Comparisons of Different Monetary Policies in China with Yield Curve Information

Pang, Iris Ai Jao

Hong Kong University of Science and Technology

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This work compares the effectiveness of quantity-based and price-based monetary policies in China using FAVAR. This essay is the pioneer to identify the 1-year lending rate and deposit rate as the policy rates, and includes yield curve information in the analysis. It is found that effects of tightening monetary policies in China follow largely the stylized facts of long run neutrality of money on real activities, a long term fall in inflation and a short term rise in interest rates.

1. Introduction

China is facing the challenges of high asset inflation and price inflation during the ongoing recovery from the financial crisis. In this context it is useful to analyze how the People's Bank of China (PBC) could limit the extension of bank credit with its monetary policy tools without sacrificing long term economic growth. Recent literature has categorized the spectrum of anti-inflationary policy tools available to the PBC into quantity-based, the tools that control the money supply, and price-based, the tools that affect saving and investment behavior through the commercial banking channel. This paper analyzes the impact of these quantity-based and price-based monetary policies on the real economy and on the control of prices in China.

The People's Bank of China (PBC) controls both the quantity of money and various price-based tools including the rediscount rate and commercial bank interest rates to promote economic growth and control inflation. It also controls the money supply through open market operations and certain administrative tools that are not market oriented, including setting targets for money growth and providing window guidance to banks.

Another policy tool most often used by the PBC to control money supply is the reserve requirement ratio. The reserve requirement ratio is the compulsory proportion of deposits that commercial banks put aside as reserves in the PBC. The central bank sets the reserve interest rate, which determines interest payments for commercial banks on required reserve. It also sets the excess reserve interest rate, which determines the interest payments on voluntary deposits that the commercial banks put aside in the PBC. Since there are excess reserves in the PBC, increasing the reserve requirement ratio might not be an effective tool for tightening the money supply.

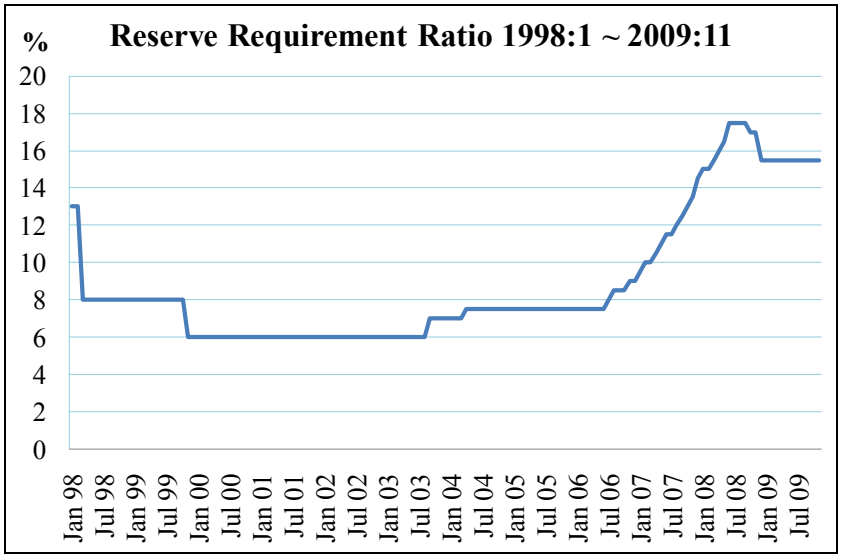
Based on the annual target of money growth rate, the PBC conducts open-market operations regularly to control money supply. The central bank issues its own bonds and sells them in the market when it wants to tighten money supply, and buys the bonds back when it wants to loosen the money supply. Apart from open market operations, the PBC issues forced PBC bills at lower interest rate to penalize banks that do not follow its window guidance.

Table 1. People's Bank of China's M2 Growth Rate Targets and Actual Value.

	M2 Growth (%)	
Year	Target	Actual
1998	16-18	15.3
1999	14-15	14.7
2000	14-15	12.3
2001	15-16	14.4
2002	13	16.8
2003	16	19.6
2004	17	14.6
2005	15	17.6
2006	14	16.9
2007	16	16.7
2008	16	17.8
2009	17	27.6
2010	17	..

Source: PBC (1998-2009), China Monetary Policy Report.

Figure 1 Reserve Requirement Ratio controlled by PBC



The PBC's most direct price-based monetary policy tools are commercial bank lending and deposit rates. In China these are called the benchmark interest rates. The benchmark lending rates are the floors of the commercial bank lending rates of various maturities. In practice, the commercial banks have little flexibility on the lending rates. The benchmark deposit rates are the ceilings of the commercial bank deposit rates of various maturities. The commercial banks essentially follow the benchmark deposit rate closely. When the PBC changes the benchmark deposit and lending rates, it affects the bank interest rates directly because it sets those interest rates, with a very limited range within which the floor for the lending rates and the ceiling for the deposit rates can vary.

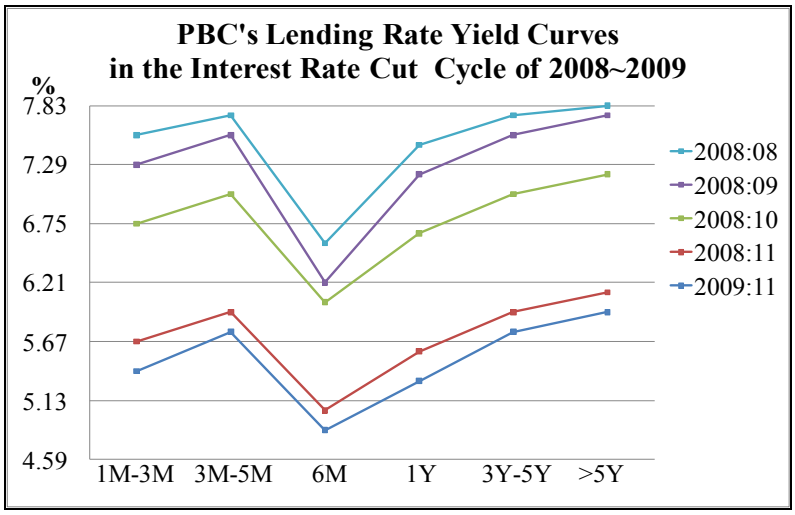
The central bank sets the benchmark rates of various maturities, and therefore it also controls the term structure or the yield curve of the benchmark rates. The change in the benchmark rates affects the saving and investment behaviors by making it either more expensive or cheaper to save or invest in the short term, medium term and long term.

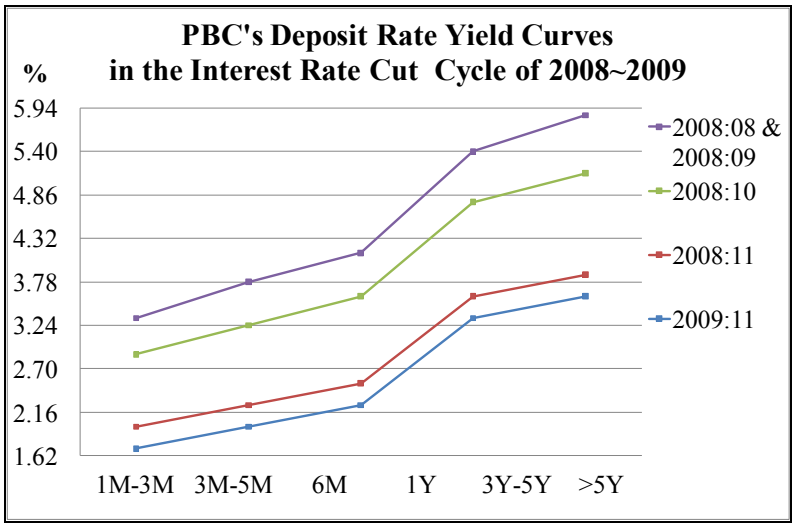
The reform of the PBC's monetary policy is ongoing. The central bank has developed a set of price-based monetary policy tools similar to those in the developed economies. The PBC has discount window facilities. The rediscount rate is one of the price-based monetary policy tools. The PBC charges the rediscount rate when banks borrow from it with discount papers that have been collateralized. In 2004, the PBC was given the authority to change the rediscount rate prior to the State Council approval. At the time, the rediscount rate was considered as the central bank policy rate. However, the turnover of operations within the rediscount instrument is too small to have any significant influence on the growth of monetary base. Therefore, the rediscount policy essentially focuses on directing the commercial paper market (PBC, 2004a; PBC, 2004b).

China has also developed an interbank market as part of its financial reform. An interbank market is a wholesale funding market between banks and therefore the interbank interest rates are considered as wholesale interest rates. Lenders are generally state commercial banks which have more deposits to deploy. Borrowers are small local banks and foreign banks.

The repo market is an interbank collateralized funding market. The interest rate involved is called the repo rate. Repo lending is very often active in maturities of overnight to 7-days, though there are 1-year repos, with activities concentrated in the short maturities. The collaterals can be PBC papers, treasury papers and commercial papers.

Figure 2 Benchmark Lending Rates and Deposit Rates Yield Curve.





The China Interbank Offered Rate (CHIBOR) market was established in 1996. It is for temporary account discrepancy settlement and short term funding purpose. The Shanghai Interbank Offered Rate (SHIBOR) market was established in 2007. The authorities intended to build a China interbank yield curve using SHIBOR. The repo rate, CHIBOR and SHIBOR follow each other very closely for all maturities.

The volume of transactions in the repo market has been higher than the CHIBOR market, and the transaction in the SHIBOR market is very thin. The high transaction volume in the repo market is due to the PBC's function to perform sterilization in the repo market.

Since the PBC exerts quantity-based monetary policy tools together with price-based monetary policy tools, it is important to look at the transmission mechanism of the different policy tools on the real economy and inflation.

The existing literature tends to apply vector autoregression (VAR) to analyze the Chinese monetary policy mechanism. However, each study uses a different interest rate as the policy rate. The choice of the policy interest rate is diverse because there is no convention that could be followed in the case of China. The PBC sets the commercial lending and deposit rates, which are different from the conventional policy rates used in other economies. For example, the U.S. Federal Reserve Bank sets the target Fed funds rate and the European Central Bank sets the refinancing rate, both of which are interest rates that determine interest payment when banks borrow from the central bank. Another problem is that the PBC sets the benchmark rates of various maturities, which creates the problem of using a unique policy interest rate in China.

Recent studies tend to agree that the simultaneous usage of the quantity-based and price-based monetary policy tools leads to distortions that prevent the interest rate channel of monetary transmission from functioning. Gieger (2006, 2008) argued that under the current monetary policy framework in China, the interest rate has to be considered as a supportive monetary instrument.

Qin et al (2005), using the discount rate as the policy rate, found that the interest rate transmission channels in VAR do not influence the real economy and inflation in long term. Laurens and Maino (2007) found a similar result using short-term PBC bill rate as the policy interest rate in VAR. Dickinson and Liu (2007), using discount rate as the policy interest rate in VAR, found that changes in the interest rate did not have an impact on output and inflation during 1984 to 1990. They believe that is because state-owned enterprises were the main borrowers during the period.

Using VAR and FAVAR models, Girardin and Liu (2006) found that a shock in CHIBOR had a significant impact on prices during 1999:01 to 2005:08, and mild impact on output during 1997:01 to 2005:08.

Girardin and Liu (2006) arrived at a result similar to Qin et al (2005) that a shock in the reserve requirement ratio has a significant impact on the growth rate of M1.

Qin et al (2005) found that quantity-based monetary policy tools, namely the reserve requirement ratio and monetary base growth, both have positive effects on GDP and inflation control, but that the reserve requirement ratio has a more significant impact on inflation control than the growth of the monetary base. Dickinson and Liu (2007) arrived at the same result as Qin et al (2005) that the growth rate of M2 had a direct impact on both real output and inflation in the 1990s as bank credits were directly used to support state-owned enterprises. Koivu et al (2008), modeling Chinese monetary policy shock with the McCallum rule, found that a money supply shock has

a significant and long term impact on the level of nominal GDP.

However, Laurens and Maino (2007) found that changes in the growth rate of M2 as a policy tool has significant and long term impact on inflation but do not have any long run impact on output. Using VAR and FAVAR models, Girardin and Liu (2006) found that in the subsample of 1999 to 2005, a shock to the growth rate of M1 has weaker effects on both output and inflation compared to a shock to interest rate.

Summing up the literature, the main divergence is found by Girardin and Liu (2006). The difference could be due to the fact that Girardin and Liu (2006) are the only authors who chose CHIBOR as the policy interest rate. Compared with CHIBOR, which is an interbank interest rate, the discount rate in China is closer to the benchmark deposit and lending rates. Interbank rates are not policy interest rates. In conventional markets, like those in the U.S., Europe, U.K. and Hong Kong, interbank rates are wholesale interest rates that affect the costs of commercial banks and therefore affect commercial bank interest rates, which in turn form part of the transmission channels through which the interest rates set by monetary policy affect real activities like saving and investment.

However, the situation is very different in China where the PBC sets the commercial bank interest rates directly. Changes in the interbank rates in China include the results of changes in commercial bank interest rates and other monetary policy instruments (Feyzioglu et. al 2009). Porter and Xu (2009), using EGARCH and ARCH, found that the changes in open market operations and reserve requirement ratio have significant impact on the volatility of interbank rate. Therefore a shock to the interbank rate could be due to changes in benchmark rates, reserve required ratio and open market operation. That is, a change in interbank rate might represent a change in quantity-based policy tools. Thus, using the interbank rate as a proxy for the policy interest rate in China is unnecessary and inappropriate.

Though using the discount rate as a policy rate reflects some of the changes in benchmark lending and deposit rates, it neglects the fact that the PBC sets deposit and lending rates of various maturities to control the level of lending and deposit rates as well as the shape of commercial bank yield curves. Being able to set different maturities of lending and deposit rates enables the central bank to fine-tune saving and investment behavior. For example, in December 2007 the PBC raised only the lending rates of maturities of 1-year by 0.18 percentage points but kept the 5-year lending rate unchanged because it wanted to deter residential property investments, which are linked to the 1-year lending rate, while tried not to affect long term investment projects.

If the level of benchmark lending and deposit rates only are included in the analysis of the transmission mechanism of the Chinese monetary policies, then the analysis could end up losing the "yield curve" information.

In this paper we look at the effectiveness of quantity-based and price-based monetary policies on real activities and inflation.

Since using interbank rates or discount rates in the analysis of the transmission mechanism of monetary policy in China is inappropriate, we include the benchmark deposit and lending rates in order to improve the analysis of the choice of the policy interest rate and the transmission mechanism of Chinese monetary policy.

The objective of this paper is to include information from the "yield curve" of benchmark rates in our data as this is a tool that the PBC controls. Since the changes in the benchmark interest rates are very sporadic we do not estimate the yield curve from the data using methods such as Diebold and Li (2006) three factors model. Instead, we include the levels and spreads of benchmark rates of different maturities in our data (see Appendix A). These levels and spreads should contain information that reflects the three yield curve factors in Diebold and Li (2006), namely the level, slope and curvature of the yield curve.

Our paper tries to embed the yield curve information in two ways. One is to include all the levels of benchmark lending and deposit rates and the spreads of different maturities against a 1-year rate in the dataset. The other is to extract three factors from benchmark rates to characterize the level, slope and curvature of the yield curve, and then include these three factors in the analysis.

