Valuation effects in China: scale, structure, and its function in external adjustment*

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At present China's foreign assets are mainly denominated in foreign currencies, while a large part of foreign liabilities are denominated in domestic currency. Under this situation, the appreciation of domestic currency tends to have negative effects on net foreign assets through the valuation effect channel. This article gives a quantitative estimation of the scale of valuation effects in China and the research results show that the valuation effects in China are negative in the 20 years from 1982 to 2012. Furthermore, the scale of valuation effects has been increasing, which has lowered the scale of China's net foreign assets. This paper also gives an estimation of the structure of the value effects, and finds that the volatility and the scale of asset price-related valuation effects are larger than that of exchange rate-related valuation effects. The results also show that the exchange rate has played a more and more important role in the fluctuation of value effects. Finally, this paper establishes an econometric model to value the function of valuation effects in the external adjustment and the results show that, during the period of 1981-2012, the role of valuation effects in China's external adjustment were quite limited, but since 2007, valuation effects have played a more and more important role.

Keywords: valuation effects, financial adjustment, net foreign assets

1. Introduction

External balance of a country has been a focus in international economics. Traditionally, when analyzing the process of a country's external adjustments, economists attribute the most importance to current account balances and deem that the cumulative value of current accounts equals net foreign assets. However, recent research questions this point of view: some studies suggest that another channel in external adjustment, the valuation effects channel, plays an important role in addition to the traditional current account channel. Due to valuation effects, the changes in net external assets do not equal the cumulative value of current accounts.

Valuation effects refer to the impact of capital gains and losses on the net external positions caused by asset prices and exchange rate fluctuations. Financial globalization has been an important trend in the world economy in recent years, which has improved the international

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capital flows and lead to large gross cross holdings of foreign assets and liabilities. As a result, the significance of valuation effects has rapidly grown.

Valuation effects can be divided into two categories: positive effects and negative effects. Taking into account current account surpluses and deficit as well, four types of combinations are arranged. The first type is a combination of positive valuation effects and current account surpluses; the second type combines positive valuation effects and current account deficits; the third type combines negative valuation effects and current account surpluses; the last type combines negative valuation effects and current account deficits. Among the four combinations, the second and third types help in a country's external balance adjustment. The second combination is beneficial to a country, since positive valuation effects can offset current account deficit in the same period. On the contrary, the third type is unfavorable because the negative valuation effects reduce concurrent account surplus.

The impact of valuation effects varies across countries. The IMF (2005) showed that valuation effects are different for industrial countries and emerging market countries. In industrial countries (such as the United States and Japan), foreign assets are likely to be denominated in foreign currency, and foreign liabilities tend to be denominated in domestic currency. In this situation, an unpredicted depreciation in domestic currency leads to an increase in net foreign positions due to an increase in the value of foreign assets and a decrease in the value of foreign liabilities. However, foreign assets and liabilities in emerging market countries are likely to be denominated in foreign currencies. Valuation effects due to unpredicted exchange rate changes are complex. Currency mismatch, which is common in emerging countries, can lead to negative valuation effects, and worsen external imbalance.

At present in China, where foreign assets are mainly denominated in foreign currencies, and a large part of foreign liabilities are denominated in domestic currency, appreciation of domestic currency tends to have negative valuation effects on net foreign assets. Also, net foreign assets in China are in rapid growth because of the twin surplus in China's balance of payments. The large size of net foreign positions magnifies the impact of valuation effects, due to changes in exchange rates and asset prices.

The goal of this article is to quantify the scale of valuation effects in China and assess its role in external adjustments. This paper is structured as follows: Section 2 is a literature review of the studies on valuation effects. Section 3 presents a theoretical framework of estimating the scale of valuation effects and their influence. Section 4 reports the estimated value of valuation effects in China and its structure. Section 5 presents the empirical results of assessing the role of valuation effects in external adjustment. Section 6 shows some conclusions.

2. Literature review

Obstfeld and Rogoff (1995) present the current account intertemporal approach, which states that current account balances equal to the changes in net foreign assets. This approach is widely used to study external adjustment by international economists. Recent research suggests that this

approach suffers from several drawbacks. Nason and Rogers (2003) find that the intertemporal approach for current accounts does not comply with the results of real data. Gourinchas and Rey (2007) argue that this approach does not take into account the unrealized capital gains and losses due to fluctuations in exchange rates and asset prices. They suggest that net foreign assets should be paid attention to when analyzing the external balance. Net foreign assets positions present a country's indebtedness at any particular time. It contains the cumulated value of current accounts and unrealized capital gains and losses (valuation effects).

2.1. Valuation effects in industrial economies

Economists pay close attention to the importance of valuation effects in external adjustments. Early research focuses on industrial countries using qualitative analysis. A majority of studies suggest that valuation effects play an important role in a country's external adjustment process. Lane and Milesi-Ferretti (2001, 2004, 2007a) show that for many countries, valuation effects have an important influence on net foreign asset positions. Tille (2003), as well as Gourinchas and Rey (2007a), and other scholars find that valuation effects improve the external balance of the United States.

Gourinchas and Rey (2007b) first quantitatively assess the impact of valuation effects on the external balance of the United States. Their results show that about 27% of external adjustment is done through valuation effects channels. Lane and Milesi-Ferretti (2007a) study the external asset positions of European and global imbalances and find that the valuation effects channel deteriorate the external balance in Europe and Japan.

On the other hand, some scholars point out that valuation channels do not necessarily improve a country's external balance. Obstfeld and Rogoff (2005) indicate that capital gains arising from the valuation effect may be offset by losses caused by the depreciation of the dollar; the impact of valuation effects on the net foreign assets of the United States is limited. Benigno (2006) also points out that the existence of price rigidity will reduce the role of valuation effects.

