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Asset Price, the Exchange Rate, and Trade Balances in China: A Sign Restriction VAR Approach*

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Although asset price is an important factor in determining changes in external balances, no studies have investigated it from the Chinese perspective. In this study, I empirically examine the underlying driving forces of China's trade balances, particularly the role of asset price and the real exchange rate. To this end, I estimate a sign-restricted structural vector autoregressive model with quarterly time series data for China, using the Bayesian method. The results show that changes in asset price affect China's trade balances through private consumption and investment. Also, an appreciation of the real exchange rate tends to deteriorate trade balances in China. Furthermore, forecast error variance decomposition results indicate that changes in asset price (stock price and housing price) explain about 20% variability of trade balances, while changes in the real exchange rate can explain about 10%.

Keywords: Stock Price, Housing Price, Real Effective Exchange Rate, China Trade Balance, Sign Restriction VAR
JEL Classification: C32, F14, F41

I. INTRODUCTION

What are the driving forces behind China's external balances? This question has been the topic of frequent discussion since China joined the World Trade Organization (WTO). Recently, there is a renewed focus on it, as US President Donald Trump has blamed China's huge trade surplus against the United States. Moreover, several

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policymakers, politicians, and economists have debated the causes and consequences of China's huge trade surplus.

This study attempts to figure out the causes behind the fluctuations in China's trade balances. To this end, I estimate a structural vector autoregressive (SVAR) model with reasonable sign restrictions and quarterly data for China, using the Bayesian method. This study focuses on the role of asset price, particularly stock price and housing price, and the real exchange rate, as determinants of changes in China's trade balances.

According to studies such as Fratzscher, Juvenal, and Sarno (2010), asset price is an important source of fluctuations in trade balances. Their results reveal that asset price (stock price and housing price) can explain about 30% variability of trade balances in the US; however, the real effective exchange rate can explain less than 10%. China's asset market has rapidly grown since the early 2000s. For example, World Bank data reveal that stock market capitalization to GDP ratio doubled from 26% in 1999 to 64% in 2015. Moreover, the housing price index constructed by Wu, Gyourko, and Deng (2012) show that the real housing price increased six times from 2004 to 2016. In addition, China has one of the largest shares in the world trade market. Therefore, investigating the effects of changes in asset price on China's trade balances can reveal some important insights.

The main findings of this study are twofold. The first is that a rise in asset price negatively affects trade balances by increasing private consumption and investment. In addition, an appreciation of the real exchange rate deteriorates trade balances in China. The second is that changes in asset price explain about 20% variability of trade balances, while changes in the real effective exchange rate explain about 10%. This is based on 40-quarters-after forecast error variance decomposition (FEVD) results.

The impulse response analysis indicates that an increase in stock price and housing price stimulates private consumption and investment. It seems that the traditional wealth effect channel and Tobin's q channel work well in China. An increase in private consumption and investment due to rising asset price reduces trade surplus in China. An appreciation of the real effective exchange rate decreases trade surplus, possibly due to price effects. It seems that the results of the impulse response analysis match with traditional economic theories. Furthermore, the FEVD shows that changes in asset price can explain about 20% variability of trade balances in China, which is not negligible. Changes in the real effective exchange rate can explain about 10%

variability of trade balances in China. The results are robust to using an alternative measure of housing price, different sample periods, and adding other important shocks.

After recent studies by Gete (2009) and Fratzscher, Juvenal, and Sarno (2010), several studies show that asset price is an important factor in determining fluctuations in trade balances. For example, Fratzscher and Straub (2009), using SVAR model and G7 country data, show that changes in stock price are important sources of fluctuations in trade balances in G7 countries. Using the structural VAR model, Holinski and Vermeulen (2012) show that the effects of changes in housing price and stock price on trade balances differ across G7 countries. Ferrero (2015), using a calibrated open economy dynamic stochastic general equilibrium (DSGE) model, shows that changes in housing price due to easing US monetary policy affect current account dynamics. These studies suggest that changes in asset price affect consumption through the wealth effect channel and investment through Tobin's q channel. They affect the demand for imported goods, which influences trade balances. However, most studies focus on advanced countries and none considers China.

This research is also closely related to studies on the effects of exchange rate on China's external balances. For example, Cheung, Chinn, and Fujii (2010) and Cheung, Chinn, and Qian (2016) show that an appreciation of the real exchange rate deteriorates trade balances in China, using country panel data[1]. However, neither study examines the role of asset price.

The closest study to this one is Hoffmann (2013). Hoffmann (2013), using the present value model and annual data from 1982 to 2007, shows that changes in price of non-tradable goods such as housing and medical care are important to explain changes in China's current account. Although Hoffman (2013) emphasizes the role of housing price as a determinant of China's external balance, he does not consider stock price and the role of asset price explicitly in the model.

Section 2 in this paper explains the econometric method and data. Section 3 presents the empirical results and section 4 provides a discussion of the results. Section 5 concludes this paper.

[1] Bahmani-Oskooee and Wang (2006) provide a useful literature survey on the relationship between the real exchange rate and trade balances in China.

II. DATA, ECONOMETRIC METHOD, AND IDENTIFICATION

1. Data

The baseline model consists of seven variables: the sum of real private consumption and investment (CON+INV), net export to GDP ratio (NXGDP), GDP deflator (GDP def), M2, real effective exchange rate (REER), real stock price, and real housing price. The data are from various sources. The majority of data are from the Federal Reserve of Atlanta (Atlanta Fed) website. The Atlanta Fed provides various macroeconomic variables for China constructed by Chang et al. (2015). The dataset includes national account data, GDP deflator, and M2. It is widely used in literature on China's macro-economy, such as Higgins, Zha, and Zhong (2016). To convert nominal variables to real variables, I deflate nominal variables using the GDP deflator. I use the GDP deflator as a proxy of aggregate price and M2 as a proxy of the tool for monetary policy in China, following Chen et al. (2016)[2].

I use the total share price of China provided by the OECD as a proxy of China's stock price. For China, it is calculated using Shanghai composite index. For housing price, I use data from Cesa-Bianchi (2013) and extend it using Thomson Reuter and The Economist dataset. I use this series in the baseline model because it is the longest series that I can acquire. For robustness checks, I use an alternative housing price index: Wharton/NUS/Tsinghua Chinese Residential Land Price Indexes (CRLPI) by Wu, Gyourko and Deng (2012). I deflate the price indexes using the GDP deflator to convert them into the real price indexes. I obtained the real effective exchange rate data from the website of the Bank for International Settlements. Because stock price, housing price, and REER are available at monthly frequency, I convert them into quarterly series using a simple average of each series. I take the logarithm of all variables except NXGDP. I estimate the baseline SVAR model with data from the first quarter in 1999 to the last quarter in 2016. The period is dictated by data availability, particularly for Chinese national account data and housing price. The dataset that I use in the baseline model can be interpreted as a minimal set to study

[2] Their study shows that short-term interest rate, which is widely used as a monetary policy tool in developed countries, is ineffective in China.

the effects of asset price and the real exchange rate on China's trade balances. Table 1 presents detailed data sources.

It is worth noting that I use domestic variables rather than relative variables (difference between China and rest of the world), which is different from Fratzscher, Juvenal, and Sarno (2010)'s specification. They use relative variables (U.S. versus G7 countries) because U.S. financial market is open to international fund flows. In this case, it is important to consider relative conditions for financial markets. However, the relation of financial markets between China and rest of the world is somewhat different. China, who is one of the largest countries in the world trade market, is actually not tightly linked to the international financial market. Because of high degree of capital controls in China, China's financial markets are segmented from the international market. Fernández et al. (2016) define China as a "wall country", which means, on average, China conducts capital controls on more than 70 percent of their transactions. Their sub-index also indicates that neither equity market nor real estate market is open to international investors. Other studies such as Carpenter, Lu, and Whitelaw (2015) conclude that China's equity market is segmented from the international market based on the several empirical test results. Given those circumstances, I believe that China's financial conditions are mainly driven by domestic factors and international factors affect China's financial market through the trade channels. In this case, using domestic variables becomes much more reasonable. Thus I use domestic variables rather than relative variables for the baseline model. To check robustness, I use relative variables between China and the US in section 3. Since the US is the largest trading partner of China, it is reasonable to use China – U.S. relative variables.

