THESIS

FINANCING THE U.S. DEFICIT: ADJUSTMENT MECHANICS BETWEEN THE U.S. AND JAPAN

Submitted by

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In partial fulfillment of the requirements

For the Degree of Master of Arts

Colorado State University

Fort Collins, Colorado

Fall 2009

COLORADO STATE UNIVERSITY

Nov 3, 2009

WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY SHENGLIN QIAN ENTITLED FINANCING THE U.S. DEFICIT: ADJUSTMENT MECHANICS BETWEEN THE U.S. AND JAPAN BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS.

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ABSTRACT OF THESIS

FINANCING THE U.S. DEFICIT: ADJUSTMENT MECHANICS BETWEEN THE U.S. AND JAPAN

Japan has run a large trade surplus with the U.S. and has financed the U.S. deficit for a long time, so the adjustment mechanism of financial flows between the U.S. and Japan is an important issue. In this paper, in order to investigate the capital flow between Japan and the U.S, I build a VAR model to study the fluctuations of interest rate spread between the U.S. and Japan and international reserve of Japan. The analysis of the Impulse Response Function suggests that the dynamic response to an event, such as the rise of the deficit of the U.S. is such that movements in the international reserve of Japan and the interest rate spread tend to restore equilibrium. To support my conclusion, I use the subset of the sample data to simulate and forecast the real event. The work shows that the model can accurately explain the adjustment process.

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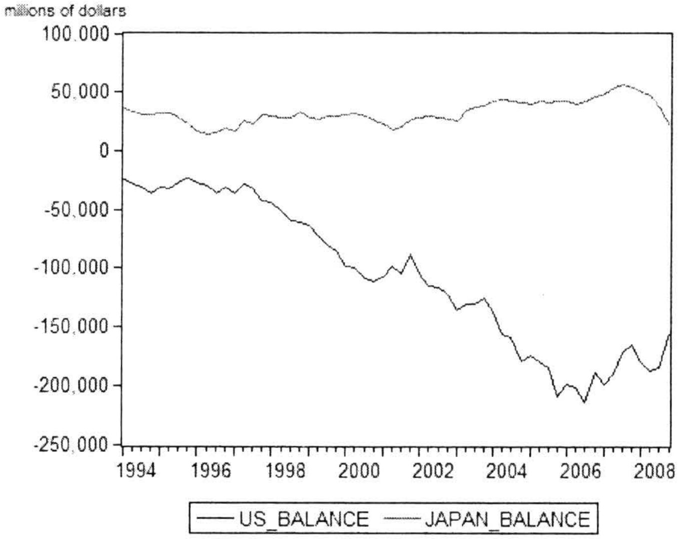
1. Introduction:

Till about the 1980s, the U.S was a net creditor country, but then a turning point occurred and the U.S began to be a net debtor, and is the currently largest debtor country in the world. Mckinnon (2001) suggested that this growing deficit need be a cause for concern[1]. The situation of the U.S is very different from that of other debtor countries. The dollar is key currency in international settlement and payment. This places the dollar in a privilege position that there is no exchange rate risk and makes the deficit of the U.S. owned in dollars. Mann (1999) argued that whether the U.S can sustain these imbalances depends on various factors. An important factor is that investors will choose dollar denominated assets and keep the dollar high as long as the growth of the rest of world remains low. Currently, the dollars has a kind of hegemonic position in the international financial system. With the exception of European countries, many exports of goods and services are invoiced in dollars. According to Gilpin's work (2001) "somewhere between 40 and 60 percent of international financial transactions are denominated in dollars. For decades the dollar has also been the world's principal reserve currency; in 1996, the dollar accounted for approximately two-thirds of the world's foreign exchange reserves". In Asia, a lot of countries trade in dollars and their primary international reserves are dollar assets.

[1] The term deficit in this paper refers to the current account deficit.

Japan has a great share in financing the deficit of the U.S., likewise a great share of trade surplus of Japan comes from the trade with the U.S. In December, 2000, Japan financed about half of the total deficit of the U.S. (total deficit is 609.2 million and Japan holds 319.7 million). In December, 2001, Japan hold 317.9 million, and the total deficit was 619.4 million. (Data source: IMF international Financial Statistics) The proportion decreased sharply in recent years. By 2008, Japan held only about 1/5 of the total deficit of the U.S. The history of the data of the current account balance suggested that the economic relationship between them can be considered as a typical example of core-periphery. The term core-periphery refers to an asymmetry in the manner in which developed countries (the core) and emerging markets (the periphery) are integrated into trade and financial relations. The core country enjoys a hegemonic position as the center of international financial relations. Trade surplus countries in the periphery country like Japan, follow a policy of undervaluing their currency in order to Gain the price advantage in exports. In the following figure, the current account balances of Japan and the U.S. always have the opposite path.

Figure 1 The current account balance of Japan and the U.S during 1994-2008



US_BALANCE is the current account balance of the U.S

JAPAN_BALANCE is the current account balance of Japan

The unit of the current account balance is millions of dollars

Data source: Organization for Economic Co-operation and Development

Following the period of Japan bashing from 1987 to 1995 bilateral trade between China and the U.S. rose very quickly. However, bilateral trade between US and Japan is still very important in sample period (1994-2008).

Figure 1 shows the historical data of the current account balance of Japan and the U.S. The current account deficit of the U.S. keeps rising, but that of Japan is relatively steady. Before 2000, the opposite path is more obvious. As the current account balance of Japan increases, the one of the U.S. will decrease. After 2000, this kind of trend is not obvious. McKinnon's paper (2006) offered an explanation for it. He argued that the trade between the U.S and China grew very quickly, and thus the share of the current account balance of the U.S. contributed by China became increasingly important. In 2000, China and Japan first had the same amount of bilateral trade with the U.S. Now China has come to be to be the largest export country to the U.S. In other words, the main reason for the sharp decrease of current account balance of the U.S. after 2000 is the growth of bilateral trade with China. Japan's experience provides an important lesson for China.