Since the focus of this paper is to analyze the transmission mechanism of monetary policy in China by including all the policy tools that the PBC uses, including the yield curve which the PBC controls, a large volume of interest rate data is involved. Applying a large dataset to a VAR model is problematic due to the shortcoming of degrees of freedom in the VAR.

Recent literature has overcome this shortcoming of the VAR. Stock and Watson (2002) developed a dynamic factor model to summarize information contained in 120 economic indicators. Based on Stock and Watson (2002), Bernanke et al (2005) established a factor-augmented VAR (FAVAR) to analyze the effect of monetary policy in the U.S. that can accommodate a vast dataset.

The FAVAR framework in our paper is different from that in Girardin and Liu (2006). In the latter FAVAR model, the observable vector consists of industrial output, consumer price index, foreign reserves and a monetary policy instrument. We argue

that only the monetary policy instrument is observable to central banks as defined in Bernanke et al (2005) and that the other economic indicators should be modeled as part of the factors.

Another difference between this paper and Girardin and Liu (2006) relates to the choice of the number of factors and the lags in modeling FAVAR. Girardin and Liu (2006) chose only one factor in the FAVAR framework as they found that the first factor explained more than 90% of the variation in their samples. They did not use any model selection tool in the selection of the number of factors. Regarding the issue of lags, Girardin and Liu (2006) chose 3 lags in their VAR model using a general Chi-square test against 13 lags. They used the same lag length in the FAVAR model without applying a separate test. In contrast, to make the selection process more precise, this paper applies generic information criteria to identify the number of factors and lags in the FAVAR model.

In general, this paper finds that the quantity-based and price-based monetary policies do not have any significant long term impact on real activities. The 1-year lending rate has the most impact on real activities in the short term though it also does not have any long term impact on real activities. A shock to the growth rate of M1, the 1-year lending rate and the 1-year deposit rate have mild long term impact on CPI inflation, while a shock to the reserve requirement ratio does not have long term impact on CPI inflation. Including yield curve factors improves the intuitiveness of the impulse response functions but do not generate different long term impacts.

The paper proceeds as follows. Section 2 describes the FAVAR model, and describes how we model the yield curve information in FAVAR. Section 3 provides a description of the dataset. Section 4 shows the empirical results. Section 5 proposes policy implications on the on-going financial reform in China. Section 6 concludes.

2. The FAVAR application

In the FAVAR, we define that there are unobservable factors that the PBC cannot control directly and observable factors that the PBC has control over. Therefore in the FAVAR all the observable factors are policy instruments.

Let F_t be a $K\times1$ vector of unobservable factors which can summarize most of the information contained in a large information set X_t which is an $N\times1$ stationary time series variable observed for $t=1,\ldots,T$; Y_t is an $M\times1$ observable policy instruments and is a subset of X_t.

F_t can be interpreted as factors that affect many economic variables. These factors can

be extracted from the large information set in X_t. The number of informational time series, N, is large and may be larger than T, the number of time periods, and is assumed to be much larger than $K+M$. It is further assumed that the large information set is related to the unobserved factors, F_t, and the observable policy instruments, Y_t:

$$X_t^{'} = \Lambda^f F_t^{'} + \Lambda^y Y_t^{'} + \varepsilon_t^{'} \tag{1}$$

where Λ^f is an $N \times K$ matrix of factor loadings, Λ^y is $N \times M$, ε_t is an $N \times 1$ vector of error terms that have mean zero and assumed to be weakly correlated.

Equation (1) is the dynamic factor model developed by Stock and Watson (2002b). It implies that X_t is driven by both unobservable factors and observable policy instruments, and therefore F_t and Y_t can be correlated. Since X_t can contain lagged values, F_t can be understood as containing arbitrary lags of fundamental factors. An advantage of the static representation of a dynamic factor model of equation (1) is that it can be estimated by the principal component method (Stock and Watson, 2002b).

The joint dynamics of (F_t, Y_t) are given by

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = B(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + e_t \tag{2}$$

where B(L) is a conformable lag polynomial of finite order d; e_t is an error term with mean zero and covariance matrix Σ.

If the terms in B(L) that relate Y_t to F_{t-1} are all zero, equation (2) is a standard VAR in Y_t; otherwise equation (2) is referred by Bernanke et al (2005) as a factor-augmented vector autoregression (FAVAR). If the true system is a FAVAR but instead equation (2) is estimated as a standard VAR, that is if the factors are omitted, then the estimates in the standard VAR system will be biased.

Since F_t is a vector of unobservable factors, equation (2) can only be estimated after F_t is derived. In our work, we apply the two-step estimation procedure in Bernanke et al (2005) to derive F_t in the first step and then estimate equation (2) in the second step.

It is reasonable to believe that information contained in X_t can be summarized into several categories. We call these categories common components, C_t. In the first step of the two-step approach, we extract the first $K+M$ principal components using all variables in X_t, and we get $\widehat{C}_t$. However, any of the linear combinations underlying $\widehat{C}_t$ could involve the policy instrument, which is part of Y_t. Therefore it would be

invalid to estimate a VAR of $\widehat{C}_t$ and Y_t. We have to remove the dependence of $\widehat{C}_t$ on the policy instrument. This requires identifying variables in X_t that are not related to the policy shock.

Since fast-moving variables in the dataset X_t, are highly sensitive to policy shocks, fast structural shocks and contemporaneous information, such as financial news and economic data release, Bernanke, et al (2005) argue that there is high collinearity between the fast-moving variables and any policy shock. The logic implies that information contained in the fast-moving variables should be accounted for by the policy shock. On the contrary, slow-moving variables that change slowly, for example real estate prices and sales, are assumed to be unaffected within the month by the policy shock, and these variables are marked with an asterisk in the Appendix. X_t is therefore split into slow-moving variables, the policy shock and fast-moving variables.

As the slow-moving variables are not related to the policy shock contemporaneously, the common components extracted from slow-moving variables, $\widehat{F_t^{slow}}$, are also not related to the policy shock contemporaneously.

We thus form $\widehat{C}_t$ such that

$$\widehat{C}_t = \beta^{slow}\widehat{F_t^{slow}} + \beta^{Y}Y_t + \upsilon_t \tag{3}$$

We then remove the dependence of $\widehat{C}_t$ .on the policy instrument to get the factors, $\widehat{F}_t$, in equation (2) as

$$\widehat{F}_t = \widehat{C}_t - \widehat{\beta^{Y}}Y_t \tag{4}$$

where $\widehat{C}_t$ are principal components from Xt and $\widehat{\beta^{Y}}$ comes from the result of equation (3).

Factors, $\widehat{F}_t$, obtained in this fashion form a part of the space covered by $\widehat{C}_t$ that is not covered by Y_t, and therefore is now valid to be entered into VAR with Y_t. To identify the unique factors against any rotation, a restriction is imposed on factors by $F'F/T=I$[1].

In the second step, we estimate the FAVAR in equation (2) which consists of $\widehat{\mathbf{F_t}}$ and Y_t.

[1] We can impose restrictions on the factor loadings or the factors. Either approach provides the same common component and the same factor space.

In our model, Y_t, is ordered after the estimated factors, $\widehat{F}_t$. This ordering is conventional in VAR and is due to the fact that monetary policy actions are supposed to react to information embedded in the factors at the current period and should only affect the factors in the next period.

2.1 A comparison of the effectiveness of quantity-based with price-based monetary policies

In the first part of the analysis we compare the effectiveness of four specific monetary policy measures undertaken by the PBC. We estimate the FAVAR four times, each with a different policy shock to Y_t, as follows: (i) increasing the Reserve Requirement Ratio by 0.5 percentage point; (ii) tightening the M1 year-on-year growth rate by 5 percentage point; (iii) raising the 1-year benchmark lending rate by 0.09 percentage point and (iv) raising the 1-year benchmark deposit rate by 0.09 percentage point.

Using the FAVAR allows us to work with a large dataset and therefore we include all maturities of deposit rates and their spreads in the data. In order to construct our dataset, we combine the yield curve data with other economic data and extract factors from this single dataset for the FAVAR model. Extracting factors this way allows the yield curve information to interact with other economic data during the factor extraction process. The factors can then explain more variation of the data than an extraction process where there is an additional "yield curve factor".

We then compare the impulse response functions of the four policy actions stated earlier.

2.2 Including yield curve factors in the 1-year benchmark lending rate policy

In the second part of the analysis we compare the impulse response functions of the1-year benchmark lending rate with and without the yield curve factors. Since the PBC controls the lending yield curve, the yield curve information could also enter the FAVAR as part of the monetary policy. We try to extract yield curve factors from the benchmark lending rates, and include them in Y_t in equation (2).

We then compare the impulse response functions of the 1-year benchmark lending rate with and without the yield curve factors.

3. The data

The dataset consists of 120 monthly China macroeconomic time series from January 1998 to November 2009. The sample length is constrained by the availability of data. Although we would like to include more indicators in our sample, many of them were not available until 2004. The data are sourced from Bloomberg and CEIC, both of which are credible compilers of official data. The series are transformed to be stationary. The list of the series and their transformations are listed in Appendix A.

The variables in the dataset are real activity indicators, asset prices and consumer prices, sentiment indicators, interbank activities and rates, bank activities, exchange rate and foreign exchange reserves, and the PBC policy instruments.

4. Empirical Results

Section 4.1 presents results from the FAVAR where factors are extracted from a dataset that combines the yield curve data with other economic data. Section 4.2 presents yield curve factors that are extracted from benchmark lending rates as well as results of the FAVAR that include the yield curve factors as policy instruments in FAVAR.

4.1 Comparison of effectiveness of quantity-based with price-based monetary policies

As mentioned earlier, we estimate the FAVAR four times, each with a different policy shock to Y_t, namely, increasing the reserve requirement ratio by 0.5 percentage point, tightening the year-on-year growth rate of M1 by 5 percentage point, raising the 1-year benchmark lending rate by 0.09 percentage point and raising the 1-year benchmark deposit rate by 0.09 percentage point.

In this section, we include the yield curve data with other economic data and form only one dataset and extract factors from this dataset for the FAVAR model.

4.1.1 Number of factors and lags

To proceed to the FAVAR model stated above, it is important to know the optimal number of factors and lags to be incorporated in the FAVAR framework of equation (2).

In order to justify the number of factors and lags used in the FAVAR model, this paper tries to apply the conventional information criterion for standard VAR in the FAVAR. AIC, HQ and SC are computed. We find that AIC and HQ decrease with the number of factors, and therefore we cannot find the optimal number of factors using AIC and HQ. One of the reasons might be that AIC and HQ do not impose enough penalty to determine the optimal number of factors in VAR in equation (2). On the contrary, using SC as the information criteria we can find the optimal number of factors and lags in equation (2).

Table 2 reports the SC scores. SC scores for policy shock in reserve requirement ratio, M1 growth rate, 1-year benchmark lending rate and 1-year benchmark deposit rate are reported in Table 2.1, 2.2, 2.3 and 2.4 respectively. The optimal number of factors is 4, 6, 7, and 5 for reserve requirement ratio, M1 growth rate, 1-year benchmark lending rate and 1-year benchmark deposit rate respectively. The optimal lag length is 6 months for reserve requirement ratio, 1-year benchmark lending rate and 1-year benchmark deposit rate, and 3 months for the growth rate of M1.

Tables of Information Criteria, SC, for the selection of number of factors, K, and number of lags.

Note: **..** represents the occurrence of singular matrix in computation.

Table 2.1 Table of SC with respect to policy shock of reserve requirement ratio +0.50%

K \ lag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	-0.9294	-0.8967	-1.9626	-1.9620	-1.9472	-1.9217	-1.8782	-1.8403	-1.7945	-1.7531	-1.7074	-1.6599	-1.6163	-1.5685	-1.5312
1	-2.2678	-2.2267	-3.0993	-2.9812	-2.9642	-2.8924	-2.7506	-2.5948	-2.4357	-2.3174	-2.1620	-2.0333	-2.0196	-1.9766	-1.8638
2	-3.9085	-3.3750	-4.7428	-4.5545	-4.5337	-4.4454	-4.2237	-3.9719	-3.6927	-3.4921	-3.3117	-3.3834	-3.2537	-2.9996	-2.8471
3	-5.6747	-5.5053	-6.3581	-6.0418	-5.8366	-5.6126	-5.2876	-4.8346	-4.4000	-4.1939	-3.8609	-3.6727	-3.3422	-2.9849	-2.8630
4	-0.0081	-0.0077	-0.0083	-0.0078	-0.0074	-7.0020	-6.5193	-5.9013	-5.2258	-4.8274	-4.3802	-3.9008	-3.3675	-2.9384	-2.7068
5	-0.0103	-0.0098	-0.0100	-0.0092	-0.0086	-0.0080	-0.0074	-6.5368	-5.7229	-5.1522	-4.6303	-4.2529	-3.6400	-2.9678	-3.3289
6	-0.0122	-0.0118	-0.0113	-0.0102	-0.0093	-0.0085	-0.0078	-6.4543	-5.4705	-4.7647	-4.2280	-3.7412	-3.7660	-4.1771	-5.7331
7	-0.0139	-0.0131	-0.0123	-0.0107	-0.0095	-0.0084	-0.0076	-5.9060	-5.0966	-4.3810	-4.2194	-3.4458	-4.8057	-0.0098	..
8	-0.0158	-0.0147	-0.0134	-0.0116	-0.0100	-0.0087	-0.0077	-6.1186	-5.5572	-4.5283	-4.6771	-4.6537	-0.0109	..	..
9	-0.0175	-0.0159	-0.0141	-0.0120	-0.0103	-0.0088	-0.0073	-5.8695	-4.9059	-4.4837	-4.7386	-0.0188	..	..	..
10	-0.0192	-0.0172	-0.0148	-0.0122	-0.0101	-0.0082	-0.0068	-5.4828	-5.1881	-0.0087	-0.0512	..	..	..	..
11	-0.0211	-0.0184	-0.0154	-0.0127	-0.0103	-0.0082	-0.0069	-6.3173	-6.6719	-0.0190	..	..	..	..	..
12	-0.0227	-0.0196	-0.0162	-0.0130	-0.0101	-0.0081	-0.0069	-0.0084	-0.0136	..	..	..	..	..	..
13	-0.0248	-0.0212	-0.0173	-0.0137	-0.0106	-0.0092	-0.0095	-0.0128	..	..	..	..	..	..	..
14	-0.0265	-0.0221	-0.0178	-0.0138	-0.0109	-0.0100	-0.0123	-0.0582	..	..	..	..	..	..	..
15	-0.0281	-0.0232	-0.0182	-0.0140	-0.0112	-0.0116	-0.0170	..	..	..	..	..	..	..	..

