated sectors to changes in monetary conditions, for a preliminary purpose, we first estimate the liquidity effect of monetary policy, following the standard econometric methods with aggregate data. We adopt a recursive VAR model (e.g. Bernanke and Blinder (1992); Leeper and Gordon (1992); Sims (1992); Strongin (1995) for the US and Miyao (2000, 2002) for Japan) and a semi-structural VAR model with short-run identifying restrictions (e.g. Christiano, Eichenbaum and Evans (1992) for the US, and Shioji (2000) for Japan). Lag length in VAR models throughout this paper is equal to 4 quarters. Our variables are quarterly data from the 1st quarter of 1970 to the 1st quarter of 1999 as follows: the logarithm of the (seasonally and reserve-ratio adjusted) monetary-base (TR) and the rate of the (collateralized) call loans (FF) for a 2-variate VAR model; we added to these two monetary variables, the logarithm of the (seasonally adjusted) real GDP (GDP), the logarithm of the (seasonally adjusted) GDP deflator (P) for a 4-variate VAR model; and we further added the logarithm of the commodity price index (PCOM) for a 5-variate VAR model.

The inclusion of the last variable PCOM into the VAR model is motivated by another familiar

empirical ‘price puzzle’, other than the liquidity puzzle. The price puzzle means that, in response to a contractionary monetary policy shock, the price index initially displays an increase, not a decrease. As a remedy against the puzzle, Sims (1992) proposed to add to VAR models a leading index of the general price level, which makes the VAR model closer to the reality. Central banks watching the leading index take policy actions before the general price inflation actually picks up. These ‘preemptive’ policy actions could lead to the price puzzles in the VAR model without the leading indicator. Following Sims’ proposal, we use the commodity price index (the Nikkei index for 17 sorts of commodity prices). The commodity index covers raw materials, such as steels, copper, lead, zinc, tin, aluminum, cotton yarn and thread, silk, refined sugar, soybean, wild rubber, and so forth.

### **Exogenous money**

We assume exogenous money supply, which implies ordering variables so that the monetary base is placed ahead of the call rate. Figure 4 indicates impulse response functions of one variable to one-standard deviation shock in the other variable. Error bands with +/- 2 standard errors computed by a Monte Carlo integration procedure with 100 repetitions are shown there. In response to an exogenous increase in monetary base, the call rate indicates significantly positive impact for more than 4 years, contradicting with an expected sign of the liquidity effect. The puzzle cannot vanish if the first-differences of both variables are used. As is shown by a structural stability test in VAR models by Miyao (2000) where the monthly data of first-differences on the call rate, industrial production and monetary base are adopted, there are possibilities of a structural break in 1995 when three major episodes took place: (1) the yen’s large appreciation; (2) the official discount rate going down to a lowest record level of 0.5%; and (3) the financial turmoil stemming from the largest credit union (Kizu Credit Union) and the largest second-tier local bank (Hyogo Bank). Considering the possibilities of structural break, we split our sample period into two sub-periods, and estimate the same VAR model. However, in both cases, the liquidity puzzle remains.

We also estimate 4- and 5-variate VAR models where the first variable placed in VAR ordering is the monetary base assumed exogenous. Figure 5 is an example of impulse response functions in a VAR model of an ordering (TR, FF, GDP, P). It is obvious that not only the liquidity puzzle still remains, but also the price puzzle emerges in a response of the GDP deflator to the call rate shock. Inflation lasts for 4 years long after a contractionary monetary policy shock. Following Sims (1992), we add the commodity price index into the VAR model. The ordering is (TR, FF, PCOM, GDP, P). As seen in Figure 6, owing to the commodity price index, the price puzzle disappears, though the liquidity puzzle is still intact. The puzzling results are conditional on an assumption of exogenous monetary base, so that in order to resolve the puzzle we have to reconsider the assumptions.

### **Endogenous money**

In order to identify each shock in the liquidity demand and the exogenous monetary policy, we experiment two types of identifying restrictions, the Cholesky decomposition and the contemporaneous zero restrictions. The former depends only on a variable ordering so that recursive relationships between innovations in each variable are obtained. The latter posits a

number of zero coefficients on structural innovations in relationships to VAR disturbances so that a structural-form equation can be fully identified from an estimated reduced-form equation.

First, we experiment a variable ordering  $X_t = (GDP_t, P_t, FF_t, TR_t)'$  in a recursive 4-variate VAR model satisfying the following:

$$X_t = \varphi(L)X_{t-1} + u_t$$

The vector of the disturbances  $u_t$  is assumed to be related to a vector of structural innovations  $\epsilon_t$  by the following contemporaneous relationship:

$$Au_t = B\epsilon_t$$

where a covariance matrix of the innovation  $\epsilon_t$  is equal to a diagonal matrix, and also the diagonal elements of two coefficient matrices A and B are 1. On the one hand, there are 12(=4\*4 - 4) and 12(=4\*4 - 4) unknown parameters in two coefficient matrices A and B respectively, in addition to 4 unknown diagonal elements in a covariance matrix  $\epsilon_t$ . Our information set, on the other hand, consists of 10(=4\*(4+1)/2) estimates of a symmetric covariance matrix of the disturbance  $u_t$ . In order to fully identify the model, we require another 18(=12+12+4-10) restrictions on parameters. Variable ordering based on the Cholesky decomposition implies 12 and 6 zero restrictions on the coefficient matrices A and B respectively, as follows:

$$A = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}, B = \begin{pmatrix} 1 & 0 & 0 & 0 \\ \cdot & 1 & 0 & 0 \\ \cdot & \cdot & 1 & 0 \\ \cdot & \cdot & \cdot & 1 \end{pmatrix}$$

In an ordering of  $X_t = (GDP_t, P_t, FF_t, TR_t)'$ , an innovation in the call rate is considered as *an exogenous monetary policy shock*, being free from any feedbacks of the real GDP and inflation as in the Taylor rule (Taylor, 1993). More importantly, an innovation in the monetary base is independent of both a change in monetary policy stance, including a part of endogenous money supply, and determinants of money demand depending on the real GDP and inflation. The identification suggests that the TR innovation can be interpreted as reflecting *an unexpected change in liquidity demand*, which is tangible during periods like financial panics or crises.

Figure 7 shows impulse response functions in the 4-variate recursive VAR model. Understanding what the TR innovation stands for, we cannot expect the liquidity effect to be found in a response of FF to TR, since the TR innovation is a shock in liquidity demand. Note that the price puzzle is apparent in the VAR without the commodity price index.

Similarly to the recursive VAR model, we next experiment short-run zero restrictions on the coefficient matrices A and B of a vector  $X_t = (GDP_t, P_t, FF_t, TR_t)'$ , as follows:

$$A = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & \cdot & 1 \end{pmatrix}, B = \begin{pmatrix} 1 & \cdot & 0 & \cdot \\ \cdot & 1 & 0 & \cdot \\ \cdot & \cdot & 1 & 0 \\ \cdot & \cdot & 0 & 1 \end{pmatrix}$$

The choice of identifying restrictions is among several candidates, most of which violate the

singularity condition in calculating the inverse of the Hessian matrix of the log likelihood function with the starting values randomly provided from a normal distribution. Though our 15 (=11+4) zero restrictions on the coefficient matrices causes the 4-variate model to be over-identified by three extra restrictions, we do not face this problem. Moreover, under the identifying restriction, the significant coefficient on the FF disturbance in the TR equation (Table 1) indicates the crucial role of endogenous money supply. These are the reasons why we chose the over-identifying zero restrictions. However, the impulse response functions in the case (figure omitted for space-saving) show that there are remains of the positive response of the call rate to a shock in the monetary base.

Table 1 Contemporaneous restrictions on 4-variate non-recursive VAR model  
(Estimation method: method of scoring (analytic derivatives))

u_gdp =	0.904*e_tr	+	e_gdp	+	0.879*e_p
	(0)				(0.01)
u_p =	1.024*e_tr	+	1.129*e_gdp	+	e_p
	(0.09)		(0.001)		
u_ff =		e_ff -	0.001*e_gdp	+	0.001*e_p
			(0.99)		(0.99)
u_tr =	e_tr+0.955*u_ff	+	1.096*e_gdp	+	0.966*e_p
	(0)		(0.12)		(0.10)

Note: Disturbances  $u_i$ ,  $i = gdp, p, ff, or tr$ ; Innovations  $e_j$ ,  $j = gdp, p, ff, or tr$ .

Figures in parenthesis are probability values.

The preliminary VAR estimations suggest that, even if we take into account the endogeneity of money supply, we should regard the innovation in monetary base as reflecting an unexpected change in liquidity demand. It would be reasonable to think that the liquidity demand shock raises the nominal interest rate, instead of considering the positive relationships between the monetary base and nominal interest rate in the VAR as evidence of the liquidity puzzle.

### 3.2 Recursive VAR models of sectional financial surplus

We estimate 6-variate recursive VAR models following Christiano, Eichenbaum and Evans (1996), which, motivated by the limited participation models, analyze the effects of monetary policy shocks on the flow of funds in each sector. The variables in VAR models  $X_t$  are the followings: the logarithm of the real GDP seasonally adjusted, the logarithm of the GDP deflator seasonally adjusted, the logarithm of the commodity price index, the rate of the collateralized call loans, the logarithm of the monetary-base seasonally and reserve-ratio adjusted, and a different sort of balance-sheet variables (seasonally adjusted) divided by the GDP deflator (seasonally adjusted).

$$X_t = \varphi(L)X_{t-1} + u_t$$

Our identifications in VAR models are based on the Cholesky decomposition, in which the

ordering of variables in the models determines how to extract innovations from disturbances. We tried some combinations of the ordering and checked the sensitivity of qualitative results, and as a result, we fixed the ordering as in the above explanation. In the chosen ordering of VAR variables, an innovation in the call rate can be interpreted as an exogenous monetary policy shock. The shock means a change in a policy stance of central bank, which include anything but a systematic part depending on the real GDP, the GDP deflator, and the commodity price index.

Our interest is also in effects on the balance-sheet variables of “liquidity” measured by amount of the monetary base. According to the liquidity preference, an exogenous increase in monetary base lowers nominal interest rates. However, the actual nominal interest rate tends to respond positively to a shock in monetary aggregates. The empirical evidence can be considered as a result of liquidity demands being shifted upward. For example, in the case of a financial crisis when systemic risks associated with banking system come to the surface, public demands for liquid assets surge and, as a result, make nominal interest rate increase higher than otherwise. We expect the surge in liquidity demand to be the case in Japan, where since 1997 some large financial intermediaries have gone bankrupt and caused financial turmoil. Moreover, central bank can mitigate financial constraints on a banking sector, which is forced to demand liquidity in face of systemic risks and financial turmoil. For this purpose, the BOJ has taken the quantitative easing policy by providing sufficient amounts of liquidity as a form of monetary base since 2001.