2.2. Valuation effects in emerging market economies

Unlike those of industrial countries, external assets and liabilities in emerging market economies tend to be denominated in foreign currency. The impact of valuation effects from exchange rate movements is complicated.

Lane and Milesi-Ferretti's (2004) study contains an analysis of net foreign assets of six emerging market economies. Their results suggest that although current account balances in Indonesia and Thailand were positive during the period of 1991-2002, the net foreign asset positions declined because of negative valuation effects. The IMF (2005) assesses the valuation effects in 49 countries during 1970-2003. The findings indicate that among 28 emerging market economies, only four economies have significant valuation effects. Lane and Shambaugh (2010) distinguish asset price-related valuation effects and exchange rate-related valuation effects, and

suggest that the valuation effects due to exchange rate changes make up a larger proportion in developing countries.

2.3. Valuation effects in China

Some domestic scholars study the mechanism of valuation effects theoretically. Zhang (2007) suggests that the process of the United States' adjustment for its exchange rate and interest rates affect the valuation effect in countries that have a demand for dollars, increasing the external imbalances of these countries. Fan et al. (2011) reviews the development of the theory of external adjustment, and summarizes the development of the financial adjustment channel.

Little relevant empirical research have been done for the reason that net foreign assets data for China has only been released from 2004 and afterwards, and data for currency structure is unavailable. Song et al (2006) analyzes the valuation effects in China's external adjustment from 1977 to 2002, using an error correction model. They show that there exist negative valuation effects in China. Fan and Shen (2009) calculate the size of valuation effects in China and its proportion of GDP during the period of 1985-2006. They also build cointegration models and error correction models to assess the role of valuation effects. He and Lin (2011) summarize the three methods to estimate valuation effects, and they estimate the valuation effects of China's foreign reserve assets from 2001 to 2009 due to changes in exchange rates with analytical methods.

So far research on valuation effects in China are mainly qualitative analyses. Empirical studies do not distinguish between exchange rate-related valuation effects and asset price-related valuation effects. The contribution of this paper is to estimate the absolute size of valuation effects in China directly, and further examine the structure of the valuation effects on the basis of the estimated currency compositions of foreign assets and liabilities by estimating valuation effects caused by changes in exchange rates and price movement separately.

3. Theoretical framework of estimating valuation effects

3.1. Theoretical framework

According to the framework of net foreign assets developed by Lane and Milesi-Ferretti(2004, 2007a), we can decompose the factors of changes in external positions. The change in the net foreign asset position NFA is given as follows:

$$NFA_t\text{-}NFA_{t\text{-}1}=CA_t+KG_t+E_t \tag{1.1}$$

where NFA_t and $NFA_{t\text{-}1}$ represent the net foreign asset position in period t and t-1; CA_t is the current account balance; KG_t is the capital gain or loss; E_t includes capital account and errors and omissions. Since current accounts can be decomposed into trade balance, current transfers, and invest income balance, Equation (1.1) can be expressed as follows:

$$NFA_t\text{-}NFA_{t-1}=NX_t+ (i_i^A A_{t-1}\text{-}i_t^L L_{t-1}+KG_t)+E_t \tag{1.2}$$

Where NX_t is the sum of trade balance in goods and net transfers, A_{t-1} and L_{t-1} are external assets and liabilities in period t-1, i_t^A and i_t^L are the nominal yields on external assets and liabilities.

Dividing both sides by GDP and using lowercase letters to represent ratios to GDP; we can write the equation (1.2) as follows:[1]

$$nfa_t - nfa_{t-1} = nx_t + \frac{i_t^A A_{t-1} - i_t^L L_{t-1} + KG_t}{Y_t} - \frac{g_t + \pi_t}{(1+g_t)(1+\pi_t)} nfa_{t-1} + \varepsilon_t \tag{1.3}$$

Where g_t is the real growth rate of GDP, π_t represents the inflation rate.

Define kg_t^A and kg_t^L as the capital gain rate on external assets and liabilities, so that $kg_t^A A_{t-1}\text{-}kg_t^L L_{t-1}=KG_t$. We denote the real rate of return on external assets and liabilities by r_t^A and r_t^L, which can be expressed as follows:

$$r_t^A = \frac{1+i_t^A+kg_t^A}{1+\pi_t} - 1\,,\ r_t^L = \frac{1+i_t^L+kg_t^L}{1+\pi_t} - 1 \tag{1.4}$$

Take equation (1.4) into equation (1.3) and simplify. We can rewrite the equation (1.3) as follows:

$$nfa_t - nfa_{t-1} = nx_t + \frac{r_t^L - g_t}{1+g_t} nfa_{t-1} + \frac{r_t^A - r_t^L}{1+g_t} a_{t-1} + \varepsilon_t \tag{1.5}$$

Where a_{t-1} is the ratio of external assets to GDP.

The framework above shows the existence of valuation effects.

We can see from equation (1.5), aside from trade balance, the other terms in the right hand side denote valuation effects. Equation (1.5) presents the existence of valuation effects theoretically. In addition to the trade balance nx_t, valuation effects also affect net foreign assets. According to the equation (1.5), the factors that have influence on the size of valuation channels includes changes in exchange rates and asset prices, net foreign asset position, the size of foreign assets, the currency composition of foreign assets and liabilities, and the internal structure of external positions.

