Impact of U.S. Quantitative Easing Policy on Chinese Inflation

— A Vector Autoregression Analysis Based on QE1 and QE2

by

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Abstract

This paper examines whether U.S. quantitative easing policy had significant impact on Chinese inflation. The vector autoregression model is applied to estimate the endogenous linkages between Chinese inflation and the relevant variables. The results from the impulse response functions and the variance decompositions state that quantitative easing in the U.S. had no significant effect on Chinese inflation. Instead Chinese real GDP growth and inflation inertia are the two most important determinants of Chinese inflation.

Keywords: quantitative easing, Chinese inflation, vector autoregression

I. Introduction

This paper attempts to determine whether U.S. quantitative easing policy (QE) substantially increased the inflation rate in China. The U.S. quantitative easing policy that began in 2008 was an extraordinary expansionary policy that was designed to ease credit conditions in U.S. bond and mortgage markets. These markets are integrated with other open economies. The U.S. plays a special role in the world economy. The U.S. dollar is the main international currency. Also, the U.S. has, by far, the largest world economy and financial sector. Hence, policies in the U.S. affect world output and interest rates. In relationship to China, several commenters (He 11; Li 6) have indicated that they believe that QE in the U.S. has had increased the inflation rate in China through two channels: an increase international food and energy prices as well as lower world interest rates which would put appreciation pressure on the Chinese yuan.

China has experienced a high inflation since its recovery from the 2008 financial crisis. Figure 1 below relates Chinese CPI inflation rate to the two periods of U.S. quantitative easing denoted QE1 and QE2. The first use of quantitative easing, QE1, started in November 2008 when the Chinese CPI inflation rate was dropping. QE1 continued through March 2012 and ended when the Chinese CPI inflation rate was above 2%. After that the inflation rate continued to increase and reached a peak at about 7% near the end of QE2.

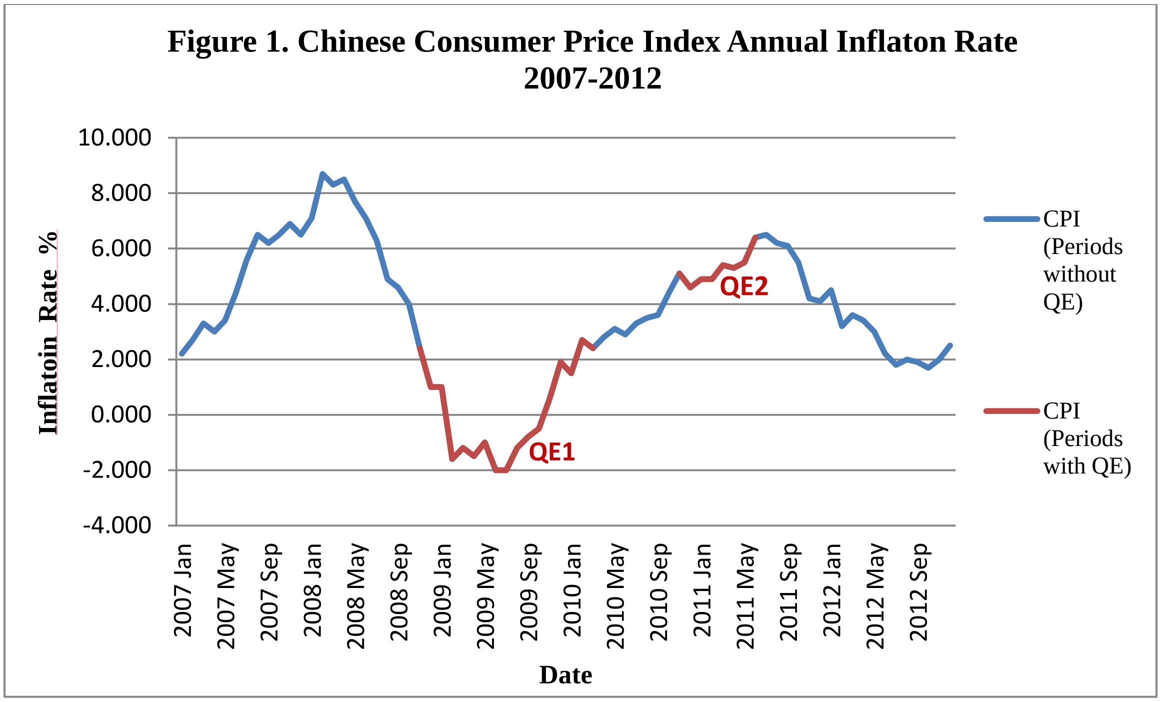


Figure 1.

Notes to Figure1. Difference colors, blue and red, are used to record the CPI in different periods. The blue line indicates the CPI inflation rate in the periods without QE while the rea line represents the CPI in the periods with QE. (Source: International Financial Statistics database in International Monetary Fund, 2013)

The timing between Chinese inflation and U.S. QE policy raise a straightforward question: do the quantitative easing policies in U.S. lead to an increase in Chinese inflation? In order to answer this question I use a Vector Autoregression (VAR) model estimate the relationship between U.S. quantitative easing policies and Chinese inflation.

A possible economic model to help understand the relationship between the U.S. quantitative easing policies and Chinese inflation is the Mundell-Fleming model. The model illustrates the relationship among an open economy’s national output, nominal interest rate, and nominal exchange rate. Moreover, the model also illustrates that it is impossible for policy makers to attain an independent monetary policy, free capital movement, and a fixed exchange rate regime at the same time within an open economy. According to the Mundell-Fleming model a quantitative easing policy would result in a capital inflow into China. To maintain the fixed exchange rate, the Chinese reserves would have to increase to accommodate the capital inflow. Alternatively, if reserves were not increased then the inflow would result in an appreciation of the yuan relative to the dollar.

However, the Mundell-Fleming model is not good enough to explain the important aspects between China and the U.S. First of all, the model assumes that price levels are constant while empirically we are explaining that why the price levels change. Second, China has changed its exchange rate policy in 2005 to “a managed floating exchange rate based on market supply and demand with reference to a basket of currencies” (Koh 1), meaning that the Chinese yuan is no longer fixed to the U.S. dollar. After the financial crisis in 2008, the Chinese yuan has appreciated about 8% against the U.S. dollar. Third, there is not an open market for capital or currencies in China; rather, the government controls both capital flows and the exchange of currencies. Fourth, the Mundell-Fleming model leaves out important factors which affecting the inflation in China.