Now we estimate the responses of balance-sheet variables to a monetary policy shock and a liquidity demand shock. Our sample period is from the 1st quarter of 1970 to the 1st quarter of 1999. Lag length of all the VAR models is equal to 4 quarters, the same as in Christiano, Eichenbaum and Evans (1996). Our estimation strategy is ‘total to partial’; as the balance-sheet variables, we examine, firstly the financial surplus or deficits (total assets accrued net of liabilities raised) in 6 sectors, and secondly, each transaction item in more segregated sectors. The six sectors are financial institutions, central government, public corporations and local government, corporate business, personal, and overseas. We also examine three sub-groups of financial institutions: Bank of Japan, private financial institutions, and public ones.

### 3.3 Identifying shocks of monetary policy and liquidity demand

First of all, we have to see what each shock of monetary policy and liquidity demand indicates. In a case of the 5-variate VAR model without the balance-sheet variables, Figure 8 shows the 3-quarters moving averages of each residuals of the call rate (FF residual) and the monetary base (TR residual), respectively. The FF residuals are decomposed from the endogenous part of monetary policy rule which depends on the real GDP, the GDP deflator, and the commodity price index. Figure 8 shows two hikes and one drop in the FF residual during the 1990s. The hikes in 1990-91 and 93-95 correspond to episodes of monetary contraction for bursting asset-price-bubble and cautiously watching the asset prices, respectively. The drop corresponds to expansionary policy during 1996-98 when the zero-interest-rate policy (ZIRP) was implemented. The TR residuals contain only shocks affecting liquidity demands of the private agents. We can see a large hike in the liquidity demand during 1997-98, which corresponds to the financial panics stemming from the bankruptcies, first of the Yamaichi Securities and the Hokkaido-Takushoku Bank, and next of the Japan Long-Term Credit Bank.

In the 6-variate VAR models with an additional balance-sheet variable, we look at the impulse response functions of the balance-sheet variable to the monetary policy and liquidity shocks in each sector. Each balance-sheet variable is divided by the GDP deflator. Figure 9 indicates the impulse response functions of the 6-variate VAR model in the case of the financial institutions. The balance-sheet variable is denoted by FIN6. The dotted lines indicate the  $\pm 1$  standard error bands. There is no price puzzle owing to the introduction of the commodity price index into the VAR model. The price level does not respond to the monetary policy shock at all. There is also a positive effect of liquidity demand shock on nominal interest rate. The effect is to the large extent significant and persistent.

We confine our interest below to two figures of responses of each balance-sheet variable to both the call rate and the monetary base shocks. Figure 10 indicates these two figures in cases of financial ‘surplus’ for financial institutions (FIN6), central government (CEN6), public corporations and local government (PUB6), corporate business (COR6), personal (PER6), and overseas (OVE6). We measure each financial surplus with an increase in accrued assets net of an increase in issued liabilities. We can make a list of sector features in the impulse response as follows:

- 1) The response of financial institutions to a monetary policy shock is initially negative and becomes positive in 5 quarters. A liquidity demand shock causes an increase in financial surplus initially and decreases the surplus in 4 quarters, though stochastically insignificant.
- 2) Central government’s response to monetary policy is significantly positive and persistent. It increases financial surplus in case of monetary contraction. There are no significant features concerning the response to a liquidity demand shock.
- 3) No responses of public corporations and local government can be seen both to monetary policy and liquidity shocks.
- 4) Corporate business sector shows an accelerating response to a monetary policy shock and a monetary contraction leads to a persistent increase in financial deficits.
- 5) Personal sector including households begins to increase the financial surplus a year after monetary policy tightening. This delayed response seems to match with a presumption of the limited participation model that households cannot adjust their financial portfolio just as a change in monetary policy.
- 6) The positive response of overseas sector to monetary contraction is of short-life. However, the overseas sector displays a significantly positive and persistent response to a liquidity shock.

### 3.4 Responses of transaction items

Next we are going to examine which transaction items accrued or issued by each sector are responsive to monetary policy and liquidity demand shocks. Among all the asset/liability items, we pick up deposits and cash currency (denoted by CASH), government bonds (JGB), stocks (STOCK), loans (LOAN), trade credits (TC), and foreign trade credits (FTC). Throughout this paper, when each transaction item is listed in either asset or liability, we handle the item as asset or liability, respectively, while when an item is on both sides of asset and liability, we use the net surplus data. Details are in Table 2. Figure 11-A to 11-F show all the figures of the responses to both monetary policy and liquidity demand shock in each sector. Figure 11-A(1) and A(2)

correspond to the cases of private financial institutions and public ones, respectively.

Table 2 Transaction items in balance-sheets

A: asset side, L: liability side.

(1) Currency and deposits							
Financial institutions			Central government	Public corporations and local government	Corporate business	Personal	Overseas
	Private	Public					
	A	A		A	A	A	A
L	L	L					
(2) Government bonds							
Financial institutions			Central government	Public corporations and local government	Corporate business	Personal	Overseas
	Private	Public					
A	A	A	A	A		A	
			L				
(3) Stocks							
Financial institutions			Central government	Public corporations and local government	Corporate business	Personal	Overseas
	Private	Public					
A	A	A	A	A	A	A	A
L	L				L		
(4) Loans							
Financial institutions			Central government	Public corporations and local government	Corporate business	Personal	Overseas
	Private	Public					
A	A	A					
			L	L	L	L	
(5) Trade credits							
Financial institutions			Central government	Public corporations and local government	Corporate business	Personal	Overseas
	Private	Public					
					A		
					L	L	
(6) Foreign trade credits							
Financial institutions			Central government	Public corporations and local government	Corporate business	Personal	Overseas
	Private	Public					
A	A	A			A		A
L	L				L		L

We can summarize the significant responses of each transaction item in different sectors indicated in Figure 11-A to F, as follows:

- 1) While there are no significant responses of financial institutions to a monetary policy shock, three transaction items are so sensitive to a liquidity demand shock: currency and deposits, stocks, and loans. In response to a positive liquidity demand shock, financial institutions as a whole decrease currency and deposit holdings for 6 quarters, and increase stocks and loans for

6 and 9 quarters, respectively. These patterns of the responses to a liquidity demand shock are true of private financial institutions. From private financial institutions, the responses of public ones are different; they increase with a year delay loans in a face of a monetary contraction shock, and increase currency and deposits to a liquidity demand shock for 6 quarters.

- 2) Central government shows insignificant responses, except for the decrease in government bonds issued in response to monetary tightening.
- 3) Except for a few temporary reactions, public corporations and local government do not display significant responses.
- 4) As for corporate business sector, some peculiar reactions are observed; to a monetary contraction shock, the Japanese firms substitute trade credits for another transaction items. They also decrease foreign trade credits possibly because they are expecting the yen's appreciation. In response to a liquidity demand shock, corporate business sector shows an increase in currency and deposit holdings and also increases stocks issued and loans borrowed from financial intermediaries.
- 5) Personal sector does respond to a monetary contraction by a slow but significant decrease in government bonds. The length of the delay is 5 quarters; this matches with a presumption of the limited participation model as described above. Contrary to the slow response to monetary policy, personal sector makes rapid adjustments to a liquidity demand shock; the currency and deposits holdings and stocks continue to increase for 5 and 8 quarters respectively, and the loans out of financial intermediaries continues to increase for more than 10 quarters.
- 6) Overseas sector increases stocks holdings and foreign trade credits, and temporarily decreases currency and deposits in the face of monetary contraction. To a liquidity demand shock, the sector decreases stocks holdings initially but increases them in the long-run.

### 3.5 Comparisons between sub-sample periods

Finally, we check the robustness of structural stability in our estimations concerning sample period. We mechanically divide the total sample period, the 1st quarter of 1970 to the 1st quarter of 1999 into two sub-periods of approximately equal length. The first sub-period is the period before the bubble, from the 1st quarter of 1970 to the 4th quarter of 1985. The second sub-period is the period of the bubble and after, from the 1st quarter of 1986 to the 1st quarter of 1999.

We cannot exhibit, for lack of space, all the figures of impulse response functions in cases of each sub-period. There seem to be similar patterns of the impulse responses to monetary policy and liquidity demand shocks in two sub-sample periods, except for the following three points:

- 1) Though we can see no price puzzle in the 6-variate VAR model for the whole period, the puzzle appears only in the second sub-period in all cases.
- 2) The liquidity demand effects on nominal interest rate are more significant in the first sub-period than in the second one.
- 3) The stocks held by financial institutions, in particular private institutions, show a clear difference in responses to monetary policy shocks. Figure 12 indicates the responses to monetary policy and liquidity demand shocks in two sub-sample periods. The stocks held were initially decreased in response to a monetary contraction shock in the first sub-period, while they were increased in the second sub-period. The 1990s was mostly featured by

monetary easing policy, but private financial institutions sold out the stocks, partly in order to dissolve the cross share-holding relationships with corporate business firms.

#### 4. Conclusion

This paper has analyzed the effects of liquidity demand and monetary policy shocks in Japan. The interaction among the macro economic variables, policy actions, and the balance-sheet adjustments, has been analyzed with VAR models for the period from 1970s to 1990s. In order to avoid the ‘liquidity puzzle’, we identify the structural innovations in the monetary base as liquidity demand shocks. The structural innovations in the call rate stand for monetary policy shocks. The responses to either monetary policy or liquidity demand shocks are different in 1) sectors, 2) transaction items, and 3) sub-sample periods.

- 1) Sectors show significantly different responses to monetary policy and liquidity demand shocks. In response to a monetary policy shock, financial institutions initially decrease the surplus and thereafter increase it; corporate business sector persistently increase financial deficits; personal sector shows a delayed response as in the limited participation model. As for a liquidity demand shock, financial institutions initially increase the financial surplus, and overseas sector displays a significantly positive and persistent response.
- 2) Among transaction items, noteworthy responses are as follow. Financial institutions quickly increase stocks and loans in response to a liquidity demand shock. Corporate business sector in face of a monetary contraction shock, substitutes trade credits for other transaction items and also decreases foreign trade credits. In response to a liquidity shock, corporate business sector increases currency and deposit holdings and stocks issued and loans borrowed from financial intermediaries. Personal sector, with delays, decreases government bonds in response to a monetary contraction, and quickly increases currency and deposits holdings, stocks, and loans borrowed in response to a liquidity demand shock. Overseas sector increases stocks holdings and foreign trade credits, and temporarily decreases currency and deposits in a face of monetary contraction. To a liquidity demand shock, overseas sector decreases initially but thereafter increases stocks holdings.
- 3) There are no differences in the responses to shocks between the first and the second half of our sample period, except for the stocks held by financial institutions, in particular private ones. The stocks held were initially decreased in response to a monetary contraction shock in the first sub-period, while they were increased in the second sub-period. It may be because during the 1990s financial institutions dissolved the cross-holding relationships with corporate business firms.