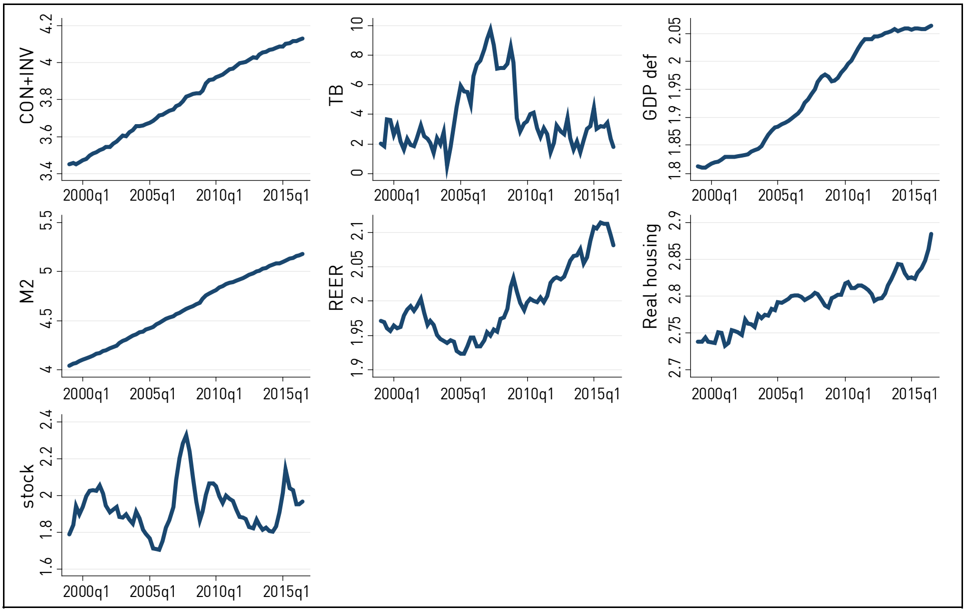
Table 1. Data Description

Variable	Source	Period
Nominal Consumption	Atlanta Fed	1999.Q1 – 2016.Q4
Nominal Gross Fixed Investment	Atlanta Fed	1999.Q1 – 2016.Q4
GDP Deflator	Atlanta Fed	1999.Q1 – 2016.Q4
Net Exports	Atlanta Fed	1999.Q1 – 2016.Q4
Nominal GDP	Atlanta Fed	1999.Q1 – 2016.Q4
M2	Atlanta Fed	1999.Q1 – 2016.Q4
Housing Price Index	Cesa-Bianchi (2013), Thomson Reuter, The Economist	1999.Q1 – 2016.Q4
	Wu, Gyourko, and Deng (2012)	2004.Q1 – 2016.Q4
Stock Price Index	OECD	1999.Q1 – 2016.Q4
Real Effective Exchange Rate	BIS	1999.Q1 – 2016.Q4

Note: Thomson Reuter and The Economist index <https://infographics.economist.com/2017/HPI/index.html> (accessed March 21, 2018)
Cesa-Bianchi (2013) <https://sites.google.com/site/ambropo/HousePriceDatabase_2015.21.01.zip?attredirects=0> (accessed March 21, 2018)
China data provided by the Atlanta Fed <https://www.frbatlanta.org/-/media/documents/cqer/researchcq/china-macroeconomy/201708DataRelease.zip> I use the September 2017 version. (accessed January 21, 2018)
Data in Wu, Gyourko and Deng (2012) <http://real.wharton.upenn.edu/~gyourko/chineselandpriceindex.html> (accessed March 21, 2018)

Figure 1 shows the time series plot of data that I use in the baseline model. Notably, the financial crisis and the great recession did not dampen China's private consumption and investment severely. Trade balances show huge surplus in the mid-2000s; however, this surplus becomes much smaller after the financial crisis. Housing price shows an upward trend and the slope becomes steeper after the early 2010s. Stock market booms occur in the mid-2000s; however, the bubbles burst after the financial crisis. The real exchange rate in China shows an upward trend, indicating appreciation in real renminbi value during the time.

Figure 1. Time Series Plot of Data



Note: Y-axis means log scale of variables except TB. TB is measured by the percentage of GDP. CON+INV means the sum of real private consumption and investment. TB means % of trade balances to GDP. GDP def means GDP deflator. REER is the real effective exchange rate. Real housing is the housing price index divided by the GDP deflator. Stock means stock price index divided by the GDP deflator.

2. Econometric Method and Identification

This paper examines the quantitative effects of changes in asset price and the real exchange rate on China's trade balances by estimating a sign restriction SVAR model using the Bayesian method. In this section, I present the econometric method and identification strategy.

Consider the following reduced form VAR model.

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

where X_t is an $n \times 1$ vector of the time series and $B(L)$ is a matrix polynomial with the lag operator L. u_t is an $n \times 1$ vector of error terms with variance-covariance matrix $E[u_t u_t'] = \Sigma$. Let structural innovations be e_t with variance-covariance matrix $E[e_t e_t'] = I_n$, where I is the identity matrix. The goal of the SVAR model is to find the mapping A, from reduced form error u_t to structural innovations e_t, which satisfies $Au_t = e_t$ and $\mathrm{E}[Au_t u'_t A'] = I_n$. There are several ways to find the mapping. For example, the conventional method with Cholesky decomposition assumes that matrix A is a lower triangular matrix.

Following Rubio-Ramirez, Waggoner, and Zha (2010)'s procedure, I use the sign restriction approach instead of using direct restrictions on matrix A to identify structural shocks. The sign restriction approach uses impositions of theory-consistent restrictions on signs of impulse responses to recover structural shocks. Moreover, Mountford and Uhlig (2009) show that the Bayesian method is more natural to estimate sign restriction VAR models. Thus, I use the Bayesian technique to estimate the model. Specifically, I use the following procedure.

- Step 1: Estimate reduced form VAR model (equation 1). Obtain estimated $\hat{B}(L)$ and $\hat{\Sigma}$
- Step 2: Using estimated $\hat{B}(L)$ and $\hat{\Sigma}$, draw random samples of $\tilde{B}(L)$ and $\tilde{\Sigma}$ from the joint posterior distribution of $(\hat{B}(L), \hat{\Sigma})$. Compute the lower-triangular Cholesky decomposition $\tilde{\Gamma}$ using $\tilde{\Sigma}$. I use the non-informative Normal-Wishart family for prior distribution in this step, following Mountfold and Uhlig (2009).
- Step 3: I randomly draw an orthonomal matrix Q, where $\tilde{\Gamma}QQ'\tilde{\Gamma}' = \tilde{\Sigma}$ using QR decomposition. Using $\tilde{B}(L)$, $\tilde{\Gamma}$, and Q, I compute impulse responses. If the sign of impulse responses match with the desired sign, I retain the draw. Otherwise, I repeat this step until the impulse responses satisfy the desired sign.
- Step 4: Repeat step 2, 3.

After sufficiently large iterations of this procedure, I obtain the posterior distribution of impulse responses of each shock[3]. With posterior distribution, I report 68% credible sets and median responses. For the estimation, I include constant and linear trend in VAR. The lag length is set to be 2 based on AIC criteria. Once I identify structural shocks, it is possible to implement FEVD using the usual procedure.

[3] I draw 200,000 random samples and discard the first 190,000 as burn-in samples. With the remaining 10,000 draws, I compute the median, 16%, and 84% quantiles.

Table 2. Sign Restrictions for Each Shock in the Baseline Model

	Stock Price Shock	Housing Price Shock	REER Shock
Con+inv	+	+	
Trade Balances			
GDP Deflator		+	-
M2		-	+
REER			+
Stock Price	+		
Housing Price		+	

Note: + denotes the positive sign, - denotes the negative sign. This sign restriction only applies to contemporaneous response of variables to shocks.

As I focus on the effect of asset price and the real exchange rate on trade balances in China, I try to recover stock price shocks, housing price shocks, and real exchange rate shocks in the baseline model. To identify those structural shocks, I use the sign restrictions in Table 2 based on various theoretical and empirical literature.

