2008

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SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN

ECONOMICS

SINGAPORE MANAGEMENT UNIVERSITY

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Abstract

This paper attempts to identify the major economic factors that influence the bilateral trade balance between Japan and the US. Differing from conventional elasticities approach, one more variable—the net foreign assets—is added in the Vector Autoregression estimation using quarterly data from 1980: I to 2006: IV. The Johansen and Juselius result indicates three long-run relationships among five macro variables: trade balance, domestic income, foreign income, net foreign assets and real exchange rate. Short run adjustment parameters are identified as coefficients of the error correction terms. The variance in trade balance due to variations in the two macro variables—the exchange rate and the net foreign assets—is examined by Impulse Response Functions and Variance Decomposition procedures. The main finding of this paper is that taking the valuation effect of the net foreign asset position into account, the final effect of the exchange rate changes on trade balance is undetermined. Although appreciation can reduce trade surplus in the short run, in a longer horizon, there is no stable relationship. The positive sign of the relation is not guaranteed in this case, and appreciation is not surely able to correct the trade imbalance between countries.

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Acknowledgements

This thesis would not have been possible without Prof. HOON Hian Teck’s kind support and encouragement to explore freely on topics that I am interested in. I am also grateful to Prof. TSE Yiu Kuen for his guidance on econometrics, and also my second examiner: Prof. CHANG Pao Li, for her valuable comments and suggestions.

I remain indebted to my parents, professors and classmates for providing me the means to learn and understand.

I am responsible to all the mistakes in this thesis.

1. Introduction

There are many open topics in economics; the relation between exchange rate and trade balance is among the most heavily studied. One popular theory regarding the effect of the exchange rate change on trade balance is the elasticities approach. In this partial equilibrium framework, prices are considered to be sticky. When the currency appreciates in one country, the export goods become more expensive while import goods cheaper, accordingly, imports increase and exports decrease. Thus the exchange rate adjustment is believed as an effective way to correct trade imbalance between countries. Numerous empirical studies come this way—by measuring the elasticities of imports and exports to the exchange rate change—to test if the well-known Marshall-Lerner condition holds (or not), then to project that to what extend should a country depreciate its currency against other's to reduce its trade deficit; or more recently, to what extend should a country appreciate its currency to reduce its trade surplus—which is exactly the case nowadays for Japan, China and other East Asian economies that are running huge trade surpluses against the US.

However, the elasticities approach (and essentially the Marshall-Lerner condition) to the trade balance adjustment is incomplete in open economies nowadays. It implicitly assumes that the initial trade account is zero. In reality, some countries—as mentioned above, Japan, China, and other East Asian economies have accumulated huge amount of external wealth as a result of the persistent trade surpluses over years. And one consequence of the international financial integration is that, in today's open economy under the dollar standard, trade surplus countries have their foreign assets mostly denominated in dollars, rather than their own currencies. When their currencies appreciate, they incur a loss in their net external wealth. Domestic spending would reduce, including spending on the imported goods. Combining this additional valuation effect with the direct price channel, the effect of the exchange rate changes on trade balance can be ambiguous. This paper is aimed to tract all these effects in the specific case of Japan.

This paper is constructed as follows. Section 2 discusses the BRM model and the special Marshall-Lerner condition in detail and presents a simple literature review. Section 3 firstly points out the additional valuation channel and the possible role that net foreign assets play in affecting trade balance, and then illustrates historically the bilateral trade condition of Japan and the U.S. and its interaction with the yen-dollar exchange rate. Section 4 develops an empirical model, and describes the econometric procedures as well as the empirical data. Section 5 presents results of the empirical analysis in detail. And finally section 6 comes with the conclusion.

2. Elasticities approach and the Marshall-Lerner condition

To study how the exchange rate changes affect trade balance, one must begin with a precise study of the conventional elasticities approach of the balance of payments. Consequently, this section, in the first place, introduces the BRM model in detail and presents the BRM and Marshall-Lerner conditions; and secondly, it presents the empirical findings of the elasticities approach in the recent literature.

2.1 The BRM and Marshall-Lerner Conditions

The literature modeling the relationship between exchange rate and trade balance, appeared first with the seminal paper of Bickerdike (1920), and continued with Robinson (1947) and Metzler (1948). These three papers are believed as the sources of the well-known Bickerdike-Robinson-Metzler (BRM) model or the elasticities approach to the balance of payments. The basic idea of this approach is the substitution effects in consumption and production induced by the relative price changes caused by the exchange rate movement.

The BRM model is actually a partial equilibrium version of a standard two-country (domestic and foreign), two goods (exports and imports) model with perfect competition in the world market. To keep in line with most of the recent empirical work[1], this paper introduces a slightly modified model setup which also incorporates the effects of domestic and foreign income, but the underlying mechanism of the BRM model through which the exchange rate changes affect trade balance is uninfluenced. The model is not only simple, but it also captures the effect of exchange rate and income level of both domestic and foreign economy. The model is given as followed.

The volume of imported goods demanded by domestic residents is a function of the real domestic income and the relative price of imported goods:

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[1] For instance: Wilson (2001), Baharumshah (2001), Stucka (2004) and earlier, Rose and Yellen (1989), Krugman and Baldwin (1987).

$$D_m = D_m(p_m, Y) \text{ and } D_m^* = D_m^*(p_m^*, Y^*) \qquad (1)$$

where D_m (D_m^*) denotes the quantity of goods imported by home (foreign) country, Y (Y^*) is the level of real income measured in domestic (foreign) output; p_m is the relative price of import goods to the domestic overall price level, both measured in terms of home currency; analogously p_m^* is the relative price of imports in foreign country. It is assumed that the demand for import goods depends positively on the real income level and negatively on the relative price of the import goods.

Different from the demand functions, the supply of exportables in each country depends only positively on the relative price of export goods:

$$S_x = S_x(p_x) \text{ and } S_x^* = S_x^*(p_x^*) \qquad (2)$$

where S_x and S_x^* are the supply of home (foreign) export goods, respectively; p_x is the home country relative price of exportables, defined as the ratio of the domestic currency price of exportables, P_x, to the overall domestic price level, P; p_x^* is analogously defined as the foreign currency price of exportables, P_x^*, divided by P^*, the foreign overall price level.

The domestic relative price of imports in domestic country can be expressed as:

$$p_m = E \cdot P_x^* / P = (E \cdot P^* / P) \cdot (P_x^* / P^*) \equiv q \cdot p_x^* \qquad (3)$$

where E denotes the nominal exchange rate, defined as a unit of foreign currency in terms of domestic currency; and q is the bilateral real exchange rate, defined as $q \equiv E \cdot P^* / P$.

Similarly, the relative price of imports in foreign country is defined as:

$$p_m^* = p_x / q \qquad (4)$$

The market equilibrium conditions for exports and imports are then:

$$D_m = S_x^* \text{ and } D_m^* = S_x \qquad (5)$$

The domestic trade balance measured in real terms, B, is:

$$B = p_x \cdot D_m^* - q \cdot p_x^* \cdot D_m \tag{6}$$

By taking the partial derivative of B with respect to q we can obtain the BRM condition—a sufficient condition for trade surplus reduction given a currency appreciation or trade deficit improvement given a currency depreciation:

$$\frac{dB}{dq} = D_m^* \cdot p_x \cdot \frac{(1+\varepsilon)\cdot\eta^*}{\eta^* + \varepsilon} - q \cdot D_m \cdot p_x^* \frac{(1-\eta)\cdot\varepsilon^*}{\eta + \varepsilon^*} > 0 \tag{7}$$

where η and ε denote the absolute values of the price elasticities of demand and supply respectively at home while stars denote the corresponding elasticities abroad. This condition links the responses of trade balance to the real exchange rate changes as well as the domestic and foreign price elasticities of imports and exports.

A special case that can be derived from the BRM condition is the so-called Marshall-Lerner condition (Marshall, 1923; Lerner, 1944), with the assumption of initially a zero trade account and infinite supply elasticities in both domestic and foreign countries.

As can be shown, if $B = 0$ (initial equilibrium), then $\frac{dB}{dq} > 0$ if and only if:

$$\frac{\eta \cdot \eta^* \cdot (1+\varepsilon+\varepsilon^*) - \varepsilon \cdot \varepsilon^* \cdot (1-\eta-\eta^*)}{(\varepsilon+\eta^*)(\varepsilon^*+\eta)} > 0 \tag{8}$$

By letting $\varepsilon \to \infty$ and $\varepsilon^* \to \infty$, the left-hand side of condition (8) becomes $\eta + \eta^* - 1$. Consequently, it implies that for a trade balance reduction after a country appreciates its currency, $\eta + \eta^* > 1$ must hold. Or, in the standard presentation of the ML condition, $\left|\eta + \eta^*\right| > 1$. In words, the ML condition states that if domestic and foreign supply elasticities are infinitely elastic, then devaluation causes an improvement of the trade balance when domestic plus foreign demand elasticities for imports, in absolute value, exceeds one.

