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Abstract

This paper examines the relationship of the bilateral trade balance and exchange rates between Australia and Japan in the period from 1988 to 2007. This study provides the short-run and long-run, relationship of trade balance and real exchange rates, and the potential existence of a "J-curve" using quarterly time series data in that period. The minimum Lagrange Multiplier unit root tests (Lee and Strazicich: 2003, 2004) have been applied to determine endogenously potential structural break(s) for each series of data. Then, using the autoregressive distributed lag (ARDL) model, the cointegration is estimated.

Recently the relationship of Australian bilateral total trade balance and exchange rates with Japan in the same period was investigated (Meloche 2009), and the results showed that there is a stable long run relationship among the trade balance, national income of both countries and real exchange rates. However, the existence of J-curve in that period was not detected. A failure to detect a J-curve could be due to an aggregation bias. This study disaggregated trade balances into 10 trade sections (Standard International Trade Classification 1-digit level) and then analysis was carried out. The empirical results showed that there is a stable long run relationship among trade balance, national incomes and real exchange rates in three trade sections. Those trade sections are beverages and tobacco (TB1), crude materials, inedible, except fuels (TB2) and animal and vegetable oils, fats and waxes (TB4). The results also support that the existence of a J-curve in the above three trade sections.

JEL classification: C22; **F31; F14**
Keywords: **J-Curve; Trade Balance; Exchange Rates; ARDL approach; Cointegration**

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1. Introduction

Japan has been the largest export destination for Australia since the late 1960s, and it has also been a major supplier of merchandise for Australia since the 1970s. On the other hand, Australia has been the principal importer for Japan (ranked 5th in 2007), but its import share to Japan's total imports was only 5%. Overall Australia was ranked as the 12th Japan's merchandise export destination in 2007. Australia's share of Japan's 2007 total exports was only 2%. Australia is an important import source country for Japan, however, its share of trade shows that Australia is a relatively small trading partner for Japan.[1] Despite fluctuations in the Australian dollar against the Japanese yen over time, the trade ranking for each country has remained relatively constant for the last 30 years. This paper will investigate whether the impact of depreciation of the Australian dollar against the Japanese yen has had a significant impact on the bilateral trade balance. The relationship between trade balance and exchange rates will be discussed with the formation of a J-curve. The J-curve formation refers to a deterioration of trade balance in the short-run after a depreciation of one's currency, and an improvement of the trade balance occurs in the long-run as demands for exports and imports adjust accordingly with the currency depreciation. The J-curve can be seen as a result of the responses of trade quantities based on its relation to currency depreciation. Sensitivity and time frame of changing demands for exports and imports towards currency depreciation will determine the shape of a J-curve. Thus, an examination of the J-curve is the examination of the relationship between the trade balance and exchange rates, and in turn those exchange rates can be tested as a determinant of the trade balance. The empirical literature on the evidence of a J-curve is mixed. Rose and Yellen (1989) did not find any evidence of a J-curve

[1] Australian Government, Department of Foreign Affairs and Trade (2009)

for the US trade balances with the other members of the Group of Seven. In their study, they used the unit-root testing and a cointergration technique. That was one of the first studies which utilised the cointegration technique to test for evidence of a J-curve.[2] They used the Engle and Granger (1987) approach as well as the Stock and Watson (1986) approach. On the other hand, Bahmani-Oskooee and Goswami (2003), Bahmani-Oskooee, Goswami and Talukdar (2005), Narayan and Narayan (2004) and Bahmani-Oskooee and Wang (2007) found evidence of a J-curve in some cases. They used the unit-root testing and the ARDL approach which was proposed by Pesaran, et al (2001). The ARDL approach has been selected for this study as it allows us to observe both the short-run and long-run relationships of trade balance and real exchange rates, which is used to examine evidence of a J-curve. More importantly the ARDL approach has advantages compared to other cointegration approaches as it is applicable irrespective of whether the underlying regressors are purely I(0) or purely I(1), which are experienced in this study. This paper allowed endogenous structural breaks in each series of data, and then the cointegration approach was used for estimation. The rest of paper proceeds as follows. Section 2 presents the relevant literature reviews. Section 3 presents the model and methodology with description of data, and Section 4 presents empirical results, followed by conclusions which will be presented in Section 5.