Because the linkages between U.S. policy and Chinese inflation are complex, the approach in this paper is not to rely on a simple model, like the Mundell-Fleming model. Instead, I use a statistical approach, the VAR model, which internally estimates the endogenous linkages between the relevant variables. In particular, I extend the VAR analysis from “External Shocks and China’s Inflation” conducted by Zhang and Wang. In their paper, the authors find that external shocks coming from the changes of the U.S. interest rate, international food and oil prices have large short-term impacts on Chinese inflation. My analysis extends the model to cover the periods when U.S. QE was implanted. By looking into the influence of variables on Chinese inflation during the QE periods, I can find out whether U.S. quantitative easing had an important impact on Chinese inflation.

This paper is organized as follow: Section 2 discusses the previous literature on U.S. quantitative easing, Chinese inflation, and the VAR model. Section 3 presents the theoretical foundation of the model. Section 4 illustrates the model specification and data collection. Section 5 discusses the empirical results. A conclusion provides the limitations of the analysis and further possible development of this work.

II. Literature Review

The contribution of my paper to the literature is by using a vector autoregression model so I can quantitatively analyze the relationship between Chinese inflation and U.S. QE policies. Since it is a cross-field analysis, it is necessary to explore the literature of all three main parts of my paper: U.S. quantitative easing policies, Chinese inflation, and vector autoregression model.

U.S. Quantitative Easing

The U.S. is not the first country to implement the quantitative easing, but its quantitative easing currently has the greatest impact on the world's economy. In order to analyze how U.S. quantitative easing influences Chinese inflation, we need to know what quantitative easing is and how it works. Quantitative easing is an unconventional monetary tool used by central banks to boost the economy in situations where the other conventional monetary policies do not work. In reality the situation we have been facing since the financial crisis in 2008 is even though the fed cut the nominal interest rate all the way to zero and it was still unable to stimulate its economy sufficiently (Blinder 2). In his paper Blinder illustrates two ways in which the Fed implements quantitative easing: the Fed injects liquidity into the market by "buy[ing] risky and/or less-liquid assets, paying either by (i) selling some Treasuries from its portfolio, which would change the composition of its balance sheet, or (ii) creating new base money, which would increase the size of its balance sheet" (3).

QE indeed helps the U.S. economy to recover; however, it also brings a spillover effect to other economies. QE vastly increases the U.S. money supply, but the increased money flow cannot be digested by the domestic U.S. market. Most of the excess money brings enormous liquidity into emerging markers. In “International Spillovers of Central Bank Balance Sheet Policies,” Chen, Filardo, He, and Zhu use an event study approach to analyze the spillover effect of U.S. QE. They find that QE “lowered emerging Asian bond yields, boosted equity and commodity prices and exerted upward pressures on bilateral exchange rates against the dollar” (32). They also mention that the global asset price channel “plays a significant role” in the transmission mechanism (Chen et al. 32). Moreover, U.S. QE would lead to a global liquidity flood. In “U.S. Consumption, Investment and Global Liquidity Overflow under Quantitative Easing Monetary Policy,” Wang and Liu argue that the quantitative easing neither stimulates U.S. consumption nor investment. Instead the prices of commodities such as raw oil, food, and minerals rise markedly (8-9).

Inflation in China

One consensus view of Chinese academia is that recent inflation pressure in China is caused by soaring production costs and imported inflation (Chen and Gu 1). Imported inflation recently became a popular explanation of Chinese inflation. In “Analysis of the Imported Inflation Pressure on China’s Price Level,” Yao uses the Granger test to analyze the relationship among the monthly CRB international commodity price index, the Chinese domestic producer price index, and the Chinese consumer price index since 2007 (1-4). She notes that a 1% change in the international food price index, the energy price index, and the industrial material price index would respectively lead to a 0.021%, 0.0096%, and 0.003% change in the Chinese consumer price index. She concludes that Chinese growth pattern relies heavily on foreign trade, and that international commodity prices significantly impact Chinese domestic price levels (Yao 1-4). Similar results are shown by Liu and Yan (11). In their paper "Is Chinese Inflation Imported?" Liu and Yan argue that the rise of international oil and food prices raise the cost of production for domestic Chinese products (1-16). By using a VAR model they find that in the 10-month-lag period, foreign factors contribute more than 30% of the CPI's composition while less than 10% of the CPI decomposition comes from domestic factors (11).

After the U.S. announced its QE1, Chinese academic literature expressed concern about the role of QE in Chinese inflation. However, the majority of the literature is focused on the theoretical approach — few use an empirical approach. In his paper "The Impact of Quantitative Easing on the Emerging Economies and China's Strategy," Li examines the impact of quantitative easing from a theoretical and literary approach (1-6). Li concludes that QE policy in developed countries "reduce bond yields, promote the appreciation of currencies, [and] increase the inflation to the emerging economies" (6). He also suggests that China should "improve RMB exchange rate formation mechanism, reinforce the supervision of international capital flows, and adjust deposit reserve ratio" to combat the negative influence of U.S. QE (6). The paper "Impacts of American Quantitative Easing Monetary Policy on China's Inflation" written by He in 2012 is one of the few that analyze the relationship between quantitative easing and China's inflation through an empirical approach. In his paper He uses a EG cointegration test to examine the relationship between the Chinese imported price index and its consumer price index from January 2009 to December 2011 (8-10). He finds that QE in the U.S. would increase international commodity prices, which would increase Chinese production costs and lead to an imported inflation (10).

Vector Autoregression Model

The vector autoregression (VAR) model was introduced by Christopher Sims in 1980, and it is a model that deals primarily with macroeconomic data. Essentially, the VAR model can be described as an extension of a univariate autoregression model. In their paper "Vector Autoregressions," Stock and Watson define the VAR model as "an n-equation, n-variable linear model in which each variable is in turn explained by its own lagged values, plus current and past values of the remaining n-1 variables" (1).