Another relevant case on the effect of the exchange rate changes on trade balance in the short run is the well-known "J-curve" effect. Numerous empirical evidences can be found in the literature indicating the existence of the “J-curve” effect. It is pointed out that in certain circumstances there is an initial deterioration in trade balance before quantities of exports and imports adjust to the exchange rate movement, mainly due to the existence of the initial contracts. In particular, as the export contracts are written in domestic currency units while import contracts are written in foreign currency units, the price effects work faster than volume effects following the movement of the country’s exchange rate. As regard to equation (7), the “J-curve” effect can be defined as the combination of a negative short-run derivative with a positive long-run derivative.

2.2 Review of the literature

In the literature, there are two methods to examine empirically the impact of the real exchange rate changes on trade balance. The first method, in the earlier days, runs the estimations of supply and demand functions directly; then makes the judgment that the BRM condition (or the special condition—Marshall-Lerner Condition) holds if the sum of the respective price-elasticities is greater than unit. However, the disadvantage of this method is that such method needs the difficult identification of several structural parameters. In the more recent work, this shortcoming is avoided by estimating instead a reduced form equation as in Rose (1991), and Boyd et al. (2001). In the model above, we can write the trade balance B as a ‘partial reduced form’ by solving the equations (1)—(5):

$$B = B(q, Y, Y^{*}) \tag{9}$$

Based on the log-linearized form of the general equation (9), various econometric methods are employed to test if there is a stable long-run relationship between trade balance and real exchange rate, and, to test directly if the derivative of trade balance with respect to exchange rate is greater than zero—to finally make the conclusion if appreciation reduces the trade surplus. As for the technique, because conventional statistical theories cannot be applied to nonstationary variables, research carried out in this area has applied cointegration method to deal with the nonstationarity of the time-series data.

One exception is the Krugman and Baldwin (1987) studying the U.S. trade balance and exchange rate relationship in the 1980s based on direct estimations of the elasticities. The majority of the literature, for instance, Rose and Yellen (1989), Bahmani-Oskooee (1991, 1992, 1994), and Rose (1991) applied the cointegration technique to test the coefficient of exchange rate, reporting an insignificant relationship between the exchange rate changes and balance of trade except for a limited number of countries, thus rejecting the Marshall-Lerner condition. Among them, only Rose (1991) employed the reduced form equation estimation. Rahman et al. (1997) examined the bilateral trade of Japan and the U.S., also found no evidence for the significantly positive relation. More evidence rejecting the stable positive relation was presented in Wilson (2001) using the multivariate Johanson-Juselius cointegration method in the case of three Asian economies—Singapore, Malaysia and Korea with the U.S. and Japan.

However, Arize (1994) and Bahmani-Oskooee (1998) supported the existence of long run relationship and the positive coefficient was proved, again, using the reduce form equations; more supporting evidence was added by Baharumshah (2001) studying the cases for Malaysia and Thailand with the U.S. and Japan. Boyd at al. (2001) also employed the reduced form, however, based on a different structural cointegrating vector autoregressive distributed lag (VARDL) model in the sample of eight OECD countries, came with supportive results.

Bahmani-Oskooee and Ratha (2004) presented a survey of the empirical studies on this topic, showing no conclusive results in the literature. Stucka (2004) overviewed various methodologies used in the literature for both developed and emerging economies, also reported variety of results. For the identical countries, different results may be obtained from different time periods and different methodologies.

As the literature appears, agreement is far yet to be reached among the economists. However, just as Rose and Yellen (1989) claimed, there is no theoretical argument leads one to the presumption that the long-run response of the balance of trade to a real depreciation must necessarily be positive; this occurs only if the BRM condition is satisfied. In other words, the positive relation between trade balance and exchange rate is only an empirical issue rather than a complete theory with predictive effects. People who believe the elasticities approach and suggest exchange rate adjustment as an effective policy to obtain the desirable trade balance intrinsically treat the BRM as a law instead of a condition. Since the BRM condition is actually "exogenous" to the model as an empirical issue, no wonder the results varies across countries, across periods, and across methodologies.

However, beyond the empirical nature of the BRM condition (and in particular the Marshall-Lerner Condition), is there any other factor that may have influence on trade balance beside the exchange rate changes? This paper aims to focus on this question and tries to shed some light on the hidden role played by the net foreign asset position, which has been neglected through the literature with few exceptions. In this paper, the asymmetric net foreign asset position across countries, which is affected by the exchange rate movement, is believed to contribute to the changes in trade balance through the recently recognized "valuation channel"—in contrast to the conventional "trade channel" through which exchange rate and trade balance are directly connected.

3. Net foreign assets and the case of Japan

This part firstly introduces the potential role that the net foreign asset plays in affecting trade balance through the valuation channel, then simply reviews the bilateral trade condition between Japan and the U.S., and the behavior of the Yen-Dollar exchange rate over the last two decades. Finally, it brings up the modified BRM model incorporating the net foreign asset. If the two conditions described following are considered, the net effect of the exchange rate movement on trade balance is indeterminate.

3.1 Net foreign asset position and the valuation channel

The Marshall-Lerner condition is derived given the assumption that the country is running neither a surplus nor a deficit in its trade account initially, that is $B = 0$. However in reality, some countries may be running persistent trade deficits against their partners over decades—the U.S. being the central topic of debates; one the other hand, some countries are running persistent trade surpluses over long period of time, examples in this line are the oil exporting countries and more recently the East Asian economies. Consequently, surplus countries build up their claims on deficit countries through the accumulation of continuous net exports over years. In other words, the assumption of initial zero condition in trade balance is violated, $B \neq 0$. Due to the international integration in global goods market and more critically in global financial market, cross holding of assets among countries are quite common nowadays, allowing countries to become net creditors or net debtors. It is useful to regard the trade balance in some specific year as the flow variable while the stock variable is associated with the net foreign asset position; a persistent positive inflow in the form of net exports helps to build up the net foreign wealth of that country.

Until recently very little is known about the stocks of foreign assets and liabilities accumulated by various countries. In this respect, Lane and Milesi-Ferretti

(2001, 2006) made an important contribution by constructing estimates of external assets and liabilities for 145 countries for 1970-2004. Lane and Milesi-Ferretti (2005) then documented the trend of increasing net flows and net positions in both industrial countries and emerging countries, as a consequence of the international financial integration. According to these authors, despite several external crises, financial integration has intensified in recent decades.

Given the increasing importance of the net foreign asset position, the relevant question is that how the net foreign asset position is related to the exchange rate changes and trade balance.

The net foreign asset position is related to the exchange rate changes through the so called "valuation channel", which is important for the external adjustment process according to Gourinchas and Rey (2007) and Lane and Milesi-Ferretti (2005). Large holdings of foreign assets and liabilities, along with increasing relevance of valuation effects—capital gains or losses—have characterized global financial integration—the valuation channel has grown in importance, relative to the traditional trade balance channel. And an increasing number of studies have been motivated on the consequence and relevance of the two basic components of changes in the net foreign asset position, namely, cumulative flows and valuation effects of both assets and liabilities. Valuation effects can be substantial.

To give in detail, for example in the analysis of Gourinchas and Rey (2007), almost all liabilities of the U.S. are denominated in dollar, while about 70 percent of the U.S. assets are denominated in currencies other than dollar. A depreciation of dollar leads to an increase in the value of the U.S. assets but leaves the value of the U.S. liabilities unaffected (measured in dollars). As a result, "historically, 31% of the international adjustment of the U.S. is realized through valuation effects on average". The same phenomena has been documented by Cavallo (2004) and Tille (2003), reporting that the valuation effect provides an additional mechanism through which the current depreciation of dollar might improve the U.S. net position. They also noted that while changes in foreign trade patterns are likely to emerge only over time, valuation changes have the advantage of taking effect immediately. Indeed, this valuation effect of the exchange rate movements can be regarded as equivalent to a transfer of wealth from foreign creditor countries to the U.S.