[2] Prior to this study, a formation of J-curve was often derived from demand functions of imports and exports.

2. Literature Review

The collapse of the Bretton Woods System in 1971 and the inability of the U.S to enforce the Smithsonian Agreement in 1972 resulted in the opportunity for the major industrial nations floating their currencies independently or jointly. The Japanese monetary authority took this opportunity and decided to float the Japanese yen independently in 1973. Since the collapse of the Bretton Woods system in 1971, the impact of currency depreciation / devaluation on the trade balance has been highlighted among the developed and developing countries. On other hand, the Australian dollar was floated in December 1983. At that time, one Australian dollar was being traded at over 200 yen, since then the Australian dollar has depreciated over time with frequent fluctuations. It recorded its lowest exchange rate against the Japanese yen at around 58 Japanese yen to the Australian dollar in October 2000. The Australian dollar has continued fluctuating, however, and it was traded at 99 Japanese yen at the end of December 2007. There is a common belief that "currency depreciation worsens the trade balance in the short-run. The immediate effect of depreciation means that cheaper exports and more expensive imports occur. Hence the trade balance initially deteriorates; it will however usually improve in the long-run as the volume of exports increases because of their competitive price, which is attractive to foreign buyers. Likewise, domestic consumers will tend to buy fewer imports as they are relatively expensive." The time path of trade balances would then form the letter J, this is a formation of the J-Curve. If there is an appreciation of its currency, there may be an inverted J-Curve.

The main reasons of the formation of a J-curve are that the demands for imports and exports are relatively inelastic in the short-run; consumers and firms have their habitual preference and they are reluctant to change their habits in the short run; firms are also often locked into long term trade contracts. However, over the longer term, depreciation in its currency can have the desired effect of improving the trade balance. Demands for exports and imports over a longer period of time will be more elastic as consumers and firms will adjust their demand in accordance with its currency.

Arndt and Dorrance (1987) reviewed the origin of the J-curve (discussed in the National Institute Economic Review of May 1968), and concluded that British manufactures were price makers in principle, as they were free to offer their products at cost, based on sterling prices. Thus, if foreign demand is sufficiently elastic, the increase in the volume of British exports would have more than offset the decline in their prices.[3] The J-curve could be comfortably achieved. Magee (1973) explained that the J-curve is a result of the responses of trade quantities based on currency devaluation. He used the terminology 'successful' PASS-THROUGH [process] to explain the occurrence of changes in the trade balance where buyers have incentives to alter their purchases of foreign goods only if the prices of these goods are favourable, in terms of their domestic currency. This in turn depends on the willingness of exporters to allow devaluation to affect the prices they charge for their products, as measured in terms of the buyer's currency.[4] Sensitivity and the time frame of the pass-through process determine the shape of a J-curve. Magee (1973) advocated further that multinational corporations presumably possess market power and speculate through currency contracts. The role of Multinational Corporations should not be ignored in the formation of a J-curve. Arndt and Dorrance (1987) applied this view to the Australian context as primary products are a substantial part

[3] It satisfies Marshall-Lerner conditions (the elasticises of demand for exports and imports are greater than one in the longer term, its trade balance will improve over the time)
[4] Magee (1973) p.315

of Australian exports. Australian primary products such as agricultural products and minerals have traditionally been exported using long term contracts. Furthermore, Australia is a small open economy who is a price taker in the international market. Hence, the development of volume effects to offset the price effects of devaluation takes longer to emerge. On the other hand, if the adjustments of volumes in export and import occur at the same time with the price change, the trade balance would not form the letter J. Rose and Yellen (1989) did not find a J-curve for the U.S trade balances with the other members of the Group of Seven. They claimed that the use of aggregate data (the U.S trade balance with the rest of the world) could be potentially misleading as the response of the trade balance to the real exchange rate to one country can be cancelled out with other countries.