The VAR model is very powerful in data description and forecasting. Because data analysis in macroeconomics includes endogeneity problems, the adoption of VAR can solve these problems, and determine the dynamic relationship among the multiple time series. The paper "External Shocks and China's inflation" written by Zhang and Wang is an example of how adopting the VAR model can explain Chinese inflation. In their paper Zhang and Wang define fluctuations from international food prices, oil prices, international interest rates, Chinese real exchange rate, and Chinese official reserves as external shocks that affect Chinese inflation (11). Through a VAR model, they analyze whether Chinese inflation inertia, real GDP, and external shocks have large impacts on Chinese inflation. Through impulse response functions and variance decomposition the authors show the following results:

1. GDP growth and inflation inertia is the largest determinant of Chinese inflation;
2. International commodity prices play a significant role in Chinese inflation;
3. Global interest rates affect Chinese inflation, though it is not that important as the previous two factors. (Zhang and Wang 14-16)

My paper will extend the VAR analysis in “External Shocks and China’s inflation” by Zhang and Wang, and cover the data to the periods when quantitative easing is employed. By comparing the results I can determine whether quantitative easing has significant impact on Chinese inflation.

The contributions of my paper to the literature are as follows: first, I can quantitatively examine the relationship between quantitative easing and Chinese inflation by using a VAR model; second I can sort out in what way the effect of quantitative easing transmits into China’s economy. Third, I can separate the QE1 and QE2 in my model and try to see if they have different impacts on China’s inflation.

III. Theoretical Foundation

Transmission mechanisms are varied and complicated. Before examining the transmission mechanisms in which the effect of QE introduces into China, we must first ascertain the consequences of QE. First, by implementing QE, the U.S. Fed injects large liquidity into the market. However, the domestic market cannot accommodate such large money flow. As we can see during the first period of quantitative easing (QE1) the Fed had already bought back about $1 trillion mortgage-backed securities (Federal Reserve Cleveland) while the U.S. money stock M2 only increased about $550 billion dollar. The excess money would flow out the U.S. market and into the global market. Second, increasing the money supply brings appreciation pressure to currencies that are pegged to U.S. dollar, such as Chinese yuan, and we saw that yuan actually appreciate against the U.S. dollar during the second round of quantitative easing (QE2). Third, QE substantially affects international commodity prices as indicated by Figure 2. Based on the three consequences above we can sort out three possible ways how quantitative easing affects China's inflation.

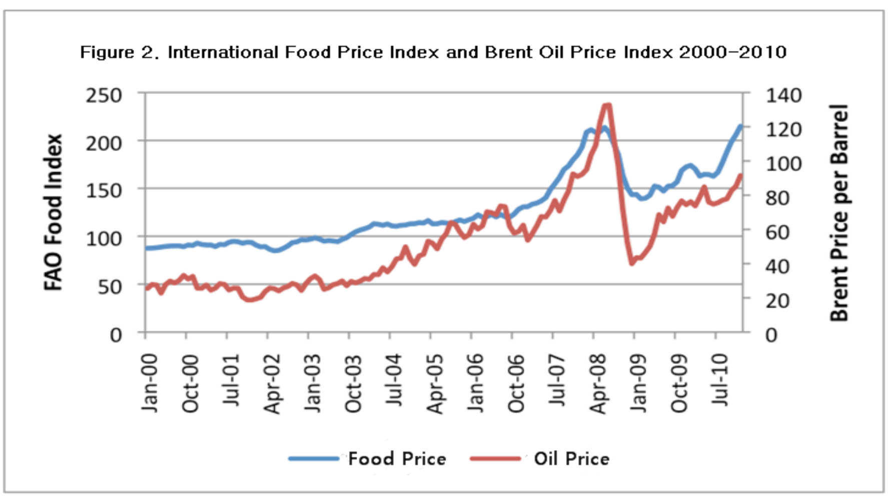


Figure 2.

Notes to Figure 2. International food and oil price dropped significantly after the financial crisis in 2008. The prices bounced back quickly during the period of QE1 and QE2. (Sources: Business Insider)

From Capital Inflow

After the financial crisis the Fed has lowered the federal fund rate to 0-0.25% while Chinese discount rate was about 4%. Such a difference in interest rate would attract floating money from U.S. to China for seeking higher return. By adopting the IS-BP-LM model we can see how capital inflow affects China's inflation (Zhou and Zhu 4). Figure 3 below shows the analysis through the IS-BP-LM model. The intersection of the red lines (IS, BP, LM) represent the original equilibrium (point A) in the model. Given an exogenous capital input, there is an increase in the balance of payment. The BP curve shifts to the right (becoming line BP' in the graph). The balance of payment surplus increases the money supply and shifts the LM curve to the right (LM') until they all intersect at the new equilibrium (point B). Because Chinese central bank was not sterilizing the effect on the interest rate, we can see that discount rate in China during QE1 has lower from 4.14% to 2.79%. As the LM curve shifts to the right, aggregate demand shifts up and pushes up the price and real output level of the economy.

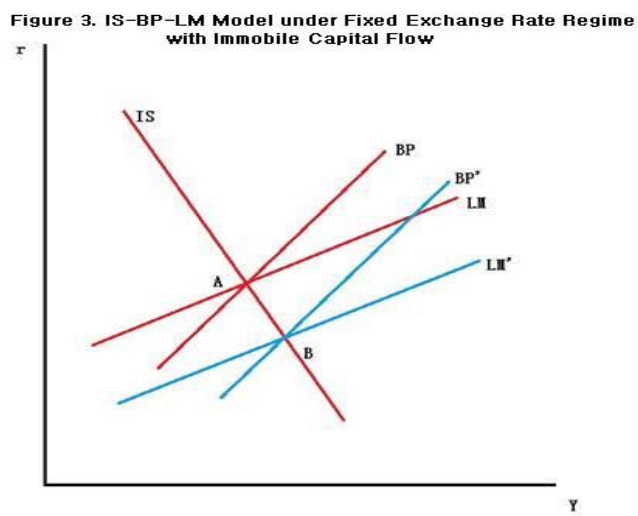


Figure. 3
Notes to Figure 4. Chinese yuan is pegged to the U.S. dollar; therefore we can assume China is under a fixed exchange rate regime. China strictly controls its capital flow; therefore its BP curve is steeper than its LM curve.