3.2. Methods of measuring the scale of valuation effects

3.2.1. Estimation of the total scale of valuation effects

Following the method used by Lane and Shambaugh (2010), we can express the change in net

[1] Here we simplify the equation by the definition of GDP: $Y_t=Y_{t-1}(1+g_t)(1+\pi_t)$, and exclude the $g_t\pi_t$ term.

foreign assets as follows:[1]

$$NFA_t\text{-}NFA_{t\text{-}1}=CA_t+VAL_t \tag{2.1}$$

Where CA_t is current account balance, VAL_t denotes valuation effect. Rewriting equation (2.1), the estimation of the scale of valuation effects is given by:

$$VAL_t=NFA_t\text{-}NFA_{t\text{-}1}\text{-}CA_t \tag{2.2}$$

3.2.2. Estimation of the composition of valuation effects

Valuation effects can be divided into exchange rate-related valuation effects VAL_t^{XR} and asset price-related valuation effects VAL_t^{MV}. Valuation effects caused by asset price movement are more complex, thus this paper provides the calculation of valuation effects caused by exchange rate changes. Then by subtracting VAL_t^{XR} from the total valuation effects VAL_t, the value of VAL_t^{MV} can be calculated.

From equation (2.1), we can derive the following equation.

$$NFA_t - NFA_{t-1} = CA_t + VAL_t^{MV} + VAL_t^{XR} \tag{3.1}$$

Theoretically, according to the uncovered interest rate parity model, valuation effects arising from changes in exchange rates may be offset by the decrease in domestic asset prices or a decline in investment income. Therefore there is no impact on net financial income. In practice, however, the difficulty to achieve uncovered interest rate parity leads to net valuation effects from exchange rate changes.

Since changes in exchange rates of different currencies are not consistent, in order to study the valuation effects caused by changes in exchange rates, there is a need to incorporate the currency composition of foreign assets and liabilities and financial instruments' structure of external positions. Based on the variables above, the weighted financial exchange rate index can be constructed as follows:

$$I_{it}^A = I_{it-1}^A * (1 + \sum \omega_{ijt}^A * \%\Delta E_{ijt}) \; ; \; \omega_{ijt}^A = \sum_{k=1}^{k=N} \lambda_{it}^{Ak} * \omega_{ijt}^{AK} \tag{3.2}$$

$$I_{it}^L = I_{it-1}^L * (1 + \sum \omega_{ijt}^L * \%\Delta E_{ijt}) \; ; \; \omega_{ijt}^L = \sum_{k=1}^{k=N} \lambda_{it}^{Lk} * \omega_{ijt}^{LK} \tag{3.3}$$

where I_{it}^A and I_{it}^L represent country i's weighted asset exchange rate index and weighted liability exchange rate index in period t, respectively; ω_{ijt}^A and ω_{ijt}^L are the weight of currency j in country i's foreign assets and liabilities; $\%\Delta E_{ijt}$ denotes the percentage change of domestic nominal exchange rates in period t; λ_{it}^{AK} and λ_{it}^{LK} represent the weight of asset k (among portfolio equity, direct investment,

[1] Excluding capital transfer, errors and omissions.

portfolio debt, reserves, and financial derivatives[1]) in country i's external assets and liabilities; ω_{ijt}^{AK} and ω_{ijt}^{LK} measures the weight of currency j of the asset k in country i's external positions.

Define I_{it}^{F} as the total financial weighted exchange rate index:

$$I_{it}^{F} = I_{it-1}^{F} * (1 + \%\Delta I_{it}^{A} * \frac{A_{it-1}}{A_{it-1} + L_{it-1}} - \%\Delta I_{it}^{L} * \frac{L_{it-1}}{A_{it-1} + L_{it-1}}) \tag{3.4}$$

Where $A_{it\text{-}1}$ and $L_{it\text{-}1}$ represent country i's external assets and liabilities respectively; $\%\Delta I_{it}^{A}$ and $\%\Delta I_{it}^{L}$ represent the percentage changs of I_{it}^{A} and I_{it}^{L}.

The equation of exchange rate-related valuation effect VAL_{it}^{XR} is derived as follows:

$$VAL_{it}^{XR} = \%\Delta I_{it}^{F} * (A_{it-1} + L_{it-1}) \tag{3.5}$$

Equation (3.5) extracts the part of the valuation effects caused by exchange rate changes. VAL_{it}^{XR} reflects the sensitivity of country i's net foreign assets to changes in exchange rates, the size of which depends on the variation of the total financial weighted exchange rate index and the total value of a country's external positions. The total financial weighted exchange rate index not only takes into account the changes in the exchange rate, but also contains the currency composition of foreign assets and liabilities.

Taking equation (3.2), (3.3), (3.4) into (3.5), the estimation of exchange rate-related valuation effects is given by:

$$VAL_{it}^{XR} = (\sum \omega_{ijt}^{A} * \%\Delta E_{ijt}) * A_{it-1} - (\sum \omega_{ijt}^{L} * \%\Delta E_{ijt}) * L_{it-1} \tag{3.6}$$

Accordingly, the estimation of asset price-related valuation effects is given by:

$$VAL_{it}^{MV} = VAL_{t} - VAL_{it}^{XR} \tag{3.7}$$

3.3. Econometric model for assessing the role of valuation effects

An important issue in studying valuation effects is the assessment of its importance in external adjustment processes. The IMF (2005) suggests that some impact would cause deviation from long-term relationship among net exports, imports, and net foreign assets. By examining the dynamic response to these shocks, we can assess the role of valuation effects channels in external adjustments empirically. The long-term relationship between net exports, imports, and net foreign assets is given by:

$$NFA_{t} = \sum_{t=0}^{\infty} R_{t,t+i} (X_{t+i} - M_{t+i}) \tag{4.1}$$

[1] Following Lane and Milesi-Ferretti (2007b), foreign assets are divided into portfolio equity, direct investment, portfolio debt, reserves, financial derivatives; foreign liabilities are divided into portfolio debt, direct investment, debt and other investments.