The following studies used the ARDL approach to examine the evidence of a J-curve for various countries. Their findings were mixed. Bahmani-Oskooee and Goswami (2003) conducted a study on the Japanese bilateral trade balance with her 9 major trading partners. The bilateral trade data was used to prevent an aggregation bias problem that was mentioned above. However, the evidence of the J-curve was present for only two of the cases, one with Germany and the other with Italy. Narayan and Narayan (2004) found the evidence of a J-curve in Fiji's trade balance in the period of 1970 and 2000. Bahmani-Oskooee, Goswami and Talukdar (2005) investigated Australia's trade balance with Australia's 23 trading partners and there were also mixed results. The J-curve phenomenon was supported by the trade balance with only 3 countries, namely Denmark, Korea and New Zealand out of the 23 trading partners. Bahmani-Oskooee and Wang (2007) investigated the bilateral trade data between Australia and the U.S. They disaggregated the data into 108 industries with the aim to observe the impact of devaluation of real exchange on the trade balance for each industry. By disaggregating the trade data between the two countries into 108 industries, they were able to see that in 64 industries their trade balances responded significantly to a change in the real bilateral exchange rate. They were also able to provide support for a J-curve in 44 industries. Their study is important in that it establishes in the case of trade between Australia and the U.S, that not all industries are equally affected by currency depreciation. Thus clearly the impact of currency depreciation can vary among the industries. This study incorporates potential structural breaks and applies the ARDL technique to investigate for evidence of a J-curve for the Australian bilateral trade balance with Japan in 10 trade sections (Standard International Trade Classification 1-digit level).

3. Models and Methodologies and Data

3.1. Models and Methodologies

The ARDL approach has been selected for this study as it allows us to observe both the short-run and long-run relationships of trade balance and real exchange rates, which is used to examine for evidence of a J-curve. More importantly the ARDL approach has advantages compared to other cointegration approaches as it is applicable irrespective of whether the underlying regressors are purely I(0) or purely I(1), which are experienced in this study.

This paper has adapted the Bahmani-Oskooee and Wang (2007) approach as it aims to observe the sensitivity of the trade balance to real exchange rates.

The non-structural partial reduced form model of Rose and Yellen (1989) is utilised as follows:

$$TB = f(GDPA, GDPJ, EX) \qquad (1)$$

Trade balances (TB) and exchange rates (EX) are the main variables in this analysis, however, national income is an important variable to explain exports and imports, thus, GDP for both countries are included in a model.

The ratio of Australia's export to Japan over Australia's imports is used to establish the trade balance. The model is transformed in logarithmic form and it allows the coefficients to be interpreted as elasticity. The test model takes the following form:

Test Model:

$$\ln TB = \alpha + \beta_1 \ln RGDPA_t + \beta_2 \ln RGDPJ_t + \beta_3 \ln REX_t + \varepsilon_t \qquad (2)$$

where TB is the ratio of Australia's nominal exports to Japan over Australia's imports.

RGDPA: the Real GDP of Australia

RGDPJ: the Real GDP of Japan

REX: the real exchange rate

(Numbers of Australian dollars per Japanese yen x CPI_J / CPI_A)

It is assumed that TB is a function of the level of Australian income (RGDPA), the level of Japanese income (RGDPJ), and the real bilateral exchange rate between Australia and Japan (REX). If an increase in Australian income is expected to boost its imports from Japan, an estimate of β_1 is expected to be negative. If an increase in the level of Japanese income leads to an increase in Australian exports, an estimate of

β_2 will be positive. However, there is no agreement in the literature regarding the directions of the relationship between the trade balance and domestic and foreign income. An increase in the economic growth of country A, that is a major trading partner of country B, can increase country A's demand for all goods from country B (complementary effect). It can be true that an increase in the economic growth of country A that is a major trading partner of country B can also induce an increase in the supply of all goods from country A to country B (substitution effect). Thus, the signs of domestic and foreign income are purely empirical. The real bilateral exchange rate (REX) is defined as an increase in REX which shows a depreciation of the Australian dollar. Hence, if the real depreciation of the Australian dollar boosts Australia's exports and discourages its imports, an estimate of β_3 is expected to be positive[5].