Compared to the valuation effect, the relationship of the net foreign asset and trade balance received less attention in the literature. So far, as to the author's knowledge, Lane and Milesi-Ferretti (2001, 2002) are the only work focusing on the impact of the net foreign asset on trade balance.

Lane and Milesi-Ferretti (2001) highlighted that "external wealth" plays a critical role in determining the behavior of trade balance, both through shifts in the desired net foreign asset position and investment returns generated to the outstanding stocks of the net foreign asset. In Lane and Milesi-Ferretti (2005) they decomposed the impact of the net foreign asset position on real exchange rate into two pieces: (a) the long-run impact of the net foreign asset position on trade balance; and (b) the long-run relation between trade balance and real exchange rate. Their empirical results—both time series evidence and cross-sectional evidence—showed a clear negative relation between trade balance and the net foreign asset position within countries: if a country's net external liabilities increase by 10 percent of GDP, its trade surplus increases on average by 1.3 percent of GDP.

The relationship discussed above implies that trade balance can be influenced by the exchange rate changes additionally through the impact on the net foreign asset position. As criticized by Lane and Milesi-Ferretti (2005), it has been standard in the traditional Mundell-Fleming approach to consider scenarios in which the initial net foreign asset position is zero and the gross scale of international balance sheet is ignored. While this paper, given the lack of evidence relating to the additional channel, is motivated to explore tentatively the implications if the additional channel is incorporated.

3.2 The case of Japan-U.S. bilateral trade

This paper chooses the bilateral trade condition between Japan and the U.S. as the subject of empirical analysis; the reasons are three-folds:

Firstly, the importance of the bilateral trade relationship between Japan and the U.S.

Figure 1 illustrates the ratio of exports to the U.S. to Japan's total exports, and the ratio of imports from the U.S. to Japan's total imports, through the period from 1962 to 2004. As one can observe from the figure, the bilateral trade with the U.S. takes a big share in Japan's whole global trading activities. On average, over a quarter of the Japanese total imports and exports are associated with the U.S., with a peak ratio as large as 38 percent in the exports during the 1980s, and both the ratio of exports and imports declined after the East Asian Crisis. Statistics also show that the U.S. is the largest trading partner receiving Japanese export goods for over 40 years and remains the largest partner of imports by Japan until 2000, surpassed then by China, due to its fast growth rate and natural connection with Japan.

This is just an observation from the perspective of Japan. However, the importance of the trade relationship between the two countries can only be more obvious when one takes a look at the side of the U.S. The U.S. has been running trade deficits since the 1970s and Japan has always been at the center of debate whether the enormous trade deficit with Japan is caused by the policy of a "less valued yen" by the Japanese government, among other possible reasons. Despite the debate in academia, in order to rebalance the trade deficit with Japan, the U.S. government successfully "persuaded" Japan to appreciating the value of yen; from 360 Yen per dollar in 1971 all the way up to touch its peak at 80 Yen per dollar in April 1995. And this gives rise to the second reason why the bilateral trade between Japan and the U.S. is chosen as the object of analysis:

The second reason is the controversial role Yen-Dollar exchange rate played in the adjustment of the bilateral trade imbalance. Figure 2 plots the bilateral trade balance between Japan and the U.S. and the bilateral Yen-Dollar exchange rate from 1978 to 2006. As in figure 2, the value of yen against dollar had been going up since

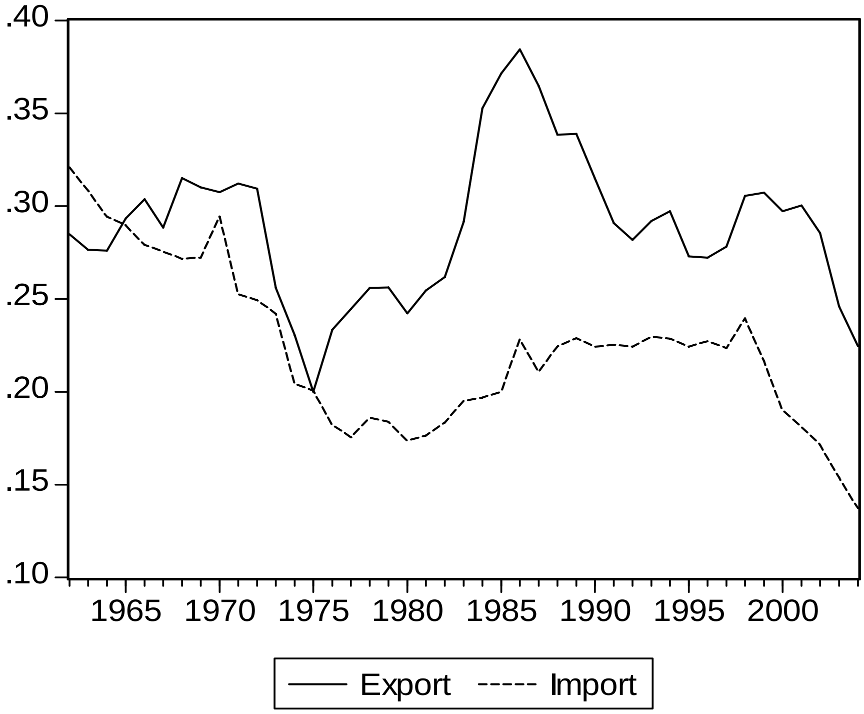

Figure 1 Export and Import Ratios in the Japan-U.S. Trade
Source: Statistics Bureau of Japan

Note: export refers to Japan's export to the US taken as the ratio of Japan's total exports, and import refers to Japan's import from the US taken as the ration of Japan's total imports.

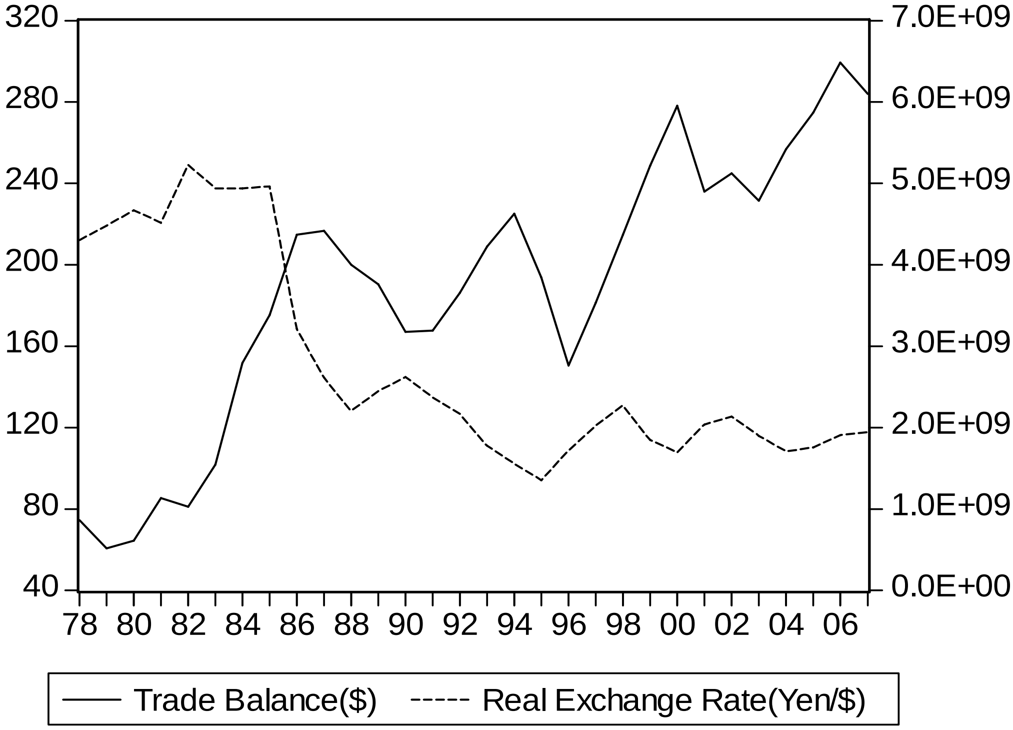

Figure 2 Japan-U.S. Trade Balance and Yen-Dollar Exchange Rate
Source: SourceOECD Database

1985. This trend ended in 1995; and the yen-dollar rates remained relatively stable for almost a decade, despite with an obviously larger volatility. The trade surplus of Japan, on the other hand, showed an increasing trend, with some up and downs. Clearly, the large trade surplus of Japan relative to the U.S. was not reduced by an appreciating Yen-Dollar exchange rate, contradicts with what the elasticity approach suggested.