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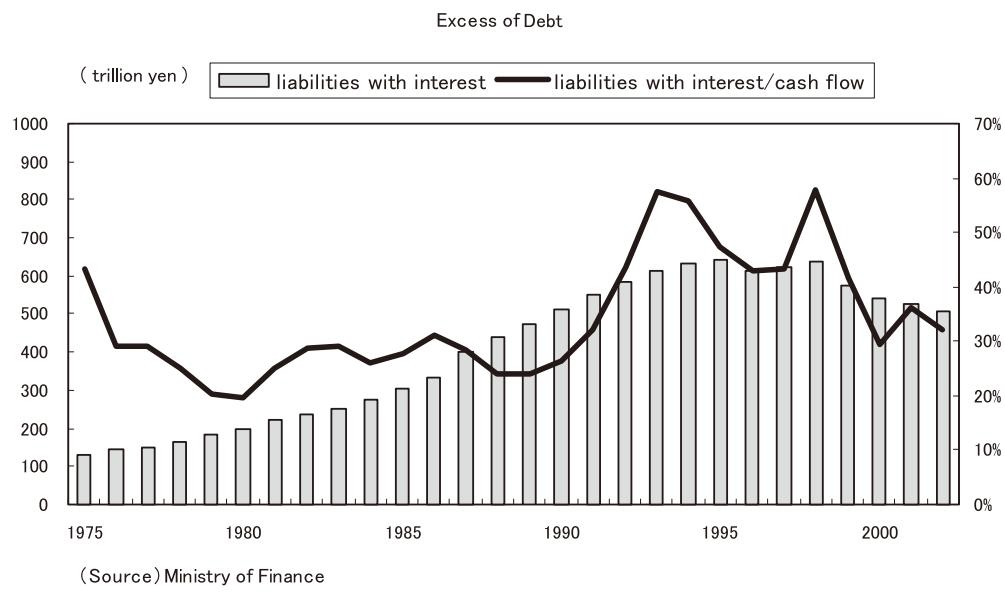
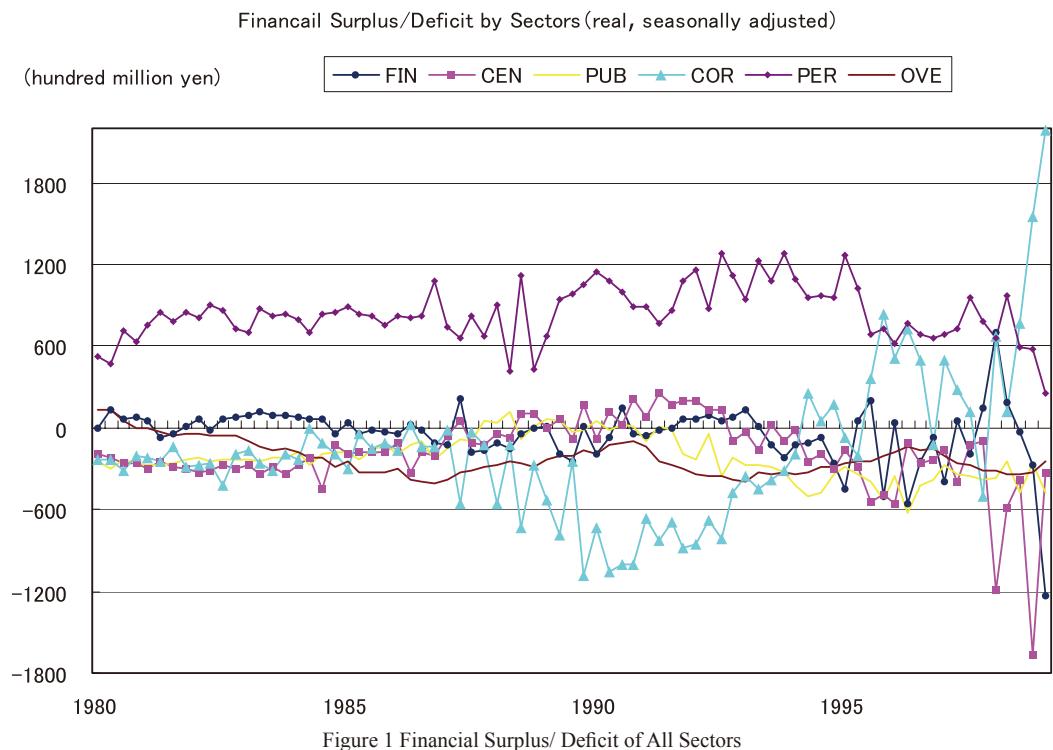
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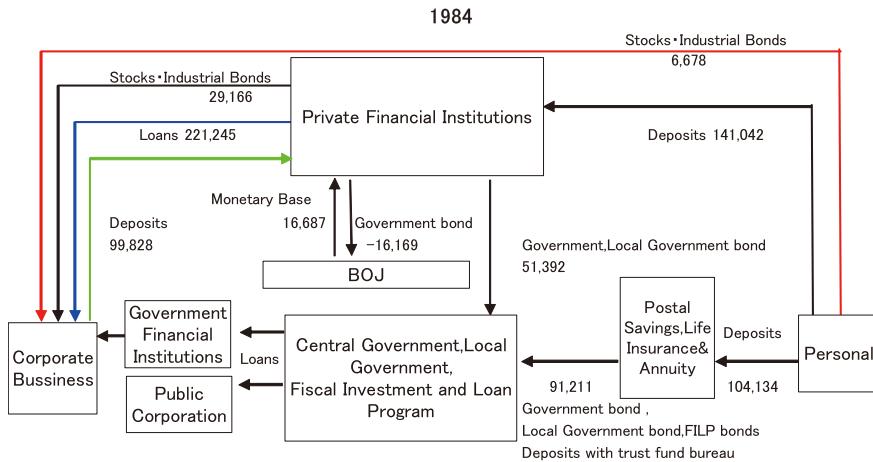