Equation (2) represents a long-run relationship between the trade balance and its determinants. The ARDL approach to a cointegration can provide short-run effects of each explanatory variable as well as long-run effects of each explanatory variable. It is also able to evaluate interaction among the variables. The major advantages of the ARDL approach over the other cointegration approaches is its applicability, irrespective of whether the underlying regressors are purely I(0) or purely I(1), whereas the Engle and Granger (1987) model, the Johansen (1995) 's maximum likelihood estimation procedure and the Gregory and Hansen (1996)'s cointergration

[5] Terms of trade (TOT) is also considered as an exogenous variable. F tests for the model specification were carried out for (LTTB|LRGDPA, LRGDPJ, LREX) versus (LTTB|LRGDPA, LRGDPJ, LTOT) (Appendix D). The results show that both LREX and LTOT have similar marginal contribution to the model and they were statistically insignificant. In order to avoid a potential multicolinearity problem, real exchange rates (LREX) and terms of trade (LTOT) are included as an exogenous variable in the test model separately. The results show that models included LREX have statistically significant F test (the long-run relationship) results between trade balances and the exogenous variables in 4 cases. Ones included LTOT have only one statistically significant results in the F tests (Appendix E).

approach require that all variables are integrated to the order of one. The ARDL approach for this study is estimated by the following equation:

$$
\begin{aligned}
\Delta \ln TB_{i,t} &= \alpha + \sum_{k=1}^{n1} \omega_k \Delta \ln TB_{i,t-k} + \sum_{k=1}^{n2} \beta_k \Delta \ln RGDPA_{t-k} \\
&+ \sum_{k=1}^{n3} \gamma_k \Delta \ln RGDPJ_{t-k} + \sum_{k=1}^{n4} \lambda_k \Delta \ln REX_{t-k} \\
&+ \delta_1 \ln TB_{i,t-1} + \delta_2 \ln RGDPA_{t-1} + \delta_3 \ln RGDPJ_{t-1} + \delta_4 \ln REX_{t-1} + u_t
\end{aligned}
\tag{3}
$$

The parameters in Equation (3), δ_i are the corresponding long-run coefficients while the parameters, $\omega_k, \beta_k, \gamma_k, \lambda_k$ are the short-run coefficients in the ARDL model. The optimal numbers of lags for each variable *(k)* are selected based on the Schwarz Bayesian criterion (SIC). As long as the formation of a J-curve is the focus, the short-run effects of real exchange rates are inferred by the sign and size of estimates of λ's (negative), and the long-run effects are inferred by the size and significance of δ_4 (positive)[6]. Furthermore, the ARDL technique allows us to investigate relationships among the variables with the speed of adjustment to restore equilibrium. The ARDL approach involves 2 stages of tests. Firstly, we test the null of no cointegration (H_0: all $\delta_i = 0$) against the alternative of an existence of cointegration among the variables using the F-test. The bound critical values for F-test (Narayan 2005) were utilised and determined whether there is an existence of cointegration among the variables.[7] Secondly, it establishes the coefficients of the long-run relations and it also incorporates the ECM term, which enables us to estimate the speed of adjustment.

[6] If short-run estimates (λs) are retained in the model, and they change from negative to positive, which represents the J-curve (Bahmani-Oskooee and Wang 2007).

[7] The bound critical values for F-test were originally developed by Pesaran and Pesaran (1996). Narayan (2005) developed the bound critical values for smaller sample sizes (T=30~80).

3.2. Unit Root Tests

In addition to the above methodologies, structural breaks are considered in each series of data. This study adapted the Lee and Strazicich's minimum Lagranger Multiplier (LM) unit root tests (Lee and Strazicichi 2003, 2004) to determine structural breaks endogenously. The importance of allowing for structural breaks for estimation is documented as follows:

Conventional unit root test techniques such as the Dickey-Fuller (DF) test and the Augmented Dickey-Fuller (ADF) test often incorrectly fail to reject a unit root hypothesis against the alternative hypothesis of non unit root when existing structural breaks are ignored[8]. Perron (1989) showed that the ability to reject a unit root decreases when the alternative (stationary) is true and an existing structural break is ignored. However, he treated those break points as exogenous (known), and he acknowledged his approach would be seen as creating potential problems for pre-testing and 'data mining'. Zivot and Andrews (1992), Perron (1997), and Vogelsang and Perron (1998) developed the unit root test techniques to determine a break point endogenously. Lee and Strazicich (2001) pointed out that those approaches tend to estimate a break point incorrectly at one period prior to the true break point. Also when the magnitude of the break increases, the unit root null hypothesis is rejected too frequently (size distortions occur). Lee and Strazicich (2004) developed a minimum Lagranger Multiplier (LM) unit root test with one structural break to combat those shortfalls. They show that the critical values for the minimum LM unit

[8] Perron (1989)

root test are invariant to the magnitude and location of the break.[9] It is a significant development to make the test free of size distortions.