Table 2.2 Table of SC with respect to policy shock of M1 growth rate -0.50%

K \ lag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	1.8939	1.8987	1.9407	1.9820	2.0252	2.0639	2.0551	2.0984	2.1392	2.1814	2.2236	2.1980	2.2363	2.2511	2.2616
1	0.6240	0.6560	0.8071	0.9436	1.0497	1.1593	1.2195	1.3498	1.4954	1.6255	1.7721	1.7627	1.8062	1.7620	1.8674
2	-1.0976	-0.9356	-0.6917	-0.4294	-0.2071	0.0124	-0.0092	0.1921	0.4478	0.6856	0.8164	0.6992	0.7001	0.8460	1.1654
3	-2.7078	-2.5561	-2.1817	-1.7412	-1.3975	-0.9904	-0.8698	-0.4569	0.0346	0.3921	0.6951	0.8025	0.7667	1.2029	1.6486
4	-5.0637	-4.7141	-4.0785	-3.4001	-2.9762	-2.3571	-2.0418	-1.5765	-0.8255	-0.3011	0.1370	0.4586	0.7661	1.2585	1.8903
5	-0.0073	-6.7869	-5.8559	-4.9098	-4.2692	-3.4858	-3.1336	-2.3186	-1.5515	-0.7329	-0.1244	0.4317	0.7167	1.5249	2.1675
6	-0.0090	-0.0084	-7.0007	-5.6820	-4.7114	-3.7316	-3.2824	-2.1419	-1.2664	-0.3065	0.1144	0.6083	0.8974	0.9302	-0.3836
7	-0.0107	-0.0096	-0.0079	-6.2281	-4.8103	-3.5250	-3.0850	-1.6200	-0.7571	0.2559	0.7535	0.9795	0.8354	-1.6206	..
8	-0.0126	-0.0110	-0.0088	-6.8191	-5.0808	-3.5316	-2.7861	-1.2137	-0.0101	0.7471	1.0659	-0.2335	-5.4257	..	..
9	-0.0142	-0.0122	-0.0094	-6.9602	-4.8509	-3.1074	-2.1253	-0.6093	0.5176	..	..	..	..	..	..
10	-0.0195	-0.0137	-0.0105	-0.0076	-4.8985	-2.8897	-2.1233	-0.7761	0.1399	..	..	..	..	..	..
11	-0.0231	-0.0150	-0.0111	-0.0079	-4.6976	-2.7224	-2.2618	-0.7161	-1.4024	..	..	..	..	..	..
12	-0.0251	-0.0162	-0.0117	-0.0080	-4.3981	-2.7308	-2.3280	-1.6358	..	..	..	..	..	..	..
13	-0.0122	-0.0176	-0.0127	-0.0087	-5.1488	-4.1195	-4.4517	-0.0080	..	..	..	..	..	..	..
14	-0.0137	-0.0185	-0.0129	-0.0084	-5.1489	-4.3133	-6.5393	..	..	..	..	..	..	..	..
15	-0.0251	-0.0199	-0.0138	-0.0089	-5.8966	-6.3670	-0.0106	..	..	..	..	..	..	..	..

(Continue) Tables of Information Criteria, SC, for the selection of number of factors, K, and number of lags.

Note: **..** represents the occurrence of singular matrix in computation.

Table 2.3 Table of SC with respect to policy shock of 1-year benchmark lending rate +0.09%

K \ lag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	-0.1558	-1.1765	-0.2232	-0.2026	-0.2234	-0.1865	-0.3637	-0.3899	-0.3537	-0.3248	-0.2914	-0.3388	-0.3372	-0.3009	-0.2636
1	-1.4391	-1.4399	-1.4202	-1.3434	-1.2572	-1.1125	-1.1708	-1.0867	-0.9396	-0.8071	-0.6818	-0.6431	-0.6699	-0.6941	-0.5603
2	-4.3799	-4.2116	-4.2567	-4.0718	-3.9286	-3.6198	-3.5646	-3.3499	-3.0850	-2.8014	-2.6698	-2.975	-2.6091	-2.4832	-2.2591
3	-5.9790	-5.8175	-5.7641	-5.4031	-5.0560	-4.5858	-4.4664	-4.0090	-3.5077	-3.0497	-2.7686	-2.7803	-2.6674	-2.2798	-1.8647
4	-0.0085	-0.0081	-0.0078	-7.1518	-6.5544	-5.9069	-5.6637	-5.1736	-4.5203	-3.9513	-3.6914	-3.4676	-3.0514	-2.7582	-2.4367
5	-0.0108	-0.0102	-0.0096	-0.0087	-0.0079	-6.9720	-6.5298	-5.8472	-5.0807	-4.2694	-3.8315	-3.4687	-2.7402	-2.3215	-2.0435
6	-0.0125	-0.0117	-0.0106	-0.0094	-0.0083	-7.1687	-6.5727	-5.5891	-4.6449	-3.8719	-3.4522	-3.0686	-3.0833	-2.8857	-3.8666
7	-0.0142	-0.0129	-0.0115	-0.0100	-0.0084	-7.1959	-6.4759	-5.1465	-4.0468	-3.5400	-3.2801	-3.0798	-4.7059	-7.0904 ..	
8	-0.0160	-0.0146	-0.0127	-0.0108	-0.0089	-7.1262	-6.4579	-5.0722	-4.2501	-3.6734	-3.7802	-4.6843	-0.0115 ..		
9	-0.0177	-0.0158	-0.0135	-0.0113	-0.0091	-7.0647	-6.1097	-4.6709	-3.3967	-3.5516	-6.3326	-0.0226 ..			
10	-0.0195	-0.0171	-0.0142	-0.0114	-0.0088	-6.5409	-5.5387	-4.1606	-3.4312	-5.9120	-0.0557 ..				
11	-0.0214	-0.0184	-0.0149	-0.0119	-0.0089	-6.5622	-5.7860	-4.7080	-4.8704	-0.0157 ..					
12	-0.0231	-0.0198	-0.0160	-0.0122	-0.0087	-6.4331	-5.5659	-5.8139	-0.0106 ..						
13	-0.0254	-0.0217	-0.0172	-0.0130	-0.0092	-0.0074	-0.0078	-0.0106 ..							
14	-0.0271	-0.0227	-0.0177	-0.0131	-0.0094	-0.0087	-0.0108 ..	..							
15	-0.0286	-0.0236	-0.0180	-0.0133	-0.0096	-0.0095	-0.0155 ..	..							

Table 2.4 Table of SC with respect to policy shock of 1-year benchmark deposit rate +0.09%

K \ lag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	-0.2533	-0.2416	-0.2123	-0.1789	-0.1453	-0.1139	-0.1551	-0.1249	-0.0990	-0.0789	-0.0459	-0.1587	-0.1715	-0.1296	-0.0871
1	-1.5144	-1.4868	-1.3872	-1.2619	-1.1789	-1.0610	-0.9877	-0.8742	-0.7395	-0.6220	-0.4832	-0.5107	-0.5589	-0.4908	-0.3596
2	-4.4562	-4.2365	-4.0572	-3.8458	-3.6925	-3.5404	-4.1307	-3.9020	-3.6611	-3.4152	-3.1664	-3.7648	-3.6058	-3.4467	-3.1247
3	-6.0570	-5.8735	-5.5674	-5.2457	-4.9370	-4.6025	-5.0072	-4.6446	-4.2030	-3.8385	-3.5201	-3.8677	-3.5927	-3.1863	-2.7843
4	-0.0084	-0.0080	-0.0075	-6.9436	-6.5607	-6.0227	-6.1856	-5.6526	-4.9310	-4.4307	-4.4389	-4.3860	-3.7838	-3.3515	-2.8180
5	-0.0107	-0.0101	-0.0093	-0.0084	-0.0078	-7.1382	-7.1056	-6.3960	-5.4701	-4.7584	-4.6238	-4.4275	-3.7790	-3.4356	-3.4362
6	-0.0125	-0.0117	-0.0105	-0.0093	-0.0084	-0.0077	-0.0075	-6.6554	-5.6311	-4.7288	-4.4283	-4.2336	-3.6524	-4.3770	-5.6972
7	-0.0142	-0.0130	-0.0114	-0.0098	-0.0086	-0.0076	-0.0074	-6.0845	-4.9437	-4.1534	-4.1479	-4.3122	-4.5357	-0.0078 ..	
8	-0.0161	-0.0147	-0.0127	-0.0107	-0.0092	-0.0077	-0.0074	-5.8768	-5.0550	-3.9366	-4.4519	-6.3874	-0.0106 ..	..	
9	-0.0178	-0.0159	-0.0134	-0.0111	-0.0093	-0.0077	-0.0071	-5.8093	-4.6118	-3.9783	-6.7592	-0.0220 ..	..	..	
10	-0.0196	-0.0171	-0.0140	-0.0111	-0.0088	-6.9465	-0.0062	-5.3093	-4.3301	-6.5647 ..	..	..	..	..	
11	-0.0215	-0.0184	-0.0148	-0.0114	-0.0088	-0.0073	-0.0066	-5.7424	-6.0814	-0.0200 ..	..	..	..	..	
12	-0.0232	-0.0199	-0.0157	-0.0120	-0.0089	-0.0074	-0.0068	-6.1099	-0.0130 ..	..	..	..	..	..	
13	-0.0254	-0.0216	-0.0168	-0.0126	-0.0096	-0.0086	-0.0095	-0.0117 ..	..	..	..	..	..	..	
14	-0.0271	-0.0225	-0.0172	-0.0126	-0.0095	-0.0097	-0.0118 ..	..	..	..	..	..	..	..	
15	-0.0288	-0.0237	-0.0177	-0.0131	-0.0103	-0.0117	-0.0178 ..	..	..	..	..	..	..	..	

4.1.2. A comparison of the four policy tools

Graph 3 displays the impulse response functions from the four policy tools.

In general, all the four policies do not have long term impact on real activities. The 1-year lending rate has the most impact on real activities in the short term. A shock on the growth rate of M1, the 1-year lending rate and the 1-year deposit rate have small long term impact on CPI inflation, while a shock on the reserve requirement ratio does not have any long term impact on CPI inflation.

A comparison of the impact of the four policies on real activities

As can be seen from Graph 3, a shock represented by an increase in reserve requirement ratio by 0.5 percentage point affects real activities very mildly. It could be that an increase in the reserve requirement ratio is an indication of the start of a tightening cycle. A drop in enterprise deposits could be due to tighter funding from banks and therefore enterprises begin to use their deposit to fund their operation or investment projects. At the same time, there is a mild fall in the growth rates of industrial production, exports and FDI. The impact of the shock on exports and FDI is also reflected in a mild fall in the growth rate of foreign exchange reserves. The shock has a mild negative impact on the growth rate of average earnings. This should be related to the slower growth in industrial production. The shock of the increased reserve requirement ratio does not bring about a fall in fixed asset investment until the 24^{th} month. A shock on 1-year deposit rate has a similar but milder impact on real activities.

Again as Graph 3 shows, a shock represented by the tightening of the growth rate of M1 by 5 percentage points affects real activities in ways that are similar to that of the increase in the reserve requirement ratio of 0.5 percentage point. The only difference in the effect on real activities between the two monetary policy instruments is that a tightening in reserve requirement ratio leads to slight appreciation of CNY for 12 months while a tightening on M1 leads to slight and gradual depreciation of CNY. The difference is also reflected in the impact on FDI and foreign exchange reserves. A shock on the growth rate of M1 leads to an increase in FDI in the first 6 months, but the impact is neutral in long term. The shock has a similar but more extended impact on foreign exchange reserves, and only disappears after 40 months.

A shock represented by an increase in the 1-year lending rate by 0.09 percentage point has the most negative impacts on real activities in short to medium term compared with the other policy tools, especially for industrial production growth and fixed asset investment growth. These impacts disappear after 42 months. The shock has negligible impact on CNY and FDI.

A shocks represented by the increase in the 1-year lending rate and M1 growth rate yield similar results in the fall of enterprise deposit growth rate. An increase in lending rate or a tightening of M1 growth via lower monthly growth of new loan means that enterprises would use their deposits to fund their operations or expansions.

A comparison of the impact of the four policies on asset prices and inflation

Of all the four policies, a shock to the reserve requirement ratio negatively affects consumer expectations, the return of Shanghai A share and housing price most for the first 18 months. At the same time household deposits increase and the growth rate of retail sales falls. The shock also brings down the inflation in urban CPI most among the four policies for the same period. Households tend to channel their investment from the stock market and property market back to savings. This might suggest that household investment channels are limited in China. These negative impacts only last for 18 months, and they do not display any long term impacts from the shock. A shock to the 1-year deposit rate has a similar impact on asset prices and inflation, but is milder.

A shock to the growth rate of M1 affects consumer expectation, the returns of Shanghai A share and household deposits, but the effects are milder than the shock to the reserve requirement ratio. A shock to the growth rate of M1 has the least impact on the housing price index among the four policies. It also has a milder impact on CPI inflation in the short term with the impact lasting for 48 months.

In contrast to the other three policies, a shock to the 1-year lending rate leads to a rise in consumer expectation, higher return on Shanghai A shares and a fall in household deposits. But again, it suggests that household deposit is an alternative to stock investments. Although the mortgage rate is linked to the 1-year lending rate, a shock to the 1-year lending rate only has a small impact on the change in housing prices, but this small impact lingers on for 30 months. Although the shock of 1-year lending rate has only mild impact on CPI inflation, the impact lasts 48 months.

Overall, we find that inflation in China is affected by household investments in asset markets in the short term and is affected by retail sales in the long term. Consumer expectation plays an important role in inflation. Among all the policy tools in the short term, the reserve requirement ratio seems to affect consumer expectation and household investment behavior the most.

A comparison of the impact of the four policies on credit channels

A shock to the reserve requirement ratio reduces the growth rate of M1 slightly during the 3rd month to the 20th month. This echoes the fall in urban CPI inflation during the same period. But the shock to the reserve requirement ratio leads to a very mild growth in monthly new loans for the same period. The shock increases 7-day CHIBOR within the first six months mildly, but leads to a stronger increase in 3-month CHIBOR. These impacts last for 36 months.

A shock to the growth rate of M1 affects CHIBOR in the same way as a shock to reserve requirement ratio but is milder. However, a shock on M1 leads to a slight fall in monthly new loan growth, but this is only for the first 4 months.