The last reason, while the most relevant reason to this paper, is the outstanding net foreign asset position of Japan. Figure 3 plots the total foreign asset and total foreign liability positions of Japan since the beginning of 1980s. Both foreign assets and foreign liabilities increased more than three folds in the last two decades, while the net position, which is total foreign assets minus total foreign liabilities, also increased steadily, given the foreign asset grew more rapidly. This increasing net foreign asset position, as aforementioned, is linked to the growing openness of global goods and financial market; basically it is the result of the persistent trade surplus with respect to the rest of the world.

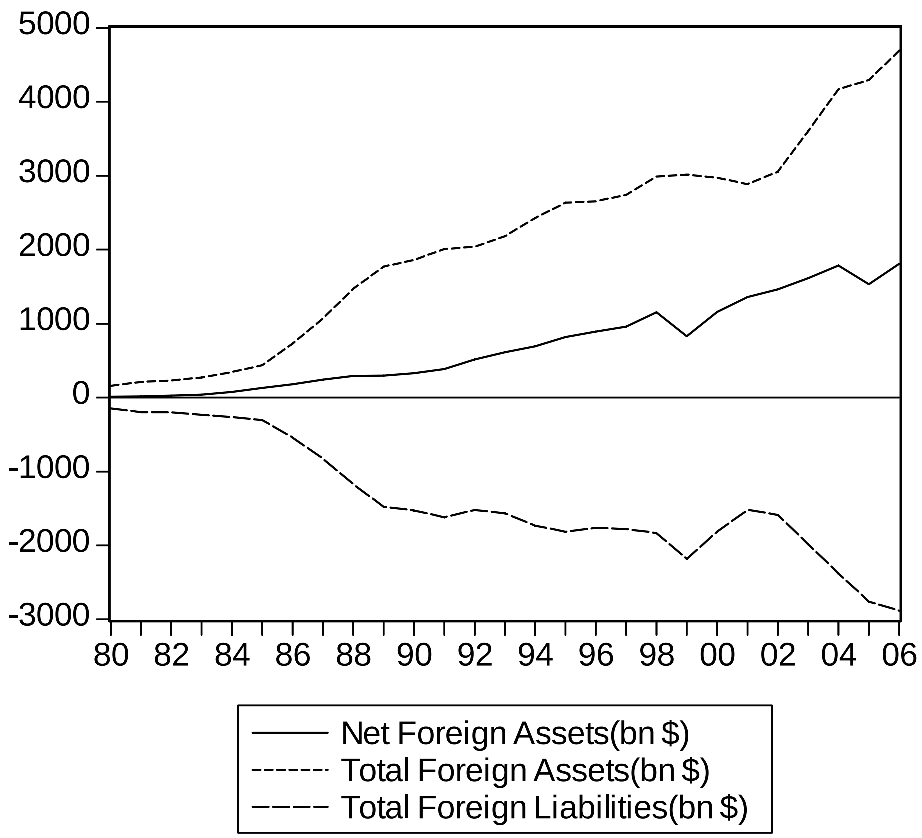

Figure 3 Japan's External Assets and Liabilities Position

Source: IMF-IFS Database

Taking these three reasons into account, the relationship of Japan-U.S. bilateral trade and the Yen-dollar exchange rate provides an ideal case for our empirical analysis—the appreciating yen failed to correct the trade imbalance between the U.S. and Japan, with the latter country possessing extensive external wealth denominated in dollars.

Before we proceed to the empirical part, it is worth noting of other work devoted to the issues regarding the Japan-U.S. trade balance and exchange rate. Among those using different frameworks, the most prominent one is Obstfeld (2006), who presented a quantitative evaluation of the effect on the Yen in some alternative scenarios under which Japan reaches its current account balance. The basic analytical framework is a global general equilibrium model referred to as the contemporary "new open economy macroeconomics" (Obstfeld and Rogoff, 2005a, b). Believing this kind of model is more suitable, Obstfeld and Rogoff (2005) argued that there is no single answer to the question of how much exchange rate change is associated with a given change in the current account: even for a fixed set of fundamental parameters, the magnitude of the exchange rate change will depend on the precise scenario under which the adjustment occurs. According to their calibration results, Obstfeld concluded that Yen should appreciate by as much as 10 percent for each 1 percent GDP reduction in its trade surplus.

However, as Gourinchas and Rey (2007) noted, the "new open economy macroeconomics" approach does not fit into the empirical data, because of the dynamics of the current account that are caused by capital gains or losses on the net foreign asset position. Similarly, Lane and Milesi-Ferretti (2005) suggested that theoretical work on open-economy macroeconomics should strive to incorporate elements such as persistent non-zero net foreign asset positions.

3.3 The BRM model with net foreign asset position

To incorporate the net foreign asset position into the original BRM model, letting

B denote the outstanding net foreign asset of Japan, denominated in dollars, equation (1) is modified as below:

$$D_m = D_m(p_m, Y, F) \quad \text{and} \quad D_m^* = D_m^*(p_m^*, Y^*, F) \qquad (1')$$

where F stands for the net foreign asset of Japan in terms of Japanese domestic goods.

Here in this model, Japan is treated as the home country, while the U.S is the foreign country.[2]

Note that in equation (1'), both the demand functions for imports in the two countries are now affected by the net foreign asset position. The difference between Equation (1) and (1') indicates the role the net foreign asset plays in creditor country and debtor country, or more specific, the case of Japan and the US in the dollar standard. But the directions that the net foreign assets affect the demand in two countries are opposite.

The opposite influence on the two countries' demand is based on the stylized fact[3] that in East Asia, creditor countries such as Japan find it difficult to lend internationally in their own currencies, instead, dollar serves the role as the key currency in international borrowing and lending. Since the foreign asset that Japanese own is denominated in dollar, when yen appreciates, the value of their asset in their own currency losses, then their wealth decreases. While on the contrary, in the U.S., since more than 70% of their liabilities are denominated in other currencies (in this paper, it is denominated in Yen), given the appreciation in Yen, the wealth of American denominated in dollars increases. As a result, the demand for import goods in Japan is positively related to its external wealth, while in the U.S. the demand is negatively related to its external liability. All the other steps are the same as in the BRM model; consequently, we can derive the following:

$$TB = TB(q, Y, Y^*, F) \qquad (9')$$

What are the effects of the real exchange rate movement on trade balance based

2 This paper adopts the simple two country model, so that the net foreign asset of Japan is the net foreign liability of the US.

3 See McKinnon and Schnabl, (2003); McKinnon (2005).

on this modified BRM model with net foreign asset position? With the following two assumptions, we can answer these questions in turn.

According to the empirical literature introduced in section 3.1, two conditions are assumed:

Condition 1: the net foreign asset is positively related to the exchange rate. When q increases, F will increase.[4] This condition describes the valuation channel—when yen depreciates against dollar, the net foreign asset of Japan denominated in yen increases, and vice versa.

Condition 2: the trade balance is negatively related to the net foreign asset position. When F increases, TB will decrease. This relationship describes the "income effect" of the net foreign asset in both countries—when the net foreign asset denominated in yen increases, the Japanese feel wealthier; so they increase their consumption of both domestically produced goods and import goods, similarly to the situation when there is an increase in their income. And on the contrary, Americans feel poorer, so they reduce their imports from Japan. Given increased import goods, the trade surplus of Japan narrows.

Based on the two conditions, how the valuation channel takes effect is apparent. When currency appreciates in Japan, their net foreign asset decreases, as a negative income shock. So they demand less import goods as their overall consumption is cut down. And the positive shock through the net foreign liabilities of the US reinforced this valuation channel. As a consequence, the trade balance of Japan will improve.

However, combined with the "price effect'' as many expected—the case that the Marshall-Lerner condition holds, the exchange rate appreciation narrows the trade balance, finally the net effect of exchange rate appreciation on the trade balance is ambiguous. There is no clear relationship between trade balance and exchange rate.

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[4] By definition, $F = \frac{B \cdot E}{P} = \frac{B}{P^*} \bullet \frac{E \cdot P^*}{P} = \frac{B \cdot q}{P^*}$, so that F is positively related to q.

4. Model, method and data

This section firstly introduces the model to test, then briefly reviews the econometric procedures to be applied, and finally, describes the data.

4.1 Model

Extending the original BRM model to incorporate the non-zero net foreign asset position, as shown in the above section, we are interested in Equation (9'). However, this is not directly testable. Transformation on the equation is required to obtain the testable model so that we can proceed to identify the relationship empirically from the real time-series data of each variable. We can then deepen our understanding of exchange rate's effect on trade balance by examining the long run and short run relationships of each of these variables with trade balance.