Where NFA_t is net foreign assets; X_t and M_t represent the exports and imports of goods and services; $R_{t,s}$ is the discount factor in period s, which is a function of the real rate of return on net foreign assets r_t. Using the method by Gourinchas and Rey (2007b), a log-linear approximation of equation (4.1) is given by:

$$x_t - \gamma m_t + (\gamma - 1) nfa_t = \sum_{i=1}^{\infty} \rho^i [\Delta x_{t+i} - \gamma \Delta m_{t+i} + (\gamma - 1) r_{t+i}] \tag{4.2}$$

where x_t, m_t, and nfa_t represent the logarithms of exports, imports, and net foreign assets; γ and ρ are the parameters; r_t is the real rate of return on net foreign assets; Δ is the difference operator.

If r_t, Δx_i and Δm_i are all stationary, equation (4.2) indicates that x_i, m_t, and nfa_t are cointegrated. The left hand side in the equation is the deviation from the long-term relationship of variables.

Under the assumption that x_t, m_t and nfa_t are cointegrated, the vector error correction model (VECM) can be constructed to assess the impact of valuation effects on external adjustments. The model is as follows:

$$\Delta Y_t = c + \alpha \beta' Y_{t-2} + \Gamma(L) \Delta Y_{t-1} + e_t \tag{4.3}$$

where $Y = [x, m, nfa]$; ΔY_t is the first difference of Y_t; Γ is the coefficient matrix; $\beta' Y_{t-1}$ is the deviation from the long-term relationship in the last period; L represents the lag operator; α is the vector of adjustment coefficients, which determines the adjustment of each variable after the deviation from the long-term relationship. The significance of coefficient α assesses the role of changes in net foreign assets in restoring the long-run relationship. The size of α also indicates the importance of valuation channels. A large α, which is significant, implies a more important role of valuation channels in external adjustments. If α is not statistically significant from 0, net foreign assets have little impact on the process of external adjustment. Under this circumstance, adjustment is mainly done through trade channels instead of valuation channels.

4. Estimation of the valuation effects in China

4.1. Data

According to the theoretical models discussed earlier, the data we need includes foreign assets and foreign liabilities, net foreign assets, current account balances, the currency composition of foreign assets and foreign liabilities, and nominal exchange rates of the main currencies in foreign positions.

The data of foreign assets, foreign liabilities, and net foreign assets during the period of 1982-2004 come from an updated version of the EWN II database constructed by Lane and Milesi-Ferretti (2007b), and the data during the period of 2005-2012 is from the State Administration of

Foreign Exchange of China[1] (SAFE of China). The current account balance data is from the State Administration of Foreign Exchange of China. The exchange rate data is from the IMF's IFS database and SAFE of China's website. The currency compositions of foreign assets and foreign liabilities are obtained by estimation.

Considering the availability of data, the period of estimation of total valuation effects is from 1982 to 2012. The range of estimation of exchange rate-related valuation effects and asset price-related valuation effects is from 2000 to 2012.

4.2. Currency composition of China's external positions

Data of currency composition during the period of 2000 to 2004 comes from the database constructed by Lane and Shambaugh (2009), which contains 117 countries data from 1990 to 2004. Because the currency structures of foreign assets and foreign liabilities are not published; so following the previous study, we estimate the currency composition of China's foreign assets and liabilities from 2005 to 2012.

4.2.1. Estimation of the currency composition of China's foreign assets

Foreign assets are divided into portfolio investments, direct investments, reserves, debt, other investments, and financial derivatives.[2] We estimate the currency structures for each type of asset.

Reserves are the main form of China's external assets. Following Zhang et al. (2010), we estimate the currency composition of China's reserves on the basis of data from the United States Treasury's International Capital System (TIC) and the IMF's Currency Composition of Official Foreign Exchange Reserves (COFER) database.

For reserves denominated in U.S. dollars, we obtain data of U.S. securities held by China during the period of 2005-2012 via reports of foreign holdings of U.S. securities positions published by TIC.[3] In addition, we calculate the weights of assets denominated in dollars in China's reserves. For non-dollar assets, we calculate the relative proportions of yen, euro, British pounds, and other currencies according to the data of currency structures of emerging markets and developing countries' reserves from the COFER database. The results are shown in Figure 1 and Figure 2.

Combining the data of assets denominated in dollars and non-dollar assets, we calculate the proportions of dollars, yen, euros, British pounds, and other currencies. The results are shown in Table 1.

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[1] According to Lane and Milesi-Ferretti (2007b), gold assets are not liabilities for another countries, thus gold assets are excluded from the foreign assets. This paper also adjusts the data from State Administration of Foreign Exchange of China accordingly. The EWB database covers data in 2007 and before, the rest of data is from SAFE. Comparing the statistic details of the data in 2005-2007 from the two databases, the statistical methods are the same for foreign assets, and slightly different for foreign liabilities.

[2] For many developing countries include China, the financial derivatives data is not available, thus following Lane and Shambaugh (2007), the weight of financial derivatives is 0.

[3] We use the U.S. securities held by China to estimate the assets denominated in dollars in China's foreign assets. Zhang et al. (2010) analyze the error of this measure.