From Cost Push

Gordon's triangle model of inflation states that the "rate of inflation depends on inertia, demand, and supply" (Gordon, 1990). Therefore, when the cost of supply increases, inflation increases. Figure 4 gives an intuitive perception of how imported goods affect Chinese production and consumption. It alsoshows the relationship between the Chinese imported price index (IMPI), producer price index (PPI), and consumer price index (CPI). First, it is important to notice that these three price indices are positively correlated. Second, they change in the same direction. Third, in terms of time, the IMPI always moves prior to PPI, and the PPI move ahead of CPI. Figure 4 illustrates that China's inflation is largely affected by imported goods. As mentioned above, QE increases international commodity prices, and the increase can transmit to Chinese inflation through production costs.

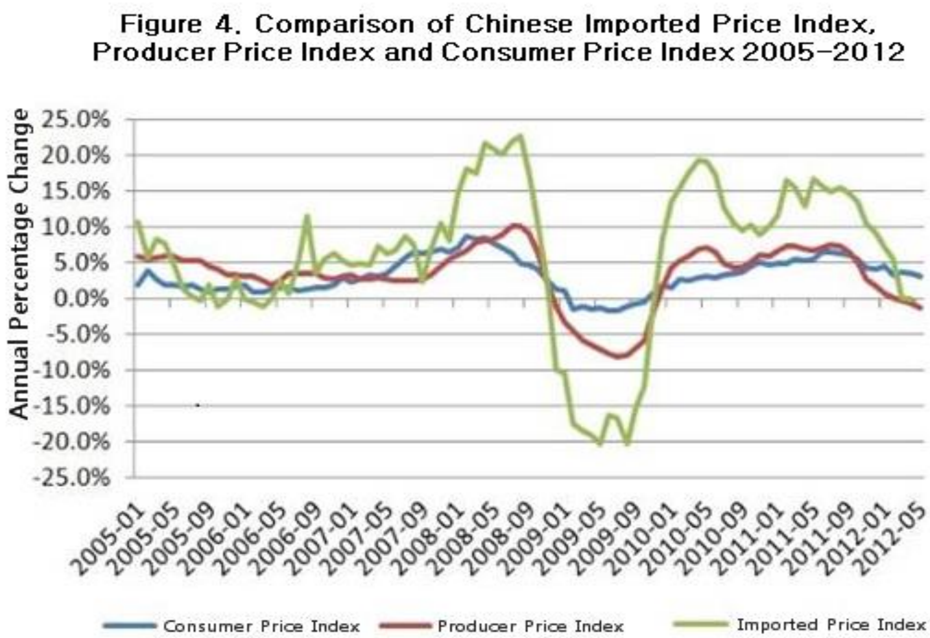


Figure 4.
Notes to Figure 4. Difference colors are used to record different price index. The blue line is Chinese consumer price index. The red line if Chinese producer price index. The Green line is Chinese imported price index. (Source: Zhang 1)

Through Pegged Exchange Rate Regime

The exchange rate between Chinese yuan and U.S. dollar has been relatively stable regardless of the exchange rate reform in 2005. The Chinese central bank wants to maintain a nominal anchor between the Chinese yuan and U.S. dollar, and this requires the Chinese central bank to store a lot of foreign exchange reserve. By storing foreign exchange reserves, the Chinese central bank needs to buy foreign government bonds with its domestic currencies. The transactions would increase the money in circulation and increase inflation. Because QE has imposed great appreciation pressure on the Chinese yuan, the Chinese central bank continues to increase its foreign exchange reserves to combat the pressure. Figure 5 below shows the details of China's foreign exchange reserve from 2007 to 2011. It also outlines that Chinese foreign exchange reserves increased from about $1.3 tillion to $3.3 trillion, about 2.5 times, in 5 years. Therefore, by keeping appreciation pressure on Chinese yuan, U.S. QE affect the Chinese inflation through an exchange rate regime channel.

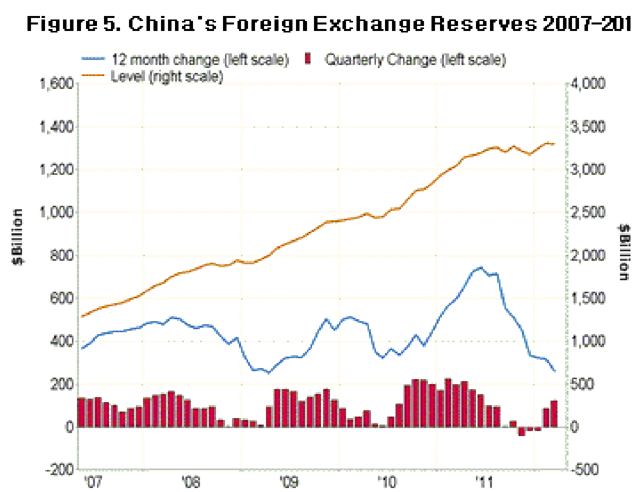


Figure 5.
Notes to Figure 5. The orange line is the level (in $billion) of Chinese foreign exchange reserves. The blue line is the 12 month change (in $billion) of the reserves. The red bars are the quarterly change of the reserves. (Source: Davies 1)

IV. Model Specification and Data Processing

Figure 6. Model Specification

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + B x_t + \epsilon_t$$

Where:
y_t is a k vector of endogenous variables;
x_t is a d vector of exogenous variables;
ϵ_t is white noise.

The equation specified in Figure 6 represents the VAR model that is estimated in my paper. It is in the vector form. One of the advantages of the VAR model is that it can deal with the endogeneity problem that the simple OLS model cannot.

Based on the theoretical foundation I provide in the last section and to be consistent with the literature, those endogenous variables include: the Chinese annual CPI rate (CPI), the annual growth rate of Chinese real GDP (GDP), the annual growth rate of International oil price index (OP) and food price index(FP), the Chinese real exchange rate (RER), the annual growth rate of Chinese official reserves assets (FER), the Chinese one-year discount rate (IR), and the annual growth rate of U.S. M2 (M2), eight endogenous variables in total.

In addition to the endogenous variables I also used two dummy variables, QE1 and QE2, to specify the different periods of QE. They are specified as followed.

$$QE1_t \begin{cases} 1 & if\ it\ is\ in\ QE1\ periods \\ 0 & otherwise \end{cases} ; \quad QE2_t \begin{cases} 1 & if\ it\ is\ in\ QE2\ periods \\ 0 & otherwise \end{cases}$$

The reason why I separate QE1 and QE2 is because the measures that the U.S. Fed used during the two periods are different. First, different amounts of money were spent by the Fed in each period. During QE, the Fed spent about $1.25 trillion while in QE2 they spent only $600 billion (FOMC Statement). Second, the QE periods were different length. QE1 lasted for 17 months, from November 2008 to March 2010, while QE2 lasted 8 months, from November 2010 to June 2011 (FOMC Statement). Third, the targets are different. QE1 was mainly targeted towards mortgage markets, buying back mortgage-backed securities and injecting liquidity into the U.S. domestic market. QE2 was focused on long-term treasuries which are similar to a normal open market operation, and its purpose was to lower the long-term yield curve (FOMC Statement).