A shock to the 1-year lending rate leads to a small increase in the 7-day and 3-month CHIBOR but these effects decline after 6 months. The shock also leads to a small increase in the growth rate of M1 in the short term, while falling gradually in the medium term with the impact disappearing after 42 months. This might be explained by the impact of the shock to a fall in household deposits; in fact, the impact on household

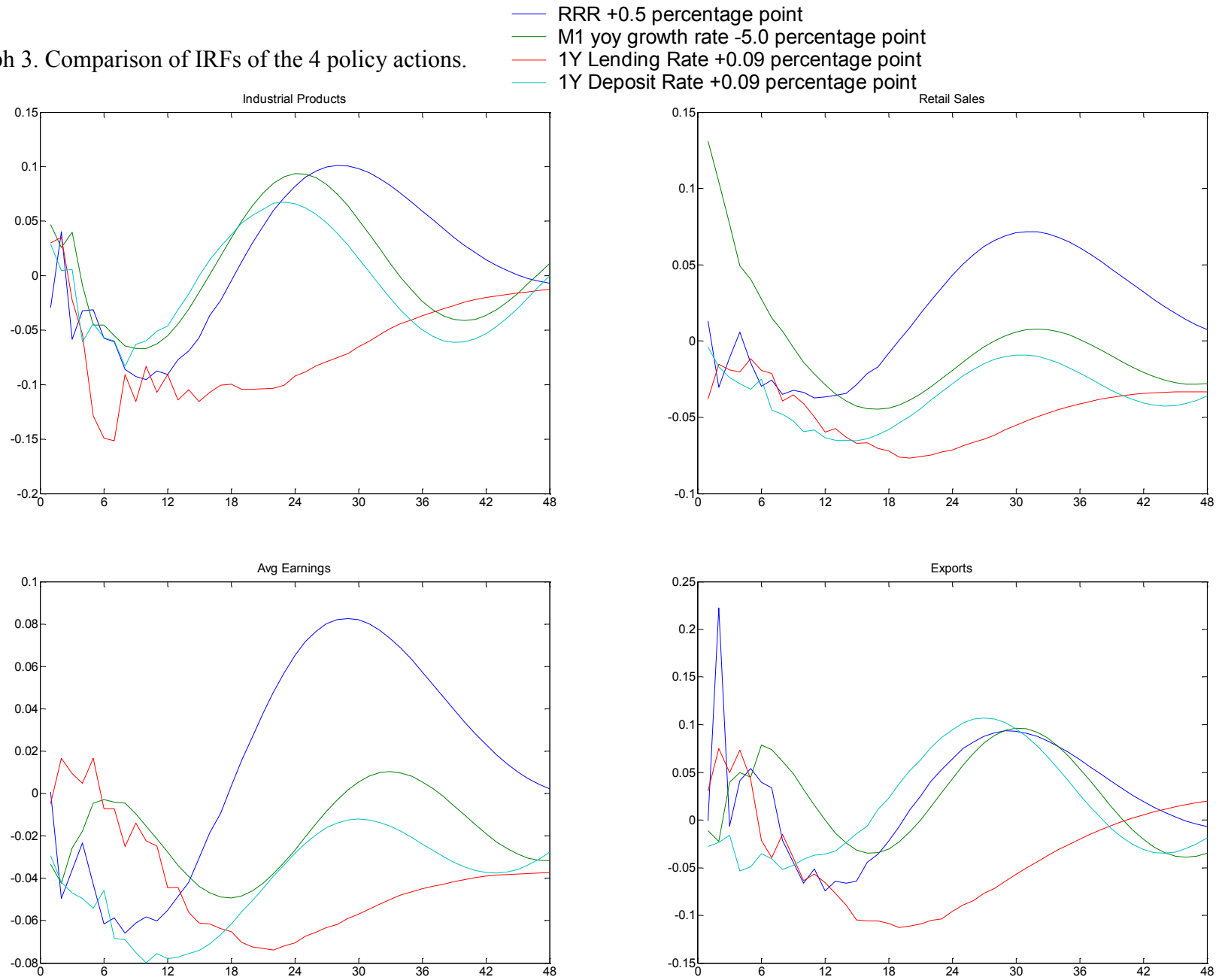
deposits matches the timing of the growth rate of M1.

A shock to the 1-year deposit rate leads to a rise in monthly new loan growth. This might be due to the fact that the higher deposit rate attracts more household deposits and hence banks have more funds to deploy. However, the shock has a small impact on M1 growth rate, as the growth in household deposits and increase in monthly new loans cancel out the impact of the growth in money.

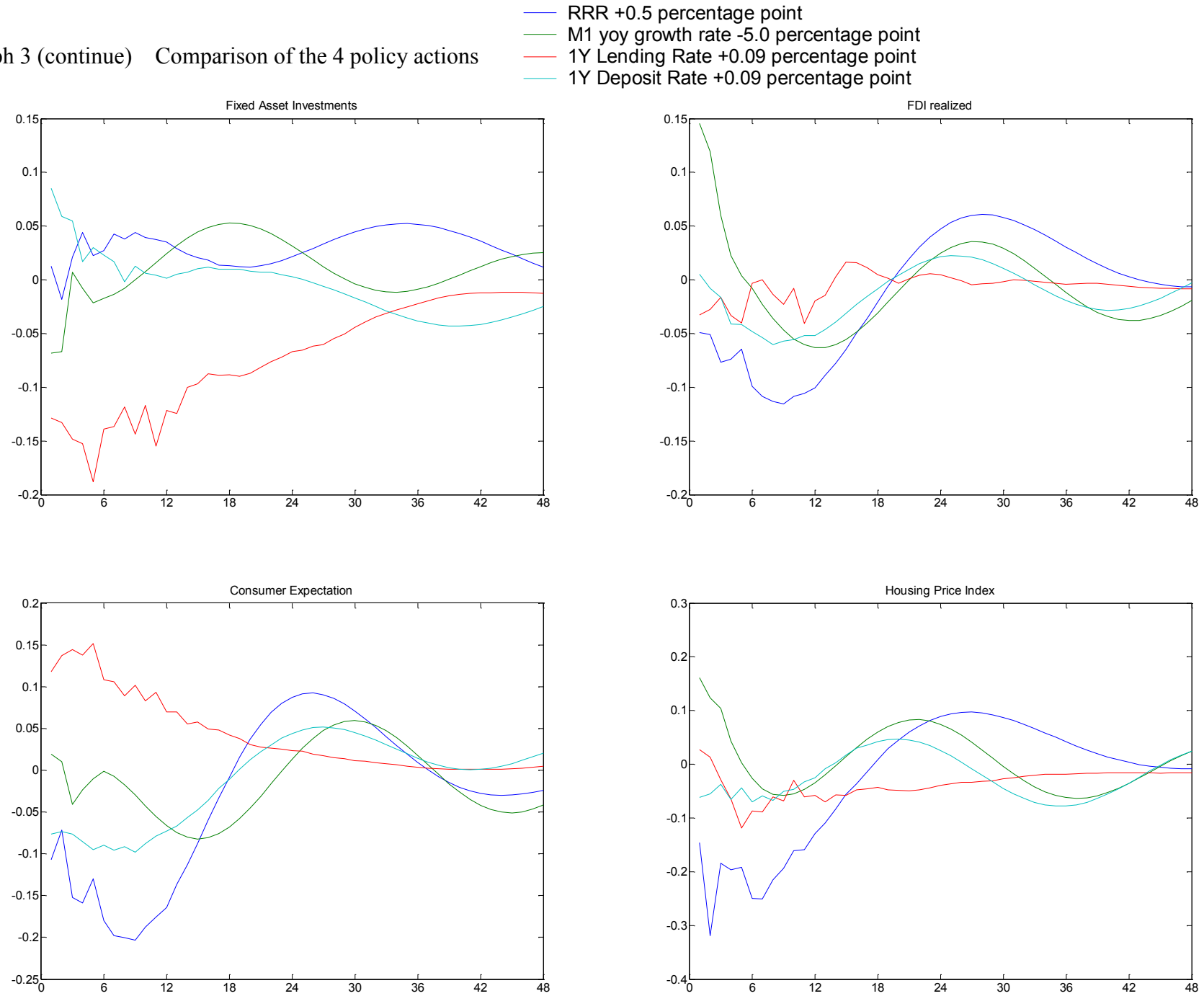
The findings match the stylized facts of a tightening monetary policy shock on impulse response functions. There is a long run neutrality of monetary policy on real economic activities, as shown by a fall in the impulse response function of real economic activities in the short term with the impacts disappearing in the long term. There is also a fall in inflation in the long term and a short term rise in interest rates. These results are similar to the ones found in the literature in the context of other economies.

Our result is only partially similar to that of Girardin and Liu (2006) as we find that the price-based tools of a 1-year lending rate has a stronger impact on real activities in the short term when compared to quantity-based tools. However, our findings differ from Qin et al (2005) and Laurens and Maino (2007) and Dickinson and Liu (2007) that find price-based tools as not having any long term impact on inflation.

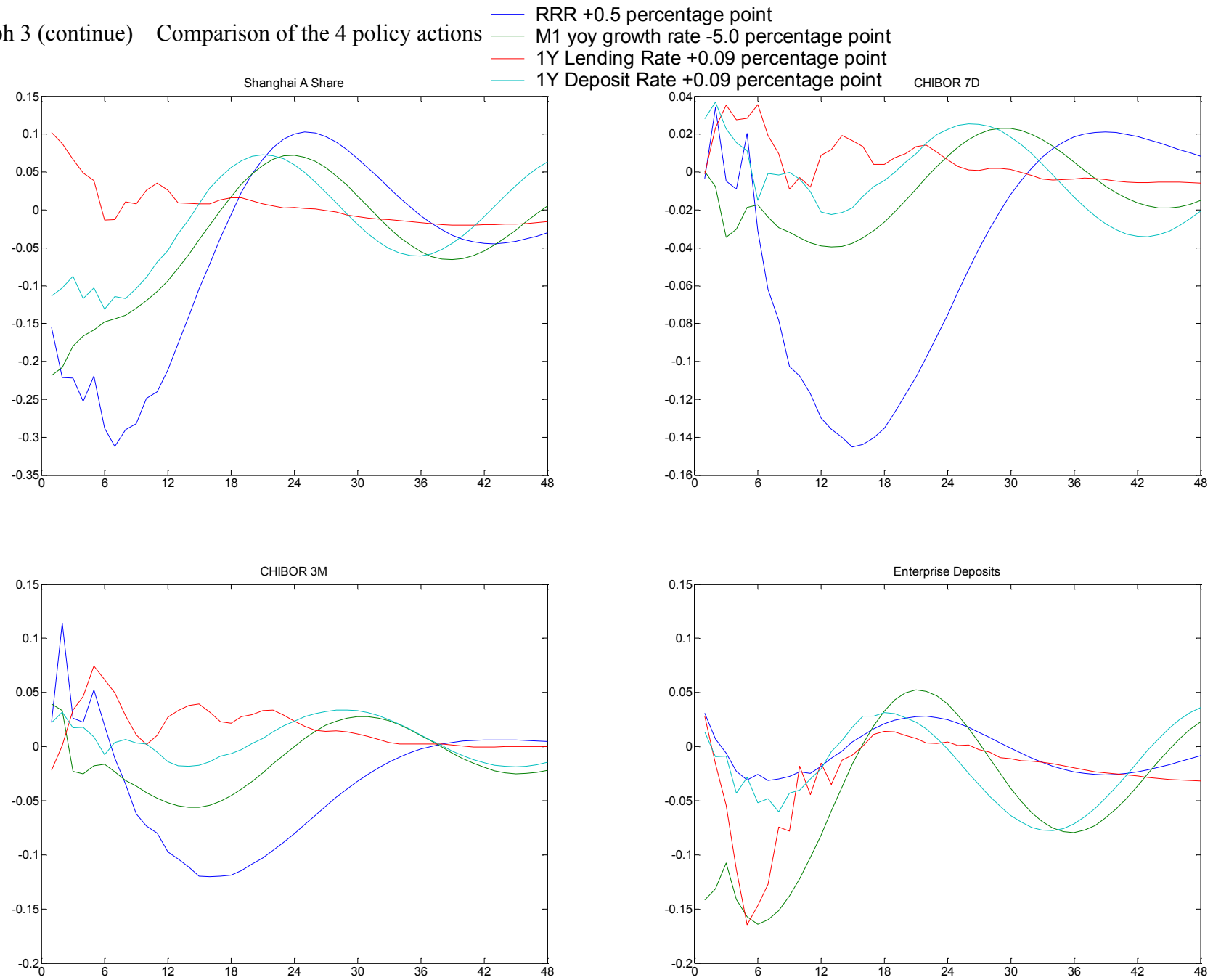
Graph 3. Comparison of IRFs of the 4 policy actions.



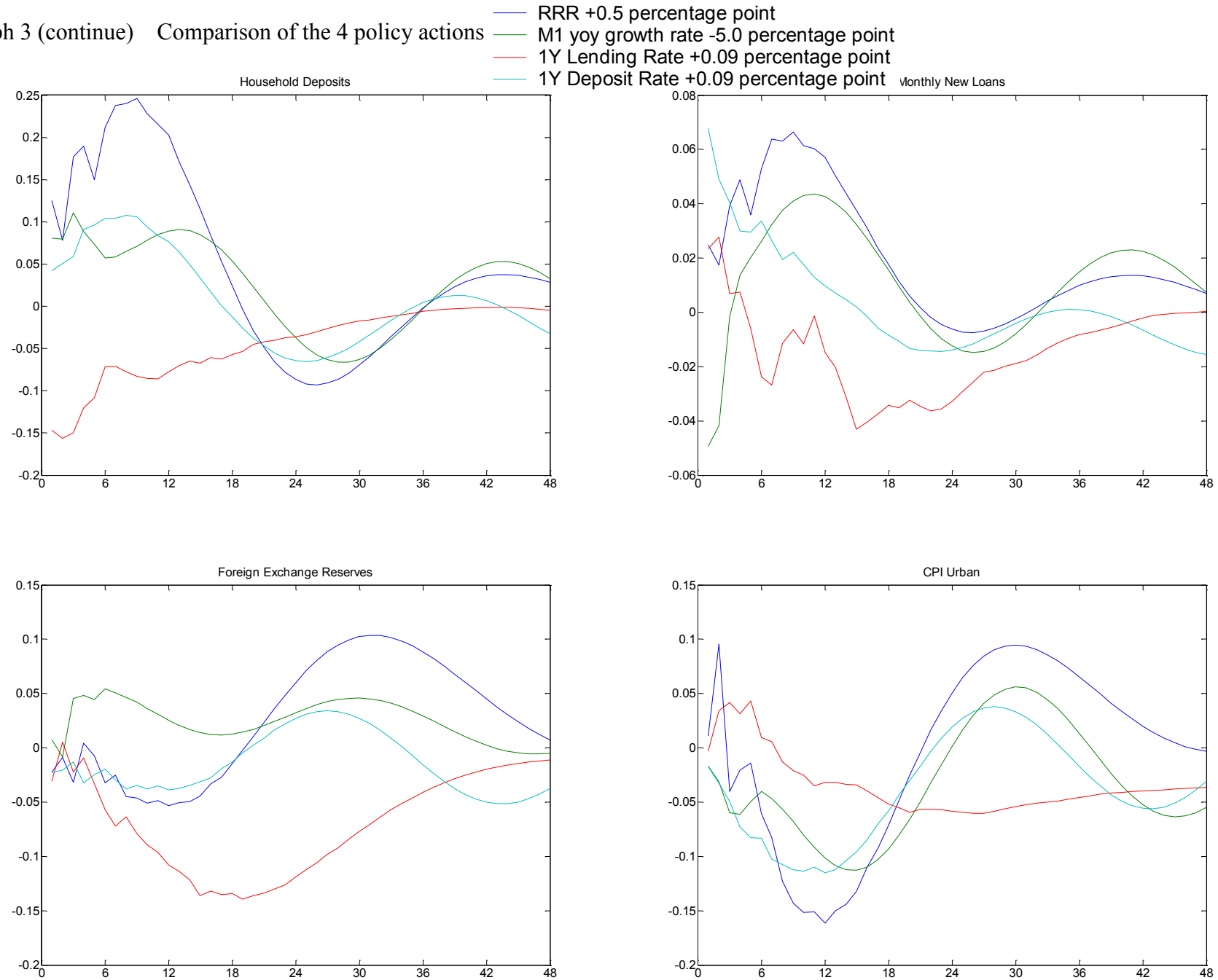
Graph 3 (continue) Comparison of the 4 policy actions