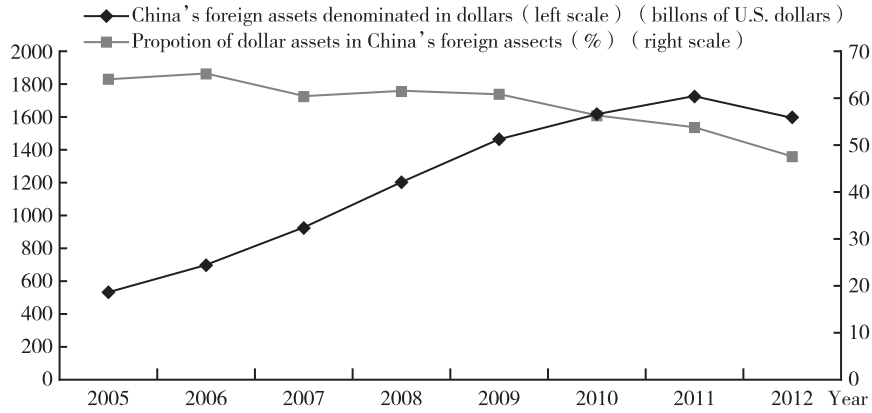

Figure 1. Foreign assets denominated in dollars and the proportion

Note: Data is from TIC and SAFE. The weight of assets denominated in dollars is calculated based on the data.

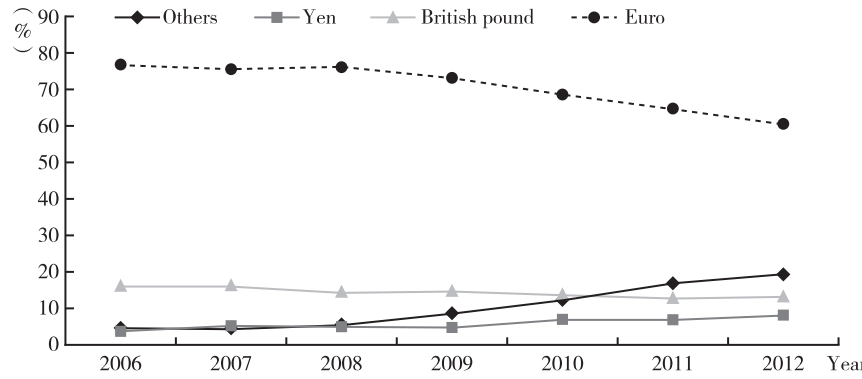

Figure 2. Currency composition of reserves for developing countries

Note: Data is from IMF's COFER database. The weights are calculated from the data.

Table 1

Currency composition of China's reserves in 2005-2012

	Dollar	Yen	Euro	British pound	Others
2005	64.2%	1.5%	27.9%	4.9%	1.5%
2006	65.4%	1.2%	26.4%	5.4%	1.5%
2007	60.3%	1.9%	29.9%	6.2%	1.7%
2008	61.8%	1.9%	29.1%	5.3%	1.9%
2009	60.6%	1.7%	28.7%	5.6%	3.4%
2010	56.2%	2.9%	29.8%	5.8%	5.3%
2011	53.9%	3.0%	29.8%	5.8%	7.6%
2012	47.8%	3.9%	31.6%	6.8%	9.9%

Note: Data is from TIC and IMF's COFER database. The weights are calculated based on the data.

In addition to reserve assets, the forms of foreign assets contain direct investment, portfolio investment, debt, and other investments. As relevant information is not published, the currency structure of these assets can only be roughly estimated. Compared with reserve assets, other assets account for a relatively small proportion, so the estimation error for these assets has little impact on the estimation of the overall currency structure.

For direct investment, since the majority of China's outward direct investments during the period of 2009-2011 are in Hong Kong, only a few investments went to Japan, the United States, and Europe. Following Lane and Shambaugh (2010), we assume that foreign direct investments are denominated in the currency of the destination country. Thus, it is reasonable to assume that direct investments in China's foreign assets are denominated in Hong Kong dollars.[1] For portfolio investments, we estimate the currency structure by the investments of the Qualified Domestic Institutional Investor (QDII). At present, China's QDII funds are invested mainly in Hong Kong and the United States, among which investments in Hong Kong are much greater than those in the United States. Because the proportion of portfolio investments is relatively small in terms of total assets, we roughly estimate that China's portfolio investments are held in Hong Kong dollars. For debt and other investments, following Lane and Milesi-Ferretti (2007b), we estimate that all debt and other investments are in dollars.

In addition, according to the Chinese International Investment Positions data from the State Administration of Foreign Exchange of China, we calculate the internal structure of China's foreign assets in the period of 2005-2012, which is shown in Figure 3.

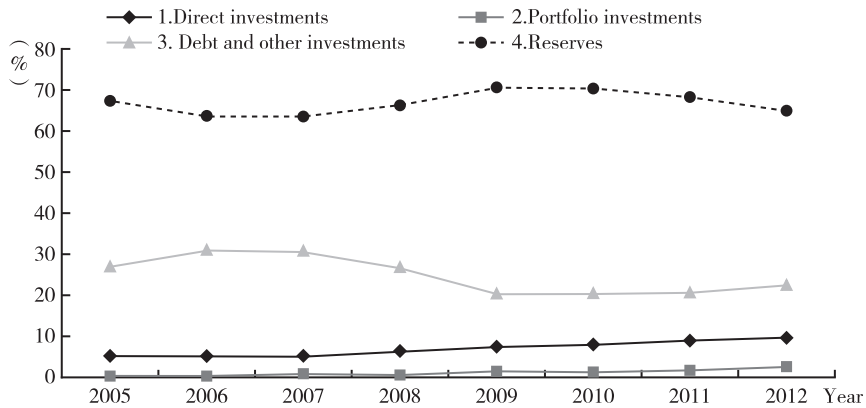

Figure 3. Internal structure of China's external assets[2]

[1] According to China statistical yearbook, in 2009 and 2010, the foreign direct investments are 56.529 billion dollars and 68.811 billion dollars. The investments to Asian are 40.408 billion dollars and 44.89 billion dollars, among which the investments to Hong Kong China are 35.601 billion dollars and 38.505 billion dollars.

[2] Following Lane and Milesi-Ferretti (2007b), we adjust the data from SAFE of China. We exclude components in portfolio debt except for equity securities, and we combine debt and other investment to one term.