Figure 2 The current account balance of Japan and the U.S during 1985-1995

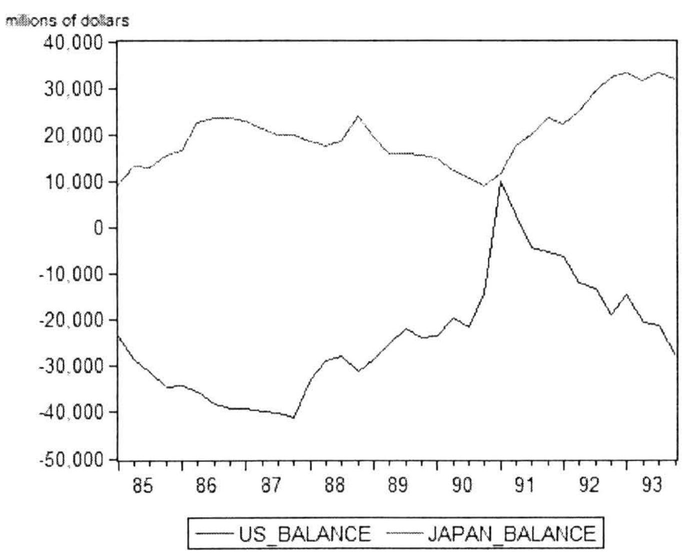


Figure 2 shows the current account balance between the U.S. and Japan during the earlier period 1984-1994. The opposite trends in the balances between the two countries are more obvious in this period. Here is a lot of evidence to show that the position of Japan and the U.S is asymmetrical. One of the most convincing evidence is the "lost decade" of Japan. As more and more Japanese goods appeared in the American market, the American government began to apply pressure to the Japanese government to allow the yen to appreciate. When Japan appreciated the yen, the biggest recession in Japanese modern history began. In April of 1995, the U.S. Treasury Secretary announced a new "strong dollar" policy, which was supposed to help the economy of Japan. Later, by using IRF (Impulse Response Function), the response of Japan will be studied. This core-periphery relationship is well studied in Dooley et al paper (2004). After the Second World War, the U.S became the central region, and Europe and Japan constituted the emerging periphery countries. These periphery countries choose a strategy of undervalued currencies, in order to promote exports. By following this strategy, they are forced to hold huge international reserves. As a result, a kind of core-periphery relationship was formed, such as the relationship between Japan and the U.S. Currently, a lot of periphery countries mainly in Asia choose the same export promotion strategy as Europe and Japan did in the earlier period, undervaluing the exchange rate, accumulating reserves, and encouraging export-led growth. This is what Dooley et al (2004) called "Revived Bretton Woods". Some argued that the system may break down if the labor surpluses are exhausted or the confidence in dollar is weakened. The sustainability of the US global imbalances remains a controversial topic. In Gourinchas and Rey's work (2004), they argue that the privilege of the dollars makes the U.S to exercise as the "World banker". Mckinnon (2001) suggests that the U.S. acts like a financial intermediary internationally, and the dollar playing the role of the international reserve currency.

The analysis of this paper suggests that the imbalance between the U.S. and Japan cannot be cleared automatically. Although the deficits create liquidity to the international monetary system, it also increases the financial fragility. The impact coming from the growing deficit is analyzed in this paper, and results suggest adjustment between the U.S. and Japan tends to be stable.

In this paper, I first review the historical data of the current account balance of Japan and the U.S. to highlight the nature of the relationship between the U.S and Japan as a core-periphery relationship. In the next section, I build the VAR model with the international reserve of Japan and the interest rate spread. We study the fluctuations in international reserve and interest rate spread and investigates the adjustment mechanisms of financial markets. After the estimation of VAR, the IRF (Impulse Response Function) will be shown. The IRF is consistent with what the theory predicted. Towards the end of this paper, the simulation and forecasting results show that the IRF can explain the actual response fairly closely.

2. Background

2.1 Global Imbalance

During 1981-1992, the deficit of the U.S. had cumulated to about $1 trillion, and Japan's current account surpluses accounted for about two-thirds of that total (Economic Report of the President and Bank of Japan). The U.S. trade deficit grew rapidly from $26 billion in 1980 to $160 billion in 1987.In the meantime, Japan's trade account increased from negligible amount in 1980 to $90 billion in 1986 (International Monetary Fund).In 2006, the U.S receives 22.8% of the exports of Japan. This close relationship between the U.S. and Japan suggests that the capital flow between these two countries raises important questions for the functioning of the international monetary system.

2.2 Framework of analysis

Dooley (2004) argued that in the 1960s, the international system was composed of a core and a periphery. The core was the U.S. and the periphery was Europe and Japan. Today, we cannot view Europe as a periphery any more, but Japan still runs a lot of trade surpluses with the U.S. and has a close economic relationship. The significant character of a core-periphery relationship is that the core country has open capital and goods markets, and the surplus trade account country chooses a strategy of devaluation of currencies, controls on capital and trade, and reserve accumulation. The argument is that, many developing countries today(especially China) have adopted the same strategy as post-war Europe and Japan, and have in essence help to recreate the mechanisms of the Bretton Woods system.

Vasudevan (2010) models a three-country world to describe the core-periphery relationship. In this model, the U.S has a large deficit with trade partners like Japan, which have a huge trade surplus and capital account country in the emerging markets. The U.S can be viewed to be at the apex of a triangular with large deficits with trade partners, and with surpluses with debtor countries. The international reserve and interest rate spread are used to trace out the adjustment mechanics. In the money markets, the government can adjust the international reserve to clear this market. Thus, for any given level of international reserve which clears the money markets, there will be an interest rate spread to set the bonds markets equilibrium. It is the same story for any given level of interest rate spread. Alvarez, Atkeson, and J. Kehoe (2009) also argue that the interest rate spread is a key point to explain the movement of capital. Vasudevan (2010) demonstrates that the dynamic adjustment in the finance market of creditor countries will be stable when they face some impacts from the U.S., such as the growing deficit.

In this paper, the international reserve of Japan and the interest rate spread will be used to study the adjustment mechanics between the U.S. and Japan, and this work will provide the empirical support for the theory. More specifically, it gives a empirical description to the adjustment process. The result also suggests that the adjustment is stable.

2.3 Equilibrium in the financial markets

In this paper, I investigate the adjustment mechanisms of financial flows between US and Japan modeled as a system with the two bonds markets and two money markets by studying the pattern of movements of the international reserves and the interest rate spread.

First, the concept of interest rate spread needs some explanation. From the uncovered interest parity relation, the American investors should get the same return no matter if they bought dollar or yen assets. In other words, there is no interest arbitrage. Suppose that there is an investor who faces two options. One option is holding a dollar asset which has an interest rate i_{us}, and the other option is holding a yen asset which has an interest rate i_{japan}. The dollar case is easy because the investor just gets i_{us} in the next period. The yen case is somewhat complicated. We suppose the exchange rate is E_1 now, and the expectation of the next period exchange rate is E_2^e. Then the investor should buy yen now, and in the next period, he will buy dollars back, so the return is

$$\frac{E_1(1 + i_{japan})}{E_2^e}$$

We know that the returns should be equal, so we get

(1) $(1+i_{u.s}) = (1+i_{japan})(\frac{E_1}{E_2^e})$

By using approximation, we get

(2) $i_{u.s} \approx i_{japan} - \frac{E_2^e - E_1}{E_1}$

This is the theory about the relationship between the exchange rate and the interest rates, but in the real world this uncovered interest parity relation does not always hold true. Risk over time is a key point to explain the movement of capital. If we consider the risk premia, so the equation can be written as follows

(3) $\delta = i_{u.s} - i_{japan} + E(e)$

E(e) is the expected rate devaluation of yen,

$$\frac{E_2^e - E_1}{E_1}$$

δ is the interest spread which can be viewed as the risk premia.

When δ goes up, it means that the yen assets are more attractive than the dollar assets, and when δ goes down, the dollar assets are expected to have a higher return. In this case, δ is a determinant of the bonds market equilibrium.