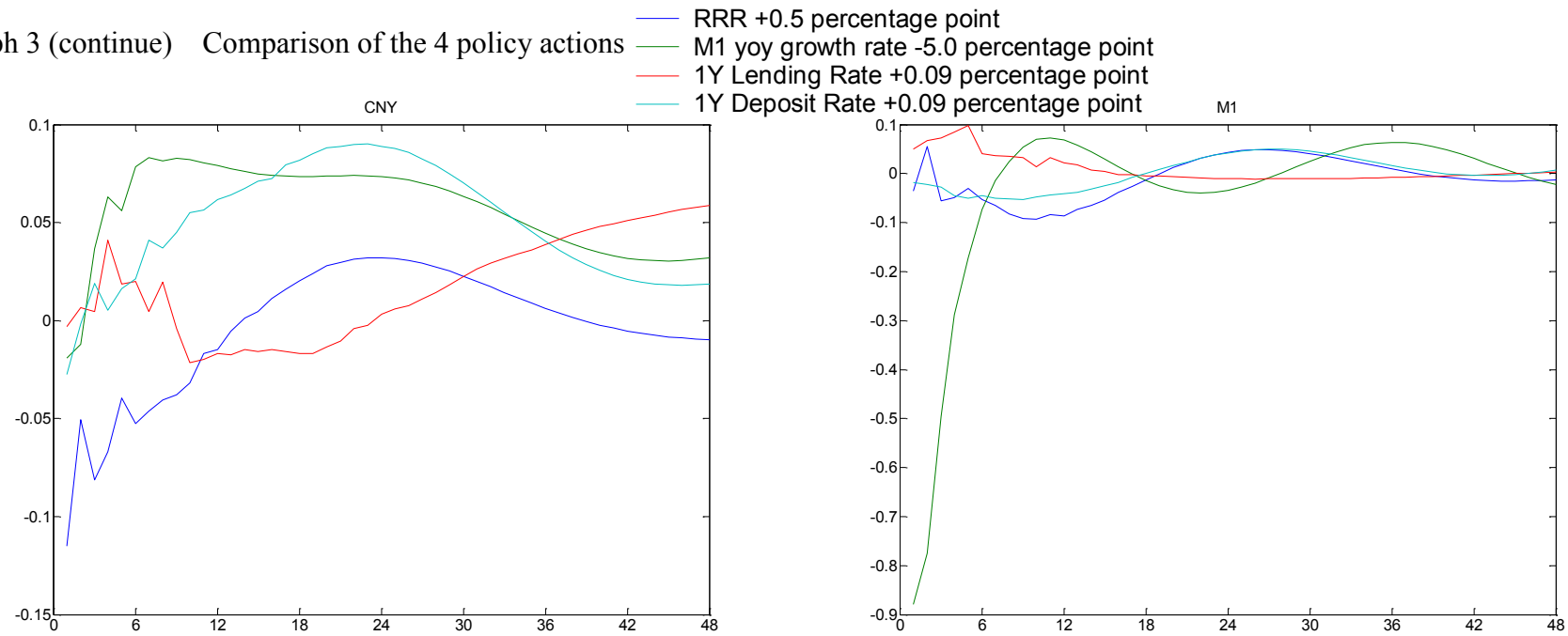
Graph 3 (continue) Comparison of the 4 policy actions



Graph 3 (continue) Comparison of the 4 policy actions



Graph 3 (continue) Comparison of the 4 policy actions



4.2 Including yield curve factors in the 1-year benchmark lending rate policy

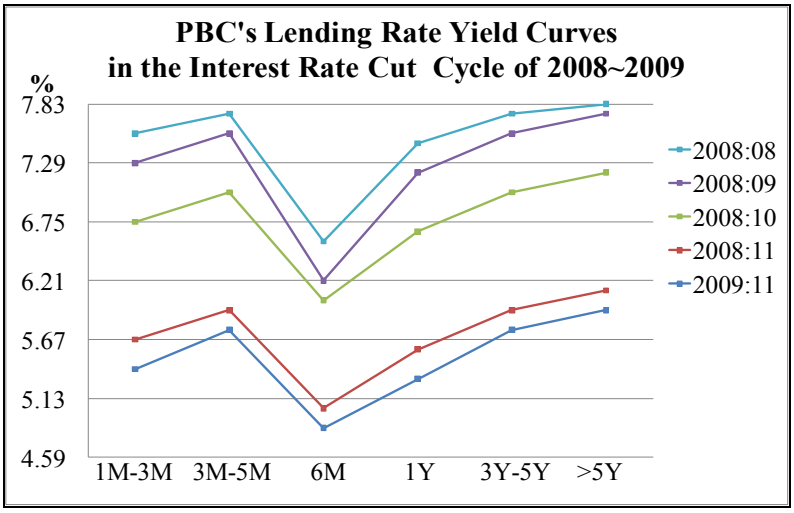
Since we would like to know if the yield curve information, specifically the level, slope and curvature of the yield curve, could improve the analysis of the 1-year benchmark lending rate, we extract 3 factors from benchmark lending rates and their spreads by principal components. Table 3 shows the factor loadings of the three factors.

Table 3. Yield curve factors of benchmark lending rates

Lending Rates and Spreads	Factor Loading 1	Factor Loading 2	Factor Loading 3
1M~3M	1.0833	-0.3993	-0.2735
6M	1.0242	-0.6326	-1.3867
1Y	1.0483	-0.7980	-0.4344
3y~5Y	1.0961	-0.1226	-0.2151
>5Y	1.0970	0.0569	-0.2131
1Y-6M spread	0.8694	-1.0742	2.3389
3Y-1Y spread	0.8786	1.6476	0.4142
5Y-1Y spread	0.8637	1.7079	0.2825

As shown in Table 3, the first factor has loadings heavily weighted on the levels of benchmark lending rates. We call the first factor, Level factor. Heavy weights are given to the lending rate spreads in the second factor. Therefore we call this the Slope factor. In the third factor, heavy weights are given to the 6-month lending rate and the spread of 1-year lending rate and 6-month lending rate. These weights characterize "valleys" in the lending yield curve as shown in Graph 2, and therefore we call this factor the Shape factor.

Recall of Graph 2. The PBC's Lending Rate Yield Curve during 2008~2009.



In Y_t of equation (2), we arrange the factors in the order such that Shape factor comes first, then the Slope factor, and then the 1-year benchmark lending rate. The policy shock is the same as the first part of the analysis where only the 1-year benchmark lending rate receives a shock of +0.09 percentage point. We do

not include the Level factor in Y_t because a shock to the 1-year lending rate could not change lending rates of other maturities since they are separate PBC policy actions; but a shock to the 1-year lending rate could change the slope and curvature of the yield curve.

4.2.1 The number of factors and lags

Using the conventional information criteria, SC, we find that the optimal number of factors is 8 and the optimal number of lags is 5 for the FAVAR model. Table 4 displays the information criteria.

Table 4 Information criteria, SC, for 1-year lending rate with yield curve factors included in FAVAR.
Note: **..** represents the occurrence of singular matrix in computation.

K \ lag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	-1.7833	-1.7016	-1.9864	-1.8296	-1.9274	-1.9532	-2.6352	-2.5511	-2.3199	-2.0957	-1.9589	-2.4728	-2.2452	-2.0450	-1.7674
1	-2.6714	-2.4752	-2.6274	-2.2807	-2.1241	-1.9790	-2.4996	-2.2614	-1.8289	-1.3745	-1.0369	-1.4044	-1.3795	-1.0115	-0.5953
2	-4.5829	-4.3595	-4.2942	-3.7891	-3.4845	-3.3308	-3.4248	-2.9705	-2.3129	-1.5870	-1.0538	-1.2549	-1.2305	-0.6915	-0.3030
3	-0.0074	-6.8256	-6.5203	-5.8228	-5.3005	-4.8820	-4.9850	-4.3521	-3.6698	-2.9458	-2.6903	-2.7252	-2.1252	-1.6382	-1.5675
4	-0.0099	-0.0089	-0.0082	-6.8820	-6.2797	-5.6026	-5.6369	-4.8146	-4.0973	-3.2434	-2.9675	-3.1195	-3.0647	-4.0248	-4.3271
5	-0.0120	-0.0107	-0.0096	-0.0082	-7.0102	-6.0842	-5.9258	-4.6557	-3.8164	-2.8513	-3.0529	-3.8201	-3.8181	-4.0032	..
6	-0.0136	-0.0121	-0.0104	-0.0085	-7.1410	-6.0875	-5.7946	-4.3649	-3.2870	-2.8854	-5.0573	-0.0197	..	..	..
7	-0.0152	-0.0133	-0.0110	-0.0088	-7.0047	-5.8060	-5.4065	-3.5703	-2.5840	-2.8686	-0.0287	..	..	..	..
8	-0.0170	-0.0147	-0.0119	-0.0093	-7.1475	-5.4786	-5.5585	-4.3002	-4.1546	-6.2980	..	..	..	..	..
9	-0.0185	-0.0156	-0.0122	-0.0092	-6.5629	-4.5316	-4.7672	-3.8149	-6.5213	-0.0206	..	..	..	..	..
10	-0.0201	-0.0167	-0.0127	-0.0092	-6.2553	-4.0649	-4.0769	-5.2498	-0.0151	..	..	..	..	..	..
11	-0.0221	-0.0182	-0.0136	-0.0097	-6.5971	-4.2295	-4.8455	-0.0087	..	..	..	..	..	..	..
12	-0.0241	-0.0196	-0.0145	-0.0100	-6.7700	-4.7849	-6.5909	..	..	..	..	..	..	..	..
13	-0.0263	-0.0214	-0.0155	-0.0105	-0.0076	-6.5591	-0.0119	..	..	..	..	..	..	..	..
14	-0.0280	-0.0222	-0.0157	-0.0105	-0.0078	-0.0088	..	..	..	..	..	..	..	..	..
15	-0.0295	-0.0232	-0.0159	-0.0108	-0.0079	-0.0111	..	..	..	..	..	..	..	..	..

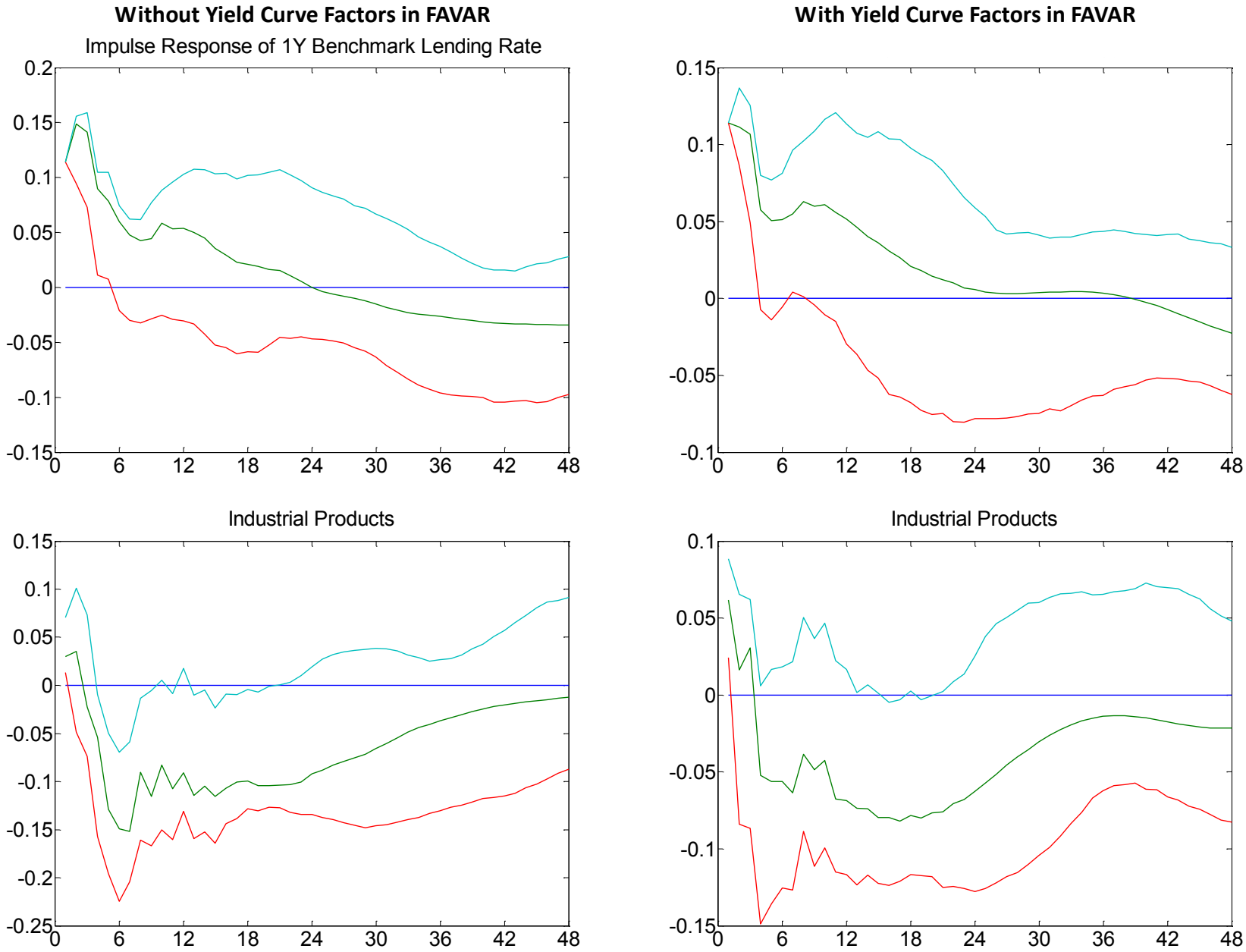
4.2.2 A comparison of the effectiveness of 1-year benchmark lending rate with and without yield curve factors

Graph 4 compares the differences of impulse response functions of a shock on 1-year lending rate with and without yield curve factors.