Combining the currency composition for each type of assets and internal structure of China's foreign assets, we calculate the currency composition of total foreign assets using the following equation:

$$\omega_{ijt}^{A} = \sum_{k=1}^{k=N} \lambda_{it}^{Ak} * \omega_{ijt}^{Ak}$$

Where λ_{it}^{Ak} is the weight of asset k in the country's i's foreign assets; ω_{ijt}^{Ak} is the weight of currency j in asset k in country i's foreign assets. The results are shown in Figure 4.

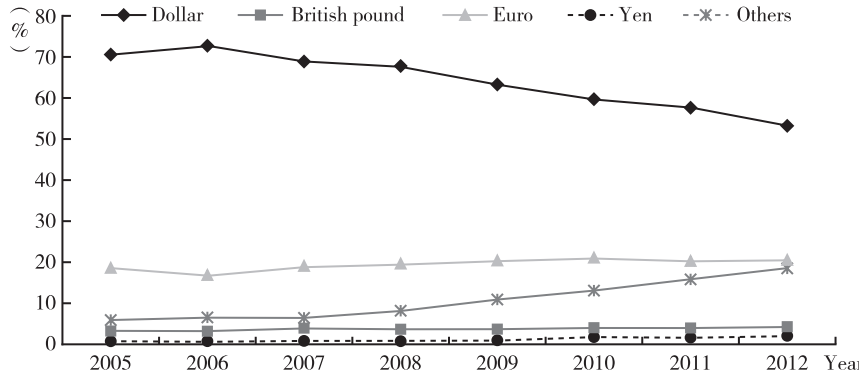

Figure 4. Currency composition of China's foreign assets

4.2.2. Estimation of the currency composition of China's foreign liabilities

Foreign liabilities are divided into portfolio debt, direct investment, debt, and other investments. We estimate the currency structures for each type of liabilities.

For direct investment and portfolio debt, following Lane and Shambaugh's (2010) assumption that direct investment and portfolio debt are held in the destination country's currency, we estimate that China's foreign direct investment and portfolio debt are denominated in Renminbi.[1]

For debt and other investments, we use the data of currency composition of China's external debt from the State Administration of Foreign Exchange of China as anestimation. The results are shown in Table 2.

In addition, according to the Chinese International Investment Positions data from the State Administration of Foreign Exchange of China, we calculate the internal structure of China's foreign liabilities during the period of 2005-2012, which is shown in Figure 5.

[1] Under this assumption, we ignore the equity securities listed abroad. Generally this part of securities can be considered denominated in the country where they are listed. Since the proportion of portfolio investment is quite small in China's external liabilities, such treatment would not lead to big errors.

Table 2
Currency composition of China's debt and other investments

	Dollar	Yen	Euro	Others
2005	68.40%	11.73%	7.29%	12.58%
2006	69.71%	10.86%	7.30%	12.13%
2007	68%	11%	7%	14%
2008	68%	12%	6%	14%
2009	67.76%	11.89%	6.38%	13.97%
2010	70.41%	8.56%	4.41%	16.62%
2011	75.94%	8.06%	7.49%	8.51%
2012	77.83%	7.37%	6.58%	8.22%

Note: Data is from SAFE of China. We use the data of debt to estimate the currency structure of debt and other investments in China's external liabilities.

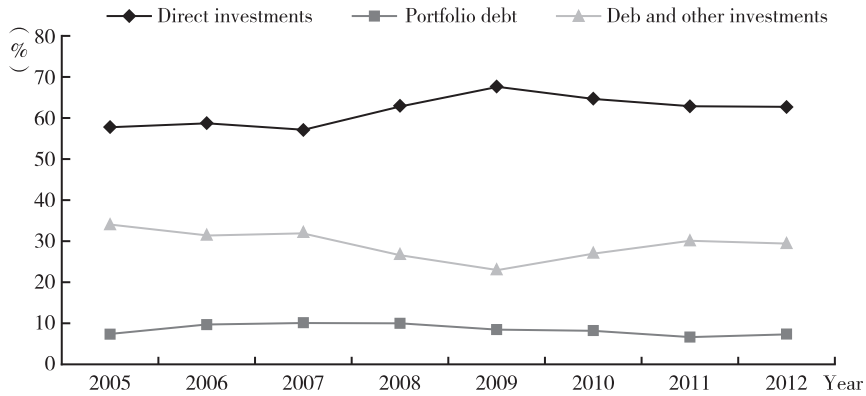

Figure 5. Internal structure of China's external liabilities
Note: Data is from SAFE of China, and adjusted according to EWN database.

Combining the currency compositions for each type of liabilities and internal structure of China's foreign liabilities, we calculate the currency composition of total foreign liabilities using the following equation:

$$\omega_{ijt}^{L} = \sum_{k=1}^{k=N} \lambda_{it}^{Lk} * \omega_{ijt}^{Lk}$$

Where λ_{it}^{Lk} is the weight of liability k in country's i's foreign liabilities; ω_{ijt}^{Lk} is the weight of currency j in liability k in country i's foreign liabilities. The results are shown in Figure 6.

4.3. Estimation of the scale of valuation effects

Based on equation (2.2) and the data above, we estimate the scale of total valuation effects in

China during the period of 1982-2012. Figure 7 shows the estimated values of valuation effects[1] in China and the scale of current account balance, respectively.