The motivation of restrictions for asset price shocks is as follows. First, I consider wealth effects of asset price. The traditional wealth effect channel implies that an increase in asset price is likely to stimulate private consumption. In addition, an increase in stock price can stimulate firms' investment through traditional Tobin's q channel. A rise in stock price raises the market value of firms and Tobin's q theory suggests that higher market value stimulates investment. In addition, housing market boom raises residential investment, implying an increase in private investment. Thus, I assume that an increase in asset price stimulates private consumption and investment[4].

Additionally, I assume that an increase in housing price raises aggregate price. This is because housing price is a part of aggregate price. Thus, an increase in housing price is likely to raise aggregate price. In response to inflation, the monetary authority in China implements contractionary monetary policy. Various studies on China's monetary policy confirm this. For example, Fernald, Spiegel, and Swanson (2014) and Chen et al. (2016), using the VAR model and China time series data, show that

[4] Previous studies support the wealth effect channel and Tobin's q channel in China. Section 4.1 contains detailed discussions.

the monetary authority reacts to inflation in China. Based on these results, I assume that an increase in housing price negatively affects M2 in China.

The motivation for restrictions on REER shocks is based on various models of the international business cycle. For example, Ball (1999) and Steinsson (2008) show that an appreciation of REER decreases import price, which can lower aggregate price. If the monetary authority cares about disinflation or deflation, it tends to implement expansionary monetary policy. Therefore, I assume that an appreciation of real renminbi (an increase in REER) reduces aggregate price and raises money supplies in China. Furthermore, all restrictions are imposed only on contemporaneous responses to each shock. These restrictions are minimal sets to identify each shock and this agnostic approach can help recovering structural shocks with minimum costs.

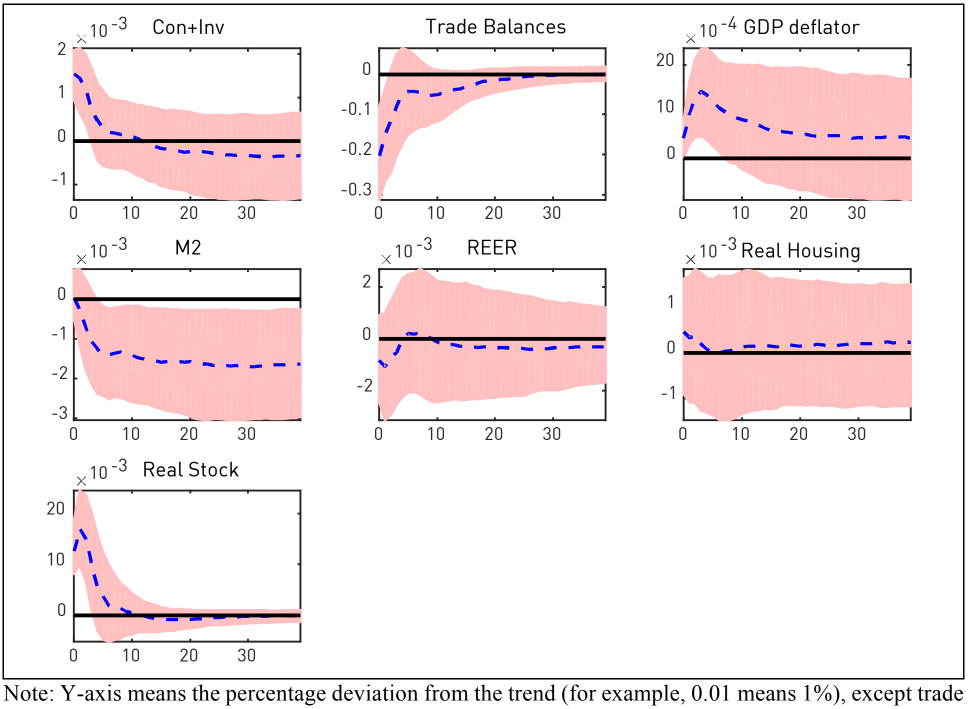
III. EMPIRICAL RESULTS

1. Baseline Results

This section refers to the baseline estimation results. First, I show the estimated impulse response functions to examine the effects of shocks on variables. Next, I present the FEVD results to understand the importance of each shock.

Figure 2 shows the estimated impulse responses to identified stock price shocks. It shows the median responses and the associated 68% credible sets following Fratzscher, Juvenal, and Sarno (2010). An increase in stock price stimulates private activity (private consumption and investment) for about 10 quarters after a shock occurs. Demands for imported goods increase, and therefore trade balances are deteriorated. Aggregate price (GDP deflator) rises due to an increase in aggregate demand. In response to this inflation, the monetary authority decreases money supplies in the economy. However, it does not seem that REER and housing price show meaningful responses. The results imply that booms in stock market stimulate private activity and deteriorate trade balances in China.

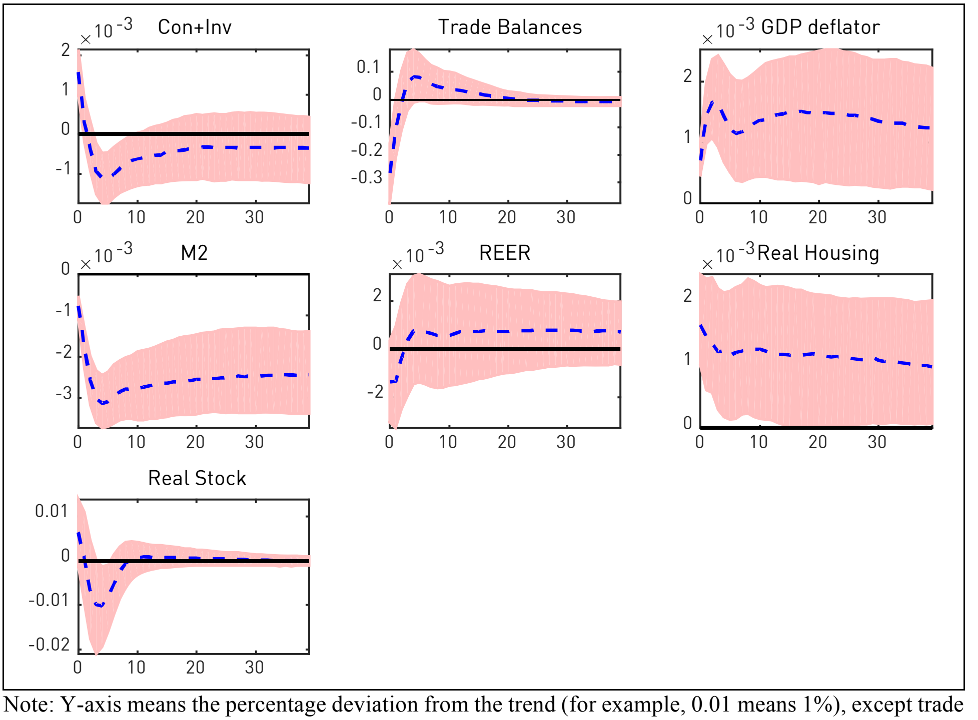
Figure 2. Impulse Response of Variables to Stock Price Shock



Note: Y-axis means the percentage deviation from the trend (for example, 0.01 means 1%), except trade balance. The response of trade balances is measured by the percentage point changes. The x-axis represents horizons. The shaded area represents 68% credible set, and the dotted lines denote median response.

Figure 3 shows the estimated impulse responses to identified housing price shocks. Positive housing price shocks stimulate private activity; however, the effects are short-lived relative to the effects of stock market booms. Consequently, the deterioration in trade balance is short-lived. An increase in housing price stimulates aggregate price; therefore, the monetary authority implements contractionary monetary policy. The responses of stock price and REER do not seem to be meaningful. One interesting point is that housing price shocks are more persistent than stock price shocks, but the response of trade balances is short-lived. This may be caused by the response of M2. An increase in housing price raises inflation, which decreases M2. This contractionary response of monetary authority possibly offsets the positive effects of housing price shocks. However, I do not impose any restrictions on M2 for stock price shocks. This may be a reason to generate persistent responses of private activity and therefore trade balances.