The variable data was collected from three reliable databases: the International Financial Statistics database from International Monetary Fund, the Oxford Database, and the Federal Reserve Economic Data database. The frequency of the data is in quarters. Time-range is from 1994Q1 to 2012Q4. Table 1 in the Appendix specifies the details of the data and variables.

Before estimating the model some adjustments and tests have to be done. First of all, we need to check for seasonal trends. Variables such as GDP, FP, and OP show obvious seasonal trends and a seasonal adjustment must be implemented. Besides the seasonal adjustment, a stationary test has to be done for every variable. Non-stationary time series would produce inconsistent estimators and lead to a spurious regression. Therefore an Augmented Dickey-Fuller test is conducted on every variable, and all the variables pass the stationary test. Table 2 in the Appendix provides details about the stationary test.

V. Empirical Results

In my paper, two models have been estimated. One is estimated without QE1 and QE2 dummy variables, which I called the X model. The second model is estimated with the two dummy variables, which I called the Y model. By comparing the results from the two models, I can determine whether QE in the U.S. has a significant impact on China's inflation rate.

The X model

By adopting a VAR model, we will focus on the results from two different approaches. The two approaches are the impulse response functions and forecast error variance decompositions (Stock and Watson, 2001). The impulse response function essentially states the relationship between two variables. If there is a one-standard-deviation shock to the error term of the variable y_s, then the shock influences both the current and future value of the variable y_t through y_s. It is assumed that "this error returns to zero in subsequent periods and that all other errors are equal to zero" (Stock and Watson, 2001). Therefore, by analyzing the impulse response function, we can observe how changes in y_s affect y_t for a set period of time.

Figure 7 shows the impulse response functions of CPI to the different variables used in the estimation of the X model.

Figure 7. Impulse Response Function of CPI

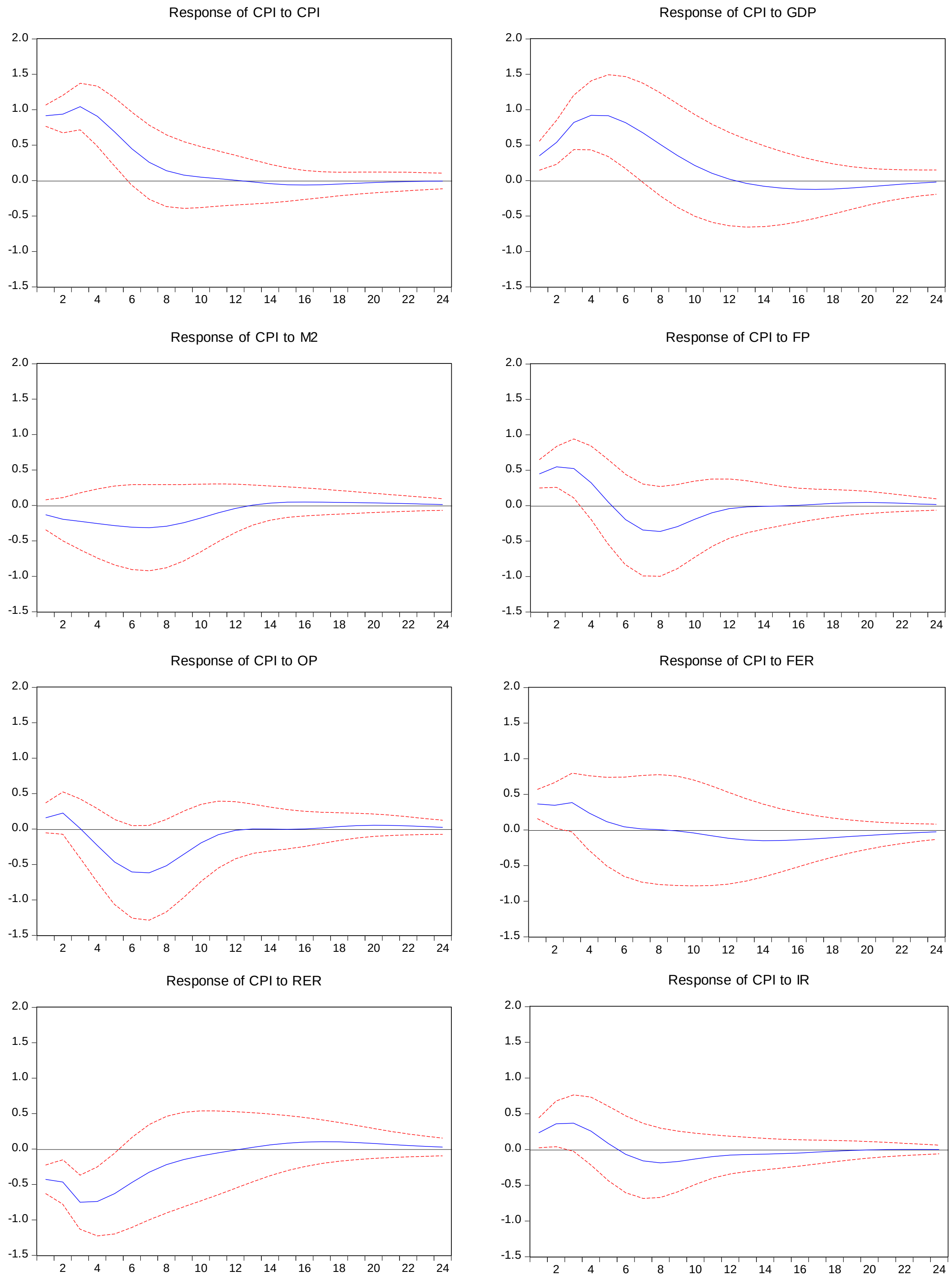


Figure 7

Notes to Figure 7. There are generalized one standard deviation innovation response functions. The y-axis of each graph is the standard deviation change of CPI. The x-axis is the time (in quarter). The blue line in each graph is the impulse response function. The red lines are the 95% confidence interval.