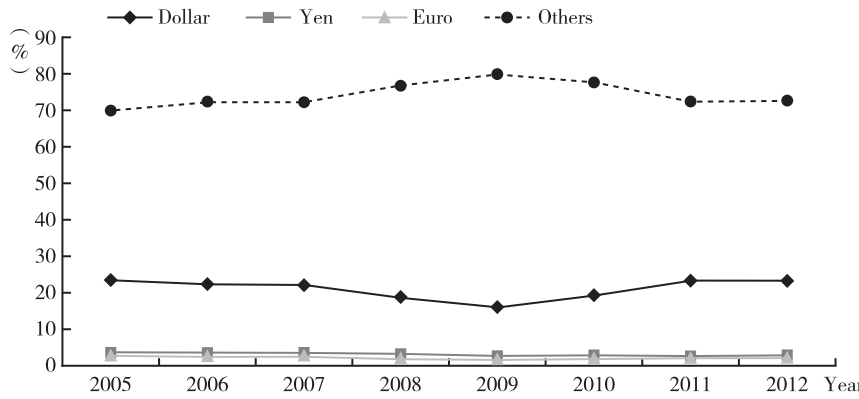

Figure 6. Currency composition of China's foreign liabilities

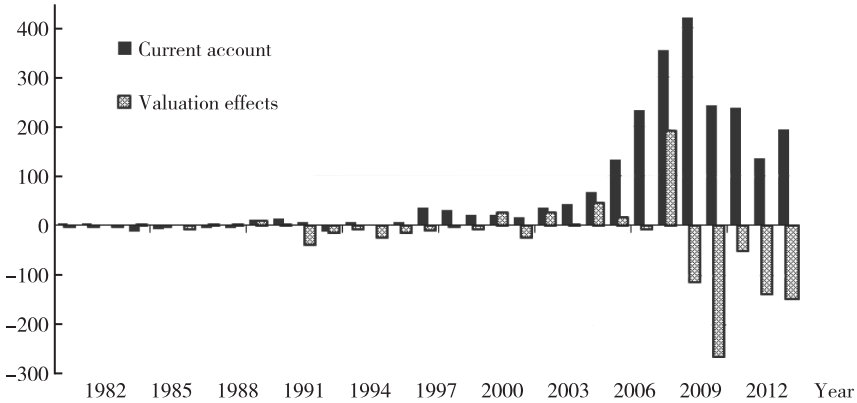

Figure 7. The scale of valuation effects and current account balance in China (billions of U.S. dollars)

The valuation effects in China's external adjustment are negative in most of the 31 years: total valuation effects are negative from 1982 to 1987 except for in 1985, as well as in 1992-1999, and in 7 out of 13 years during 2000-2012. Negative valuation effects reduce the net external asset position in China. The scale of valuation effects increase over time with certain volatility. Before 1990, the values of current account balance and valuation effects were small, but gradually increased afterwards. Then there was a rapid growth of the two variables after the 2004. In 2007, the valuation effects in China reached a maximum size of $189.962 billion (See Table 3). Since 2005 (except for 2007), the effects of the valuation have been large negative values. In 2009, the scale of valuation effects reached -$266.75 million, which was larger than the absolute value

[1] We present the estimation results in dollars. We ignore the results converted to Renminbi due to the limitation on pages.

of the current account balance of $243.257 billion in the same year, indicating that negative valuation effects has completely offset the increase in net external assets from the current account surplus. In other years, the negative valuation effects also reduce the contribution of current account surplus to net foreign assets to a large extent.

4.4. Estimation of the structure of valuation effects

Based on equations (3.6) and (3.7), we estimate the composition of valuation effects. We estimate the scale of asset price-related valuation effects and exchange rate-related valuation effects separately.

Table 3 reports the estimated value of total valuation effects (VE), exchange rate-related valuation effects (VE: exchange rate), asset price-related valuation effects (VE: asset price), and the scale of the current account balance (CA).

Table 3
The scale and of China's valuation effects and its structure from2000-2012(billions of U.S. dollars)

Year	CA	VE	VE: Exchange rate	VE: Asset price	Year	CA	VE	VE: Exchange rate	VE: Asset price
2000	20.52	25.93	-3.34	29.27	2007	353.18	189.96	-16.88	206.84
2001	17.41	-25.74	-3.33	-22.41	2008	420.57	-114.77	-114.38	-0.39
2002	35.42	24.65	12.77	11.89	2009	243.26	-266.75	32.26	-299.01
2003	43.05	0.91	17.73	-16.82	2010	237.81	-51.27	-98.23	46.97
2004	68.94	45.57	7.82	37.76	2011	136.10	-140.60	-114.99	-25.61
2005	132.38	14.60	-34.45	49.06	2012	193.14	-148.88	12.74	-161.62
2006	231.84	-7.41	7.92	-15.32					

As can be seen from the table, the valuation effects caused by asset price changes are negative in 7 out of 13 years during the period of 2000-2012. The asset price-related valuation effects reached a maximum value of $206.84 billion in 2007, and the maximum absolute value of negative effects of -$299.01 billion in 2009. Valuation effects caused by exchange rate movements were negative in 7 out of 13 years during 2000-2012, and increased rapidly after the exchange rate reform in 2005. The value of exchange rate-related valuation effects was $ -114.38 billion in 2008, and reached the maximum absolute value of $ -114.99 billion in 2011.

From the discussion above, we find that exchange rate-related valuation effects and assets price-related valuation effects have large volatility, and the latter has larger fluctuations than the former. The changes in valuation effects caused by asset price movements are the main factors leading to changes in overall effects. The role of exchange rate-related valuation effects has grown rapidly since 2005.

5. The role of valuation channels in external adjustments

5.1. Variables and data

According to the method used by IMF (2005), the variables for empirical study are net foreign assets, exports, and imports. Since some of the values of net foreign assets are negative, we cannot follow the IMF (2005) using a logarithmic approach. Instead we use the ratios of the variables to nominal GDP and define them as NFA, IM, and EX. This may affect the prediction efficiency of the model, but it has no practical impact on the significance of the valuation effects in the statistical test.