Lumsdaine and Papell (1997) then extended endogenous unit root tests with two breaks. However, their test tends to over reject the unit root null hypothesis, and which increases with the magnitude of the breaks.[10] Lee and Strazicich (2003) developed the minimum LM unit root test with two structural breaks, which endogenously determines the location of two breaks in level and trend and tests the null of a unit root.[11] Once again, the minimum LM unit root test with two structural breaks is invariant to the magnitude of the breaks. Lee and Strazicich (2003) noted that the alternative of the minimum LM unit root test with two structural breaks unambiguously implies trend stationarity; however, it could be true that the series is unit root with structural breaks.

LS minimum LM unit root test with two structural breaks is obtained in the following regression:

$$\Delta y_t = \alpha \tilde{S}_{t-1} + \zeta \Delta Z_t + \sum_{j=1}^{k} c_j \Delta \tilde{S}_{t-j} + \varepsilon_t \tag{4}$$

Where $\tilde{S}$ is a de-trended series such that $\tilde{S}_t = y_t - \tilde{\psi}_x - Z_t \tilde{\tilde{\zeta}}, t = 2,...,T$. $\tilde{\tilde{\zeta}}$ are coefficient in the regression of $\Delta y_t / \Delta Z_t$, $\tilde{\psi}_x$ is given by $y_1 - Z_1 \tilde{\tilde{\zeta}}$ .and y_1 and Z_1 are

[9] *Strictly speaking, the endogenous-break LM unit root test is invariant to breakpoint nuisance parameters only for model A. The LM test for model C is not invariant to nuisance parameters, but nearly so (Lee & Strazicich 2004,p.1082)*

[10] Lee and Strazicich (2003) examined Nelson and Plosser (1982) 's data and compared the results with those of the Lumsdaine and Papell (1997) test

[11] The model is also able to determine more than two breaks

the first observation of y_t and z_t respectively. $\Delta\tilde{S}_{t-j,} j = 1,...,k$ are added in the regression to correct for potential serial correlation.[12] Z_t is a vector of exogenous variables.

For Model C with two-break, Z_t is described as $[1,t,D_{1t}, D_{2t},DT_{1t}, DT_{2t}]'$, where D_{jt} =1 for $t>T_{Bj}+1$, j=1,2 and zero otherwise, and $DT_{jt}=t - T_{Bj}$ for $t\geq T_{Bj}+1$, j=1,2 and zero otherwise. T_{Bj} denotes the time period when a break occurs. The models utilised in this paper are summarised as follows:

Model A with one-break: $Z_t = [1,t,D_{1t}]'$,

Model C with one-break: $Z_t = [1,t,D_{1t}, DT_{1t}]'$,

Model A with two-break: $Z_t = [1,t,D_{1t}, D_{2t}]'$,

Model C with two-break: $Z_t = [1,t,D_{1t}, D_{2t},DT_{1t}, DT_{2t}]'$

Model A allows for shift(s) in the level (intercept) only and Model C allows for simultaneous change(s) in the level (intercept) and trend (slope).

The unit root null hypothesis is described by α = 0 and the LM t-test statistic is given by: $\tilde{\tau}$ =t-statistic testing the null hypothesis of α = 0 (5)

The location of the break (T_B) is determined by searching all possible break points for the minimum unit test t-test statistic

$$Inf\,\tilde{\tau}(\tilde{\lambda}) = \underset{\lambda}{Inf}\,\tilde{\tau}(\lambda) \qquad (6)$$

[12] The general to specific procedure suggested by Perron (1989) is utilised. It begins with a maximum number of lagged first-differenced terms k=8, and examine the last term to see if it is significantly different from zero at 10% level. If insignificant, the maximum lagged term is dropped and the model re-estimated with k-7 terms. The procedure is repeated until either the maximum term is found or k=0.