Figure 3.A Characteristics of the flow of funds in 1984

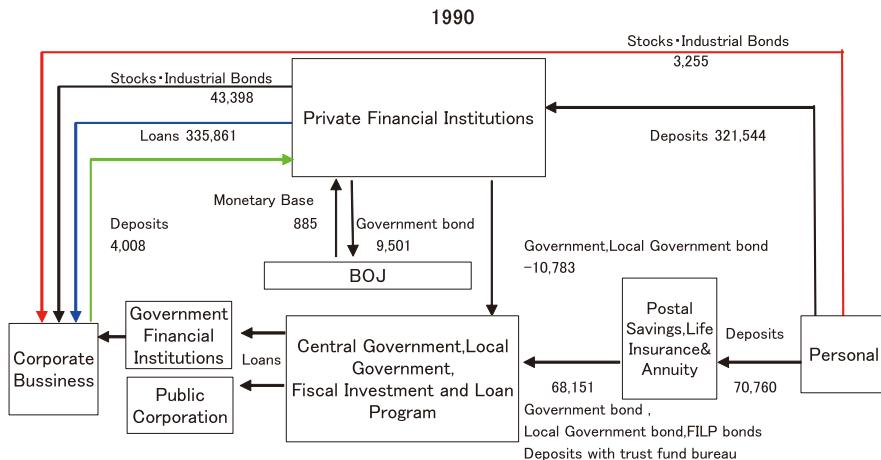


Figure 3. B Characteristics of the flow of funds in 1990

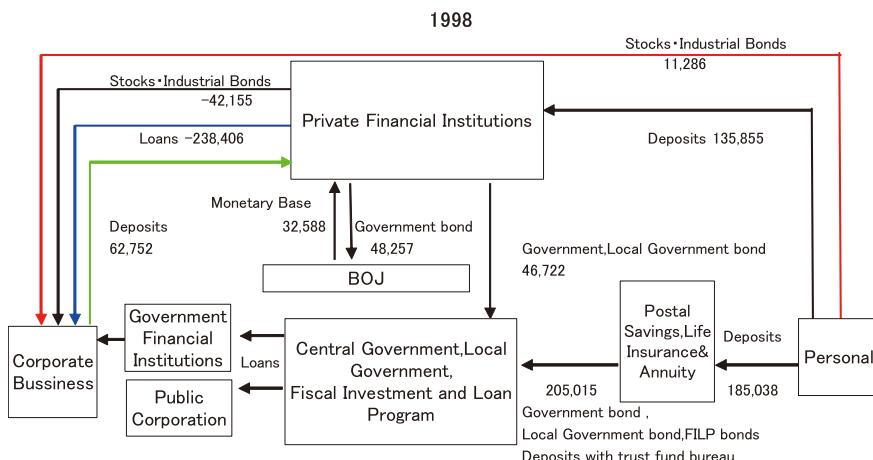


Figure 3. C Characteristics of the flow of funds in 1998

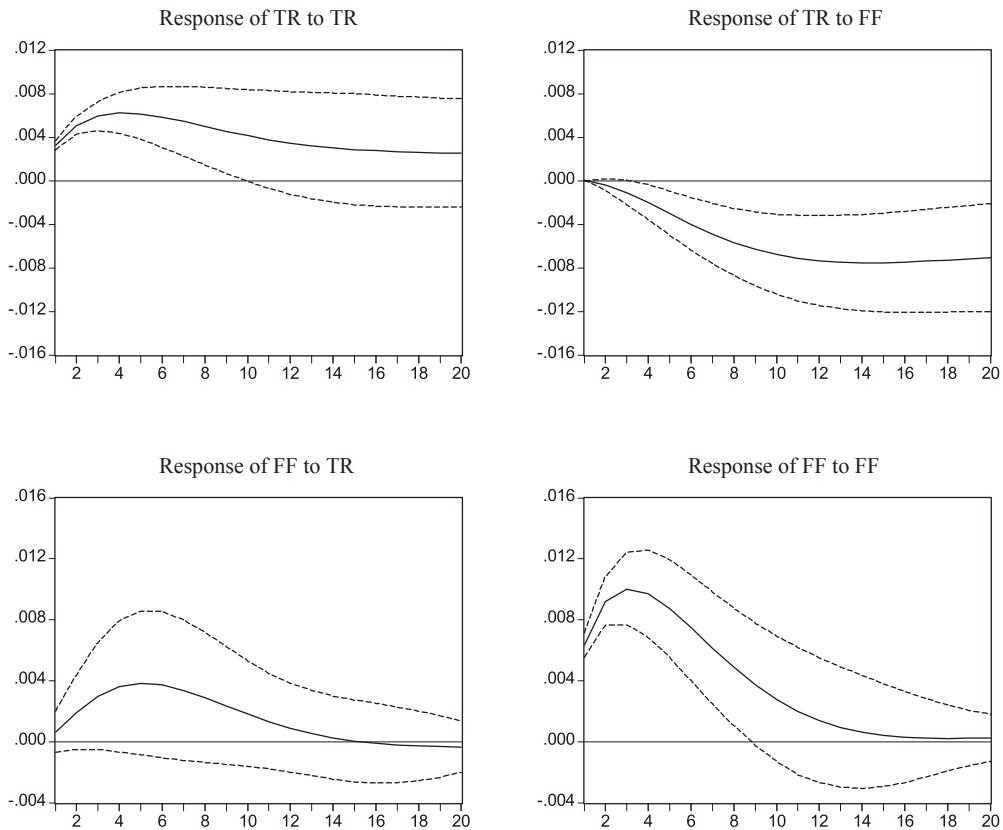
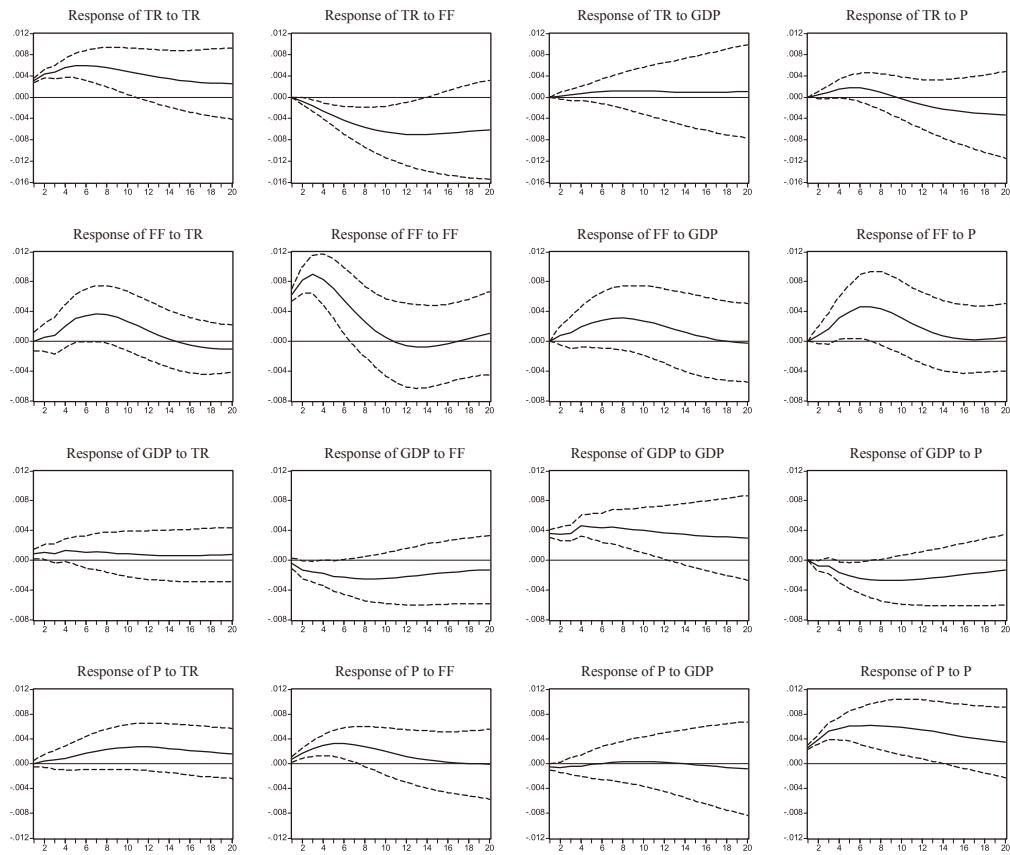


Figure 4 2-Variate VAR Model with exogenous money : Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.

Figure 5 4-Variate Model with exogenous money : Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.

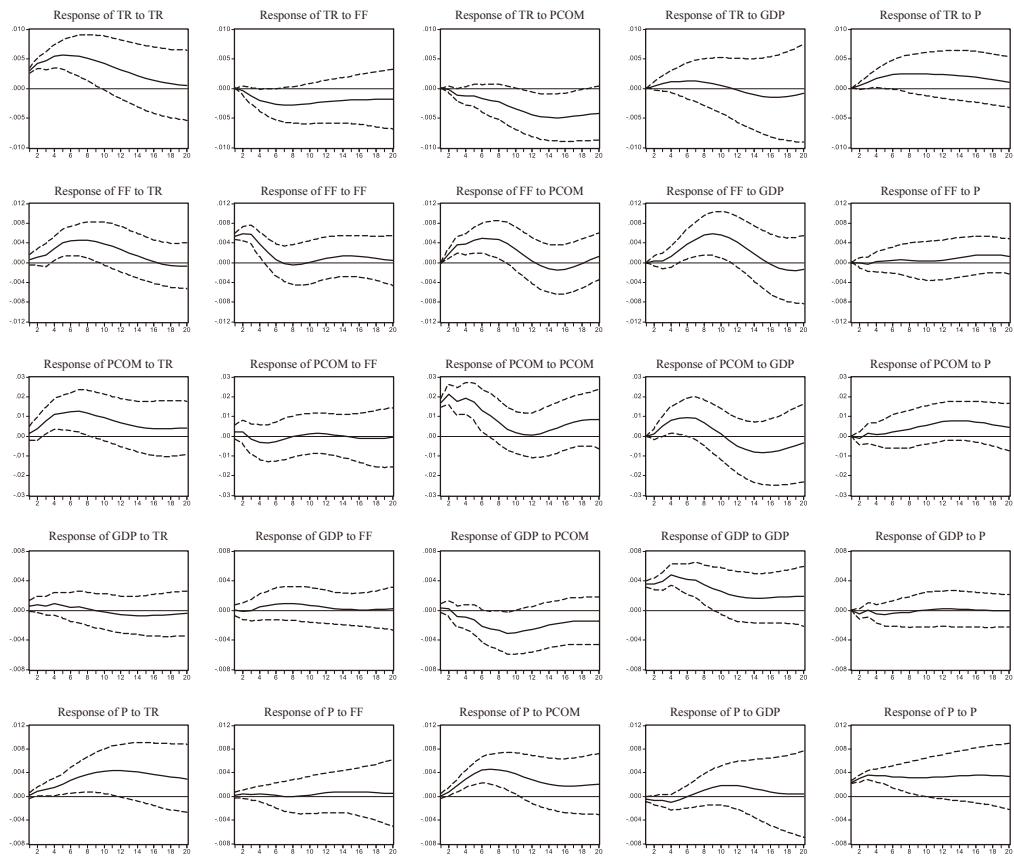


Figure 6 5-Variate Model with exogenous money : Response to Cholesky One S.D. Innovations ± 2 S.E.

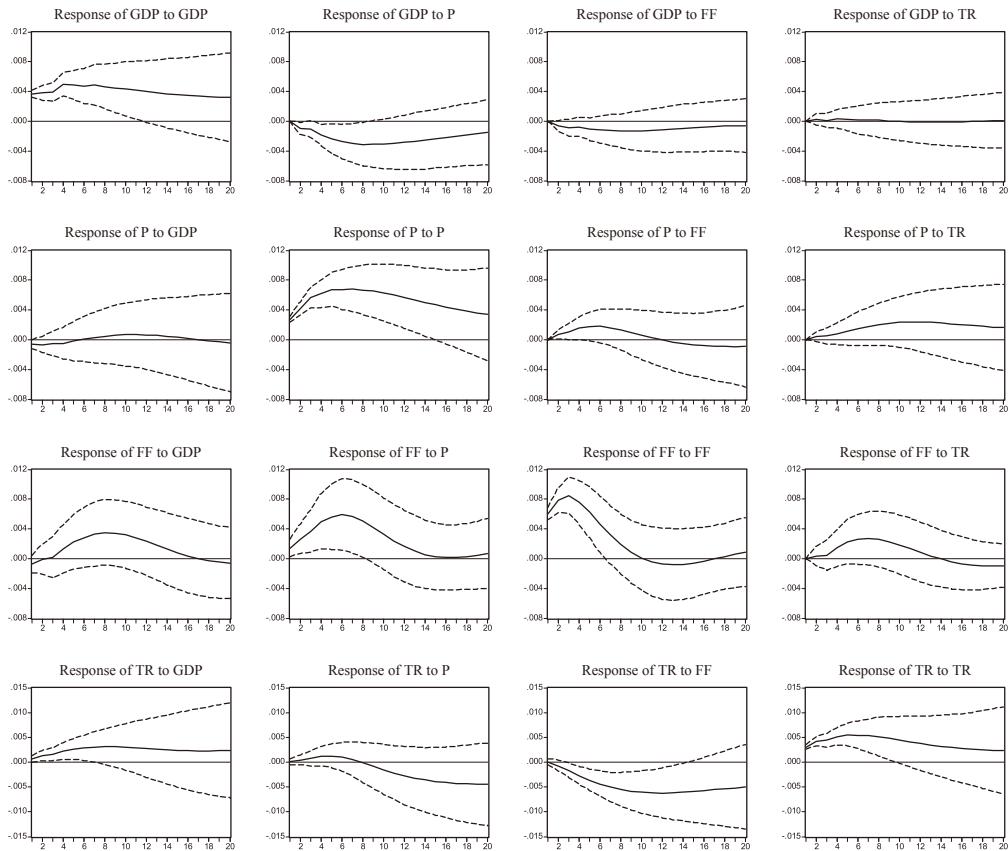
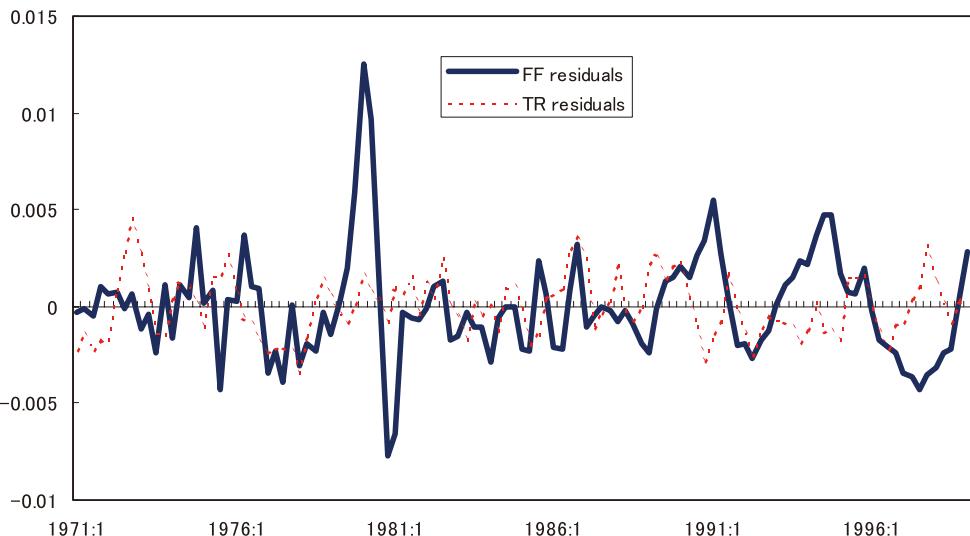
Figure 7 4-Variate Model with endogenous money : Response to Cholesky One S.D. Innovations  $\pm 2$  S.E.