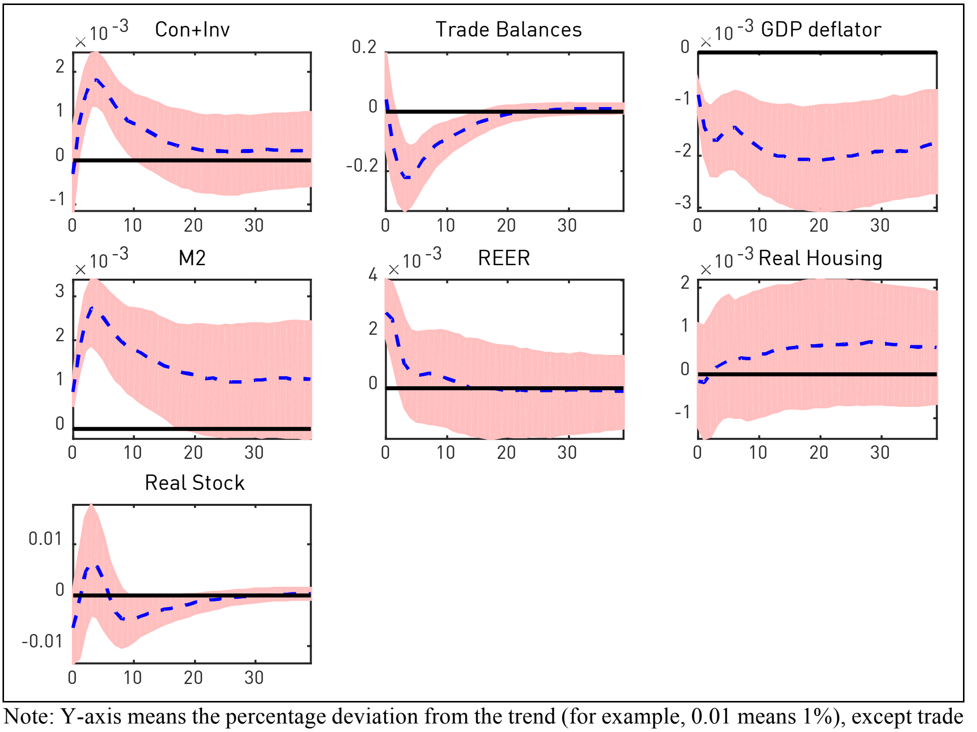
Figure 3. Impulse Response of Variables to Housing Price Shock



Note: Y-axis means the percentage deviation from the trend (for example, 0.01 means 1%), except trade balance. The response of trade balances is measured by the percentage point changes. The x-axis represents horizons. The shaded area represents 68% credible set, and the dotted lines denote median response.

Figure 4 shows the estimated impulse responses to identified real exchange rate shocks. An increase in REER (an appreciation of real renminbi against the currency value of China's trading partners) reduces the price competitiveness of Chinese products in the world market, which leads to decrease in exports. Furthermore, an appreciation of renminbi lowers the price of imported goods in China, which stimulates demands for imported goods. These two channels possibly deteriorate trade balances. Notably, the J-Curve effects stated by Magee (1973) do not seem to be strong in China. Although the contemporaneous response of trade balances is slightly positive, it soon turns negative. As price of imported goods falls, private consumption and investment increase. Since an increase in REER possibly decreases aggregate price by lowering price of imported goods, the response of aggregate price is negative. In response to disinflation or deflation, the monetary authority implements expansionary monetary policy.

Figure 4. Impulse Response of Variables to REER Shock



Note: Y-axis means the percentage deviation from the trend (for example, 0.01 means 1%), except trade balance. The response of trade balances is measured by the percentage point changes. The x-axis represents horizons. The shaded area represents 68% credible set, and the dotted lines denote median response.

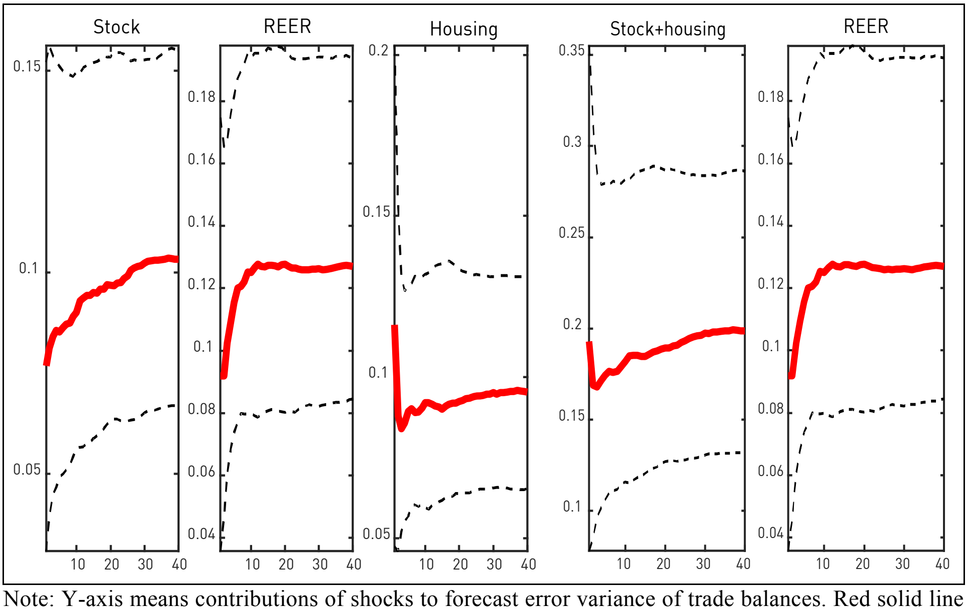
Figure 5 shows the median FEVD results and the associated 68% credible sets for trade balances. The results show that housing price shocks can explain more than 10% variability of trade balances on impact. However, the importance of housing price shocks decreases in longer horizons. In contrast to housing price shocks, the importance of stock price shocks and real exchange rate shocks increases in longer horizons. After 10 years (40 quarters), each asset price shock (stock price and housing price shocks) explains about 10% change in trade balances. Real exchange rate shocks explain about 12% variability of trade balances. The contribution of each asset price shock seems to be as important as that of real exchange rate shocks. Moreover, the total contribution of asset price, defined by the sum of changes due to stock price and housing price, is about 20% after 10 years. It is lower than that in advanced countries, but it is not negligible[5]. Furthermore, this is nearly two times larger than the contribution of real exchange rate shocks (see right panel in figure 5).

In sum, the baseline impulse response analysis shows that changes in asset price (stock price and housing price) affect private activity (private consumption and investment), which leads to changes in trade balances. Real exchange rate shocks affect trade balances through changes in international relative price. FEVD implies that the size of the contributions of changes in asset price to variability of trade balances is not negligible. Quantitatively, changes in asset price explain about 20% variability of trade balances in China, while real exchange rate shocks explain about 10%.

Figure 5. Forecast Error Variance Decomposition

(a) FEVD for 3 identified shocks

(b) FEVD with asset price shock and REER shock



Note: Y-axis means contributions of shocks to forecast error variance of trade balances. Red solid line means the median forecasting error variance decomposition. Black dotted line means the associated 68% credible sets. Asset price shocks are defined by the sum of stock price shocks and housing price shocks.

5 For example, Fratzscher, Juvenal, and Sarno (2010) show that changes in asset price explain about 30% variability of trade balances in the US.

Table 3. Sign Restrictions for Each Shock in the Extended Model

	Stock Price Shock	HP Shock	REER Shock	Supply Side Shock	MP Shock	Gov’t Spending Shock
Con+inv	+	+		+	+	-
Trade Balances						
GDP Deflator		+	-	-	+	+
M2		-	+	+	+	-
REER			+		-	
Stock Price	+					
HP		+				
Gov’t Spending						+

Note: + denotes the positive sign, and – denotes the negative sign. This sign restriction only applies to contemporaneous response of variables to shocks.

2. Robustness Checks

I show three robustness checks in this section. The first relates to additional important shocks. The second relates to the sensitivity of choice of the housing price index. The last is related to using relative variables.