In Godley and Lavoie's work (2006), they build a two-country model which describes the capital flows under flexible exchange rates. They let the interest rate be exogenously determined by government policy, and reserve holding to adjust the equilibrium in money markets. In contrast, Taylor (2004a, 2004b) let the interest rate be determined endogenously as markets are cleared. He proves that for a two-country closed system there are only two equilibrium conditions for the finance market that are independent. Based on this theory, for any given international reserves of Japan to balance the money markets, there is an interest rate spread to balance the bonds market. Vasudevan (2010) starts from a similar framework and investigates the dynamic adjustment patterns which can be described by two equations. They are:

(4) $\dot{\delta} = \delta(\delta, \sigma) \quad \frac{\partial \dot{\delta}}{\partial \delta} < 0, \frac{\partial \dot{\delta}}{\partial \sigma} < 0$

(5) $\dot{\sigma} = \sigma(\delta, \sigma) \quad \frac{\partial \dot{\sigma}}{\partial \delta} > 0, \frac{\partial \dot{\sigma}}{\partial \sigma} > 0$

where δ is the interest rate spread and σ is the international reserve of Japan. In equation 4, the first derivatives of $\dot{\delta}$ respect to δ and σ are both negative, but in equation 5, the first derivatives of $\dot{\sigma}$ respect of δ and σ are both positive. When the deficit of the U.S. increases, it would lead to an excess supply of its bonds. The central Bank in Japan needs to absorb this excess supply of bonds, so the international reserve of Japan will increase. An increase in international reserve would lead to appreciation of yen, eroding reserve accumulation through its impact on reducing the trade surplus. For the expected depreciation of the dollar, the interest rate spread will increase with rising reserves. However, in the further, the increasing interest rate spread means that holding dollar is more risk, so that can explain the negative signs in the equation 4. Since the increase in international reserve of Japan would lead to an depreciation of the dollar, it explained the positive sign in $\frac{\partial \dot{\sigma}}{\partial \delta} > 0$. When the interest rate spread increase, it will also lead depreciation of the dollar, and make itself bigger ($\frac{\partial \dot{\sigma}}{\partial \sigma} > 0$). The simulation results are given by Vasudevan (2010) by setting simple linear, first-order form. This paper analyzed this dynamic process empirically by using IRF, and confirms that stable adjustment pattern.

Based on the theory stated above, the fluctuations in international reserve of Japan and the interest rate spread will be analyzed to investigate the adjustment mechanics.

3. Model &Method:

Since the dynamic relationship is going to be investigated in this paper, the VAR (Vector Autoregression) method is a preferred way. Unlike simultaneous-equation models, VAR model is a-theoretic. Sims (1980) and Litterman (1979, 1986) argue that VAR would predict better than the simultaneous-equation model. However, the biggest challenge for the VAR model is to decide the lag length. The normal way is to compare the Akaike Information Criterion or Schwarz Bayesian Criterion. In Bahmani-Oskooee and J. Brooks' work (2003), they suggest that the goodness of fit can also be used as a criterion. However, the lag length problem is very complicated and not the focus of this paper. I use the Schwarz Bayesian Criterion to determine the lag length. We also need to test whether the variables in the VAR model stationary. If the VAR model is built with non-stationary variables, the results may mislead us due to the spurious regression. When the variables are non-stationary, as N. Gujarati and Sangeetha (2007) suggest, the first difference can be used to transform the data.

The VAR model is built as follows

(6) $y_t = \sum_{i=1}^{k} \alpha_i y_{t-i} + u_t$

where y_t, y_{t-i}, u_t are $m \times 1$ vectors, k is the lag length, and α is $m \times m$ vectors.

We can then study the effects of policy through impulse response function. Although some researchers doubt the utility of Impulse Response Function (IRF), Gujarati and

Sangeetha (2007) and H. Greene (2008) considered it to be the centerpiece of VAR. The IRF can trace the response of the variables in the system to shocks which is what this paper mainly focuses on. Suppose there is a two-equation system such as equation 4. There are two error terms, u_1 and u_2, in this system. If there is one standard deviation shock to u_1, this change will affect this whole system for several periods in the future. The IRF will give us a good description of how the system fluctuates.

In this paper, the relationship between the U.S. and Japan will be the main focus. More specifically, the process of adjustment in the financial market between the U.S. and Japan will be investigated by tracing out the international reserve of Japan and interest rate spread. When the U.S increases the deficit, which can be viewed as an impact from the outside of the system, the old equilibrium will be disturbed and there will be an excess supply of dollars. The key questions are how will Japan respond and what will the process of the adjustment of whole finance markets be between Japan and the U.S. By using the VAR model, the answer will be given in the later part.

4. Data, Empirical Technique and Results:

4.1 Data:

Table 1 presents the variables name, frequency, length and the data sources. Short term interest rate, exchange rate and international reserves are monthly but GDP deflator is annual.

Table 1 Description of the variables

Initial Variables	Frequency	Length	Sources
Long term Interest rate	Monthly	1994.Jan-2008.Dec	Organization for Economic Co-operation and Development
Exchange rate	Monthly	1994.Jan -2008.Dec	Federal Reserve Bank of St.Louis
GDP deflator	Annual	1994-2008	International Monetary Fund
International reserves of Japan	Monthly	1994.Jan -2008.Dec	Bank of Japan
Consumption Price Index	Monthly	1994.Jan-2008.Dec	Organization for Economic Co-operation and Development

The interest rate spread poses some problems. In this paper I obtain it in the following way. The interest rate spread is given by

(7) $\delta = i_{u.s} - i_{japan} + E(e)$

, where E (e) is the expected rates of devaluation of exchange rate.

Measuring the expected rate of devaluation of the exchange rate presents a host of issues (Kurita, 2007;Galati, Melick, and Micu 2005;Ibrahim, 2007). Since it is not the key question in this work, I do not want to dwell on these issues. Instead I derive the expected devaluation following the procedure of Blanchard (2009).

Let P denote for the GDP deflator of the U.S., P^* be the GDP deflator of Japan, and e be the nominal exchange rate, which is the price of the dollar in terms of yen.

So we get real exchange rate

(8) $\varepsilon = \dfrac{e \times P}{P^*}$

By using the GDP deflator data, the annual data of the real exchange rate can be calculated. In order to match the frequency of the other data, I need to construct the other part.

The real exchange rate of each year (suppose that every year the real exchange rate of first month is the one calculated by using the GDP deflator) is known. If I know the rate of change of the real exchange rate, the other part of real exchange rate can be constructed. In order to derive the rate of change of the exchange rate, I assume that the Relative Purchasing Power Parity (PPP)[2] theory holds.

Nagayasu and Inakura (2009) use advanced statistical techniques to argue that the violation of PPP was always caused by some barriers in trade and can be viewed as a

[2] In Dooley (2004) and Taylor (2004a, 2004b), they do not agree with the PPP theory. However, it is a controversial question, and there are also a lot studies to support this theory. In order to match the frequency of data, the PPP theory is used to construct the real exchange rate data.

temporary phenomenon. Sarno and Valente (2007) tested the PPP theory by using sample of the U.S., UK, France, Germany, and Japan. They argued that the in long-term PPP holds and the deviations are reversed quickly if the exchange rates are allowed to respond to shocks.