Equation (9') indicates that the balance of trade is a function of the real exchange rate, the level of domestic and foreign real income, and additionally, the net foreign asset of Japan. Taking logs on both sides, after the log-linear transformation of the right hand side of the equation, we obtain the following model, which can be empirically analyzed:

$$\ln(TB_t) = \alpha_0 + \alpha_1 \ln(q_t) + \alpha_2 \ln(Y_t) + \alpha_3 \ln(Y_t^*) + \alpha_4 \ln(F_t) + u_t \qquad (10)$$

where ln represents the natural logarithm operation, and u_t is assumed to be a Gaussian white noise. Even though trade balance is usually defined as the arithmetic difference between the value of exports and imports, this study, following Baharumshah (2001) among others, measures trade balance as the ratio of import value to export value. The use of this ratio has several advantages. First, it is invariant to units measuring for exports and imports. Second, the regression equation can be expressed in log-linear form or constant elasticity form. Accordingly, the estimated coefficients are elasticities.

4.2 Econometric methods

The model in last section is our starting point of the empirical study to provide evidence about the effect of each variable on trade balance. The basic idea is to apply the multivariate cointegration test to check the relationship between trade balance and each of the variables, while paying special attention to the relationship between trade balance and real exchange rate. Given existence of the cointegration relationship among variables, we can apply the Vector Error Correction Model (VECM) and impulse-response functions as well as the variance decomposition technique to further examine the long run relationship and short run adjustment.

Though cointegration is a statistical characteristic, whether it exists among economic variables of interest is a question that has significant implications for understanding the behavior of those variables. Cointegration simply implies that there is a linear combination of nonstationary variables that is stationary. Evidence of cointegration in this paper means that a stationary long-run relationship among jointly endogenous random variables is present.

However, to start the cointegration analysis among the variables, we have to first examine the univariate properties of the data. The underlying variables could be cointegrated only if each of themselves is integrated in the same order. More specifically, in this work, to carry out the cointegration test, we have to first test if each of the five series is integrated in the same order. If the series do not follow the same order of integration, there can be no meaningful relationship among them. Two popular procedures to test for the unit roots can be applied to the variables: the Augmented Dicker-Fuller (ADF) test and the Phillip-Perron (PP) test, which are asymptotically equivalent.

As regard to the test for cointegration among the variables, two broad approaches have been frequently applied. The Engel and Granger (1987) method is based on assessing whether single-equation estimates of the equilibrium errors appear to be stationary. The second approach, due to Johansen (1988) and Johansen and Juselius (1990), is a version of analyzing multivariate cointegrated system based on the Vector

Autoregression (VAR) approach. It sets out maximum likelihood estimation to determine the rank of the cointegrating vector. The Johansen-Juselius approach is claimed to be superior to the regression-based Engel and Granger procedure.

To carry out the Johansen test, we should first formulate the VAR system. A vector of p variables, $Z_t = (Z_{1t}, \cdots, Z_{pt})$, is generated by the k-order vector autoregressive process with Gaussian errors:

$$Z_t = A_1 Z_{t-1} + \ldots + A_k Z_{t-k} + \mu + \varepsilon_t, \quad t = 1, \ldots, T \tag{a}$$

Where Z_t is a $p \times 1$ vector of $I(1)$ variables, coefficients to be estimated are the A's, ε_t is assumed to be $iid\ N(0, \Sigma)$, while μ denotes for the constant vector. The order of the model, k, must be determined in advance.

Assuming cointegration among variables in the vector Z_t, equation (a) can be transformed to the error correction form by differencing:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \cdots + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-k} + \mu + \varepsilon_t, \quad t = 1, \ldots, T \tag{b}$$

The rank of the coefficient matrix Π determines the number of the cointegrating vectors of Z_t. While the rank of Π, r is greater than 0 and less than the full rank p, Π can be factored: $\Pi = \alpha\beta'$, both α and β are $p \times r$ matrices. Accordingly, two statistic tests of the Johansen-Juselius method, the trace and maximum eigenvalue tests enable us to determine the number of cointegrating vectors.

The presence of causal relationship between the variables does not necessarily identify the direction of causality relation between variables. To this end, the Granger causality test is carried out to explore the causal relationship as well as direction. However, once the cointegration relationship is tested to exist among the variables and the cointegrating rank r is determined, standard VAR representation of the first difference is misspecified. Instead, as Engel and Granger (1987) and Toda and Phillips (1993) demonstrated, the vector error correction representation should be applied:

$$\Delta Z_t = a + \sum_{i=1}^{k} A_i \Delta Z_{t-i} - d(\beta' Z_{t-1}) + v_t \tag{c}$$

Where Z_t is an $p \times 1$ column vector of variables, a is the constant vector, k denotes the lag length, d is an $p \times r$ matrix of coefficients, v_t is an $p \times 1$ column vector of normal disturbances. That is, besides the first difference stationary terms, there is an additional error-correction term reintroducing the information lost in the first difference process. Here the short-run dynamics of variables in the system are represented by series in difference and the long-run relationships by the variables in levels. The additional channel for Ganger causality cannot be detected if we ignore the error-correction term, and results can be problematic.

Writing the model in VECM form also enables us to perform variance decomposition (VDCs) and impulse-response functions (IRFs) analysis that sheds more light on the interaction among the endogenous variables. The VDCs procedure, quite straight forward, decomposes the total variance of one variable to attribute it among innovations to all variables. By examining the variations caused by its own shock as well as shocks to other variables, we can measure the overall relative importance of an individual variable. The IRFs proceeding traces the dynamic effect on all endogenous variables in the system of a one-time innovation in one endogenous variable. By plotting the impulse response functions, we can examine the dynamic response of one variable to a one-period standard deviation shock to another variable. Since these two techniques are widely used, details are omitted here.

4.3 Data description

The autoregressive vector consists of five variables: trade balance of Japan (TB) with the U.S., the real exchange rate of yen to dollar (q), real domestic income of Japan (Y),US (foreign) real income (Y^*), and the net foreign asset position of Japan (F). The data is on a quarterly basis from 1980: Q1 to 2006:Q4, according to the availability. All the time-series except the net foreign asset are obtained directly from the OECD Source database. The nominal exchange rate is the end of period market rate. All the nominal terms are deflated into real terms using respective CPI as the price indexes.

Regarding the net foreign asset (F), no quarterly data is directly available. Instead, I employed temporal interpolation method to transform the annual net foreign asset data into quarterly figures. Particularly, the Chow-Lin method (Chow and Lin, 1971) is adopted since it is widely applied in the literature due to its more reliable characteristics. The basic idea here is to find some foreign asset-related quarterly series and come up with a predictive equation by running a regression of annual foreign assets on annual related series. Then use the quarterly figures of related series to predict the quarterly foreign asset figures and adjust them to match the annual aggregates. The annual net foreign asset data is obtained by subscribing total foreign liabilities form total foreign assets, obtained from the IMF-IFS database. The related quarterly time-series are chosen as total foreign reserve and liabilities of monetary authorities, according to the statistical significance. Quarterly net foreign assets data can be obtained from standard computer packages, and to focus on topic, details are omitted.

5. Empirical results

5.1 Unit root analysis

Before applying the cointegration procedure, all variables are tested to show if the series are stationary or nonstationary, and their order of integration. The relationship of cointegration can only be examined among variables integrated in the same order. To this purpose, both the Augmented Dickey-Fuller (ADF) test and Phillips and Perron (PP) test are applied. The results of both tests to the level of those series are presented in Table 1[5]. Only the most robust test results are given, with a constant term and a trend in the regression. All the results prove strong evidence to reject the null hypothesis of stationarity, indicating that all five series are integrated, at a 5% significance level. Results from the ADF test also gives the optimum lags that each series are autocorrelated.

Table 1 Unit Root for the Level

			ADF-test			
			Test critical values:			
	Opt Lag	test stat	1% level	5% level	10% level	Prob.*
ln(TB)	5	-2.8604	-4.05051	-3.45447	-3.15291	0.1798
ln(q)	3	-2.03686	-4.04868	-3.4536	-3.1524	0.5742
ln(Y)	3	-1.67299	-4.04868	-3.4536	-3.1524	0.7563
ln(Y*)	2	-2.67321	-4.0478	-3.45318	-3.15215	0.2499
ln(F)	0	-3.02547	-4.35607	-3.59503	-3.23346	0.1446
			PP-test			
ln(TB)		-2.96796	-4.04607	-3.45236	-3.15167	0.1462
ln(q)		-2.23944	-4.04607	-3.45236	-3.15167	0.4628
ln(Y)		-1.25104	-4.04607	-3.45236	-3.15167	0.8941
ln(Y*)		-2.72735	-4.04607	-3.45236	-3.15167	0.228
ln(F)		-3.02547	-4.35607	-3.59503	-3.23346	0.1446

Note: TB = trade balance; q = real exchange rate; Y = domestic real income; Y* = foreign real income; F = net foreign asset.