(1) The Effect of Adding Other Important Shocks

To check robustness of the baseline results, I identify some additional shocks that are potentially important in explaining changes in trade balances. To this end, I identify supply side shocks and monetary policy shocks based on Fratzscher, Juvenal, and Sarno (2010). Additionally, I try to identify government spending shocks. This is because the national income identity implies that public saving is important in determining trade balances. Table 3 summarizes the sign restrictions for this extended model.

The motivation for the restrictions of each shock is as follows. First, the restrictions on supply side shocks and monetary policy shocks are based on Fratzscher, Juvenal, and Sarno (2010). They impose restrictions on supply side shock based on several DSGE studies. In many DSGE studies, supply side shocks such as productivity improvements and technological progress raise output but reduce inflation through cost-down channels. Following those results, I assume that positive supply side shocks raise private activity and reduce price. In addition, expansionary monetary policy shocks increase output and inflation in many seminal studies. Chen et al. (2016), using VAR and the theoretical model, show that an increase in M2 positively affects China's GDP and GDP deflator. Following their results, I assume that positive M2 shocks raise private consumption, investment, and the GDP deflator in China.

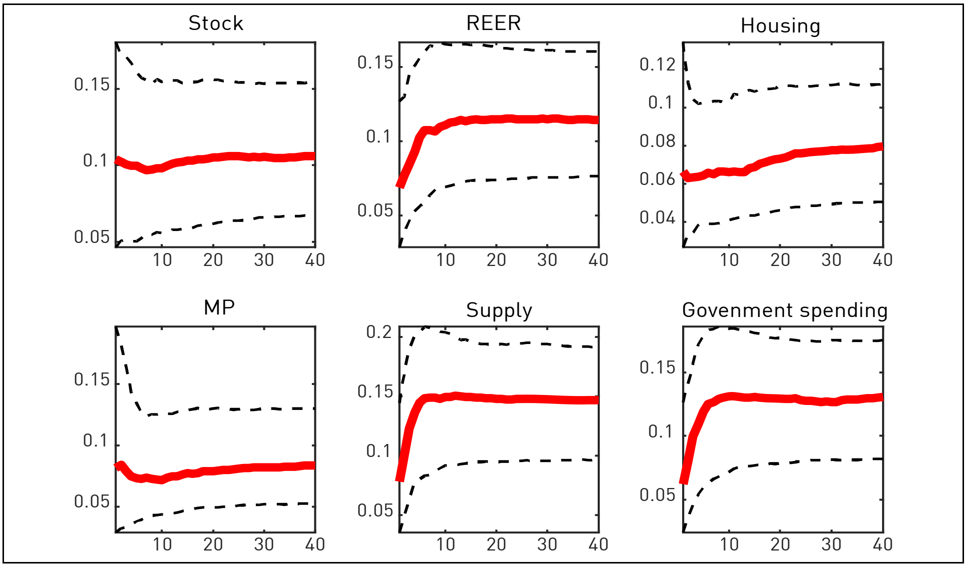
The restrictions on government spending shocks are based on the results in Chen and Liu (2018). They investigate the effect of government spending in China using the DSGE model. Their calibrated DSGE model shows that a positive government spending shock crowds out private consumption and investment, particularly investment. This is due to Ricardian equivalence and a rise in interest rate. Their model assumes that households are Ricardian, and therefore they increase savings to smooth the consumption path in response to future tax increases. As the monetary authority follows the Taylor-type rule, it increases interest rate in response to inflation, owing to an increase in aggregate demand. This will crowd out private investment. Following their model, I assume that positive government spending shocks negatively affect private consumption, investment, and M2 supplies; however, those positively affect GDP deflator. All restrictions are imposed only on instantaneous responses to each shock. Figure 6 shows the results of the forecast error variance decomposition in the extended model[6].

Similar to the baseline model, stock price shocks and housing price shocks can explain about 20% variability of trade balances in China (See right panel in Figure 6), while real exchange rate shocks can explain about 10%. The results are in line with the baseline results. Additional identified shocks, particularly supply side shocks and government spending shocks, seem to be important in explaining changes in trade balances. For example, supply side shocks can explain roughly 15% variability of trade balances after 10 years. Furthermore, roughly 13% change in trade balances is due to government spending shocks. However, monetary policy shocks do not seem to play a major role in explaining changes in trade balances, particularly in the long run. Overall, adding other shocks does not alter the implications of the baseline results.

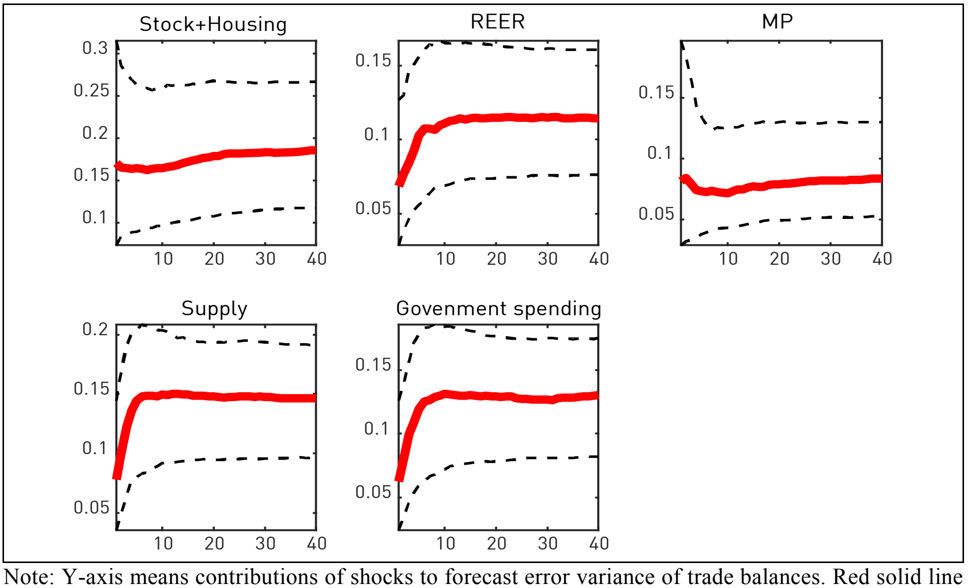
[6] The appendix contains the results of the impulse responses analysis. The impulse response analysis shows theory-consistent results.

Figure 6. Forecast Error Variance Decomposition: Extended Model

(a) FEVD with all identified shocks



(b) FEVD with asset price shock and other shocks



Note: Y-axis means contributions of shocks to forecast error variance of trade balances. Red solid line means the median forecasting error variance decomposition. Black dotted line means the associated 68% credible sets. Asset price shocks are defined by the sum of stock price shocks and housing price shocks.

(2) Alternative Housing Price Index

In this subsection, I report the results using an alternative housing price measure. Wu, Gyourko and Deng (2012) construct the new housing price index for China. They report constant quality national housing price as well as those of 35 major cities in China. This series is widely used in research on housing price in China[7]. Unfortunately, this series is only available since 2004. In the baseline model, I use the longest housing price index that I can obtain owing to the degree of freedom in the VAR model. However, this index has a different trend than the housing price index constructed by Wu, Gyourko and Deng (2012)[8]. To check the sensitivity of choice of housing price index, I re-estimate the VAR model with the alternative housing price index. Due to data availability, I estimate this model from the first quarter of 2004 to the last quarter of 2016[9]. The identification scheme and the specification of VAR are the same as in the baseline model.

Figure 7 shows the FEVD results[10]. Changes in stock price contribute roughly 11% change in trade balances, which is in line with the baseline results. The FEVD results also show that stock price shocks are as important as REER shocks. Housing price shocks can explain about 10% variability of trade balances; this is also consistent with the baseline results. The changes in total asset price can explain more than 20% variability of trade balances, which is roughly two times larger than that of REER shocks.

Overall, robustness checks confirm the baseline results. Asset price is important in explaining the variability of trade balances in China. Changes in asset price can explain roughly 20% variability of trade balances in China, while changes in real exchanges rate contribute about 10%.