Figure 8 The Shocks of Monetary Policy and Liquidity

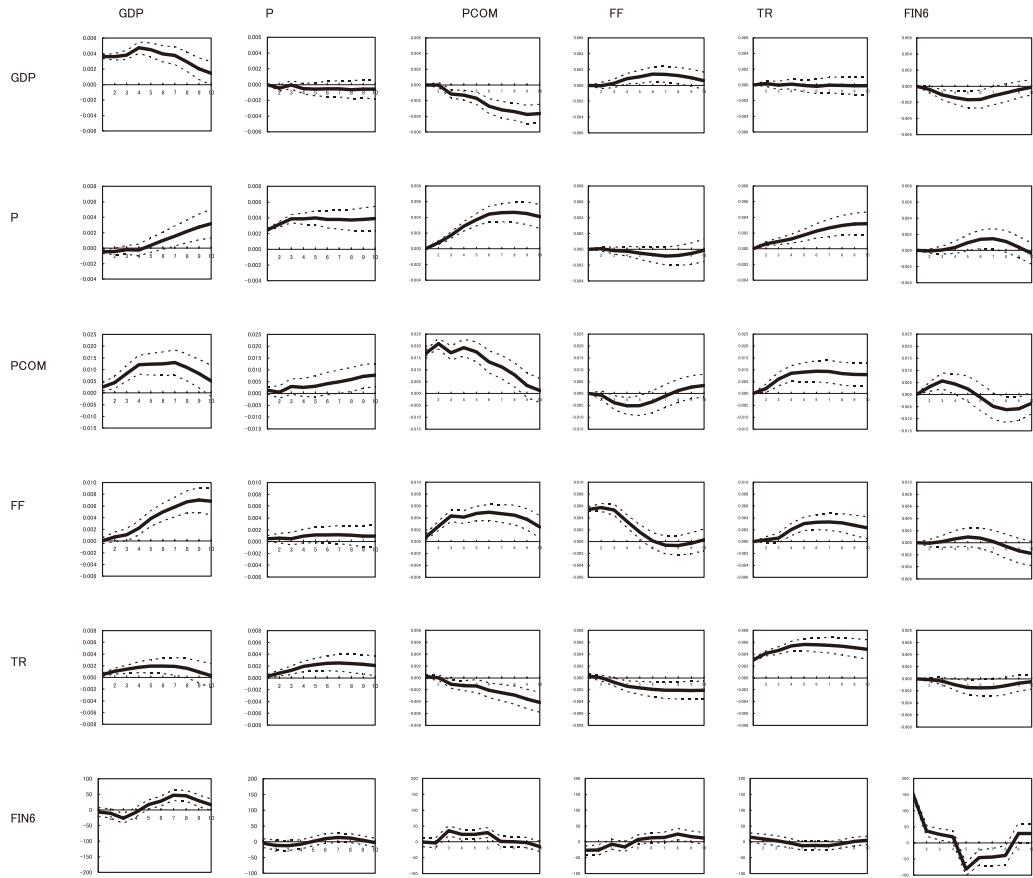


Figure 9 6-Variate VAR Model: (GDP, P, PCOM, FF, TR, FIN6)

Notations: *GDP*: the logarithm of the real GDP, *P*: the logarithm of the GDP deflator, *PCOM*: the Nikkei index for 17 sorts of primary commodity, *FF*: the call rate, *TR*: the logarithm of the monetary base, *FIN6*: the financial surplus or deficits of financial institutions.

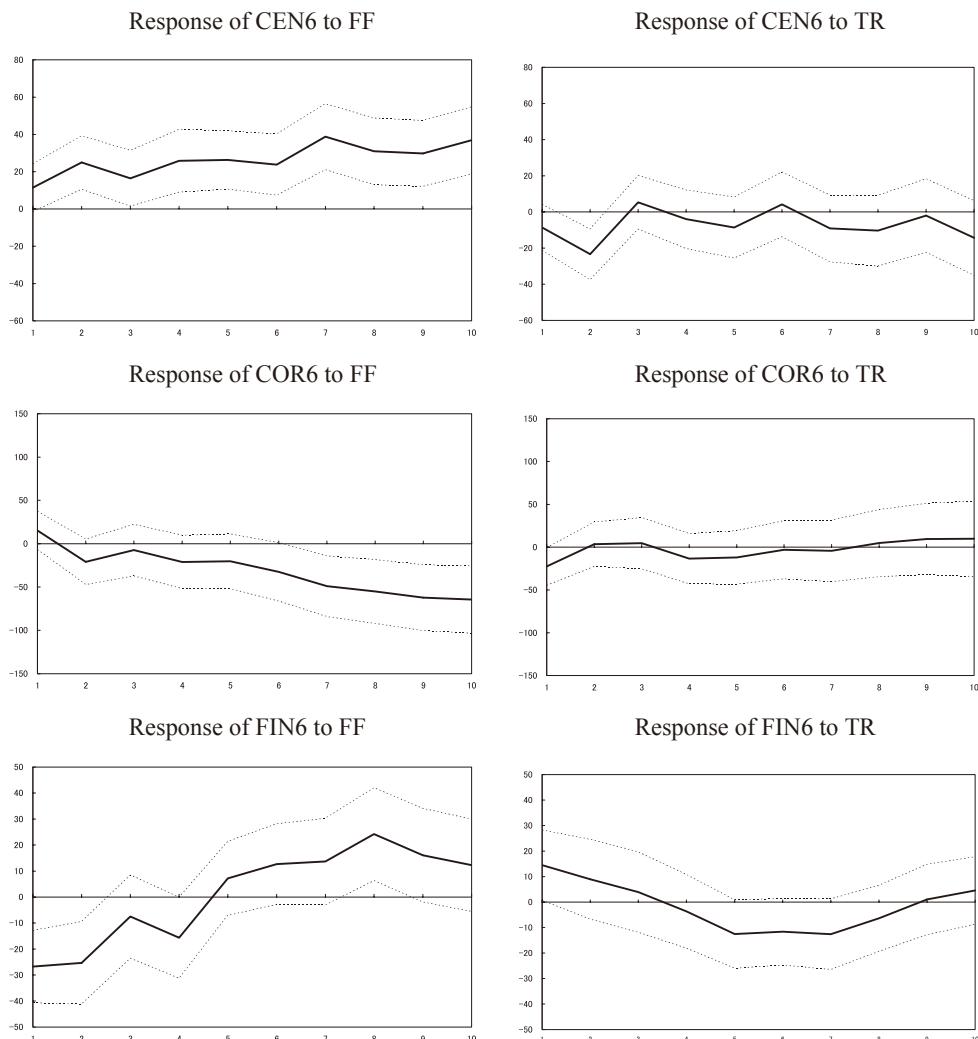


Figure 10 Impulse Response Functions of Financial Surplus to Monetary Policy and Liquidity Demand Shocks in 6 Sectors