According to the PPP theory, the rate of change of the real exchange rate is determined by the change rate of price level in both countries.

The formula is like this

$$(9)\quad \frac{e_{t+1}}{e_t} = \frac{\dfrac{cpi_{t+i}^{d}}{cpi_t^{d}}}{\dfrac{cpi_{t+i}^{f}}{cpi_t^{f}}}$$

Suppose that the real exchange rate of the first month is the one of the year. By using the relative purchasing power parity theory, the real exchange rate series monthly can be constructed.

4.2 An intuitional picture about the data:

The percent changes of international reserve and interest rate spread are used to run the regression, because these two variables have different scales. Below are illustrations of the data for these variables.

Figure 3 Rate of change of the international reserve of Japan in dollars

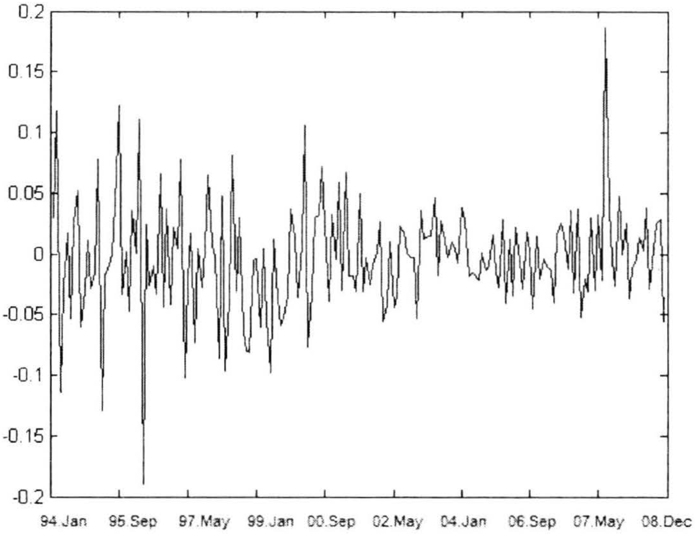


Figure 3 shows the rate of change of the international reserve of Japan. The fluctuations looked like a stationary variable (will be tested in the later part) because there is no obvious trend and there is no big fluctuation during the entire sample.

Figure 4 Rate of change of the interest rate spread

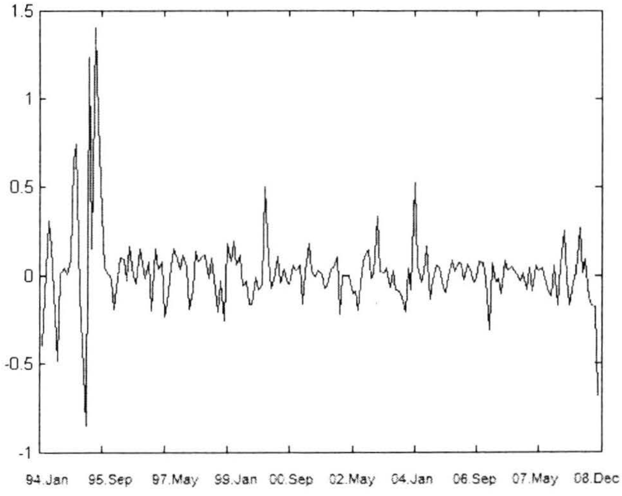


Figure 4 shows the change rate of interest rate spread. Compared with Figure 3, the fluctuations of change rate of interest rate spread is lighter than the previous one. However, there is a big fluctuation in the beginning.

4.3 Empirical Technique and Results:

First, Unit Root Tests is used to see if the data is stationary. The variables in the VAR model should be stationary. If the series is non-stationary; the first difference can be performed to make it stationary and then run the model (Greene, 2008). The unit root test is performed in the following.

The Unit Root Test is used to determine whether a time series is stationary by using autoregressive model. Let $y_t = \delta_0 + \delta_1 t + u_t, u_t = \alpha u_{t-1} + \epsilon_t$, and the null hypothesis is

$$H_0: \alpha = 1$$

By combining these two equations we get

(10) $y_t = \delta_0 + \delta_1 t + \alpha u_{t-1} + \varepsilon_t$

And then from $y_{t-1} = \delta_0 + \delta_1(t-1) + u_{t-1}$, we get

(11) $y_t = [\delta_0(1-\alpha) + \alpha\delta_1] + \delta_1(1-\alpha)t + \alpha y_{t-1} + \varepsilon_t$

Minus y_{t-1} in both sides, we get

(12) $\Delta y_t = [\delta_0(1-\alpha) + \alpha\delta] + \delta(1-\alpha) + \gamma y_{t-1} + \varepsilon_t$

where $\Delta y_t = y_t - y_{t-1}$, and $\gamma = \alpha - 1$

Now the null hypothesis is

$$H_0: \gamma = 0$$

If the null hypothesis is rejected, it means that there is no unit root and the time series is stationary.

Now if

σ is the percent change of international reserve of Japan, δ is the percent change of interest rate spread, D (σ) is the first difference of change in international reserve, and D (δ) is the first difference of the change in interest rate spread.

Here are the results

Null hypothesis: rate of change of interest rate spread/international reserve has a unit root

Table 2 Test results for the rate of change of international reserve and interest rate spread

variables	t-statistic	p-value
δ	-3.0905	0.1163
σ	-10.5227	0.0001

The P value suggests that the series interest rate spread may be non-stationary.

So we turn to the first difference

Table 3 Test results for the first difference of the rate of change of international reserve and interest rate spread

variables	t-statistic	p-value
D(δ)	-7.2142	0.0001
D(σ)	-7.5767	0.0001

The null hypothesis can be rejected for both D (δ) and D (σ).

Since that the VAR model requires that both variables used in the model should be stationary, the rate of change of international reserve and interest rate spread cannot be chosen, and the first difference of the variables would be more appropriate for the VAR model. The dynamics of the adjustment would also be more appropriatedly investigated with the first differences of the variables.

The next step is to build the regression model

There is one problem for the VAR model. It is complicated to determine the lag length of the vectors. One of the normal methods is to compare the Schwarz SC values in different lags.

Since we have two variables to trace, there will be two equations. With different length of lag, the results are presented in the following tables

The Schwarz SC value

Table 4 Schwarz SC values for different length of lag

Length of lag	Equation of D(σ)	Equation of D(δ)
1	-2.85	0.15
2	-3.00	0.18
3	-3.18	0.05
4	-3.04	0.15
5	-3.17	0.19

From the Schwarz SC value table, I prefer to select the length of 3, because it has the least value for both equations.

I build the VAR model like this

(13) $y_t = \alpha y_{t-1} + \beta y_{t-2} + \gamma y_{t-3} + u_t$

Where $y_t = \begin{bmatrix} D(\sigma)_t \\ D(\delta)_t \end{bmatrix}$, $\alpha = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix}$, $\beta = \begin{bmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{bmatrix}$,$\gamma = \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix}$ $u_t = \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix}$, u is the error term, ε is the international reserve, and δ is the interest rate spread.