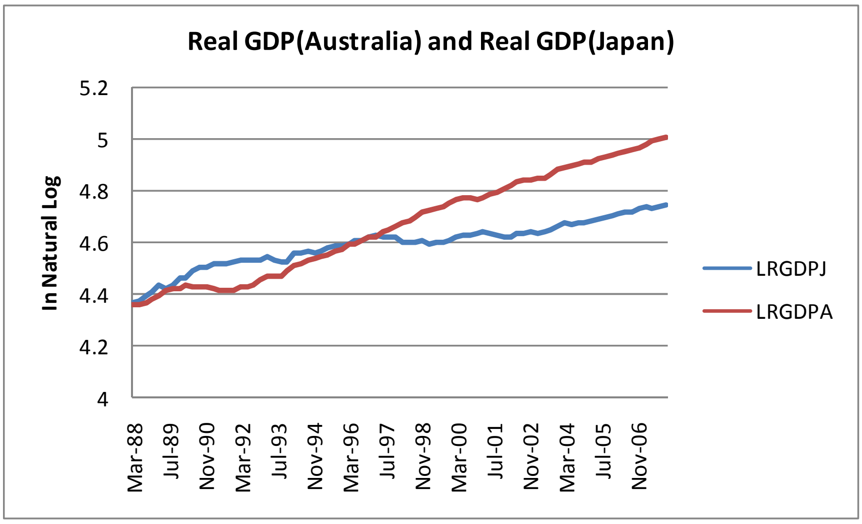
Where $\lambda = T_B/T$ for the one break model, and $\lambda = T_{B1}/T$, T_{B2}/T for the two-break model.

There are 80 observations for each variable; and the time span for the data is 20 years. Although the time span is relatively short, the two-structural break model is also considered.

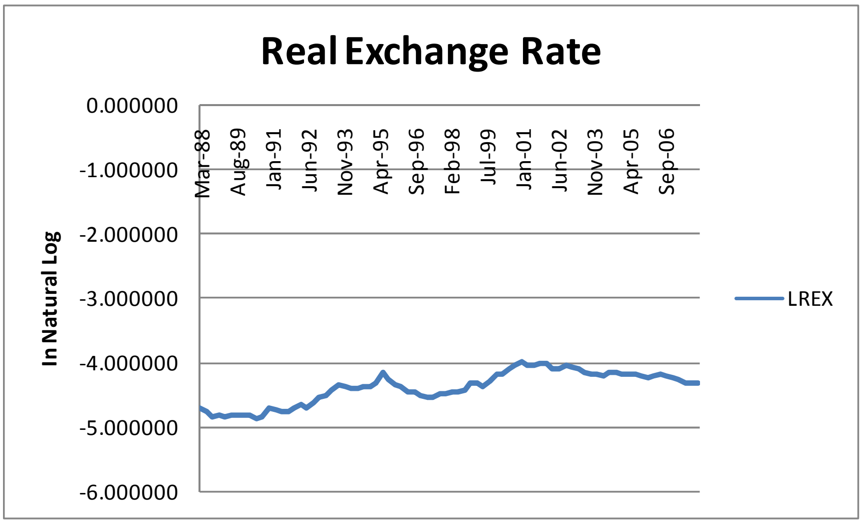
3.3. Data

Quarterly Bilateral Exports and Imports between Australia and Japan at the Standard International Trade Classification (SITC) 1-digit level (10 trade sections) have been obtained from the Australian Bureau of Statistics (ABS). The data consists of the period from 1988 Q1 to 2007 Q4.

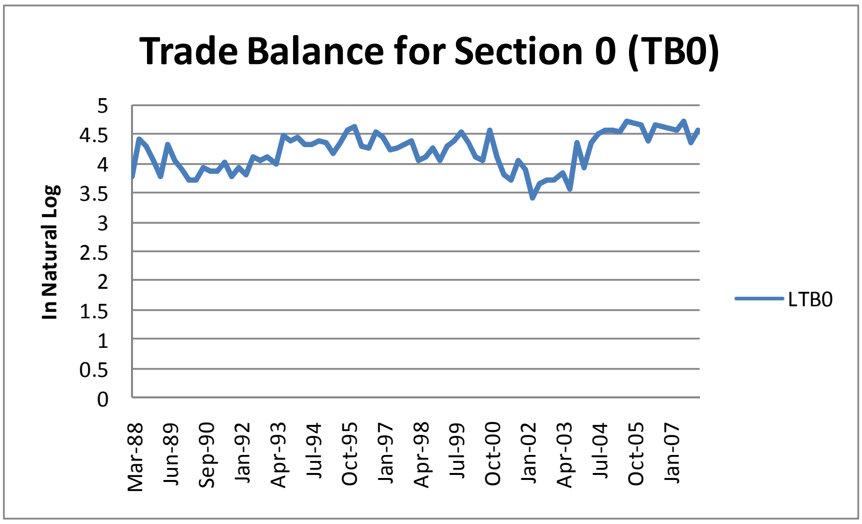
Gross Domestic Product (GDP), Consumer Price Index (CPI) for both countries in the same period was collected from the OECD Main Economic Indicator database (2008) and, Exchange Rates for Japanese yen per Australian dollar were collected from the Reserve Bank of Australia Bulletin Database (2008).