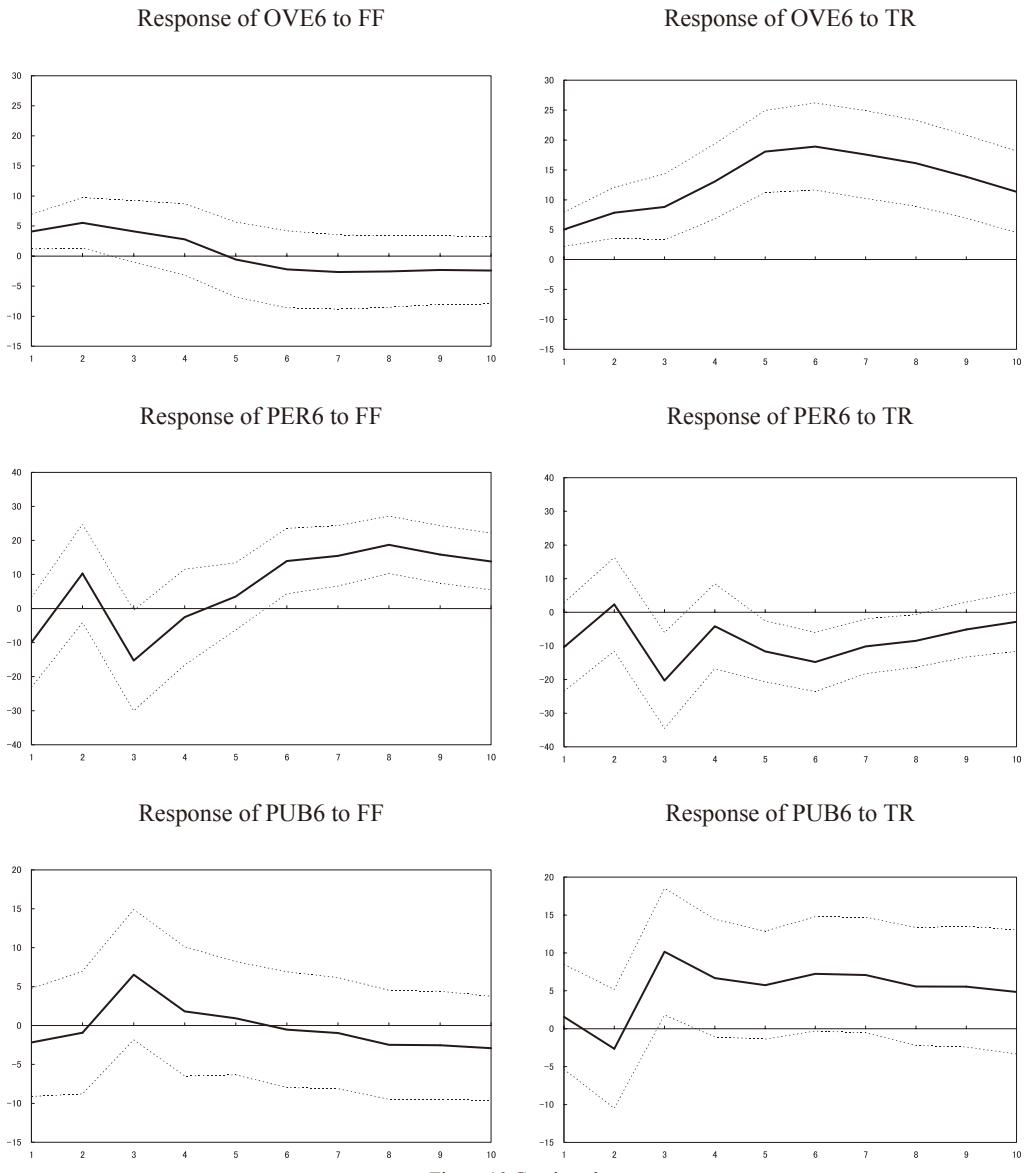
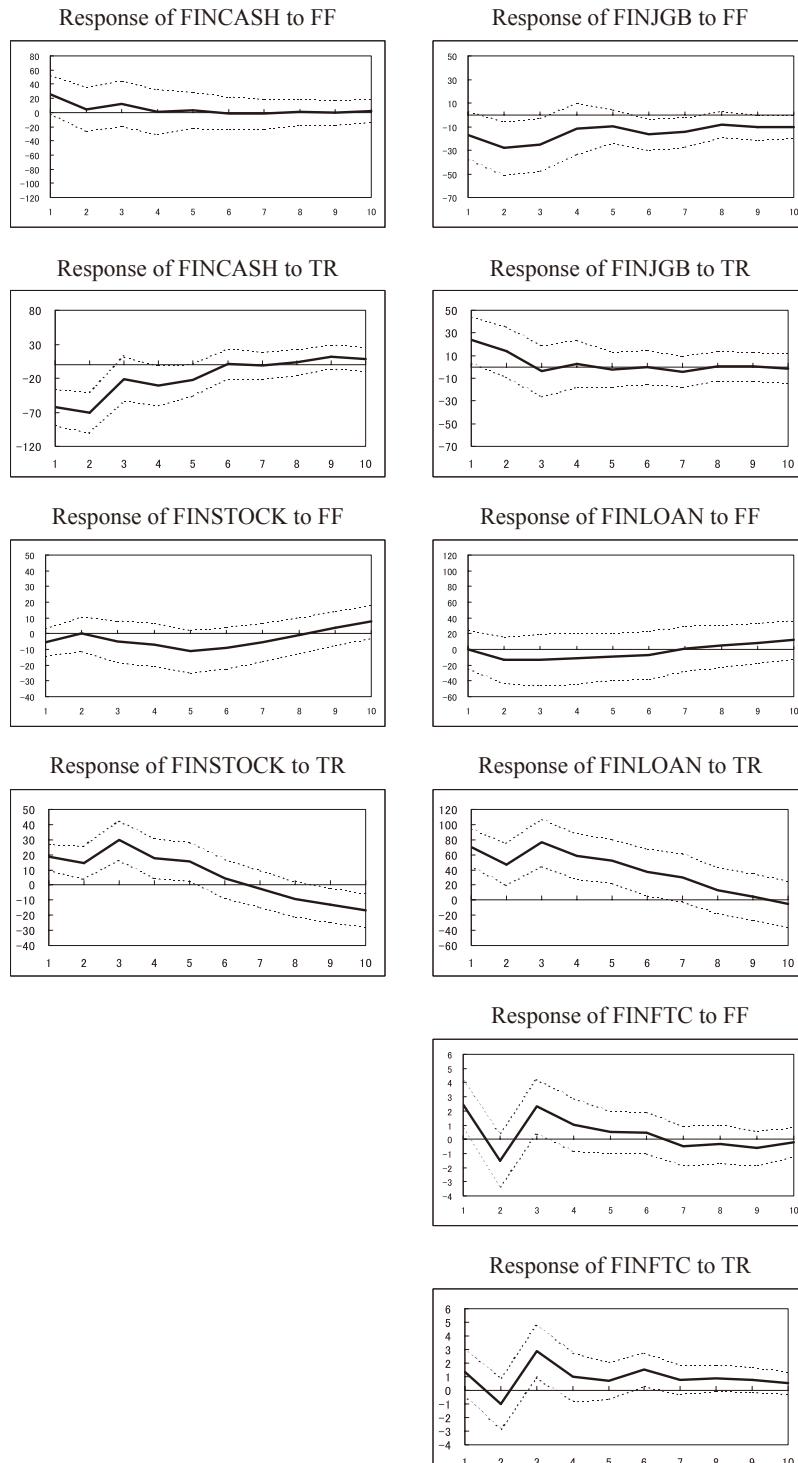


Figure 10 Continued

Notations: *FIN6*: the financial surplus in financial institutions, *CEN6*: one in central government, *PUB6*: one in public corporations and local government, *COR6*: one in corporate business, *PER6*: one in personal, *OVE6*: one in overseas, *FF*: the call rate, *TR*: the logarithm of the monetary base.

Figure 11-A Impulse Response Functions of Financial Institutions ( $\pm 1$  standard error bands)