The period we study is 1981-2012. The data of net foreign assets from 1981-2004 comes from an updated version of the EWN II database constructed by Lane and Milesi-Ferretti (2007b), and data from 2005-2012 is from the State Administration of Foreign Exchange of China. The values of imports, exports, and nominal exchange rates are from the IMF's IFS database. The GDP data is obtained from the CEINET statistics database provided by the China Economic Information Network, and converted to the U.S. dollars using the average exchange rate over the same period.

5.2. Unit root test

Before analyzing the relationship among China's foreign assets, imports, and exports, we need to test whether these variables are stationary. We conduct an ADF test to NFA, IM, and EX. The results indicate that the three variables are all non-stationary, but their first differences dNFA, dEX, and dIM are stationary. Thus we conclude that NFA, IM, EX are I (1).

Table 4
ADF test

Variables	(c,t,k)	ADF statistics	5% significance level	P-value	Stationary
NFA	(c,0,0)	-0.4826	-2.9604	0.8817	Non-stationary
EX	(c,0,0)	-1.3653	-2.9604	0.5861	Non-stationary
IM	(c,0,0)	-1.5737	-2.9604	0.4837	Non-stationary
DNFA	(0,0,0)	-3.3036	-1.9525	0.0018	Stationary
DEX	(0,0,0)	-4.7195	-1.9525	0.0000	Stationary
DIM	(0,0,0)	-4.0426	-1.9525	0.0002	Stationary

Note: In test form(c,t,k), c,t and k represent intercept term, time trend and lag term. 0 indicates that the term is not contained. The order of lag is picked according to AIC.

5.3. Cointegration

We conduct the Johansen test to NFA, EX, and IM, choose the model with the intercept term

but no trend, and choose the smallest lag to be 1 according to AIC criteria. The results are shown in Table 5.

Table 5
Johansen test

Null hypothesis	Eigenvalue	Trace	Maximum eigenvalue
0 cointegration vector	0.5185	37.5424(0.0053)*	27.7739(0.0050)*
At least 1 cointegration vector	0.2023	9.7685(0.2990)	7.6941(0.4107)
At least 2 cointegration vectors	0.0564	2.0743(0.1498)	2.0743(0.1498)

Note: P-value is given in the parenthesis. * denotes significant at 5% significance level.

The results indicate that a cointegration vector exists among NFA, EX, and IM. The results from the trace test and Eigenvalue test both suggest a cointegration vector among the three variables. According to the Johansen test, the cointegration among net foreign assets, exports, and imports is as follows:

$$NFA = 15.8185 * EX - 21.7473 * IM$$
$$[3.0529] \quad [3.8456]$$

The equation above shows that the coefficients of EX and IM are statistically significant, which suggests that a long-term cointegration exists among net foreign assets, exports, and imports in China during the period of 1981-2012. Net foreign assets are positively correlated with exports, and negatively related to imports, which is consistent with empirical facts.

5.4. Vector error correction model

Given the condition that NFA, EX, and IM are cointegrated, we establish the vector error correction model. We choose the model containing an intercept term and no trend by observing the data. The regression results are shown in Table 6.

According to the results above, the vector of adjustment coefficients is not statistically significant. This indicates that the role of valuation effects in China's external adjustment is limited, and the process of adjustment is mainly done through trade channels. The results are consistent with the fact that current account balance plays an important role in China's external adjustment due to policy encouraging exports, and valuation effects play a minor role.

Due to the limitations of the data, a vector error correction model can be applied only to annual data to analyze the entire interval of 1981-2012 and the periodic changes cannot be accurately measured. The magnitude of changes in exchange rate in China increased since the reform of the exchange rate regime in 2005. In addition, the values of China's external positions

and net foreign assets are in rapid growth. Changes in these factors can increase valuation effects. Combined with estimation results, we find that the scale of valuation effects increased since 2007, which plays a more and more important role in China's external adjustment.

Table 6
Estimated value of VECM

	D(NFA)	D(EX)	D(IM)
Vector of adjustment coefficients	-0.0398 [-1.9323]	-0.0429 [-2.8260]	0.0044 [0.3055]
D(NFA(-1))	0.5649 [2.5884]	0.2750 [1.7097]	0.0341 [0.2219]
D(EX(-1))	0.3349 [0.8697]	-0.4107 [-1.4474]	-0.4038 [-1.4874]
D(IM(-1))	-0.8967 [-1.9832]	0.2476 [0.7433]	0.6298 [1.9756]
Intercept	0.00422 [0.6715]	0.0051 [1.1152]	0.0039 [0.8897]
R^2	0.3423	0.3242	0.1429
AIC		-14.2757	

Note: The t-value is given in brackets.

6. Conclusions

This article gives a quantitative estimation of the scale of valuation effects in China, and examines the structure of valuation effects by estimating exchange rate-related valuation effects and asset price-related valuation effects separately. On the basis of these estimates, we assess the impact of valuation effects on China's external balance empirically by establishing a vector error correction model.

The results show that the valuation effects in China are negative in the 30 years between 1982 and 2012. Negative valuation effects reduce the net external asset position in China. The main factor contributing to this change of valuation effects is the movement in asset prices. Changes in exchange rates also play an increasing role. From 1981 to 2012, the role of valuation effects in the external adjustment process in China were limited, but the impact has been growing since 2007. This trend should be paid close attention to.

In order to reduce the influence of negative valuation effects on China's net foreign assets, several policies should be undertaken, which include promoting the internal and external equilibrium during the process of China's economic development, improving currency composition management of China's net foreign assets, and increasing Renminbi's global role and the flexibility of the currency's exchange rate.

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