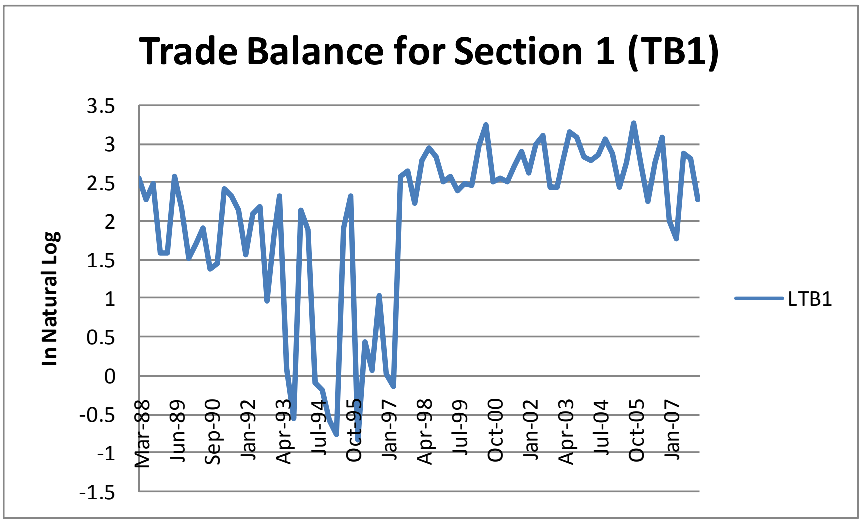
Real GDP(Australia) and Real GDP(Japan)
In Natural Log
5.2
5
4.8
4.6
4.4
4.2
4
Mar-88
Jul-89
Nov-90
Mar-92
Jul-93
Nov-94
Mar-96
Jul-97
Nov-98
Mar-00
Jul-01
Nov-02
Mar-04
Jul-05
Nov-06
LRGDPJ
LRGDPA