The regression result is presented in the following table

Table 5 Regression results by using sample 1994-2008

Name of coefficient	α_{11}	α_{12}	α_{21}	α_{22}	β_{11}	β_{12}
coefficient	-0.9638	0.0283	-0.3764	-0.4842	-0.6134	0.0381
t-statistic	-13.3259*	1. 9183*	-1.0261	-6.4519*	-6.9819*	2.3502*
Standard error	0.0723	0.0147	0.3668	0.0750	0.0879	0.0162

Name of coefficient	β_{21}	β_{22}	γ_{11}	γ_{12}	γ_{21}	γ_{22}
coefficient	0.0772	-0.1729	-0.3053	0.0209	0.1930	-0.2623
t-statistic	0.1734	-2.1007*	-4.3860*	1. 4313	0.5469	-3.5401*
Standard error	0.4452	0.0823	0.0696	0.0146	0.3529	0.0741

* is significant at 5% . ** is significant at 10%

The system can be written as

$$\begin{aligned}\begin{bmatrix} D(\sigma)_t \\ D(\delta)_t \end{bmatrix} &= \begin{bmatrix} -0.9638 & 0.0283 \\ -0.3764 & -0.4842 \end{bmatrix} \begin{bmatrix} D(\sigma)_{t-1} \\ D(\delta)_{t-1} \end{bmatrix} + \begin{bmatrix} -0.6134 & 0.0381 \\ 0.0772 & -0.1729 \end{bmatrix} \begin{bmatrix} D(\sigma)_{t-2} \\ D(\delta)_{t-2} \end{bmatrix} \\ &+ \begin{bmatrix} -0.3053 & 0.0209 \\ 0.1930 & -0.2623 \end{bmatrix} \begin{bmatrix} D(\sigma)_{t-3} \\ D(\delta)_{t-3} \end{bmatrix}\end{aligned} \tag{14}$$

Or

$$
(15) \quad \begin{aligned} D(\sigma)_t &= -0.9638 \times D(\sigma)_{t-1} + 0.0283 \times D(\delta)_{t-1} - 0.6134 \times D(\sigma)_{t-2} \\ &+ 0.0381 \times D(\delta)_{t-2} - 0.3053 \times D(\sigma)_{t-3} + 0.0209 \times D(\delta)_{t-3} \end{aligned}
$$

$$
(16) \quad \begin{aligned} D(\delta)_t &= -0.3767 \times D(\sigma)_{t-1} - 0.4842 \times D(\delta)_{t-1} + 0.0772 \times D(\sigma)_{t-2} \\ &- 0.1729 \times D(\delta)_{t-2} + 0.5469 \times D(\sigma)_{t-3} - 0.2623 \times D(\delta)_{t-3} \end{aligned}
$$

In the first equation, all the coefficients of the lags of $D(\sigma)_t$ are significant and negative and the absolute values are going down as the length of the lag increase. More specifically, the three lag variables of $D(\sigma)_t$, which are $D(\sigma)_{t-1}$, $D(\sigma)_{t-2}$, and $D(\sigma)_{t-3}$, had coefficients -0.9638, -0.6134, -0.3053. The decrease trend can be interpreted easily, because it is easy to understand that we are more affected by the recent events. The negative sign means that if $D(\sigma)_t$ is positive in time t, then in time t+1, it may be negative. Another thing that is worthy of notice is that the coefficients of $D(\delta)_t$ are very small but all significant and positive in the first equation. So in the first equation $D(\delta)_t$ does not have a big effect, and $D(\sigma)_t$ is mainly affected by its own lags. In the second equation, all the lag variables of D (σ) are insignificant, but all the lag variables of $D(\delta)_t$ are significant and negative. For the same reason stated above, $D(\delta)_{t-1}$ has the largest absolute value. We can see that the negative sign of the lag variables of $D(\delta)_t$will make the interest rate spread fluctuate around a certain number, because once $D(\delta)_t$ keep positive for a while, the negative sign will make sure that $D(\delta)_t$ will became negative soon.

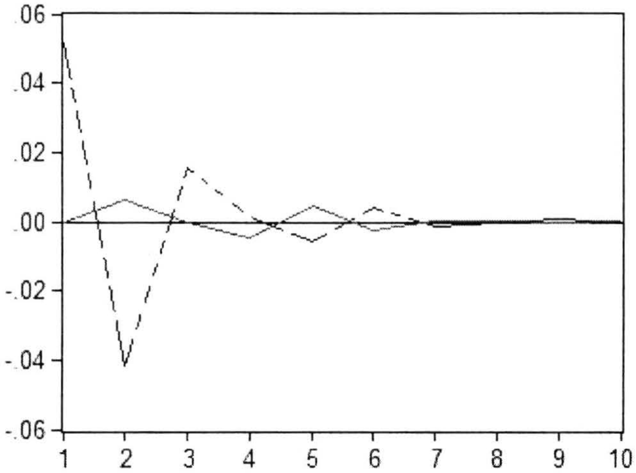
We cannot explain the coefficients in any straightforward way, such as the economic meaning of the coefficients, because the VAR is a-theoretic. In the VAR system, the system is constructed by the lags of the variables themselves. Thus, the better way to analyze the system is to investigate the Impulse Response Function. In the following section, I will focus on this.

4.4 Impulse response function

Figure 5 Impulse Response Function for sample 1994-2008

Response of $D(\sigma_t)$ to Nonfactorized

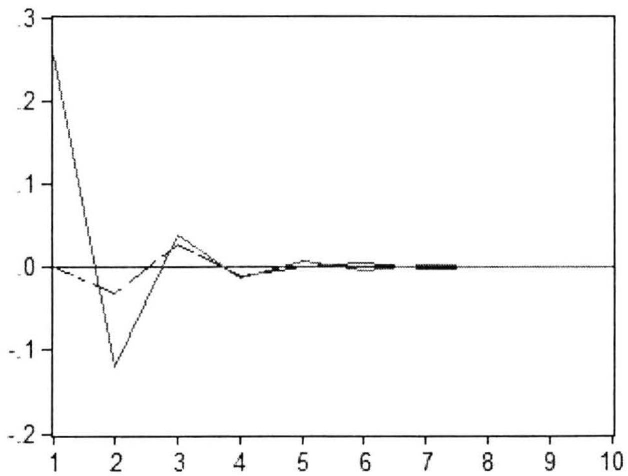
One S. D Innovations



----- $D(\sigma_t)$ —— $D(\delta_t)$

Response of $D(\delta_t)$ to Nonfactorized

One S.D Innovations



----- $D(\sigma_t)$ —— $D(\delta_t)$

Figure 5 shows the IRF (Impulse Response Function). In the first part, which shows the response of D(σ) to D(δ), when D(δ) goes up, D(σ) goes down. A rise in D(δ) pushes up the interest rate spread so that the risk of holding dollar assets also increases. This causes the international reserve holdings to go down. However, in the second part, which shows the response of D(δ) to D(σ), when D(σ) increases, D(δ) also increases. The increase of international reserve will lead to a depreciation of yen, and then the expected devaluation of yen will increase. As a result, the interest rate spread will increase.