[7] See Chen and Wen (2017), for example.

[8] See the supplement figure in appendix B.

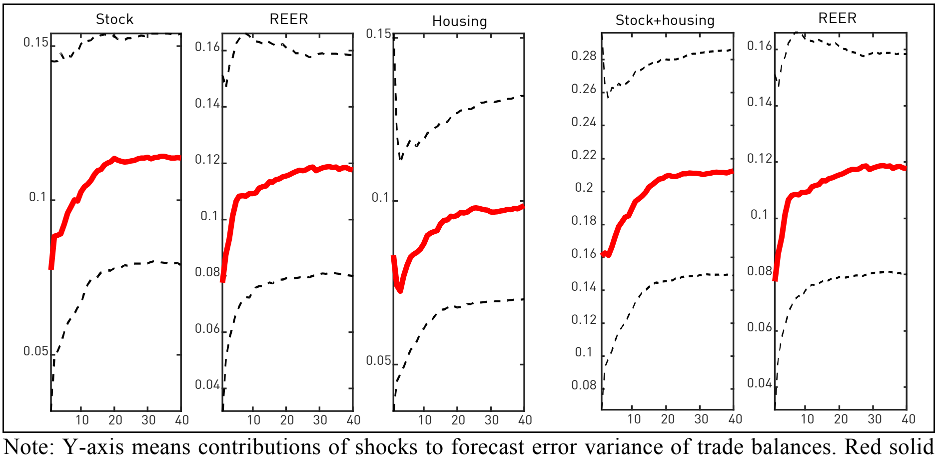
[9] China's exchange rate regime shifts from fixed exchange rate regime to managed floating since 2005. Because of data availability of alternative HP measure, the analysis with alternative HP measure starts from 2004. Thus most variations come from managed floating periods. Therefore the results are relatively free from the effects of the exchange rate regime change in China.

[10] Appendix C contains the results of the impulse response analysis. The results are in line with the baseline results.

Figure 7. Forecast Error Variance Decomposition: Alternative HP Measure

(a) FEVD for 3 identified shocks

(b) FEVD with asset price shock and REER shock



Note: Y-axis means contributions of shocks to forecast error variance of trade balances. Red solid line means the median forecasting error variance decomposition. Black dotted line means the associated 68% credible sets. Asset price shocks are defined by the sum of stock price shocks and housing price shocks.

(3) Relative Variable Specification

In this section, I show the results from the model with relative variables following Fratzscher, Juvenal, and Sarno (2010). Because it is not easy to construct relative variables for China and rest of the world, I use China – U.S. relative variables. Since the US is the largest trading partner of China and is the most important country in the international financial market, I use variables for the US as a proxy of rest of the world's financial and economic conditions. Table 4 summarizes the definition of the variables. The definition is similar to that in Fratzscher, Juvenal, and Sarno (2010).

The FEVD results are reported in figure 8. To identify shocks, I use the same sign restrictions for the baseline model. The implications are in line with those in the baseline model. Asset price shocks explain about 20% variability of trade balances in China, while real exchange rate shock can explain about 10%. It seems that domestic conditions are main driving forces behind fluctuations in China's stock price and housing price. Thus using relative variables does not significantly alter the implications of the baseline model[11].

[11] The impulse response results are shown in appendix D.

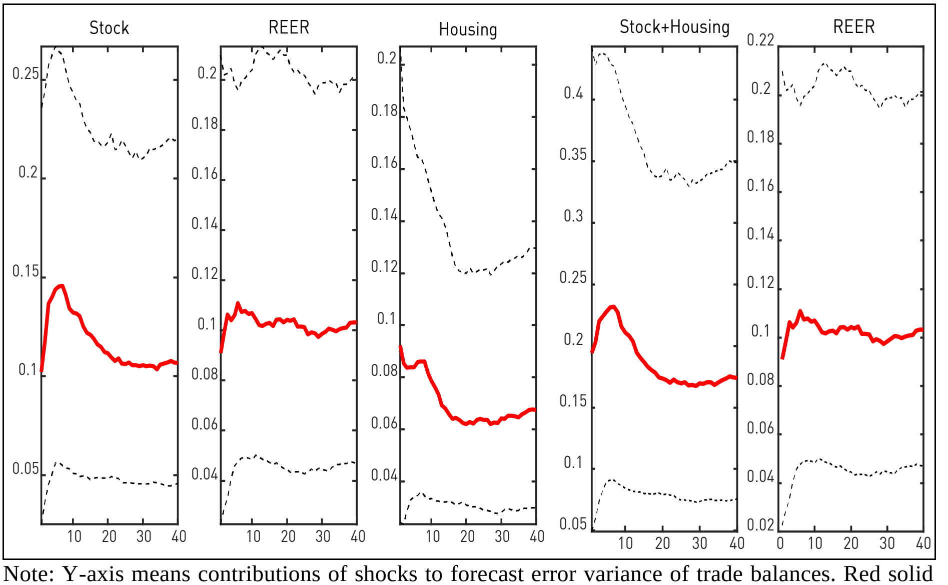
Table 4. Definitions of the Relative Variables

Relative Variables	Definition
Con + Inv	Log difference of real private consumption plus investment between China and U.S.
Stock Price	Log difference of stock price index of China and S&P 500 index
Housing Price	Log difference of housing price index of China and Case-Shiller index of U.S.
Short Term Interest rate	Effective federal funds rate in the US minus 7 days Repo rate in China12
Inflation	Log difference of GDP deflator between two countries

Note: All U.S. variables comes from the Federal Reserve Bank of St. Louis website except stock price. Stock price is downloaded from the OECD website. 7 days Repo rate for China comes from the Atlanta Fed website.

Figure 8. Forecast Error Variance Decomposition: Relative Variable Specifications

(a) FEVD for 3 identified shocks (b) FEVD with asset price shock and REER shock



Note: Y-axis means contributions of shocks to forecast error variance of trade balances. Red solid line means the median forecasting error variance decomposition. Black dotted line means the associated 68% credible sets. Asset price shocks are defined by the sum of stock price shocks and housing price shocks.

[12] Thus positive changes in the relative interest rate mean expansionary monetary policy in China.

IV. DISCUSSION

I discuss three issues in this section. The first relates to prior literature on the wealth effect channel and Tobin's q channel in China. The second relates to co-movement of housing price and trade balances. Finally, I discuss the role of the real exchange rate in determining trade balances in China.

1. Impact of Asset Price on Consumption and Investment in China

Although changes in asset price can affect private consumption through several channels, one of the most promising channels is the wealth effect channel. Several studies for advanced countries such as the United States, Europe, and Japan confirm that changes in asset price affect consumption through the wealth effect channel. Recent studies have examined such wealth effects in China; however, they remain in the early stages.

According to Borst (2012)[13], about 50% of household wealth in China consists of stock and real estate. Thus, it is natural for Chinese households to consider asset price in their consumption decisions. The existing research also confirm wealth effects by housing price and stock price dynamics in China. For example, Chen, Funke, and Mehrotra (2017), using China city-level panel data from 1999 to 2009 and the panel error correction model, show that housing price significantly affects private consumption. Koivu (2012) provides some strong evidence on wealth effects in China induced by changes in stock price, using structural VAR and quarterly Chinese data from 1998 to 2007. Some studies, using country panel data including China, show the significance of wealth effects. For example, Peltonen, Sousa, and Vansteenkiste (2012), using 14 emerging country panel data including China and several panel models, show that stock price and housing price significantly affect private consumption.

In addition, there are some empirical evidence to support that changes in asset price affect the investment decisions of firms in China. For example, Barnett and Brooks

[13] Borst (2012), Household wealth and housing market, China Economic Watch, Peterson Institute for International Economics. <https://piie.com/blogs/china-economic-watch/household-wealth-and-housing-market> (accessed March 20, 2018)

(2006) show that real estate price is an important factor in determining real estate investment in China, using China regional data and the panel regression technique. Xiao (2009), using Chinese firm level data and panel data analysis, shows that changes in stock price significantly affect firm's investment decisions through Tobin's q channel.

In this paper, the impulse response analysis consistently shows that an increase in stock price and housing price leads to an increase in private consumption and investment. Those results are in line with pre-existing evidence.