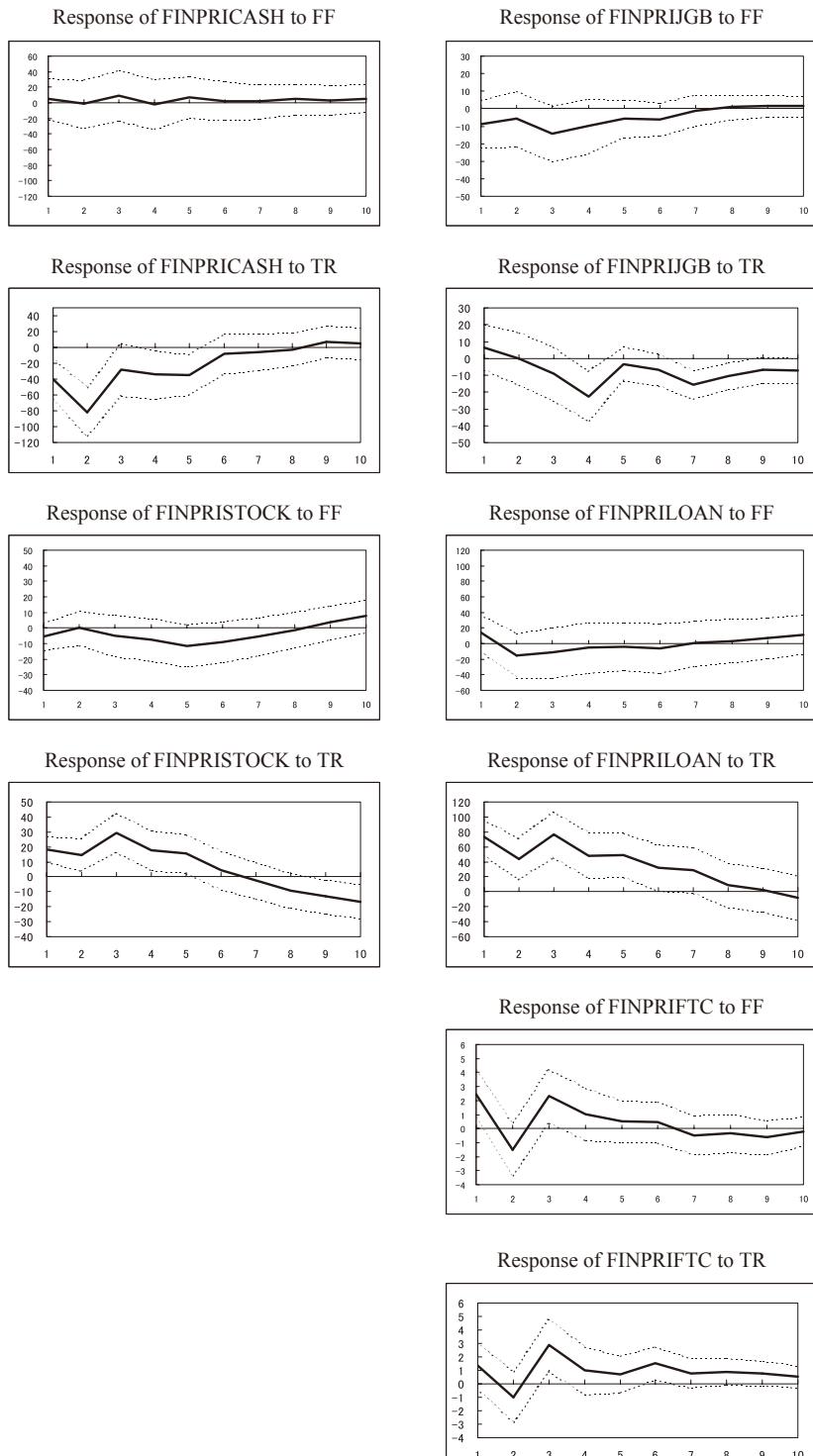
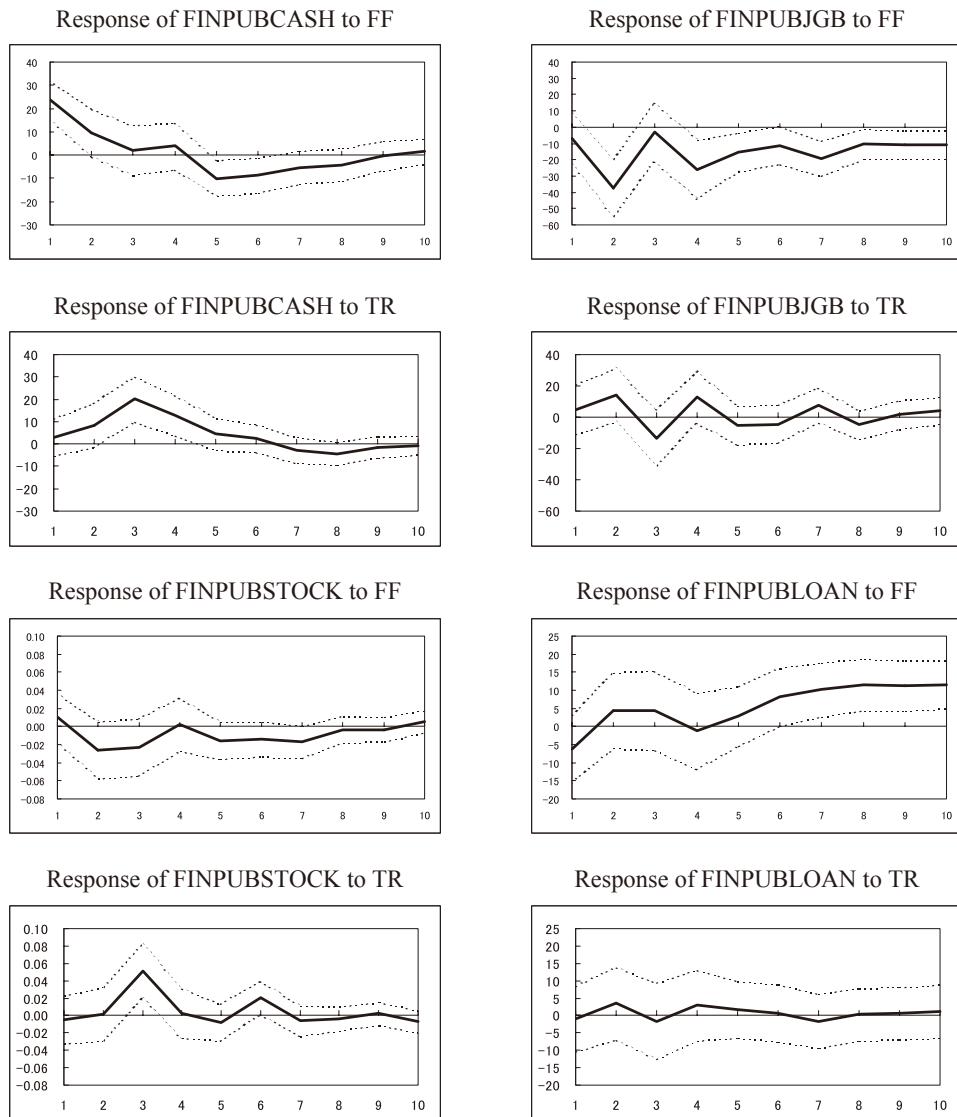
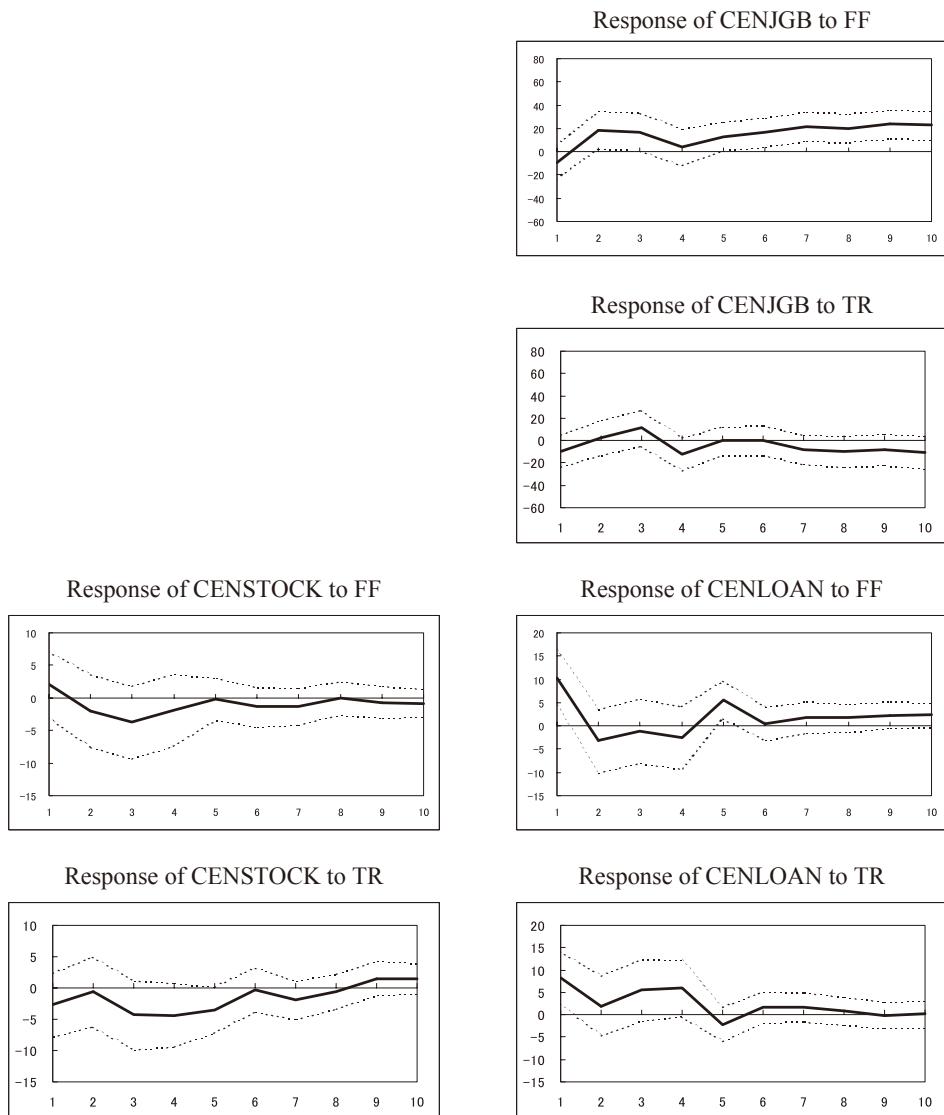
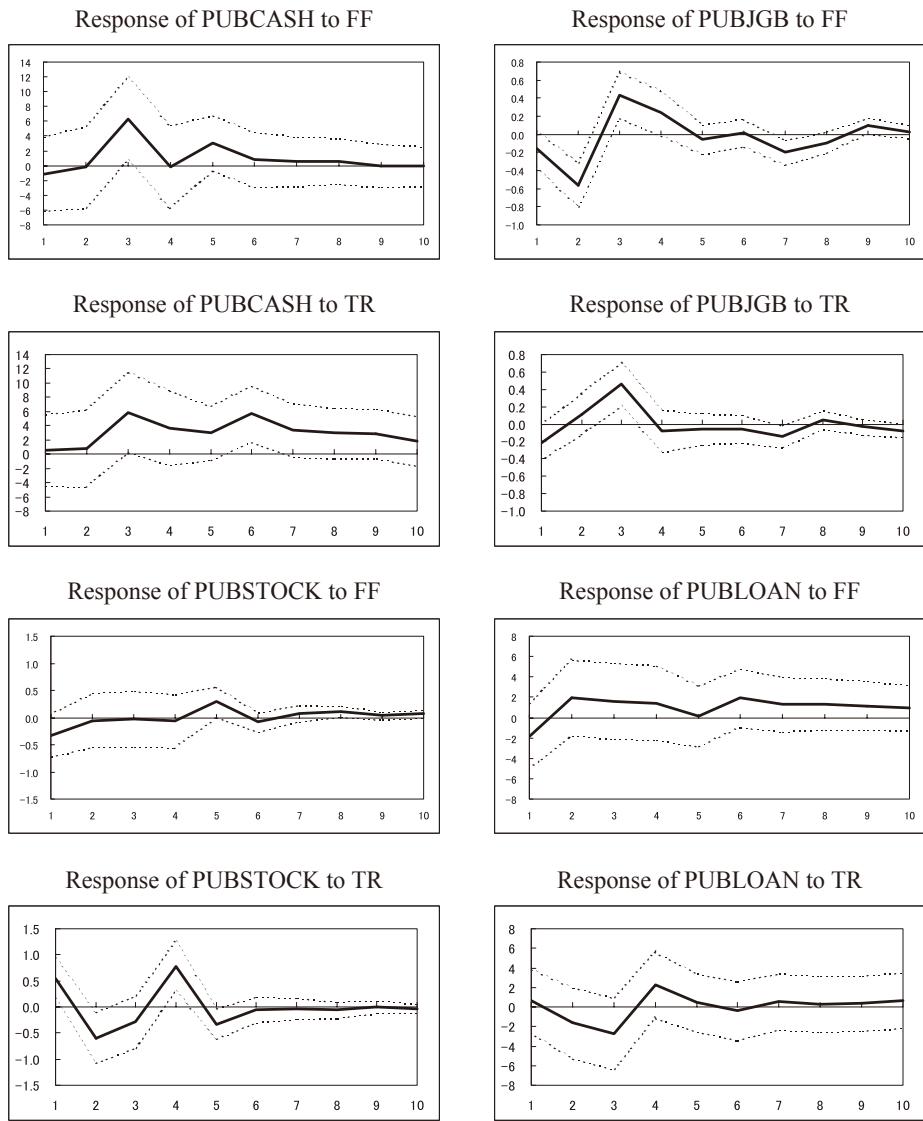


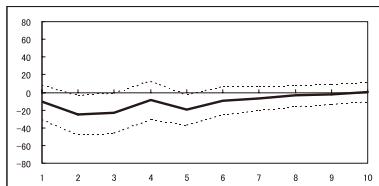
Figure 11-A(1) Impulse Response Functions of Private Financial Institutions ( $\pm 1$  standard error bands)

Figure 11-A(2) Impulse Response Functions of Public Financial Institutions ( $\pm 1$  standard error bands)

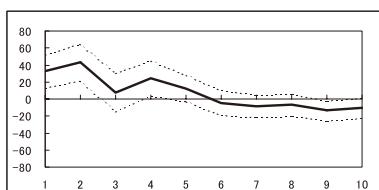
Figure 11-B Impulse Response Functions of Central Government ( $\pm 1$  standard error bands)

Figure 11-C Impulse Response Functions of Public Corporations and Local Government ( $\pm 1$  standard error bands)