[5] Both the ADF test and PP test are applied to the quarterly series of the variables except the net foreign asset. For this series, the unit root test is performed according to the original annual data, so that we can avoid extra noise from the process of disaggregation.

Given all the series are non-stationary in their level; we now turn to test stationarity in their first differences. The test results for the first difference of each of the variables are presented in Table 2. In the results of ADF test, three of the five first differences exhibit stationary property at the 1% critical value, while the first difference of domestic income series is stationary only at the 5% critical value. However, for the first difference of the trade balance data, it is tested to be nonstationary even at the 10% critical value.

But if we further apply the PP test to the first differences, as in the second panel of Table 2, all the results are highly significant, so that the existence of a unit root is rejected in the first differences. The final conclusion is that all the time-series have a single unit root, but in the first differences, all of them are stationary. This result is consistent with other empirical work in the macroeconomic literature, all finding that macroeconomics data behave as I (1) process. Therefore, we can implement the econometric procedure based on the assumption that all series are non-stationary, or more specific, exhibit I (1) property.

Table 2 Unit Root Test for the 1st Difference

			ADF-test			
			Test critical values:			
	Opt Lag	test stat	1% level	5% level	10% level	Prob.*
dln(TB)	4	-3.12754	-4.05051	-3.45447	-3.15291	0.1056
dln(q)	2	-5.28419	-4.04868	-3.4536	-3.1524	0.0002
dln(Y)	2	-3.57615	-4.04868	-3.4536	-3.1524	0.0368
dln(Y*)	1	-5.56856	-4.0478	-3.45318	-3.15215	0.0001
dln(F)	4	-5.23357	-4.4679	-3.64496	-3.26145	0.0021
			PP-test			
dln(TB)		-12.0632	-4.04693	-3.45276	-3.15191	0
dln(q)		-9.79803	-4.04693	-3.45276	-3.15191	0
dln(Y)		-9.29692	-4.04693	-3.45276	-3.15191	0
dln(Y*)		-8.13214	-4.04693	-3.45276	-3.15191	0
dln(F)		-11.4949	-4.37431	-3.6032	-3.23805	0

5.2 Cointegration analysis

Before we go on to multivariate cointegration test, we need to determine the lag length for the basic VAR model in advance. It is well known that results of the Johansen-Juselius procedure are quite sensitive to lag length. The lag length of the model is selected based on lag selection criteria, five criteria are adopted to make the decision: modified LR test statistics (LR), Final Prediction Error criteria (FPE), Akaike's information criteria (AIC), the Swartz-Bayesian information criteria (BIC) and the Hannan and Quinn information criteria (HQ). Table 3 indicates the results of the lags each criterion suggests.

Table 3 Optimal Lag Selection

Lag	LR	FPE	AIC	SC	HQ
0	NA	1.15E-09	6.39049	6.25693	6.3365
1	1384.057	4.07E-16	21.2481	20.44670*	20.92414*
2	65.31217	3.19E-16	21.4956	20.0265	20.9018
3	48.24028	2.97E-16	21.5778	19.4408	20.714
4	53.85902*	2.49e-16*	21.77506*	18.9703	20.6413
5	25.93275	2.99E-16	21.6247	18.1521	20.221
6	25.45278	3.58E-16	21.4955	17.3551	19.8219
7	24.66638	4.30E-16	21.3857	16.5776	19.4422
8	29.33305	4.69E-16	21.3982	15.9223	19.1848
9	25.03242	5.48E-16	21.378	15.2343	18.8946
10	23.0752	6.61E-16	21.37	14.5584	18.6166
11	25.82312	7.38E-16	21.4947	14.0154	18.4715
12	24.59741	8.38E-16	21.6767	13.5295	18.3835

Note: LR denotes the sequential modified Likelihood Ratio test statistic at the 5% level.

Three of the five criteria—LR, FPE and HQ—suggest to set the lag length at 4, while the SC and HQ statistics indicate that the lag length is 2. To further insure the appropriate lag order in the model, residuals of VAR are tested for serial correlation. Results are concluded in Appendix A. When setting lag at 2, clearly, the residuals are serially correlated at first four lags, and even at higher orders like 11, 12 lag. On the other hand, in the 4-lag case, the LM test statistics reveal no significant serial correlation in the error term at all lags of the residuals up to 12 lags.

So I apply 4 lags in the VAR model to test for cointegration. I also include the constant term and a trend according to the property of the variables, and select the critical values at 5% level.

The following Table 4 and Table 5 report the results of Maximum Eigenvalue and Trace test for cointegration.

Table 4 Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.379884	49.21838	33.87687	0.0004
At most 1 *	0.283372	34.31946	27.58434	0.0059
At most 2 *	0.24038	28.31853	21.13162	0.0041
At most 3	0.083561	8.987718	14.2646	0.2872
At most 4	0.023208	2.418643	3.841466	0.1199

Note: * denotes rejection of the hypothesis at the 0.05 level.

Table 5 Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.379884	123.2627	69.81889	0
At most 1 *	0.283372	74.04435	47.85613	0
At most 2 *	0.24038	39.72489	29.79707	0.0026
At most 3	0.083561	11.40636	15.49471	0.1877
At most 4	0.023208	2.418643	3.841466	0.1199

Note : * denotes rejection of the hypothesis at the 0.05 level.

It is evident that at 5% critical value, both the Maximum Eigenvalue test and Trace test suggest 3 cointegrating equations among the five variables. Altogether, we can determine that there are three cointegration vectors; in other words, there are three independent long-run relationship between trade balance, real exchange rate, domestic and foreign income, and domestic net foreign asset position.

5.3 VECM Modeling and Causality Test

Based on results of the cointegration test and lag selection criteria, this paper chooses 3 ranks and 4 lags to obtain the estimation of cointegrating relationships through a vector error correction model.

The results of the diagnostic tests indicate that the VECM is adequately specified, as summarized in Appendix B. There is no evidence of autocorrelation in the disturbance of the error term. The Residual Heteroskedasticity test suggests the errors are homoskedastic and independent of regressors, and the normality of the error terms is supported by the Jarque-Bera test result.

Since there are three cointegration relationships among the variables, to estimate coefficients of the integrating equations, we must normalized three variables in the cointegrating vector. It is a common practice to normalize on the variable of interest, here in this case, $\ln TB$. Regarding the other two vectors, since we are interested in the relationship between trade balance and real exchange rate and net foreign asset respectively, I choose to normalize on the remaining two vectors, that is, $\ln Y$ and $\ln Y^*$. The VECM model then determines the coefficients of cointegrating vectors, which are summarized in Table 6.[6]

Table 6 Cointegration Analysis with Normalization

variable	β	α
ln(TB)	1	-0.12131
		(-0.05518)
ln(Y)	0	0.034396
		(-0.00827)
ln(Y*)	0	0.000599
		(-0.00582)
ln(q)	-0.39491	-0.10332
	(-0.17762)	(-0.049)
ln(F)	-0.10701	-0.0221
	(-0.02583)	(-0.06289)

Note: number in parenthesis is std. of the estimated coefficient.

The β column is the coefficients of cointegration equation, denoting the long-run relationship among the variables. The results indicate that Japan's trade balance has a positive relationship with the exchange rate, since the coefficient of

6 All the estimated coefficients of the cointegrating vectors and of the error correction terms are summarized in Appendix C.

$\ln(q)$ is positive[7], indicating that an appreciation has a positive effect on trade balance, just opposite to what the elasticities approach expected. However, this coefficient is highly insignificant, showing that the long-run relationship between the exchange rate and trade balance is not significant; thus in the long-run, adjusting exchange rate is not able to affect trade balance in any direction. On the other hand, the coefficient of net foreign asset, $\ln(F)$, is significantly positive, means that in the long run, trade balance and net foreign asset position are positively related.