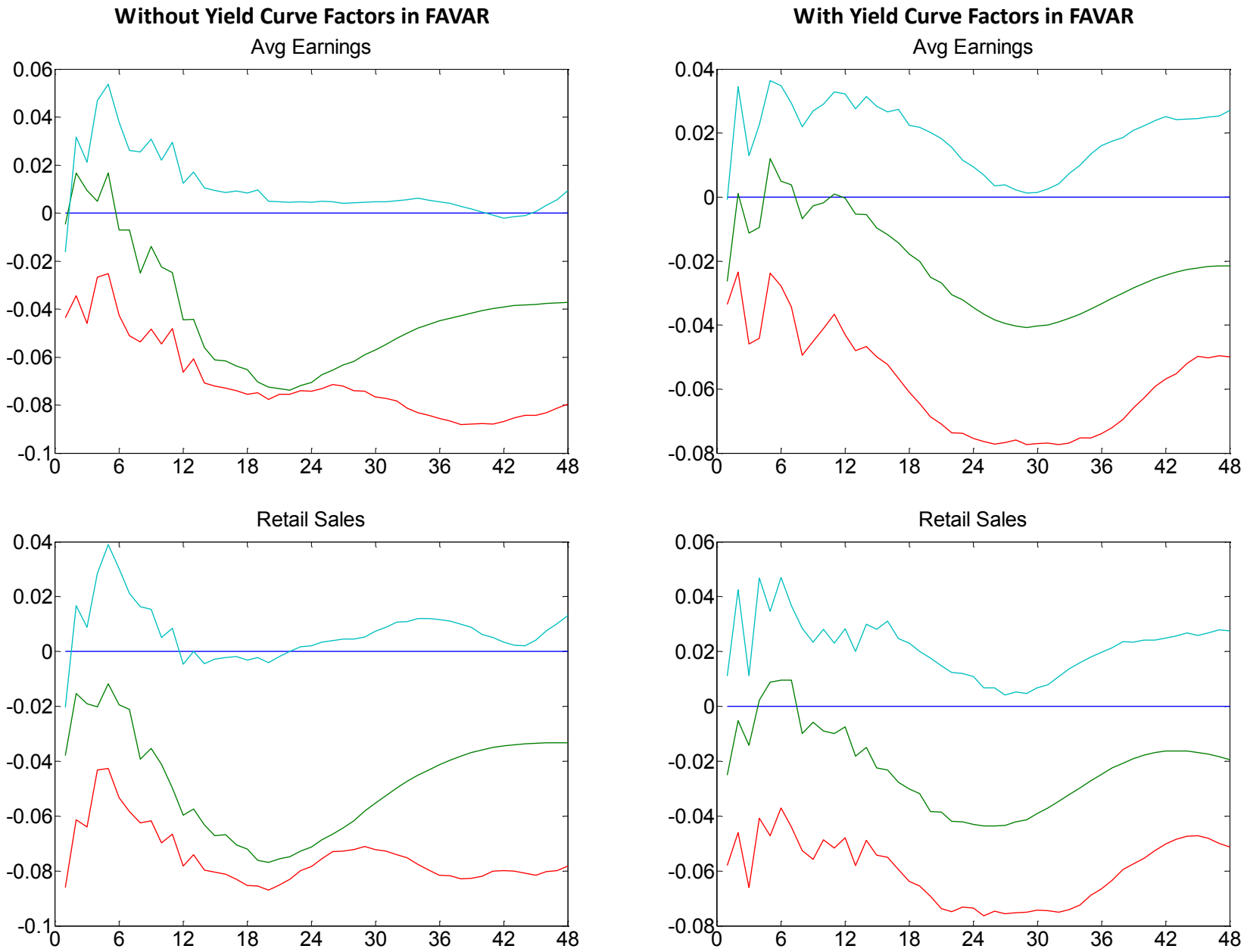
Adding yield curve factors to the FAVAR does not make a large difference to the impulse response functions of the 1-year lending rate on real activities and inflation in the long term.

However, it changes the impulse response functions in the credit channels. After including the yield curve factors, the immediate impact of a shock of 1-year lending rate on 7-day CHIBOR is stronger. In Section 4.1.2, Graph 3 shows that the shock has no immediate impact on 7-day CHIBOR after 1-month. Since the interbank short rate should respond to the policy rate very quickly, adding the yield curve factors seems appropriate. The shock also leads to a fall in monthly new loan growth, enterprise deposit growth and M1 growth after including yield curve factors, which makes more sense than a small rise in the three monetary indicators in Section 4.2.1.

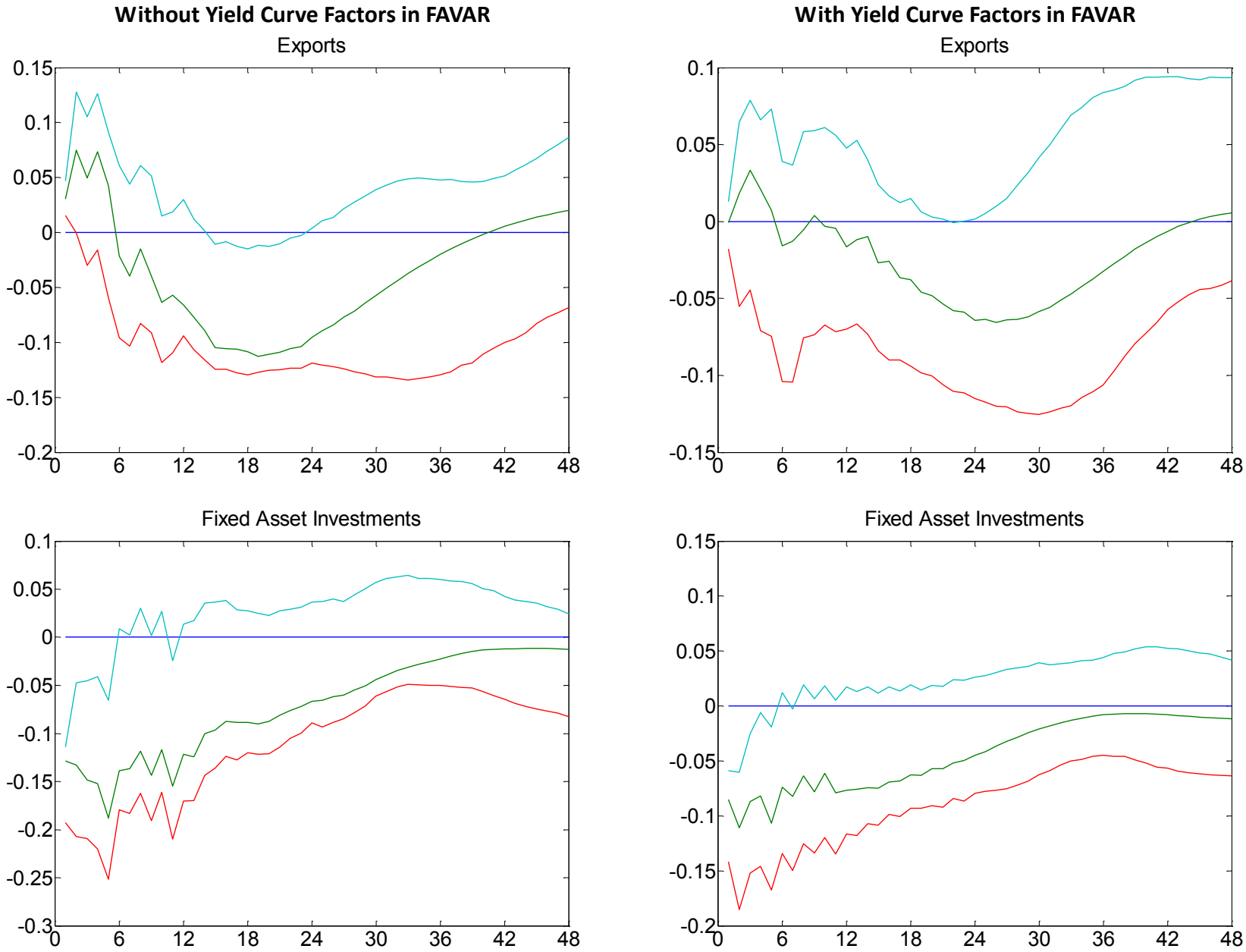
Graph 4 Side by side comparison of IRFs with and without yield curve factors in FAVAR w.r.t. a shock of 0.09% in 1-year lending rate.



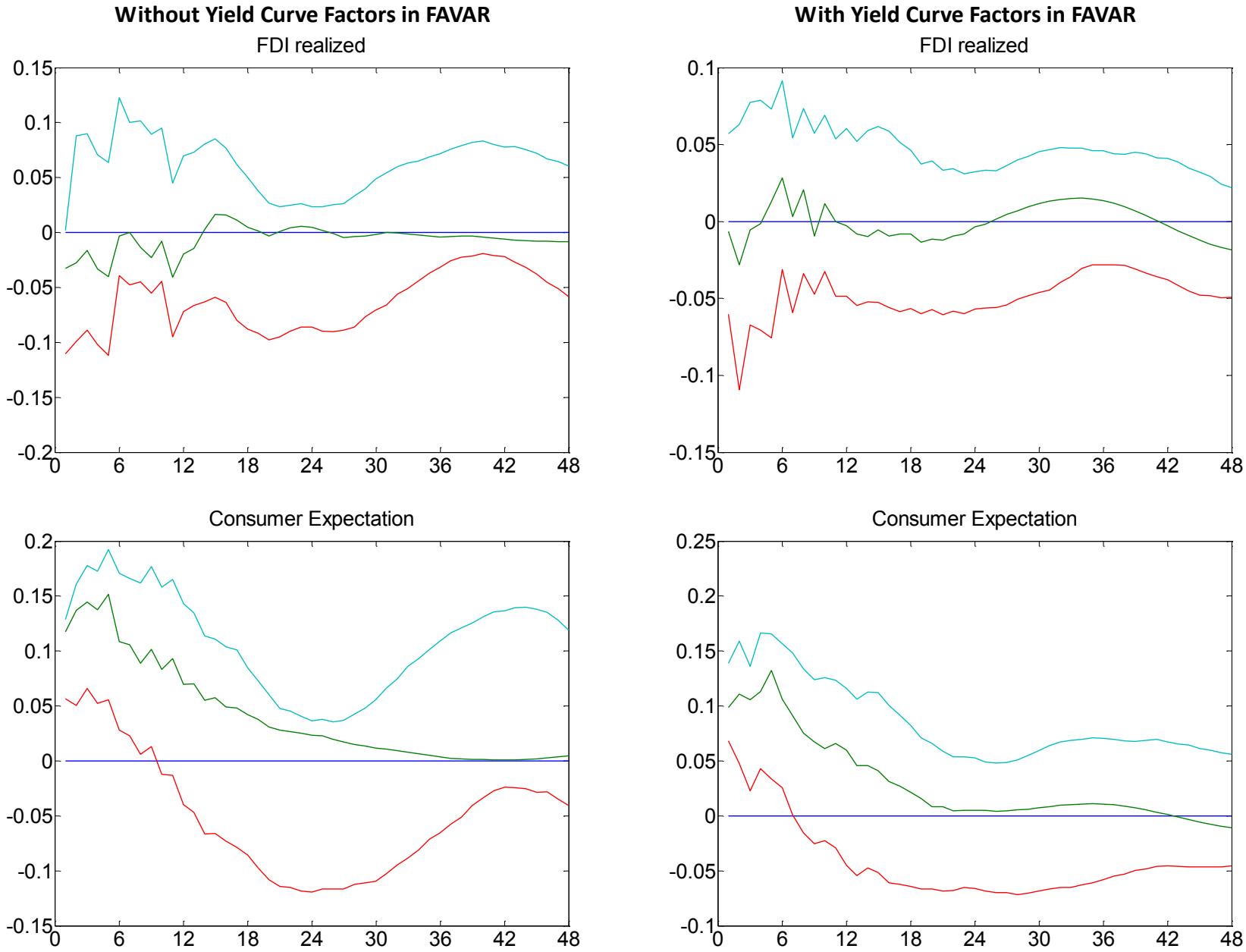
Graph 4 (Cont') Side by side comparison of IRFs with and without yield curve factors in FAVAR w.r.t. a shock of 0.09% in 1-year lending rate.



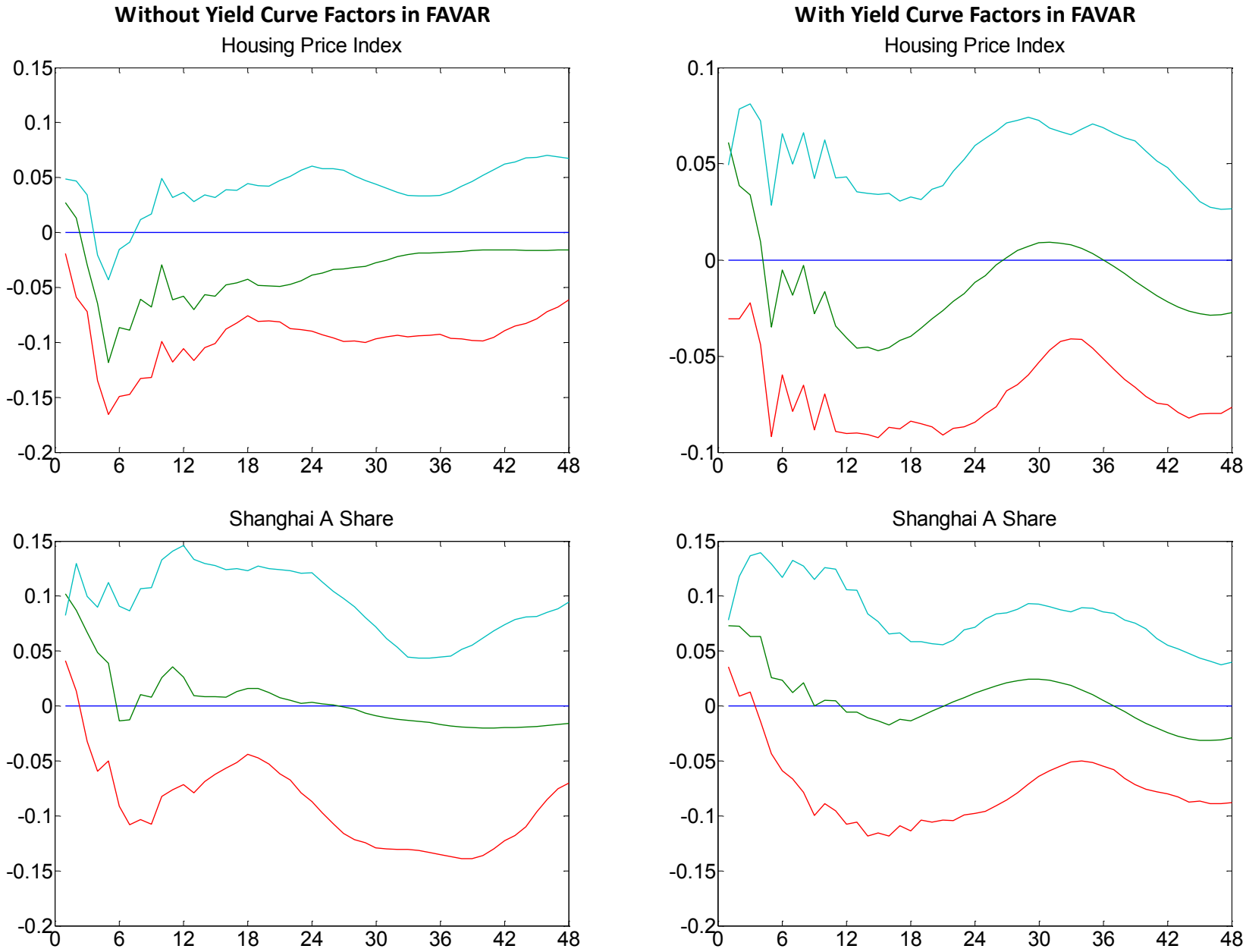
Graph 4 (Cont') Side by side comparison of IRFs with and without yield curve factors in FAVAR w.r.t. a shock of 0.09% in 1-year lending rate.



Graph 4 (Cont') Side by side comparison of IRFs with and without yield curve factors in FAVAR w.r.t. a shock of 0.09% in 1-year lending rate.