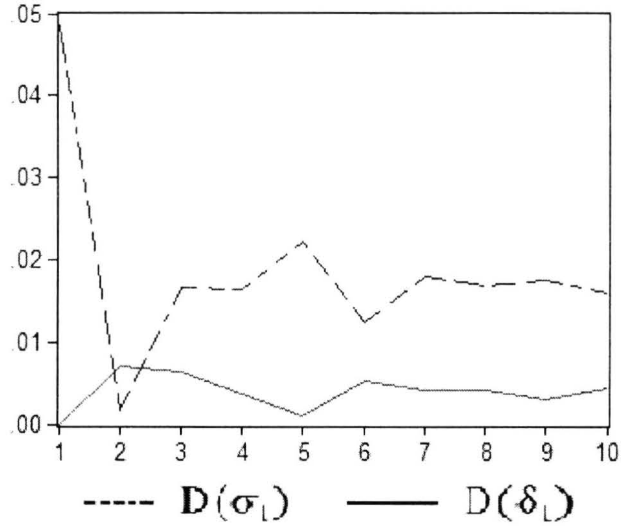
From the IRF graph, the impact will die out after a while. Vasudevan's (2010) suggests that the adjustment process between Japan and the U.S. is stable. In this paper, by using the IRF, the same result can be gotten.

The analysis of the cumulated response function also bears out this conclusion.

Figure 6 Accumulated Impulse Response Function

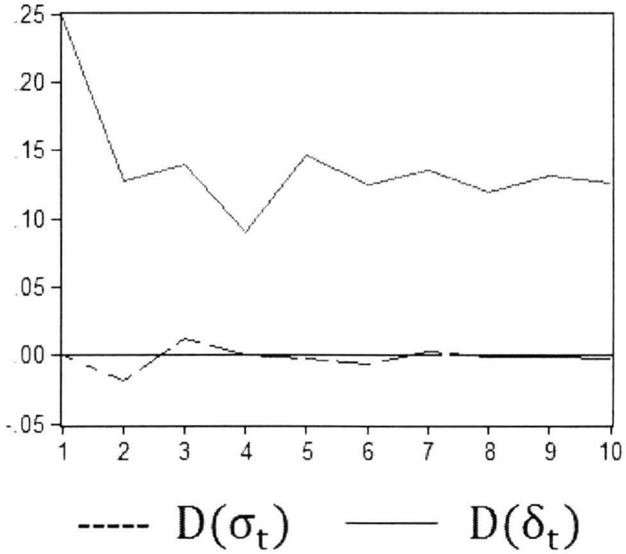
Accumulated Response of D(σ) to Nonfactorized

One S.D Innovations



Accumulated Response of D(δ) to Nonfactorized

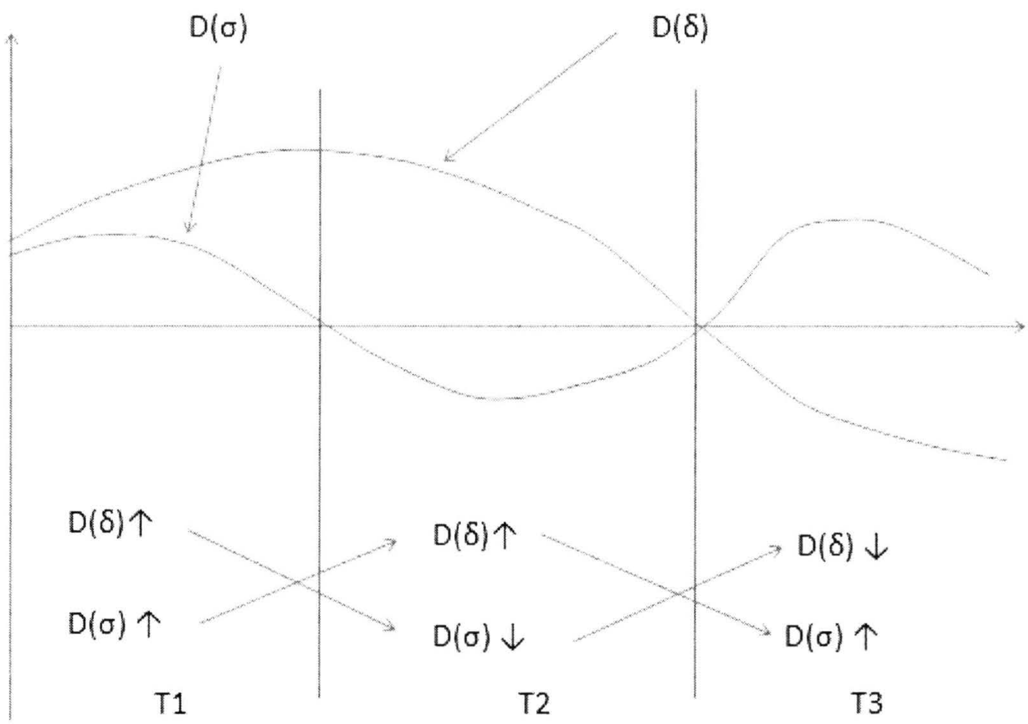
One S.D Innovations



The first part of figure 6 shows that the accumulated response of D(σ) has the opposite path with the trend of D(δ), but in the second part of figure 6, the accumulated response of D(δ) has the same trend with the trend of D(σ).

Figure 7 might help explain this process.

Figure 7 The graph example to illustrate the dynamic adjustment



It is just a graphical illustration of the dynamic adjustment. It does not reflect actual empirical data how the two variables fluctuate.

Suppose the impact happened at T1.

When the impact happened (more deficits of the U.S), the supply of dollars increased in the money market and it caused the higher devaluation of the yen. At the same time, Japan would increase the international reserves to maintain the exchange rate. In T1 period, both D(σ) and D(δ) are positive. This means that when the impact just happened, the international reserves of Japan and interest rate spread increased.

As the international reserves of Japan increase, it leads to a depreciation of yen, which will make the expected devaluation of yen increase. As a result, the interest rate spread will increase in the next period ($\delta = i_{u.s} - i_{japan} + E(e)$, where E(e) is the expected devaluation of yen). That is shown in the second part of figure 5: the response of D(δ) is the same with the trend of D(σ).

When the interest rate spread increase, it means that holding the dollar assets is a more risky choice, so the international reserve of Japan will decrease in the next period. That means that a increasing interest rate spread will lead to a decreasing international reserve of Japan, and this is shown in the first part of figure 5: the response of D(σ) is opposite with the trend of D(δ).