Thus, the following conclusions can be summarized:

1. Evidence does not support the long run positive relationship of trade balance and exchange rate.

2. In the long run, net foreign asset position is positively related to trade balance.

The α column is the coefficients of the short run adjustment terms, associated with the corresponding cointegrating vector. The coefficient of exchange rate on trade balance is positive in the short run, supporting the argument of the elasticities approach. In the short run, the coefficient of net foreign asset is also positive. However, we can see this coefficient is not significant at all.

Again, in short run, there are two conclusions:

1. Although appreciation can not narrow the trade surplus in the long run, it is effective in the short run to reduce the trade surplus.

2. In contrast to the stale long run connection with the trade balance, in the short run, the linkage between trade balance and net foreign asset is insignificant.

Having testified the relationship among variables does not automatically tells us the causal relationship of these related variables. To find out the endogenous variables and exogenous variables in the system and the causal direction, Granger-Causality test procedure is employed. As shown before, there are three cointegrated equations, accordingly, three error correction terms are constructed and included in the estimation of VECM model. Including the error correction terms provides us

[7] The sign of each coefficient is opposite from what appears in the result in Table 6 because the estimates of the VECM puts all the endogenous variables on one side of the equation.

additional channels to identify the Granger causal relationship. The Granger causality test results based on the VECM model is as following:

Table 7 Granger Causality Test

	chi-sq statistics (p-value)				
Dependent Variables	d(TB)	d(Y)	d(Y*)	d(Q)	d(F)
d(TB)		10.57797*	2.643214	1.184579	3.945304
		（0.0317）	（0.6192）	（0.8806）	（0.4135）
d(Y)	14.26769*		3.993329	5.91718	6.374011
	（0.0065）		（0.4069）	（0.2054）	（0.1729）
d(Y*)	24.75319*	9.26861		0.846031	2.715328
	（0.0001）	（0.0547）		（0.9322）	（0.6065）
d(Q)	5.491971	10.18127*	1.922679		20.71967*
	（0.2404）	（0.0375）	（0.75）		（0.0004）
d(F)	0.832685	5.819876	2.789693	16.33678*	
	（0.934）	（0.213）	（0.5936）	（0.0026）	

Note: * denotes rejection of the hypothesis at the 0.05 level, number in parenthesis is std. of the estimated coefficient.

For the relationships between trade balance and exchange rate and net foreign asset position, respectively, no causality relation is detected. On the other hand, the Granger causality actually runs from both domestic and foreign income to the bilateral trade balance. This indicates that, the bilateral trade balance condition between Japan and the U.S. is essentially determined by their fundamentals—real income and consumption conditions in the two countries. And for Japan’s domestic income, it is actually caused by its trade balance position and its real exchange rate against dollar. One reasonable result is that the Granger causality relation is found between exchange rate and the net foreign asset, running in both directions, which means these two variables affect and are affected by each other.

5.4 IRF and VDC

Once we obtained the results of the VECM specification, we can use IRF and VDC methods to examine how shocks in each variable affect the adjustment in trade balance. Setting $\ln TB$ as the response variable in the model, and $\ln Y$, $\ln Y^*$, $\ln q$, and $\ln F$ as the impulse variables, the results are showed in Figure 4 respectively.

In each graph, the horizontal axis indicates time span measured in quarters and the vertical axis indicated response in $\ln TB$ to one standard deviation shock of the impulse variable. Since the trade balance response is expressed in natural logarithm, the magnitude of response can be interpreted as percentage change of Japan's trade balance with the US.

All the results are in accordance with expectations. It appears that the shock in Japan's GDP has a small but permanent positive effect on its trade balance, but initially, the trade balance turns negative to the shock in Japan's income. The US GDP, on the other hand, has a larger permanently positive effect on Japan's trade balance; this can be associated with a greater demand from the U.S. on Japan's export goods. The response of trade balance to the shock in exchange rate remains positive, suggesting that initial depreciation can be effective to improve trade balance, however, as the horizon extends, this effect dies out, leaving trade balance unchanged. And in this case, the well known "J-Curve" effect does not exist, however, it seems to appear in the response of trade balance to a shock in the net foreign asset. It appears that net foreign assets position has negative influence on trade balance initially, this also proved the assumption of a negative relation between net foreign asset and the trade balance.

Another useful procedure to illustrate the relationship of trade balance with other variables is the forecast error variance decomposition, which decomposes the forecast error variance of trade balance into parts due to each of the innovations in the system. While impulse response functions trace the effects of a shock to each one of the endogenous variables on target variable in the VAR, variance decomposition separates the variation in the target variable into component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting variables in the VAR. Detail is plotted in Figure 5.

Figure 5 indicates that most of the forecast error variance is explained by innovations in the foreign income level and exchange rate. The fluctuations in the foreign income level account for more than 35% of the forecast error in trade balance, while exchange rate explains nearly 50% of the forecast error variance. Domestic economic activity seems to affect trade balance only to a small proportion, less than 10%. And the role played by the net foreign asset can even be neglected since the influence is quite insignificantly different from zero. The forecast error of trade balance is more sensitive with the shocks in real exchange rate and the foreign income level than domestic income level and net foreign asset position.