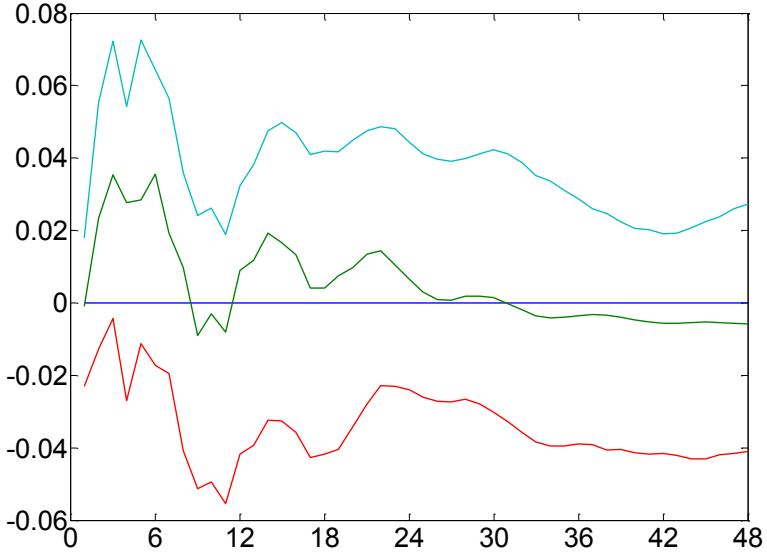


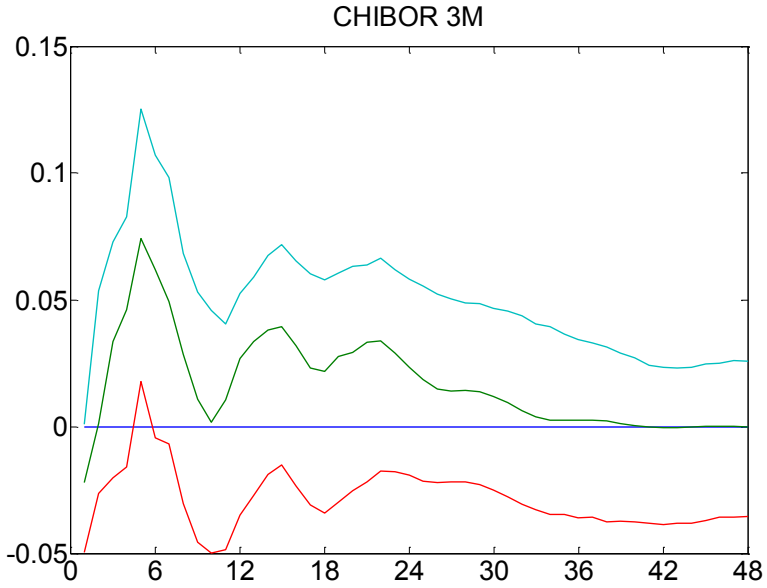
Graph 4 (Cont') Side by side comparison of IRFs with and without yield curve factors in FAVAR w.r.t. a shock of 0.09% in 1-year lending rate.



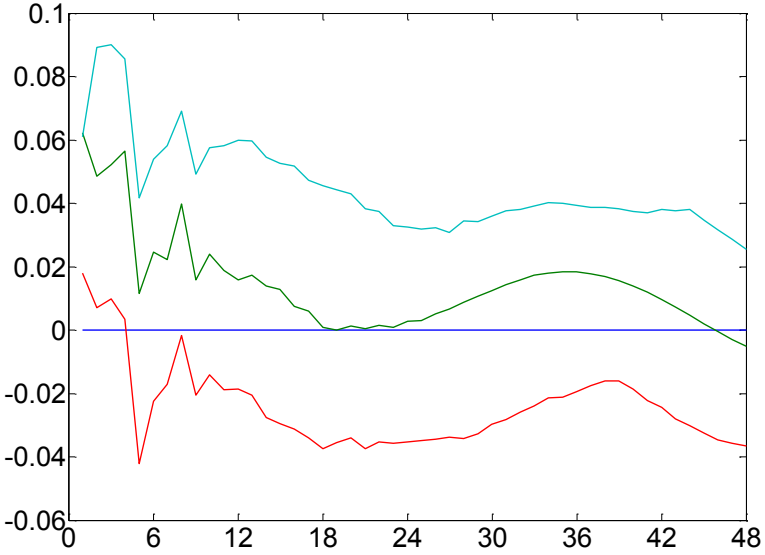
Graph 4 (Cont') Side by side comparisons of IRFs with and without yield curve factors in FAVAR w.r.t. a shock of 0.09% in 1-year lending rate.

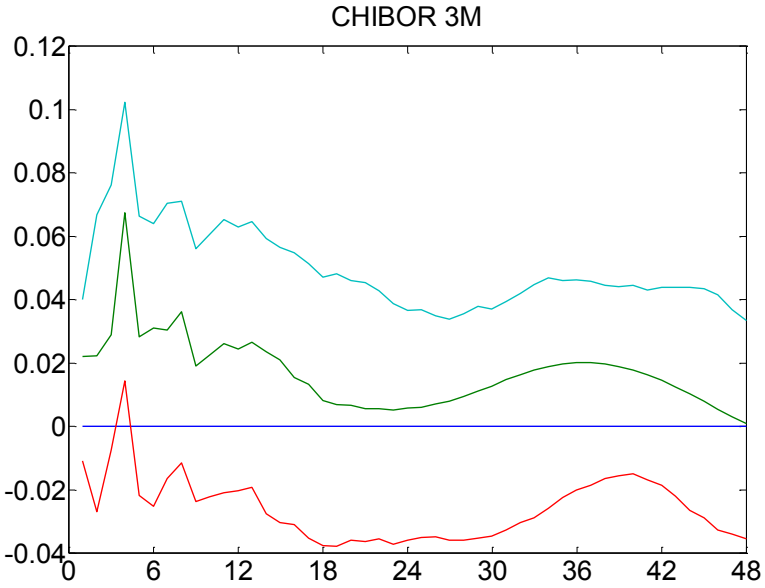
Without Yield Curve Factors in FAVAR



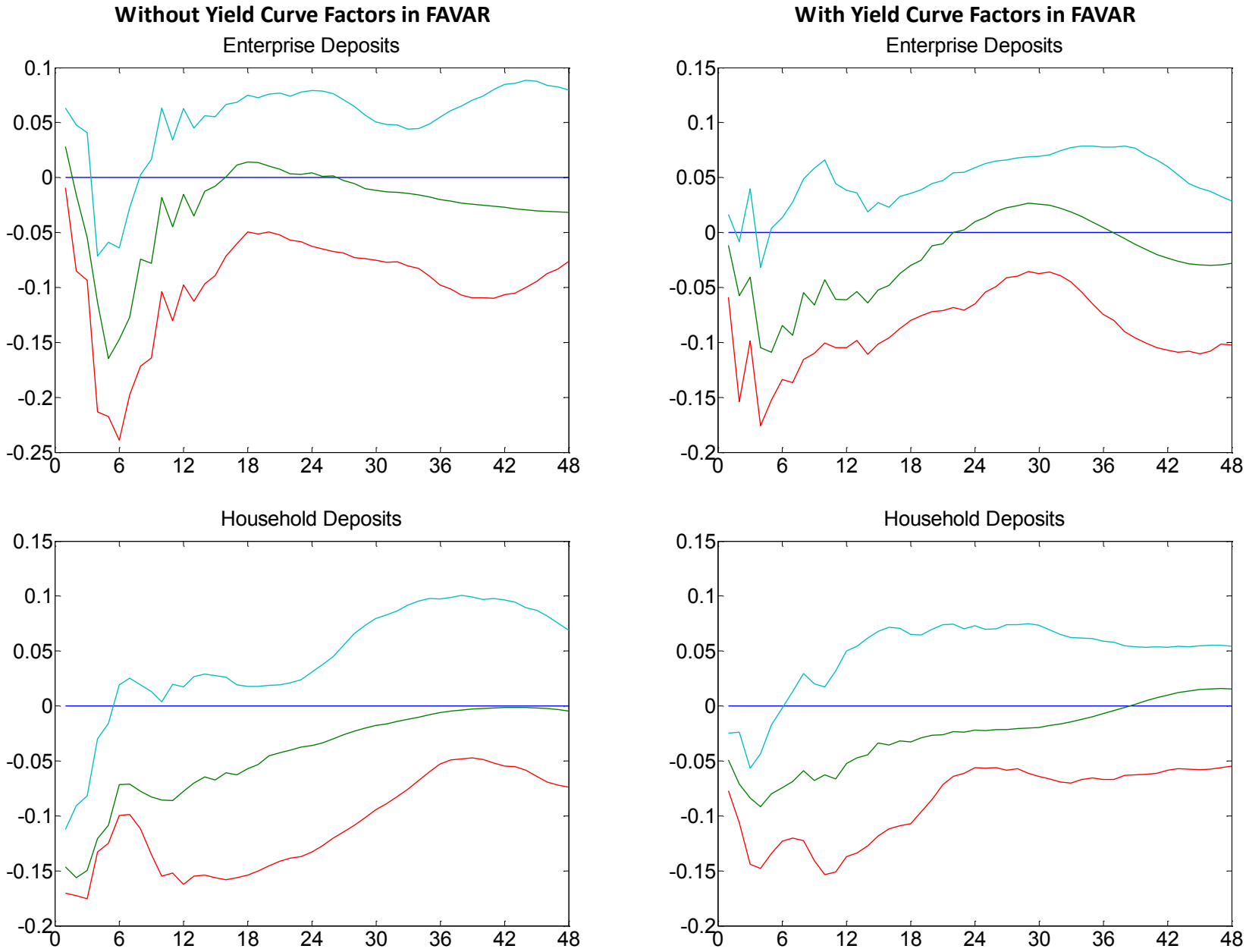


With Yield Curve Factors in FAVAR

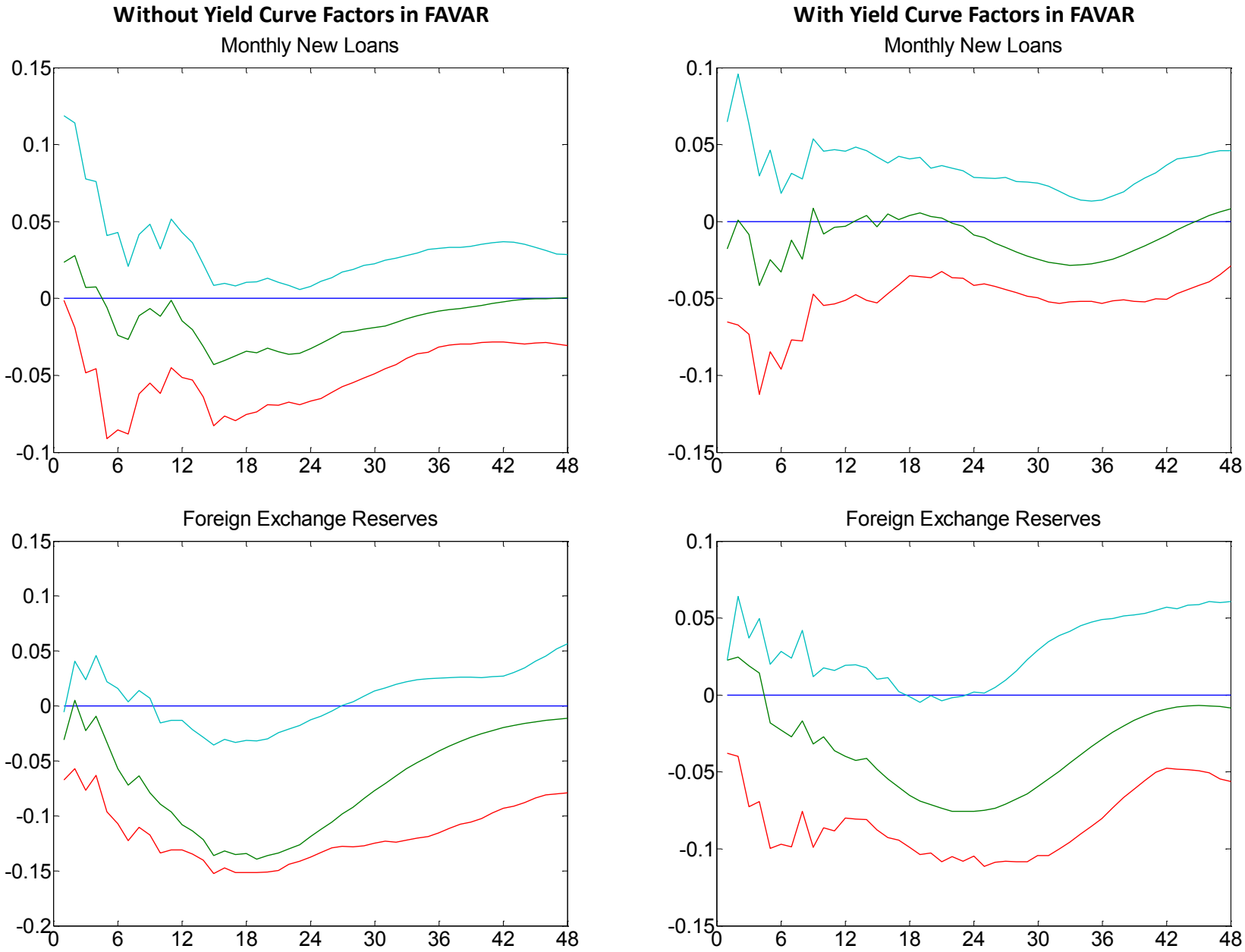




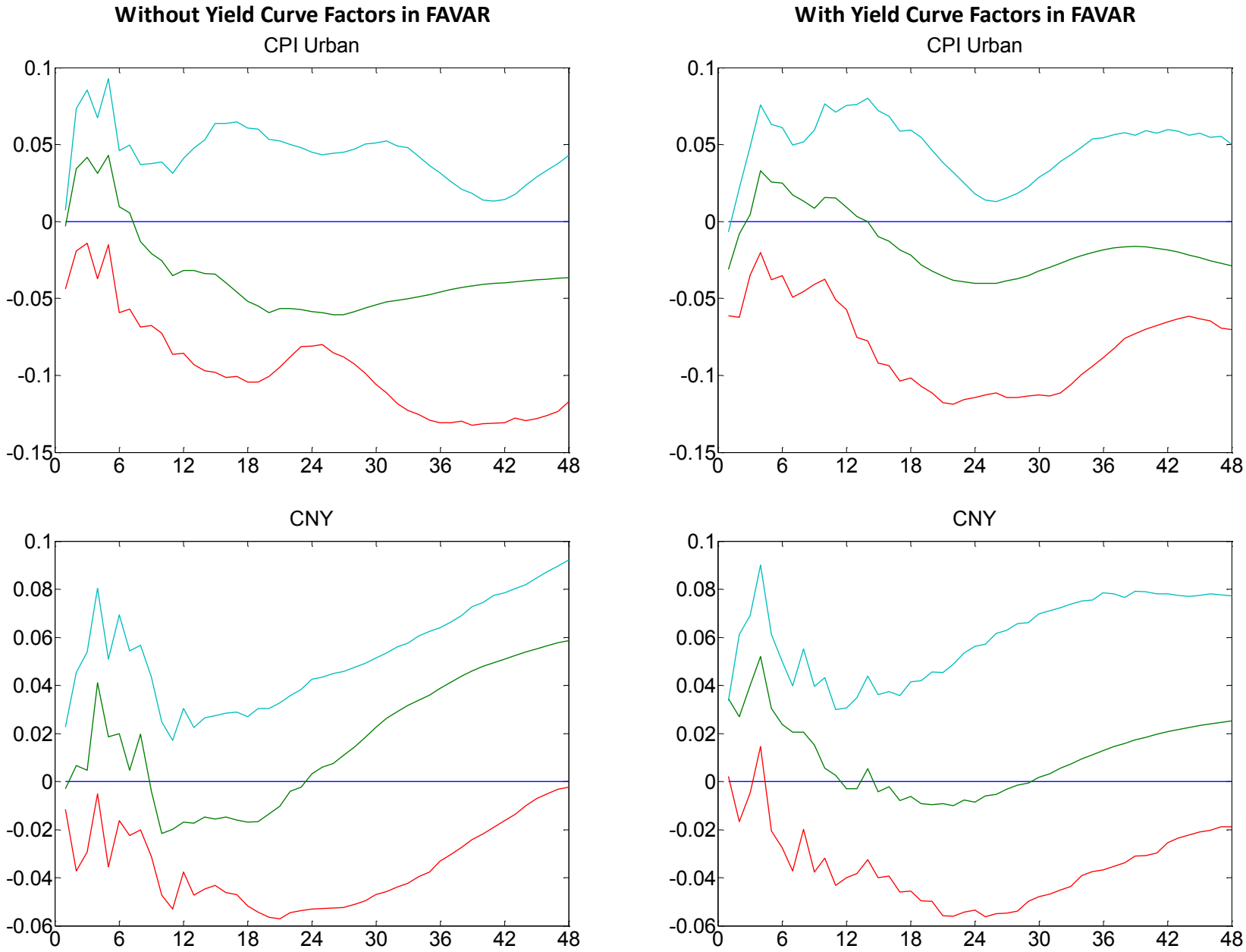
Graph 4 (Cont') Side by side comparison of IRFs with and without yield curve factors in FAVAR w.r.t. a shock of 0.09% in 1-year lending rate.