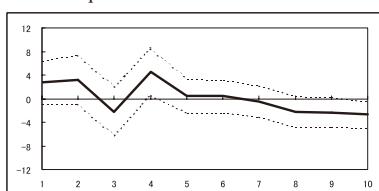
Response of CORCASH to FF



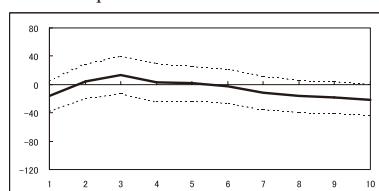
Response of CORCASH to TR



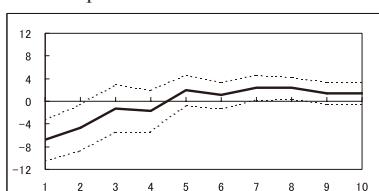
Response of CORSTOCK to FF



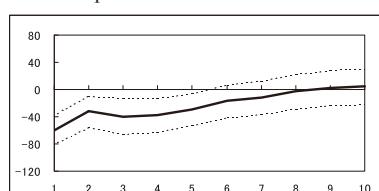
Response of CORLOAN to FF



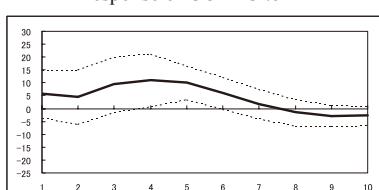
Response of CORSTOCK to TR



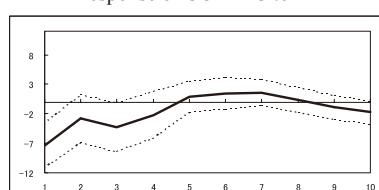
Response of CORLOAN to TR



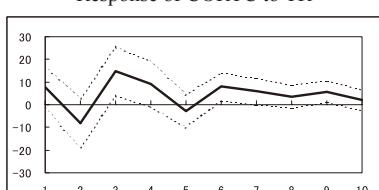
Response of CORTC to FF



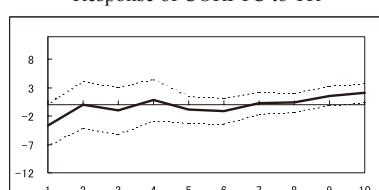
Response of CORFTC to FF

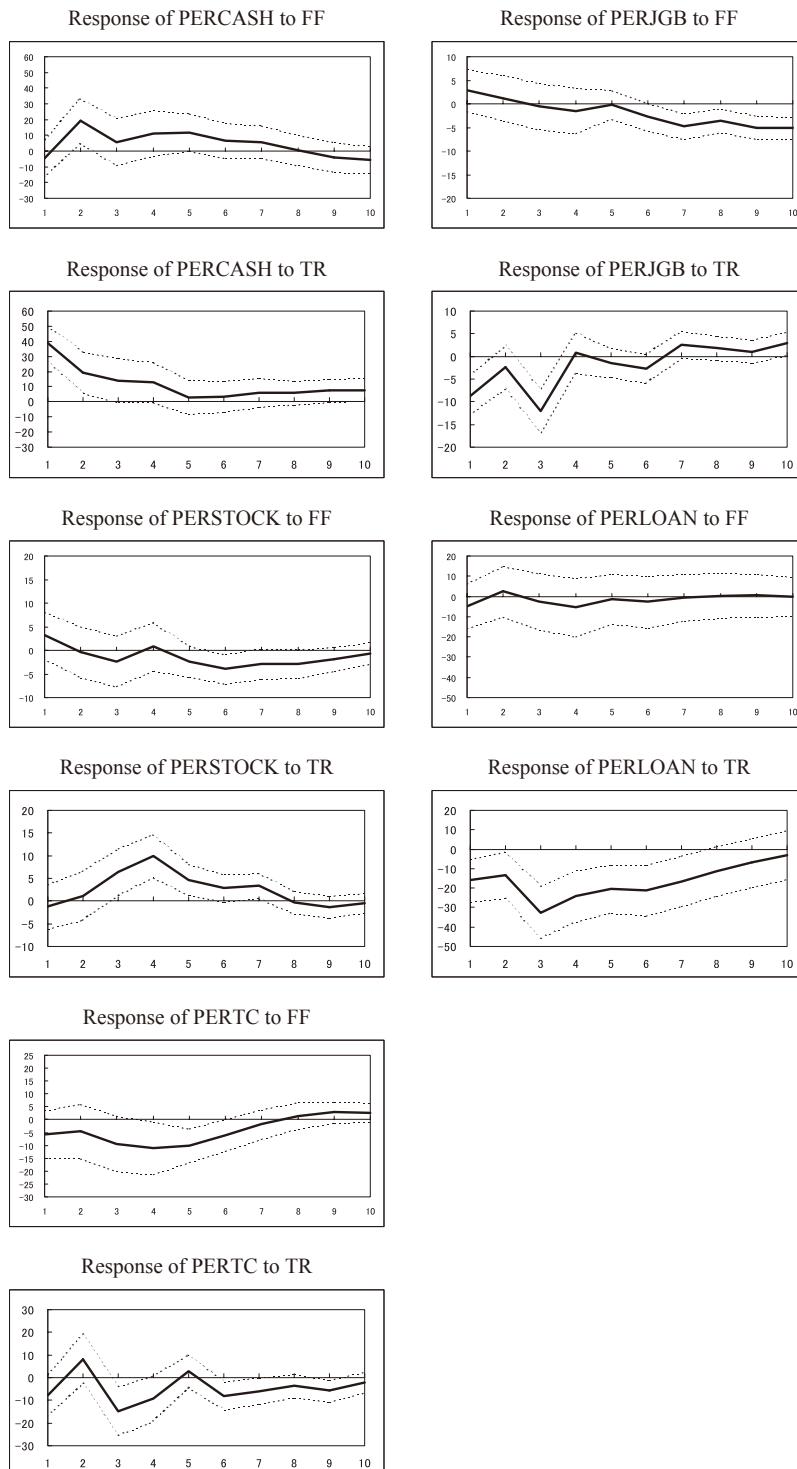


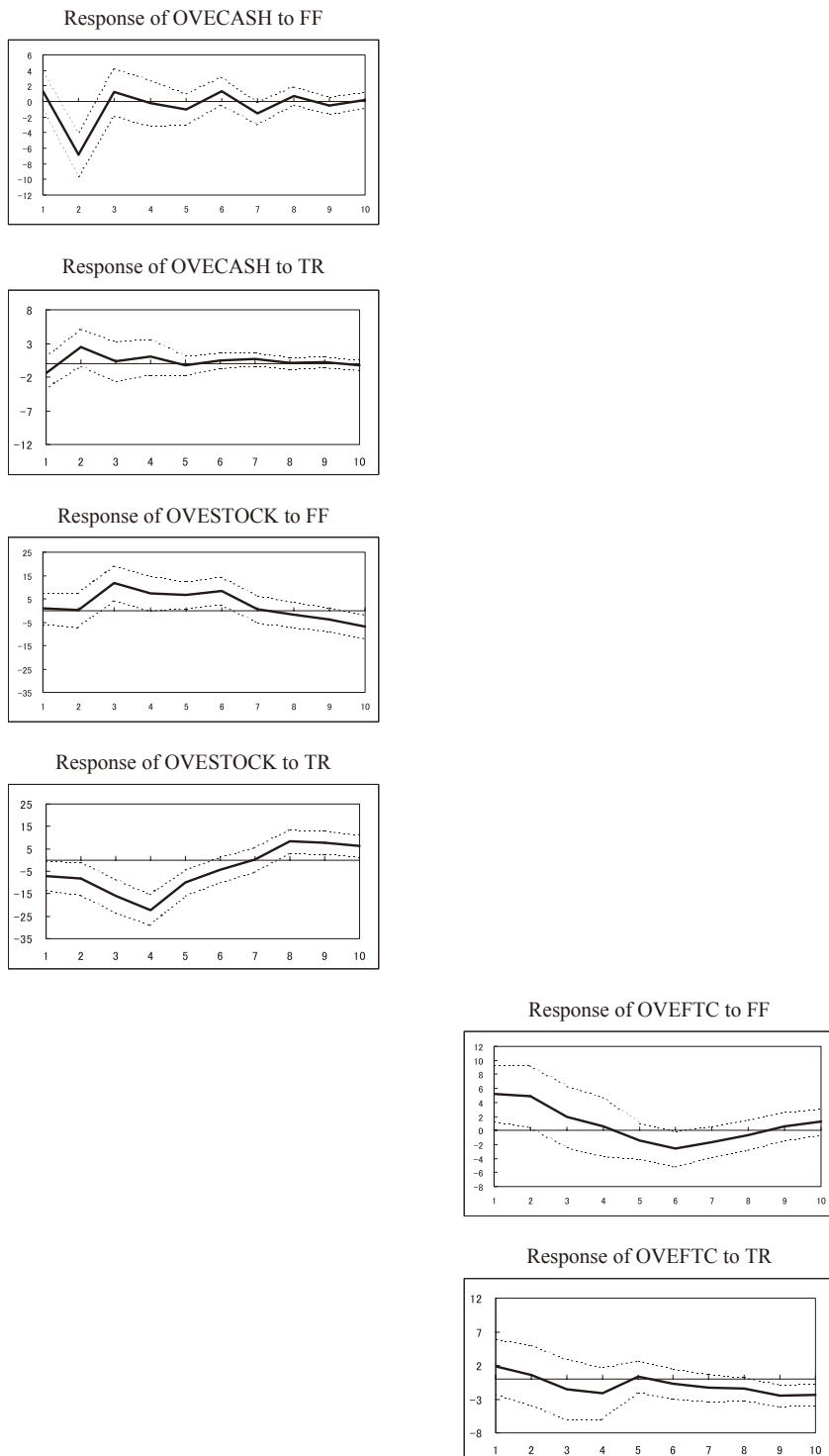
Response of CORTC to TR



Response of CORFTC to TR

Figure 11-D Impulse Response Functions of Corporate Business ( $\pm 1$  standard error bands)

Figure 11-E Impulse Response Functions of Personal ( $\pm 1$  standard error bands)

Figure 11-F Impulse Response Functions of Overseas ( $\pm 1$  standard error bands)

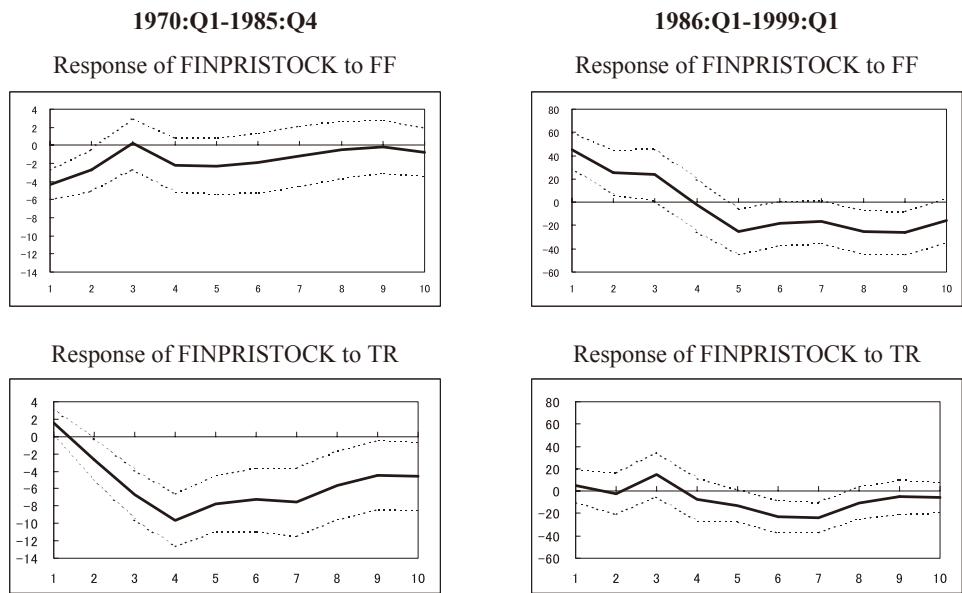


Figure 12 Responses of Stocks Held by Private Financial Institutions