2. Housing Price and Trade Balances in China: Do They Really Move in The Same Eirection?

Although this paper addresses the connection between asset price and trade balances in China, few other studies examine this relationship. There are several reasons why this topic is not very popular; however, the experience of the mid-2000s is an important one. Many researchers focus on the role of asset price in determining current account because of the collapse of the asset market—particularly the housing market—accompanied by reducing current account deficits during the financial crisis. Before the financial crisis (in the mid-2000s), the housing market was in boom and many advanced countries faced huge current account deficits. Several studies focus on this negative correlation.

In contrast to advanced countries, China had a huge current account surplus during the housing market boom just before the financial crisis (See figure 1). Bergin (2011) also mentions this, noting the huge surplus in China's current account, despite rapid growth in housing price, just before the financial crisis (2004–2006). This is opposite to that of many advanced countries. Thus, researchers focus less on the role of housing price in determining trade balances in China.

However, simple correlation shows that housing price and trade balances in China tend to move in opposite directions, except in that period. Table 5 shows contemporaneous correlations between housing price and trade balances divided by GDP in various sub-periods. The contemporaneous correlation between housing price and trade balances for the entire sample periods is almost 0; however, the correlations are negative (-0.13 and -0.72) in the periods except from 2004 to 2006. Those two variables show strong positive correlations only from 2004 to 2006. Also, I compute the correlation between Hodrick-Prescott filtered (HP-filtered) housing price index and trade balances[14]. It shows that the relation changes from positive to negative after the financial crisis. The simple correlation and the empirical results in the paper suggest that the relationship between housing price and current accounts in China can be similar to that in advanced countries, especially after the financial crisis.

Table 5. Contemporaneous Correlation Between Housing Price and Trade Balances

	1999.Q1 – 2016.Q4	1999.Q1 – 2003.Q4	2004.Q1 – 2006.Q4	2007.Q1 – 2016.Q4
Corr(HP, TB)	-0.01	-0.13	0.88	-0.72
HP-filtered, Corr(HP, TB)	-0.01	-0.05	0.87	-0.17

Note: HP is the log of real housing price. TB is trade balances as a percentage of GDP. HP-filtered means that the correlation between Hodrick-Prescott filtered log of housing price and trade balances.

3. How Important is The Real Exchange Rate for Trade Balance in China?

Many researchers believe that the real exchange rate is important in determining trade balances, and several studies attempt to gauge its value. Recently, US President Donald Trump’s accusations against artificial currency devaluation in China have renewed attention on this topic.

In fact, many studies have discussed the effects of exchange rate on trade balances in China[15]. Among them, some researchers use VAR models and FEVD to study the importance of real exchange rate shocks. They find that the real exchange rate is not a major source for explaining variability of trade balances in China. For example, Hoffman (2013) emphasizes the importance of fluctuations in non-tradable good price in explaining China’s external balances. Kim and Lee (2015) examine the underlying driving forces of trade imbalances between the US and China. Their FEVD results

[14] It is widely used to capture the simple relation between variables in business cycle frequency. Furthermore, it is robust to computing the correlation between nonstationary variable (housing price) and stationary variable (trade balances). Smoothed coefficient is set 1600.

[15] For example, see Frankel (2005), Ahuja et al. (2012), and references therein. Additionally, the J-curve theory summarizes the relationship between exchange rate and trade balances from a theoretical perspective. Bahmani-Oskooee and Wang (2006) summarize the results of empirical tests on the J-curve in China.

imply that fluctuations in the US-China bilateral real exchange rate do not play an important role in determining trade balances between the two countries[16]. Zhang and Sato (2012) also show that the US-China bilateral real exchange rate can explain less than 10% variability of trade balances between the two countries at all horizons. Their results also reveal that changes in the real effective exchange rate only explain less than 10% variability of China's total trade balances. The results in this paper are in line with these prior studies. The FEVD results in this study consistently show that real exchange rate shocks explain about 10% variability of trade balances in China, which is similar to the results in previous VAR studies.

V. CONCLUDING REMARKS

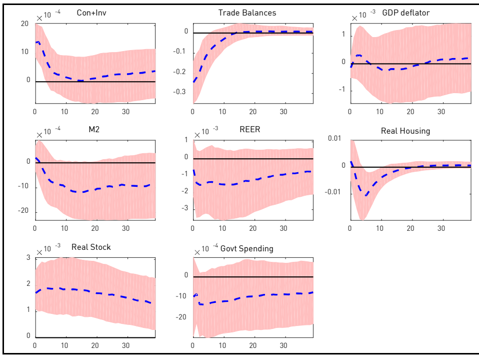
This paper investigates the role of the real exchange rate and asset price, particularly stock price and housing price, in determining trade balances in China using the sign restricted SVAR model and quarterly data from 1999 to 2016. The main findings are twofold. First, an increase in asset price negatively affects trade balances by stimulating private consumption and investment. An appreciation of real value of renminbi deteriorates trade balances in China. Second, changes in asset price can explain roughly 20% variability of trade balances in China, which is not negligible. Real exchange rate shocks can explain about 10% variability. Several robustness checks confirm these results.

It is possible to extend this research in other directions. One is the DSGE model with an explicit asset market. Although many DSGE studies investigate trade balances in China, most do not consider the role of the asset market. This paper demonstrates the importance of the asset market in explaining changes in trade balances in China. Thus, the theoretical approach is a promising option. Another possible direction is studying the non-linear effects of asset price on trade balances. It seems that the relationship between housing price and trade balances is different along the time. Therefore, there is a possible non-linear relation between housing price and trade balances. Thus, considering non-linear relations such as time-varying effects or threshold effects can be interesting directions for future research.

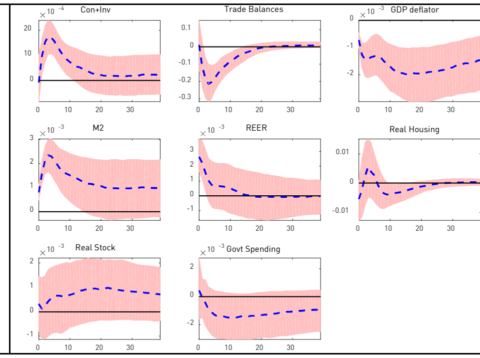
[16] They name identified real exchange rate shocks "Real demand shocks" in the paper.