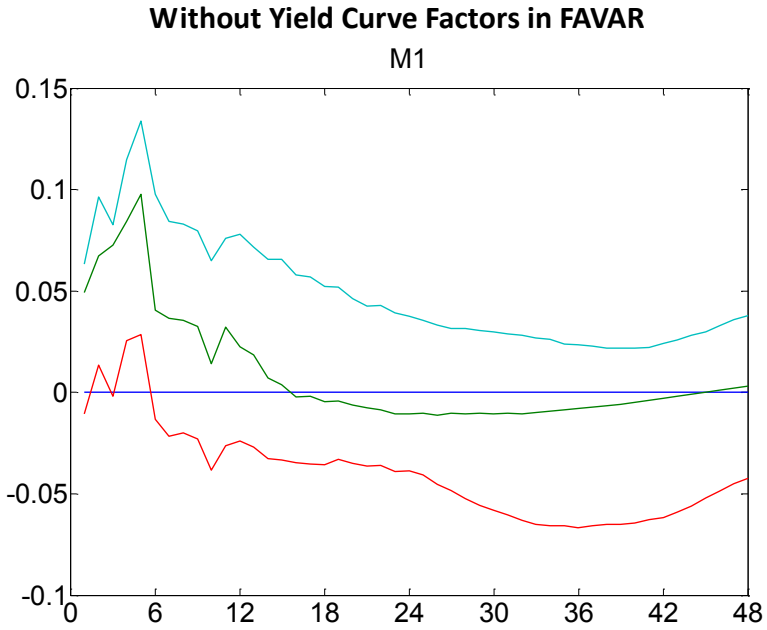
Graph 4 (Cont') Side by side comparison of IRFs with and without yield curve factors in FAVAR w.r.t. a shock of 0.09% in 1-year lending rate.

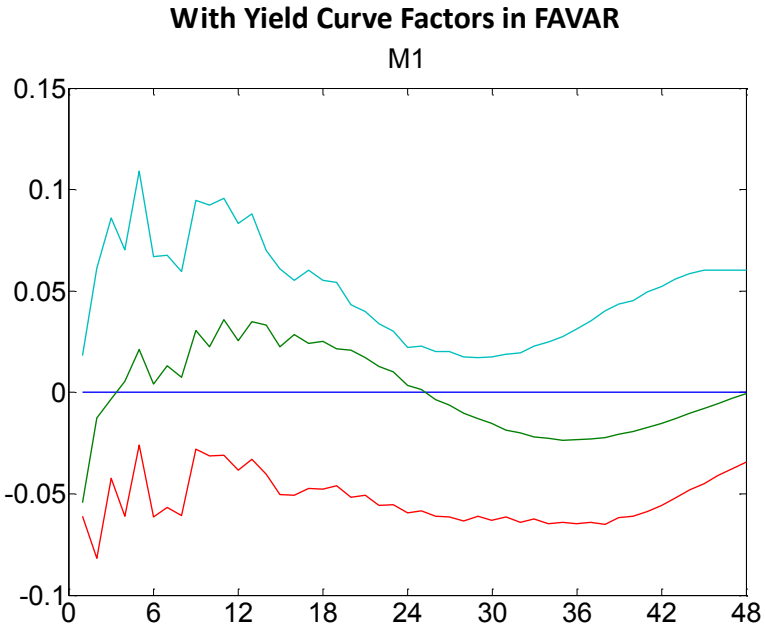


Graph 4 (Cont') Side by side comparison of IRFs with and without yield curve factors in FAVAR w.r.t. a shock of 0.09% in 1-year lending rate.



Graph 4 (Cont') Side by side comparison of IRFs with and without yield curve factors in FAVAR w.r.t. a shock of 0.09% in 1-year lending rate.





5. Policy Implications

Our results find that to effectively control the rate of inflation in the short term in China consumer expectation have to be anchor. We also find that the reserve requirement ratio is the most effective policy tool among the four policies that we have examined. The PBC could continue to use this policy to anchor consumer expectation.

However, this tool does not control inflation in long term. Although controlling the growth of money via window guidance and the price-based tool of 1-year benchmark lending rate could control inflation in long term, these tools distort market behavior, and therefore lead to inefficient capital allocation.

As financial liberalization continues in China, deregulating the commercial bank interest rate is just a matter of time. Ultimately, the PBC would not use benchmark commercial interest rates as its interest rate policy tool. However, as long as the PBC continues to control the benchmark rates, these rates continue to influence the short term rates, e.g. CHIBOR, and therefore the development of another policy rate becomes difficult under the current situation.

The PBC should consider reforming the monetary policy system towards a market-oriented system. The development in 2004 to reform the rediscount rate to a policy rate could continue. When liquidity in the banking system is tight, banks would go to the rediscount window and transaction volumes would then increase. That should increase the importance of the rediscount rate. The monetary tightening cycle has just begun; the PBC could take this opportunity to continue the reform.

6. Conclusion

In the first part of this paper, we look at the effectiveness of the four PBC monetary policies, namely the reserve requirement ratio, the growth rate of M1, the 1-year benchmark lending rate and the 1-year benchmark deposit rate, on real economic activities and inflation by including the yield curve information in our dataset. In the second part, we first extract the yield curve factors and model them as part of the policy actions in the FAVAR when the policy is the 1-year benchmark lending rate. We then compare the impulse response functions with those in the first part.

In general, we find that none of the four policies have any long term impact on real activities. A shock to the growth rate of M1, the 1-year lending rate and the 1-year deposit rate have small long term impact on CPI inflation, while a shock to the reserve requirement ratio does not have any long term impact on CPI inflation.

We also find that inflation in China is affected by household investments in asset markets in the short term and is affected by retail sales in the long term. Consumer expectation plays an important role. Among all the policy tools, the reserve requirement ratio seems to affect consumer expectation and household investment behavior in the short term the most.

After including separate yield curve factors as part of the interest rate policy, we find that the impulse

response functions in the short term become more intuitive. But there are no large differences in impulse response functions in the long term after the separate yield curve factors are added in the model.

In short, we find that the impulse response functions of tightening monetary policies in China follow largely the stylized facts that there is long run neutrality of money on real economic activities, a long term fall in inflation and a short term rise in interest rates.

The reserve requirement ratio controls the short term CPI effectively, but cannot control long term inflation. However, the control of inflation in the long term depends on window guidance and the benchmark interest rate, which are not market-oriented tools and lead to inefficient capital allocation. Thus, the PBC needs to continue to reform the monetary policy system.

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Appendix A Data Description

All series are downloaded from either Bloomberg (B) or CIEC (C). The transformation codes are: 1 – no transformation; 2 – first difference; 4 – logarithm; 5 – first difference of logarithm.

	S = slow-moving; F = fast-moving; I = policy instrument	Indicator	Transformation	Source	Ticker
Trade					
1	S	Import yoy	1	B	CNFRIMPY Index
2	S	Export yoy	1	B	CNFREXPY Index
3	S	Exports general merchandize yoy	1	C	ceic cjhca
4	S	Assembly processing trade yoy	1	C	ceic cjhcd
5	S	Imported Raw Materials for Processing Trade yoy	1	C	ceic cjhce
6	S	Imports General Merchandize yoy	1	C	ceic cjbca
7	S	Exports to Europe yoy	1	C	ceic cjfac
8	S	Exports to Asia yoy	1	C	ceic cjfaa
9	S	Exports to U.S. yoy	1	C	ceic cjfci
10	S	Imports from Europe yoy	1	C	ceic cjcac
11	S	Imports from Asia yoy	1	C	ceic cjcaa
12	S	Imports from U.S. yoy	1	C	ceic cjcag
13	S	Export Tax Rebate yoy	5	B	CHGR5 Index
14	S	Import Tax yoy	5	B	CHGR4 Index
Earnings					
15	S	Total Earnings yoy	1	B	CHLFTWGE Index
16	S	State Owned Enterprises Earnings yoy	1	B	CHLFTSTW Index
17	S	Collective Owned Enterprises Earnings yoy	1	B	CHLFTCWG Index
18	S	Other Units (private enterprise) Earnings yoy	1	B	CHLFTOTW Index
19	S	Business Tax yoy	5	B	CHGR6 Index
Retail Sales					
20	S	Retail Sales Total Value yoy	5	B	CNRSCONS Index
21	S	Local Value Added Tax yoy	5	B	CHGR2 Index
22	S	Local Consumption Tax yoy	5	B	CHGR3 Index
23	S	consumable retail sales yoy	5	C	ceic chbaa
24	S	electronic appliances retail sales yoy	5	C	ceic chaady
25	S	furniture retail sales yoy	5	C	ceic chaaed
26	S	decoration retail sales yoy	5	C	ceic chaaee

Industrial Production					
27	S	Industrial Product Value-added yoy	1	B	CHVAIOY Index
28	S	Industrial Production Sales yoy	1	C	ceic cbfo
29	S	Industrial Production Sales Light Industries yoy	1	C	ceic cbfp
30	S	Industrial Production Sales Heavy Industries yoy	1	C	ceic cbfq
Investments					
31	S	Fixed Asset Investments yoy	5	C	ceic coba cobdju
32	S	Commodity Housing Transaction Volume yoy	5	C	ceic cecb
33	S	Non-Cumulative FDI realized utilization yoy	5	C	CEIC COQCB
Sentiment					
34	F	Consumer Confidence	1	B	CHCSCONF Index
35	F	Consumer Expectation	1	B	CHCSEXPC Index
36	F	Econ-Business Cycle Signal	1	B	CNCIBCS Index
37	F	Econ-Leading Index	1	B	CNCILI Index
38	F	Econ-Coincident Index	1	B	CNCICI Index
39	S	Econ-Lagging Index	1	B	CNCILAI Index
40	F	Housing Price Index	1	C	ceic ceqbpv
Stock Prices					
41	F	Shanghai A Share Index yoy	5	B	SHASHR Index
42	F	Shanghai B Share Index yoy	5	B	SHBSHR Index
43	F	Shenzhen A Share Index yoy	5	B	SZASHR Index
44	F	Shenzhen B Share Index yoy	5	B	SZBSHR Index
Interbank Activities					
45	F	7-day repo transaction volume yoy	5	C	ceic cmocc
46	F	30-day repo transaction volume yoy	5	C	ceic cmoce
47	F	90-day repo transaction volume yoy	5	C	ceic cmocg
Interbank Rates					
48	F	7-day repo rate	1	C	CEIC CMOAB
49	F	30-day repo rate	1	C	CEIC CMOAD
50	F	90-day repo rate	1	C	CEIC CMOAF
51	F	CHIBOR 7D	1	B	IBO007 Index
52	F	CHIBOR 3M	1	B	IBO03M Index
53	F	CHIBOR7D Savings1Y spread	1	B	IBO007 - CNDR1Y
54	F	CHIBOR3M savings1Y Spread	1	B	IBO03M - CNDR1Y
Money and Credits					
55	S	Enterprises deposits yoy	5	B	CHBDENTP Index
56	S	Household deposits yoy	5	B	CHBDHH Index

57	F	Monthly New Loan yoy	5	B	CNLNNEW Index
58	S	Foreign exchange reserves yoy	5	B	CNGFOREX Index
Consumer Prices					
59	S	Rural CPI yoy	1	B	CNCPIRUR Index
60	S	Urban CPI yoy	1	B	CNCPIURB Index
Exchange Rate					
61	S	RMB against USD	1	B	CNY Curncy
Monetary Policy Instruments					
62	I	Reserve requirement ratio	1	B	CHRRDEP Index
63	I	Rediscount rate	1	B	CNDSC Index
64	I	M1 yoy	1	B	CNMS1YOY Index
65	I	Lending 1-3M	1	B	CHLR1-3Y Index
66	I	Lending 3-5M	1	B	CHLR3-5Y Index
67	I	Lending 6M	1	B	CHLR6M Index
68	I	Lending 1Y	1	B	CHLR12M Index
69	I	Lending 3-5Y	1	B	CHLR3-5Y Index
70	I	Lending 5Y above	1	B	CHLR5YA Index
71	I	Saving 3M	1	B	CNDR3M Index
72	I	Saving 6M	1	B	CNDR6M Index
73	I	Saving 1Y	1	B	CNDR1Y Index
74	I	Saving 3Y	1	B	CNDR3Y Index
75	I	Saving 5Y	1	B	CNDR5Y Index
Policy Interest Rate Spreads					
76	I	1Y Lending Deposit Spread	1	B	CHLR12M - CNDR1Y
77	I	1Y3M deposit spread	1	B	CNDR1Y - CNDR3M
78	I	1Y6M deposit spread	1	B	CNDR1Y - CNDR6M
79	I	3Y1Y deposit spread	1	B	CNDR3Y - CNDR1Y
80	I	5Y1Y deposit spread	1	B	CNDRY5Y - CNDR1Y
81	I	1Y6M lending spread	1	B	CHLR12M - CHLR6M
82	I	3Y1Y lending spread	1	B	CHLR3-5Y - CHLR12M
83	I	5Y1Y lending spread	1	B	CHLR5YA - CHLR12M