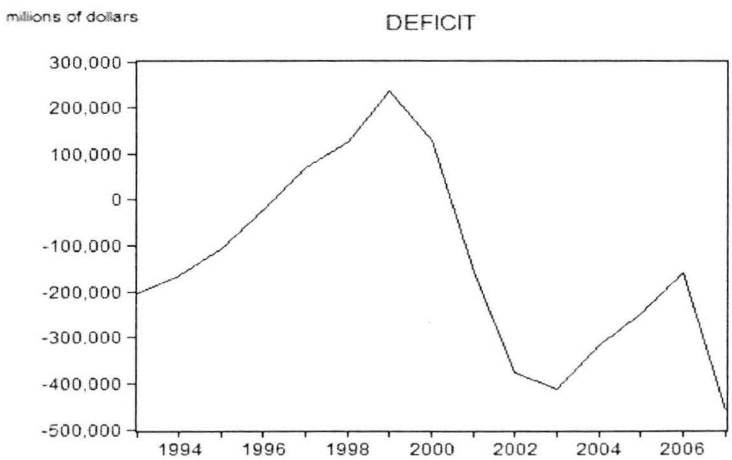
In conclusion, increasing deficit has two effects. One is to make Japan increase their international reserve. The other is to increase the interest rate spread because more deficits lead to an increase in the expected rate of devaluation of the dollar. When Japan increases their international reserves; it will make the interest rate spread increase as well. An increase of international reserve would lead to a depreciation of yen. This is what the part 2 of figure 5 shows: the response of interest rate spread is the same with the trend of international reserve of Japan. The last part of this adjustment is that when interest rate spread increases, holding more dollar assets would be more risky for Japan. In response, the international reserves of Japan is decreased, this is what I illustrated in part 1 of figure 5: the response of international reserve is opposite to the trend of interest rate spread.

5. Application

In this part, the subset of data is used to run the regression again, and then by the simulation result can be used to explain the real adjustment in history.

Figure 7 shows the historical data of deficits of the U.S.

Figure 8 Deficit of the U.S during 1993-2007



As can be seen, in 1997, the U.S had a positive current account balance, and then after 2000, the deficit began to rise. Year 2003 is a little special, because the deficit touched the peak in 2003. After 2003, the deficit begins to be a little better. Thus the deficit increased rapidly from 2001 to 2002, the high deficit o year 2001 can be viewed as an unexpected impact.

By using the data set from 1994-2000, I get the following result from the VAR model

$$\begin{aligned}(17)\quad & D(\sigma)_t = -0.9791 \times D(\sigma)_{t-1} + 0.0238 \times D(\delta)_{t-1} - 0.6112 \times D(\sigma)_{t-2} \\ & +0.0460 \times D(\delta)_{t-2} - 0.2473 \times D(\sigma)_{t-3} + 0.0232 \times D(\delta)_{t-3}\end{aligned}$$

$$\begin{aligned}(18)\quad & D(\delta)_t = -0.4629 \times D(\sigma)_{t-1} - 0.4501 \times D(\delta)_{t-1} + 0.0970 \times D(\sigma)_{t-2} \\ & -0.1323 \times D(\delta)_{t-2} + 0.0588 \times D(\sigma)_{t-3} - 0.2653 \times D(\delta)_{t-3}\end{aligned}$$

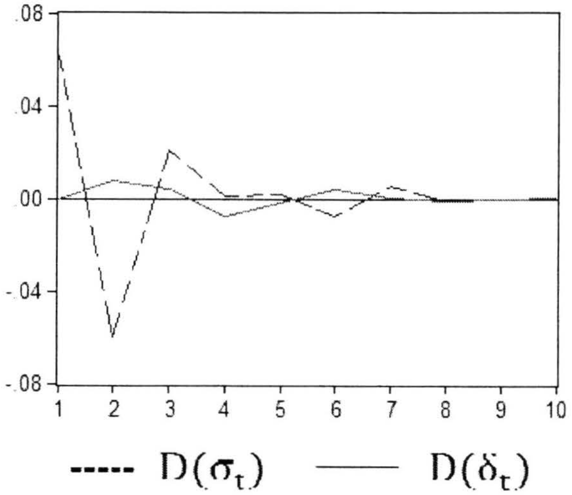
The following IRF (figure 8) is based on this subset of the data.

It is similar with the IRF we already got. The responses of D (σ) are always different with the trend of the D (δ), and the responses of D (δ) are always the same with the trend of the D (σ).

Figure 9 Impulse Response Function during 1994-2000

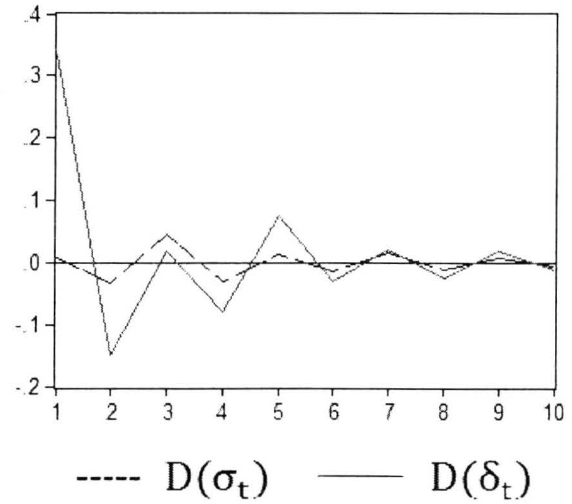
Response of $D(\sigma_t)$ to Nonfactorized

One S.D Innovations



Response of $D(\delta_t)$ to Nonfactorized

One S.D Innovations



Based on the equations 15 or 16, the data of 2001 can be calculated. I choose to simulate the data of Jan 2001 to Mar 2001. In Figure 9 and Figure 10, the X line is the time line.

The following figures showed the real data and the simulated data.

Figure 10 Real & simulated data of the first difference of international reserve of Japan