How should we interpret the impulse response function? Let us take the response function for CPI to GDP as an example. A one-standard-deviation shock to the Chinese real GDP growth rate would positively affect the CPI and cause the CPI to increase by its 0.35 standard deviation. The increase of CPI reaches a peak of 0.92 its standard deviation at 4 periods after the shock. This means that a shock in Chinese real GDP growth rate has the largest impact on CPI 1 year after the shock. After a year, the response function of CPI decreases and gradually turns into a negative response 12 periods after the shock (three years in the future). Eventually the response dies out along the line y=0 (a feature of a stable VAR model). It is important to notice that the 95% confidence interval of the response function intersects the line y=0 at period 7. That means from period 7 onwards, we can treat the response of CPI to real GDP growth rate as statistically insignificant. That is to say, statistically speaking, the real GDP growth rate has no effect on CPI after 7 periods. Since the response is significant before period 7 and is positive, we can conclude that Chinese real GDP growth rate has a positive impact on Chinese inflation rate. We can also conclude that the impact is large since the response of CPI is from 0.35 to 0.92 of its standard deviation. By analyzing the other graphs, we can make several conclusions as follows:

1. Inflation inertia positively affects inflation significantly. The influence dies out from the 6^{th} quarter.
2. The growth rate of U.S. M2 has a negative effect on Chinese inflation rate at the very beginning and turns to a positive effect from the 13^{th} quarter. However, the effect is statistically insignificant.

3. The growth rate of International food prices positively affects Chinese inflation rate while the growth rate of oil prices do not.
4. Increasing more foreign exchange reserve would increase Chinese inflation rate, but an increase in Chinese real exchange rate would help to control the inflation.
5. An increase in the Chinese discount rate would have a small positive effect on Chinese inflation but the effect dies out very quickly (in 2 quarters).

In addition to the impulse response functions, the forecast error variance decompositions method is used in the paper to analyze the effect of each variable on Chinese inflation rate. The impulse response function is mainly about the interaction of two variables while the variance decompositions tell how each variable interacts with a particular variable at a set time. Stock and Watson (2001) define the forecast error decomposition as "the percentage of the variance of the error make in forecasting a variable due to a specific shock at a given horizon". They suggest we can treat the decomposition as "a partial R^2 for the forecast error" (Stock and Watson, 2001). Figure 8 below shows the forecast error variance decomposition of CPI up to period 8.

Figure 8. Forecast Error Variance Decomposition of CPI (Model X)

Period	CPI	Chinese Real GDP	U.S. M2	International Food Prices	Internation Oil Prices	Chiense Foreign Exchage Reserves	Chinese Real Exchange Rate	Chiense 1-year Disount Rate
1	*61.87187*	*13.15788*	*2.076331*	*22.63862*	*0.255302*	*0*	*0*	*0*
2	*49.06363*	*20.77623*	*3.093156*	*26.09732*	*0.172467*	*0.315529*	*0.02936*	*0.452312*
3	*37.01916*	*30.6931*	*3.173595*	*21.57868*	*2.41852*	*1.382826*	*3.357786*	*0.376332*
4	*28.33636*	*35.9315*	*3.320693*	*15.60644*	*6.022912*	*4.188313*	*6.342022*	*0.251763*
5	*22.32418*	*37.81733*	*3.550859*	*11.34786*	*10.17601*	*6.962607*	*7.599436*	*0.221724*
6	*18.45544*	*37.5967*	*3.890041*	*9.693782*	*13.73073*	*8.756969*	*7.578556*	*0.297778*
7	*16.11704*	*36.59252*	*4.296296*	*9.781913*	*16.04874*	*9.608*	*7.140785*	*0.414705*
8	*14.84357*	*35.63732*	*4.688765*	*10.40072*	*17.17803*	*9.941695*	*6.784318*	*0.525588*

Figure 8.
Notes to Figure 8. Cholesky ordering is: M2 FP OP GDP CPI FER RER IR. The ordering is from most exogenous to endogenous. Figures in Figure 8. are in percentages.

By using the variance decomposition, we can tell which variable is important to Chinese inflation. For example, in period 1, inflation inertia explains about 62% of the inflation change, Chinese real GDP growth rate contribute 13% to the change, and the growth rate of International food prices accounts for 23% of the change. As we can see as time goes on, the important of inflation inertia decreases. The proportion of Chinese real GDP growth rate, growth rate of foreign exchange reserves, and real exchange rate increase instead. However, the growth rate of U.S. M2 explains a very small part, no more than 5%, in Chinese inflation, and this result is consistent with the impulse response functions' result above. It is important to notice that even though the discount rate is significant in the analysis of impulse response functions, it contributes the smallest part in Chinese inflation (less than 1%).

The results from the X model are quite consistent with the literature and the theories. In the next section I add QE1 and QE2 dummy variables and estimated the Y model.

The Y model

By added two dummy variables QE1 and QE2 I can specify the effect caused by U.S. QE. Through a comparison with the results from the X model, I can determine whether QE1 and/or QE2 have substantial impact on Chinese inflation. Figure 9 below compares the impulse response functions of CPI to U.S. M2 with and without QE dummies.