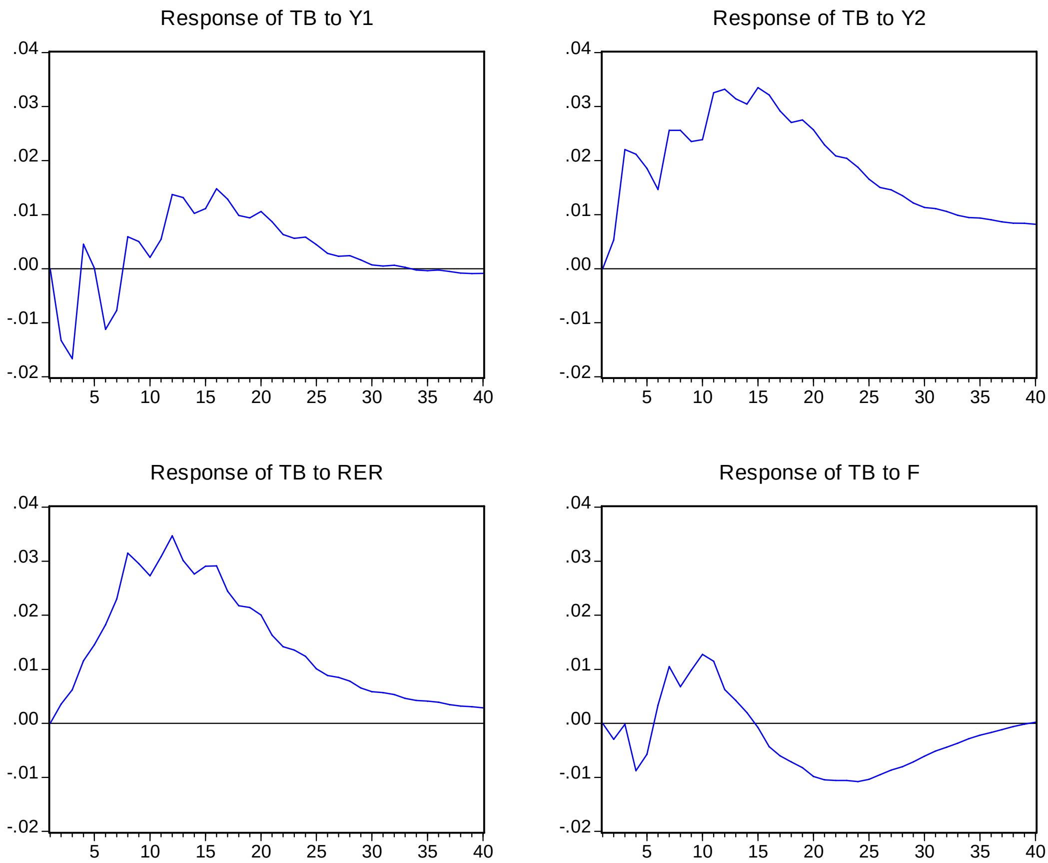

Figure 4 Responses to One SD Innovations

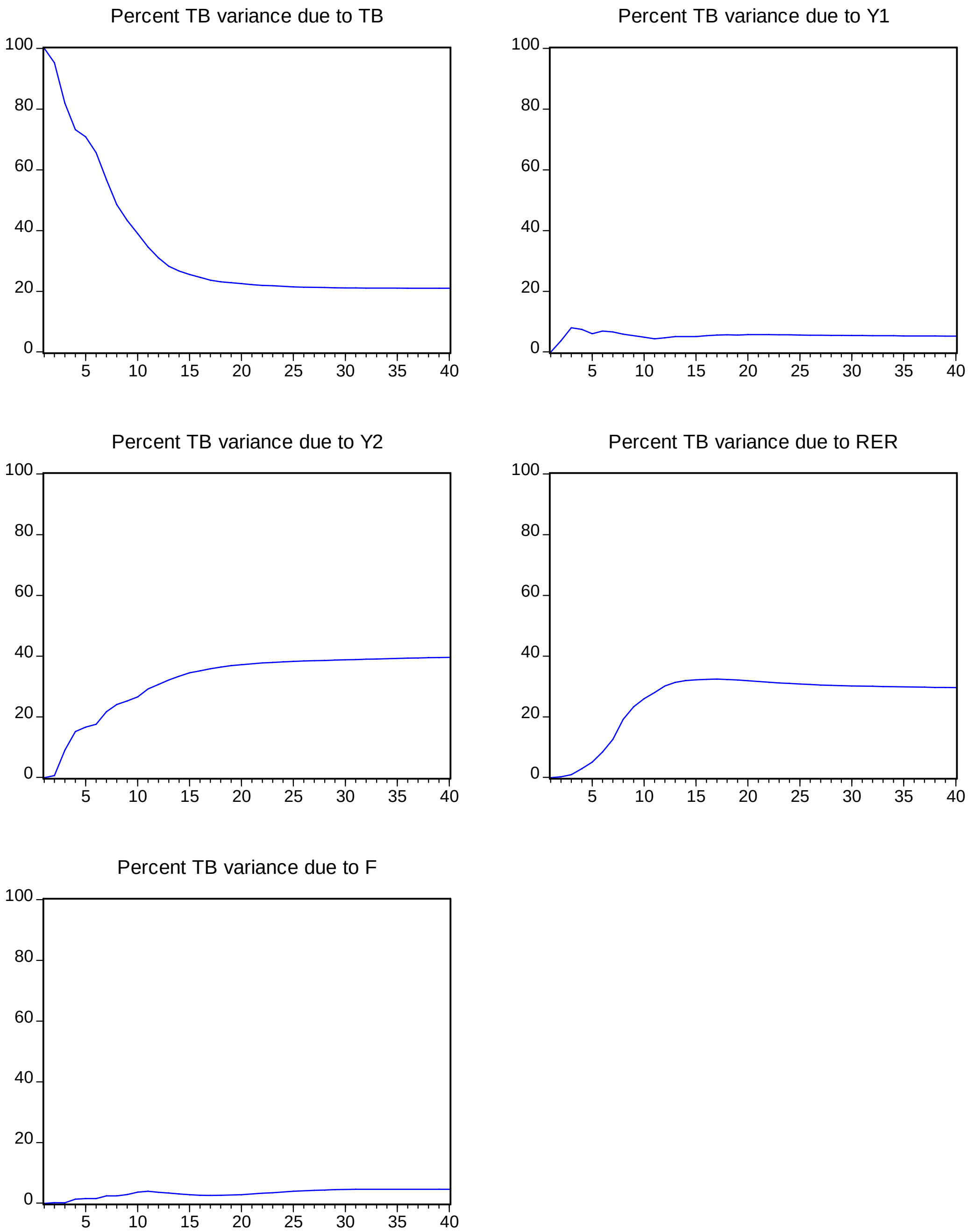

Figure 5　Variance Decomposition

6. Conclusions

This paper examines the relationship of exchange rate and bilateral trade balance between Japan and the U.S. Based on the macroeconomic data from 1980-2006 on a quarterly basis, after the unit root tests of individual variables, the model is estimated using the Vector Autoregressive form. After some robust test on specification, the Johansen-Juselius cointegration method is applied to detect cointegration relation among the endogenous variables. Once the cointegration relationship is testified to exist, cointegration rank is determined accordingly, and then the Vector Error Correction model is employed to identify long-run relationships of the cointegrating variables and short-run adjustment coefficients for the error correction terms. Besides that, Granger causality procedure is carried out to investigate the causal relationship and directions of causality between the variables. Finally, Impulse Response Analysis and Variance Decomposition procedure are performed to provide more insight into short run interaction between trade balance and those endogenous variables in the system.

This paper differs from other empirical literature in that it also incorporates the net foreign asset position as a relevant factor to trade balance. The net foreign asset position is assumed to provide an additional channel—the valuation channel through which exchange rate movement can affect trade balance. This assumption is reasonable given the stylized fact that, with the increasing integration in global trade and financial markets, some countries build up significant amount of foreign claims on their trade partners through the persistent trade surpluses. In addition, in the case of most of East Asian economies, their external wealth are not denominated in their own currencies, but in dollars instead. Assuming that net foreign asset is related to trade balance, the exchange rate changes can also affect trade balance indirectly, by causing shifts in the external wealth of surplus countries.

Evidence is found that when incorporating the additional channel of the net foreign asset position, there is no significant long run relation between exchange rate and trade balance. The Marshall-Lerner condition suggested by the traditional elasticities approach is rejected by data. However, empirical results suggest that Japan’s trade balance is indeed positively related with exchange rate in the short run. That is, appreciation in the yen-dollar exchange rate is effective in the short run to reduce Japan’s trade surplus, but in the long run, there is no predictive effect. Granger causality result shows that in the long run, what actually determines trade balance is the real income levels in two countries. The net foreign asset position, on the other hand, is linked to trade balance in the long run. The causal relation runs from exchange rate to the net foreign asset, thus supporting our assumption about the additional valuation channel. Since the impact of the exchange rate adjustment on trade balance is ambiguous given the absence of a stable long run relationship, it is not appropriate to rely on currency appreciation in order to correct trade surplus in the case of Japan and more likely in similar cases of surplus countries with an outstanding external position denominated in dollars.

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Appendices

Appendix A

LM Autocorrelation test with lag order 2 in the VAR

Lags	LM-Stat	Prob
1	62.23612	0.0001
2	52.6256	0.001
3	25.7068	0.4234
4	47.33346	0.0045
5	20.31625	0.73
6	29.01388	0.2633
7	26.15702	0.3993
8	40.54401	0.0256
9	15.18427	0.937
10	33.60917	0.1165
11	38.48519	0.0415
12	49.80263	0.0023

LM Autocorrelation test with lag order 4 in the VAR

Lags	LM-Stat	Prob
1	35.58278	0.0782
2	25.2758	0.447
3	30.47416	0.207
4	21.80723	0.6468
5	30.70699	0.1989
6	26.30873	0.3913
7	29.54032	0.242
8	20.66547	0.7111
9	14.5333	0.9516
10	20.12255	0.7404
11	24.94751	0.4653
12	28.72834	0.2754

Appendix B

LM Autocorrelation test of the VECM residuals

Lags	LM-Stat	Prob
1	25.20675	0.4508
2	30.89563	0.1925
3	24.73519	0.4773
4	29.0516	0.2618
5	30.69885	0.1992
6	19.37032	0.779
7	20.50485	0.7199
8	22.73692	0.5929
9	27.93867	0.3107
10	16.8516	0.8871
11	18.6985	0.8113
12	23.81612	0.53

Jarque-Bera Normality test of the VECM residuals

Component	Jarque-Bera	df	Prob.
1	7.052829	2	0.0294
2	11.13948	2	0.0038
3	7.319057	2	0.0257
4	10.17943	2	0.0062
5	2.540113	2	0.2808
Joint	108.4334	105	0.3896

VEC Residual Heteroskedasticity Tests

Joint test:		
Chi-sq	df	Prob.
705.0558	690	0.3371

Appendix C

Normalized cointegrating coefficients

TB	Y1	Y2	RER	F
1	0	0	-0.39491	-0.10701
			(-0.17762)	(-0.02583)
0	1	0	0.675838	-0.13759
			(-0.08961)	(-0.01303)
0	0	1	-0.36762	-0.14659
			(-0.05761)	(-0.00838)

Note: standard error in parentheses.

Adjustment coefficients

D(TB)	-0.12131	0.359452	-0.12519
	(-0.05518)	(-0.09886)	(-0.14403)
D(Y1)	0.034396	0.024538	0.000187
	(-0.00827)	(-0.01481)	(-0.02158)
D(Y2)	0.000599	-0.00275	-0.04211
	(-0.00582)	(-0.01043)	(-0.0152)
D(RER)	-0.10332	0.027048	0.611934
	(-0.049)	(-0.08779)	(-0.1279)
D(F)	-0.0221	0.292314	0.796106
	(-0.06289)	(-0.11267)	(-0.16415)

Note: standard error in parentheses.