Appendix A. Impulse Response of Variables to Shocks: Extended Model

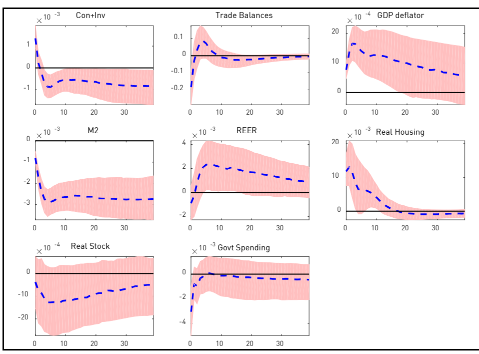
A. Stock price shock



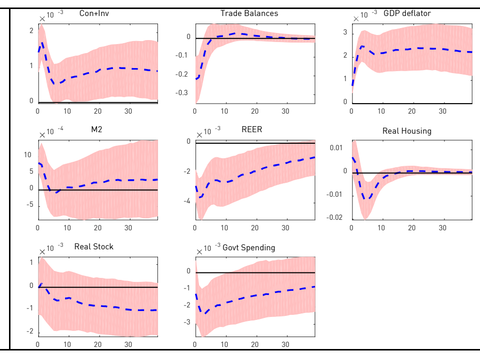
B. REER shock



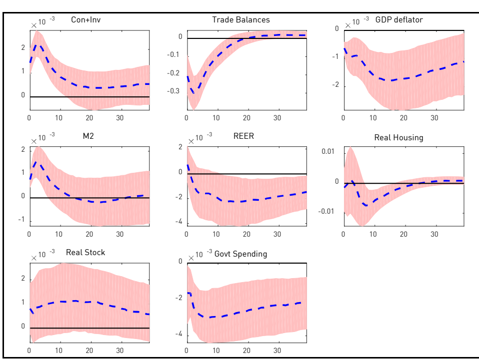
C. Housing price shock



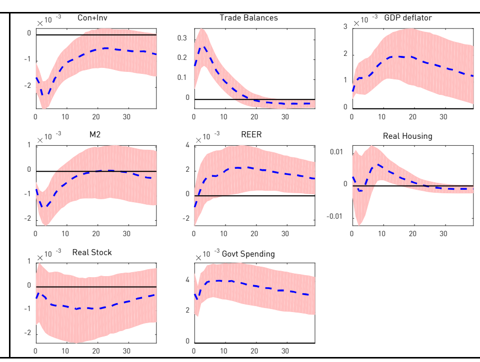
D. Monetary policy shock



E. Supply side shock

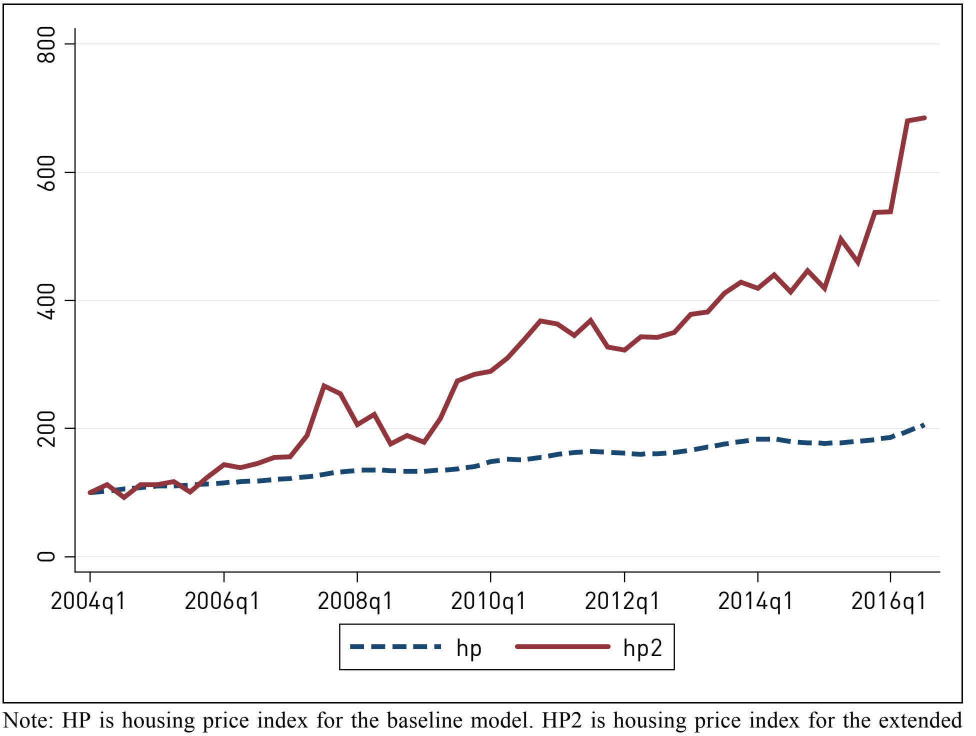


F. Government spending shock



Note: Y-axis means % deviation from the trend except trade balance. The response of trade balances is measured by %p changes. X-axis means horizons. Shaded area means 68% credible set, dotted lines means median response.

Appendix B. Time Series Plot of Two Alternative Housing Price Indexes in China

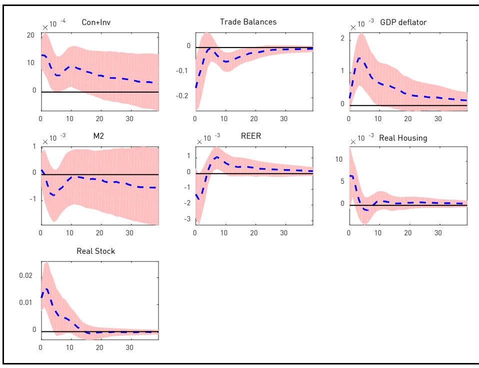


Note: HP is housing price index for the baseline model. HP2 is housing price index for the extended model. I rescale both series with 2004.Q1 value =100 to compare to each other.

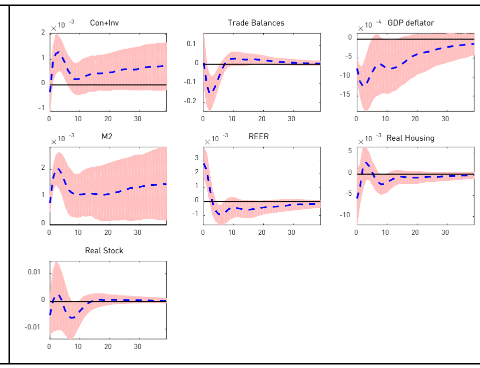
Two series show different trend. The slope of HP2 series for the robustness check is much steeper.

Appendix C. Impulse Response of Variables to Shocks: Alternative HP Measure

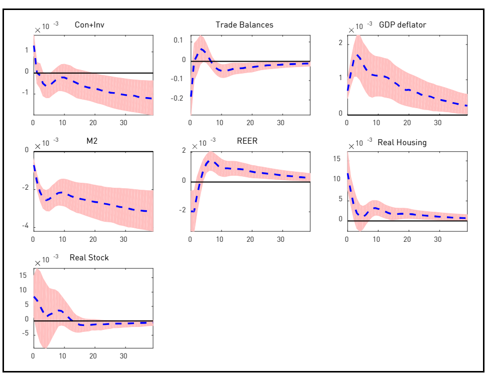
A. Stock price shock



B. REER shock



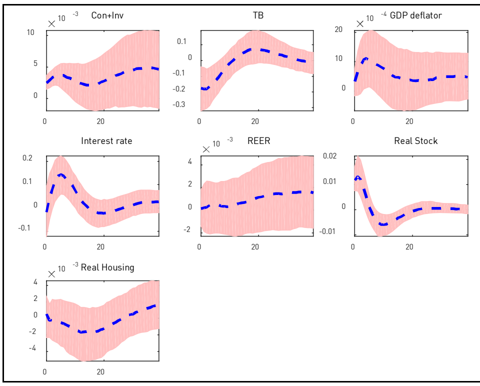
C. Housing price shock



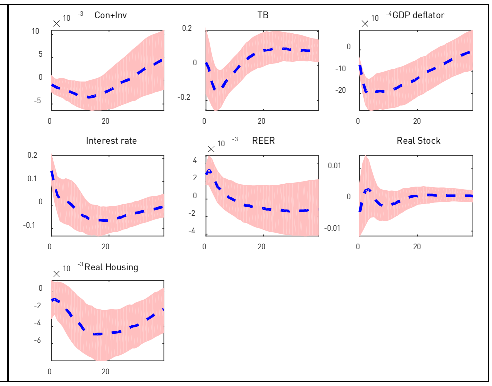
Note: Y-axis means % deviation from the trend except trade balance. The response of trade balances is measured by %p changes. X-axis means horizons. Shaded area means 68% credible set, dotted lines means median response.

Appendix D. Impulse Response of Variables to Shocks: Relative Variable Specification

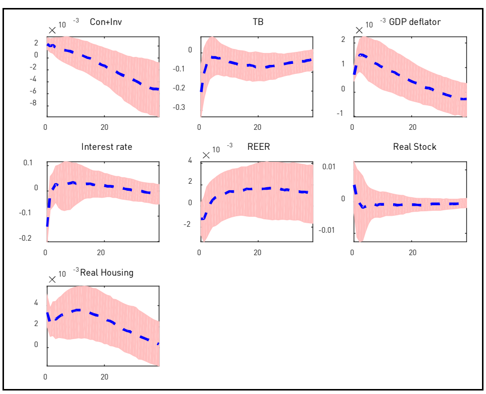
A. Stock price shock



B. REER shock



C. Housing price shock



Note: Y-axis means % deviation from the trend except trade balance. The response of trade balances is measured by %p changes. X-axis means horizons. Shaded area means 68% credible set, dotted lines means median response.

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