Figure 9. Comparison of Impulse Response Functions

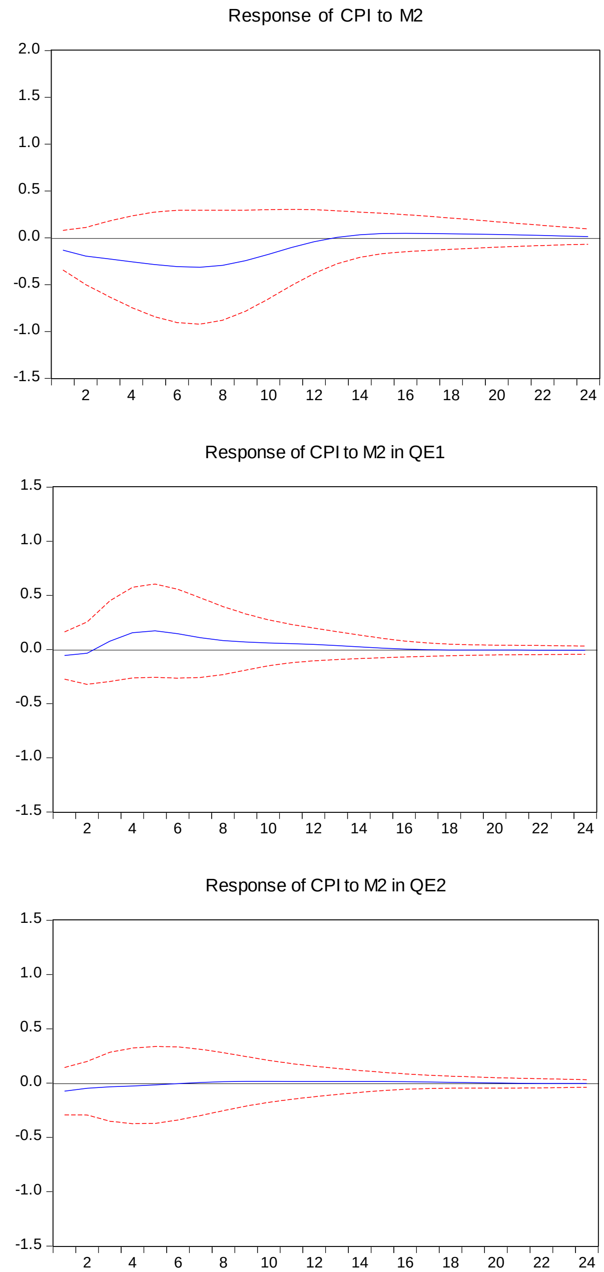


Figure 9.

Notes to Figure 9. Three impulse response functions are shown in Figure 9. The top one is the response of CPI to M2 without QE dummies, which is from the X model. The middle one is the response of CPI to M2 in QE1 (with QE1 dummy), which is from the Y model. The bottom one is the response of CPI to M2 in QE2 (with QE2 dummy), which is from the Y model. Other impulse response functions are shown in Figure A1 in the Appendix.

There are some important findings from Figure 9. First, by adding the QE1 and QE2 dummy variables into the model, the negative effect from the growth rate of U.S.

M2 to Chinese inflation rate have been offset in both the response functions from the Y model. Second, the response of CPI to M2 in QE1 actually has a positive effect to Chinese inflation from the 2nd quarter. The positive effect continues until it dies out. Thrid, unfortunately both the response functions from Y model are statistically insignificant which means the effects of QE1 and QE2 are negligible to Chinese inflation.

Forecast error variance decomposition is employed in model Y to see the effects of both QE1 and QE2. Figure 10 below shows the results up to 8 periods.

Figure 10. Forecast Error Variance Decomposition of CPI (Model Y)

Period	CPI	Chinese Real GDP	U.S. M2	U.S. M2 in QE1	U.S. M2 in QE2	International Food Prices	International Oil Prices	Chinese Foreign Exchange Reserves	Chinese Real Exchange Rate	Chinese 1-year Discount Rate
1	57.23471	10.9538	1.718877	0.022182	1.213415	28.63954	0.217472	0	0	0
2	45.54022	17.75428	1.773564	0.018611	0.920545	32.87532	0.169616	0.231365	0.010519	0.705953
3	33.55238	27.17994	1.713676	0.575419	0.70117	28.43989	2.449805	0.85796	3.662342	0.867421
4	25.10129	31.3725	1.748834	1.374817	0.610976	23.68502	5.749797	2.923451	6.696038	0.73728
5	19.78207	32.46529	1.912076	1.974598	0.568895	19.79862	9.833997	5.292241	7.817572	0.554642
6	16.68097	32.12865	2.215323	2.305395	0.546372	17.11235	13.64331	7.274189	7.58134	0.51209
7	14.91674	31.40795	2.641665	2.499787	0.539199	15.43675	16.36387	8.601307	7.007704	0.585028
8	13.93605	30.77542	3.158122	2.662402	0.544364	14.47562	17.77322	9.400535	6.578927	0.695336

Figure 10.
*Notes to Figure 10. Cholesky ordering is: M2 M2*QE1 M2*QE2 FP OP GDP CPI FER RER IR. The ordering is from most exogenous to endogenous. Figures in Figure 10. are in percentages.*

Through the variance decomposition, we can see that both the contributions from the growth rate of U.S. M2 in QE1 and QE2 do not substantially increase. Instead they are less important in explaining China’s inflation rate.

By estimating the Y model we can draw a couple conclusions. The first being, that even though QE1 has positive effect on Chinese inflation, it is statistically insignificant in the impulse response function. QE2 also proves to be statistically insignificant in the impulse response function. The other main conclusion is that, both QE1 and QE2 have smaller contribution to the variance of Chinese inflation in the variance decomposition. Based on the above findings, I would conclude that both QE1 and QE2 have no significant impact on Chinese inflation.

VI. Conclusion

In this paper I estimated two VAR models (X and Y model) about Chinese inflation. By adding two dummy variables, QE1 and QE2, into the X model, the Y model is used to estimate the impact of the U.S. QE on Chinese inflation. By analyzing the results from the X and Y model, some important conclusions are drawn.

First of all, U.S. QE had no significant impact on Chinese inflation rate. Even though from the Y model we see that QE1 has a positive effect on Chinese inflation rate, the effect is statistically insignificant. The effect of QE2 on Chinese inflation rate is negative and quite close to 0. Same as QE1, the effect of QE2 is statistically insignificant. Moreover, the variance decomposition tells that the contributions QE1 and QE2 to Chinese inflation are actually pretty small.

Second, inflation inertia and Chinese real GDP growth play important roles in Chinese inflation. Inflation inertia is the biggest factor in explaining Chinese inflation within the first three quarter. Even though its importance decreases over time, it still largely affects the future inflation. Chinese real GDP growth is the most significant element in determining Chinese inflation. This is quite consistent with the literature and economic theories. A rapid real output growth increases demand of the economy. An increase in demand pulls up the inflation.

Third, external shocks coming from international food prices still largely affect Chinese inflation. China is a large country with a huge population. Food is highly demanded in China. Therefore an external shock would substantially affect Chinese inflation through a cost-push channel.

Forth, Chinese foreign exchange rate and reserve policies influence Chinese inflation to a certain extent. The response function of CPI to RER in Table A1 tells us that increasing real exchange rate would help to control the inflation in China. Similarly, increasing more foreign exchange reserves would aggravate the inflation. The Chinese central bank needs to make a balance when determining its policies.