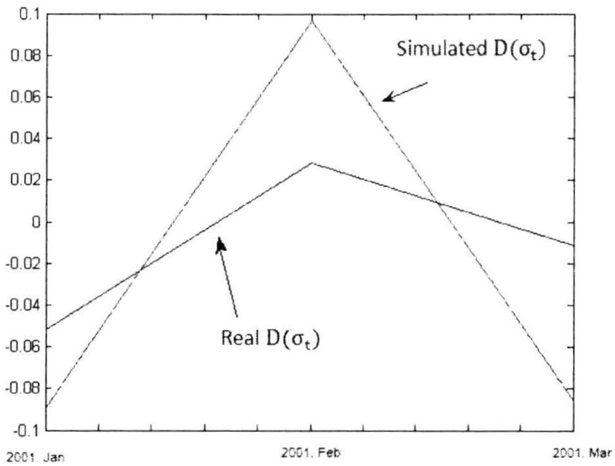


Figure 11 Real & simulated data of the first difference of interest rate spread

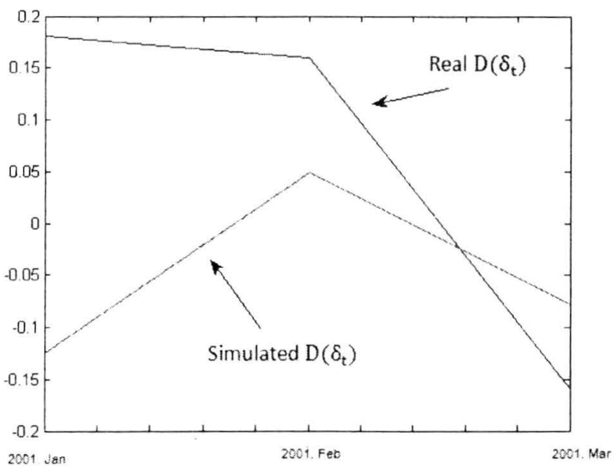
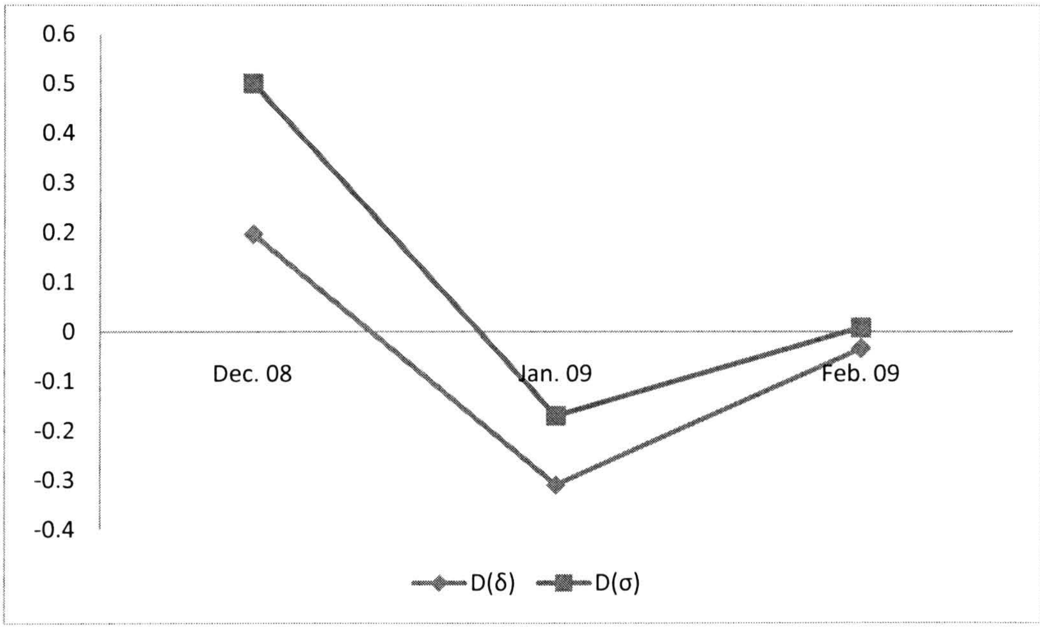


Figure 9 and Figure 10 show the simulated results and the real data. As can be seen, the predicted data is very similar with the real data. In the first figure, they have the same trend, and the same turning point (Feb 2001). In the second figure, although they have different trends at first, they have the same turning point (Feb 2001) and the same trend after the turning point (Feb 2001).

All the policy effects cannot be viewed very quickly, so the current value always shows the effect of policy in last period or more previous. In this case, the second period is the turning point because it shows when the policy works. As the U.S issues more bonds, the Japan can increase the international reserve to stablilize the current exchange rate, so D (σ) is positive after the impact happened. In figure the current account balance of the U.S. is positive in 2000, so the first value of D (σ) should be negative. As can be seen, the values of D (σ) is negative before the turning point. As the impact of deficit works though, the value of D (σ) should become positive, and in figure 9, the turning point shows the effect if felt in the second period after the initial impact happened. In figure 9, D (σ) started with a negative value in Jan 2001 and then in Feb 2001.D (σ) begins to be positive. As we stated above, the same explanation can be used to explain the first negative value of D(δ). In the second month, the effect of the impact works, thus both D (σ) and D (δ) are positive in the second month, which is considered as turning point. Central bank of Japan increases their international reserve and the increase of supply of dollar leads to the increase of interest rate spread. As the interest rate spread increases, according to our IRF, the international reserves should decrease, and that is what figure 10 tells us. The work shows that the IRF can explain the real world event very well, and the simulated results are consistent with the real one.

The next step is to forecast the data out of the sample. Since the sample size is 1994-2008, I am going to forecast the data of the last month of 2008 and the first two months in 2009. Figure 12 presents our results.

Figure 12 Forecasting of the first difference of international reserve of Japan and interest rate spread



The forecasting work shows that the real and predicted varaibles have the same trend. They both have a positive staring point and then both became negative in the next period. Finally, in the end point, they are close to 0. It means that the financial market is almost at the equilibrium state.

6. Conclusion

In this paper, I first investigate the historical data of the current account balance of the U.S. and Japan and discover that there is a close relationship between these two countries. I choose to study the patterns of adjustments of interest rate spread and international reserve of Japan to investigate stability of this mechanism of financing the U.S. deficit. By constructing a VAR model, I am able to use the IRF (Impulse Response Function) to analyze the reaction of the system to the impact of a rising deficit. The IRF suggests that the response of the international reserve is opposite to that of the interest rate spread, but the response of interest rate spread is the same with that of the international reserve (as figure 5 showed). When the impact happened, whenever one variable increases, the other one will make it go back to equilibrium so that a rising deficit is financed in a stable manner. At the end of my paper, In order to support my argument, I run the regression again with the subset of data. I compared the simulated results with the real data, and the results were consistent with the model expected. After the simulation, I go to the forecasting part, and the model give the data out of the sample.

By using the VAR model, the results show the equilibration mechanism for the international system in the face of the growing deficit of the U.S. From the standpoint of Japan, it is important to restore equilibrium to the financial market as soon as possible. Although the fluctuations will die out in a while, the higher exchange rate is bad for the export-lead growth economy. Based on the empirical result, the adjustment time can be reduced. However, the mechanisms of adjustment do not in any way reduce global imbalances. From the standpoint of the U.S, with the development of Japan, the core-periphery relationship will be weakened. It means that in order to keep the hegemony position, the U.S needs to find new periphery countries. As Dooley's work (2004) argued, Asia has become to be the new one, and the typical example is China now. Currently, the sustainability of the U.S. imbalance is doubted because of the crisis. However, as the empirical results show, the key point of this core-periphery relationship is the development strategy. If there is no necessity to keep the exchange rate stable, the central bank of Japan will not buy the international reserve to keep the exchange rate. The U.S. will not automatically reduce their imbalance, and theperiphery is tied in to the same export promotion strategy.

With a floating exchange rate Japan will lose the price advantage. This could also indicate the limit of the particular core-periphery relationship. This situation once happened in France, but for Japan, a floating exchange rate is currently not a good choice, because the previous experience of the "lost decade" suggests that a stable exchange rate is good for the Japan's development. Currently, however, the position of Japan is not as important as before for the U.S. China has become to be the largest creditor country now, and hold 23.35% (largest one) of all the deficit of the U.S. (Japan holds 21.13%). Mckinnon (2006) argued that China is repeating what Japan did. Because of the same situation, I predict that similar results can be obtained by using the data of China, and the most important lesson from Japan's experience is that stabilization of the exchange rate is very critical. I do not think floating the exchange rate now is a good choice for China, because exports still have an important position for China. But more important is the implication that capital flows and the adjustment mechanisms of the financial markets will not foster an automatic reduction in the global imbalances. Concrete and coordinated policy initiatives are essential if the international financial system is to be able to protect itself from the increasing fragility created by the global imbalance.

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