Limitations and Implications for Future Research

There are several limitations inherent in this paper. For instant, variables such as the Chinese real exchange rate, the official reserves, and the discount rate may not complete capture the whole effect from Chinese policies. For the same reason, the variable U.S. M2 may not capture the whole effect of U.S. QE. The second limitation is that China actually has control of its monetary policies and reserves policies. Imported inflation into China might be determined to a curtained extent by Chinese central bank's policies. One possible evidence to support this is that during QE1 the central bank of China fixed the exchange rate at 6.8 yuan/U.S. dollar while in QE2 the central bank let it drop to 6.3 yuan/U.S. dollar. Letting the exchange rate appreciate would harm Chinese GDP growth, but considering the high inflation rate in QE2, the Chinese central bank might choose to control inflation at the cost of a slow output growth.

Since that U.S. M2 may not capture the whole effect of U.S. QE, one may try to use the dollar amount of change in MBS and 10-year long-term treasuries as proxies of QE1 and QE2 respectively in the future research. Moreover, one might use this VAR model and try to use the Johansen cointegreation test to find a long-term relationship between these variables and form a central bank equation of the Chinese central bank during QE periods.

Appendix

Table 1. Details of Variables and Sources

Variable	Abbreviation	Source:
Chinese Anuual CPI Rate	CPI	International Financial Statistics Database
Chinese Real GDP Annual Growth Rate	GDP	Oxford Database
Annual Grwoth Rate of International Oil Price Index	OP	International Financial Statistics Database
Annual Grwoth Rate of International Food Price Index	FP	International Financial Statistics Database
Chinese Real Exchange Rate	RER	International Financial Statistics Database
Annual Growth Rate of Chiense Official Reserves Assets	FER	International Financial Statistics Database
Chinese One-year Discount Rate	IR	International Financial Statistics Database
Annual Growth Rate of U.S. M2	M2	Federal Reserve Economic Data Database

Table 2. Stationary Test of Variables

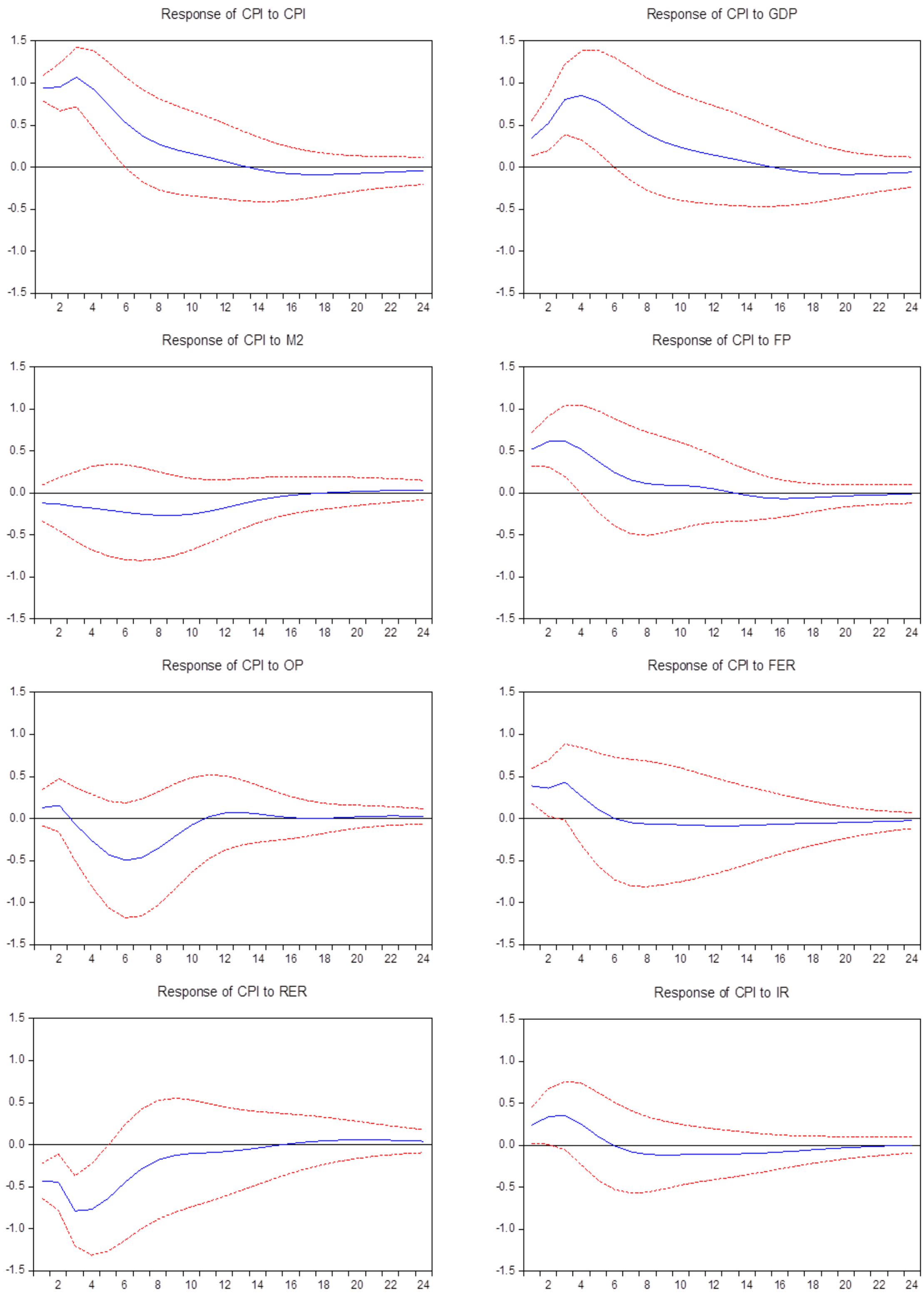
Variable	Level (ADF Test)
CPI	0.0013*
GDP	0.0627***
OP	0.0028*
FP	0.0000*
RER	0.0023*
FER	0.0607***
IR	0.0021*
M2	0.0093*

* indicates a 1% Significant Level

** indicates a 5% Significant Level

*** indicates a 10% Significant Level

Figure A1. Other Response Functions in Model Y



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