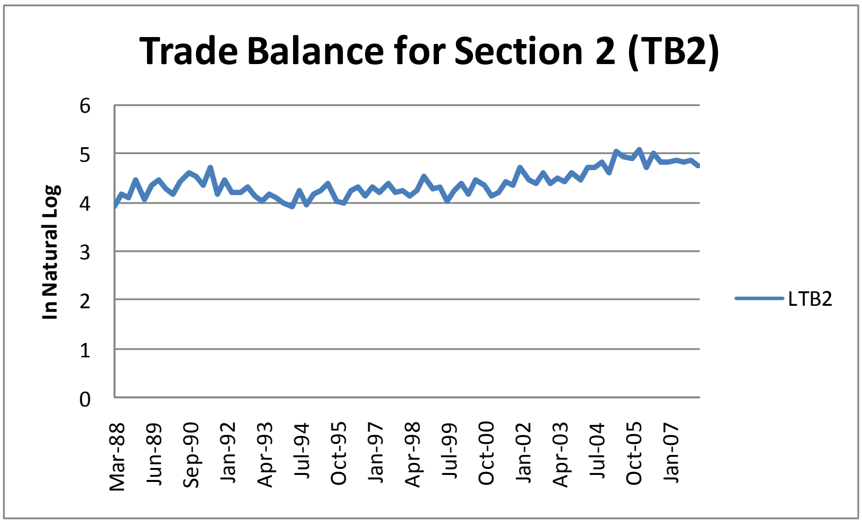


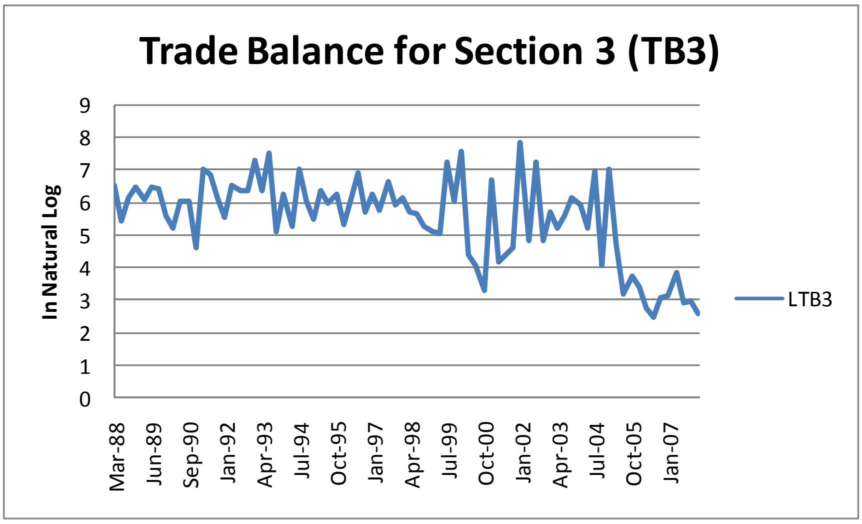
Real Exchange Rate
In Natural Log
0.000000
-1.000000
-2.000000
-3.000000
-4.000000
-5.000000
-6.000000
Mar-88
Aug-89
Jan-91
Jun-92
Nov-93
Apr-95
Sep-96
Feb-98
Jul-99
Jan-01
Jun-02
Nov-03
Apr-05
Sep-06
LREX



Trade Balance for Section 0 (TB0)
In Natural Log
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Mar-88
Jun-89
Sep-90
Jan-92
Apr-93
Jul-94
Oct-95
Jan-97
Apr-98
Jul-99
Oct-00
Jan-02
Apr-03
Jul-04
Oct-05
Jan-07
LTB0


Trade Balance for Section 1 (TB1)
In Natural Log
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
Mar-88
Jun-89
Sep-90
Jan-92
Apr-93
Jul-94
Oct-95
Jan-97
Apr-98
Jul-99
Oct-00
Jan-02
Apr-03
Jul-04
Oct-05
Jan-07
LTB1


Trade Balance for Section 2 (TB2)
In Natural Log
6
5
4
3
2
1
0
Mar-88
Jun-89
Sep-90
Jan-92
Apr-93
Jul-94
Oct-95
Jan-97
Apr-98
Jul-99
Oct-00
Jan-02
Apr-03
Jul-04
Oct-05
Jan-07
LTB2


Trade Balance for Section 3 (TB3)
In Natural Log
9
8
7
6
5
4
3
2
1
0
Mar-88
Jun-89
Sep-90
Jan-92
Apr-93
Jul-94
Oct-95
Jan-97
Apr-98
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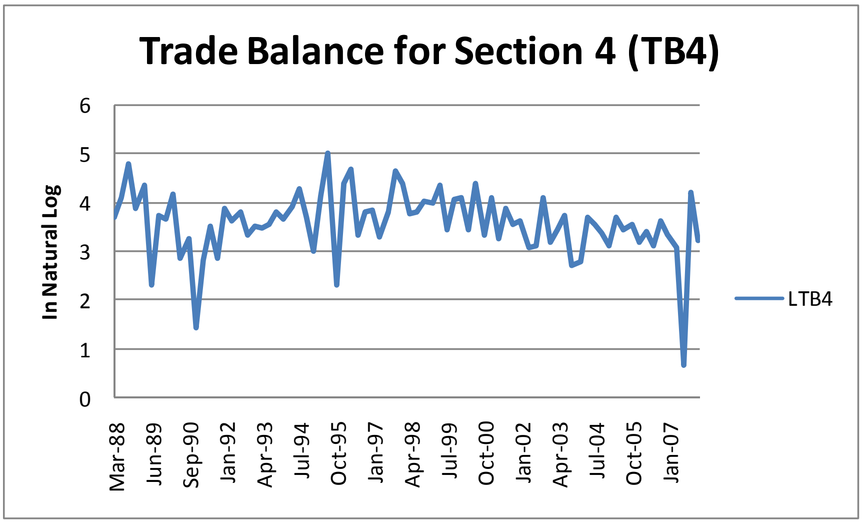
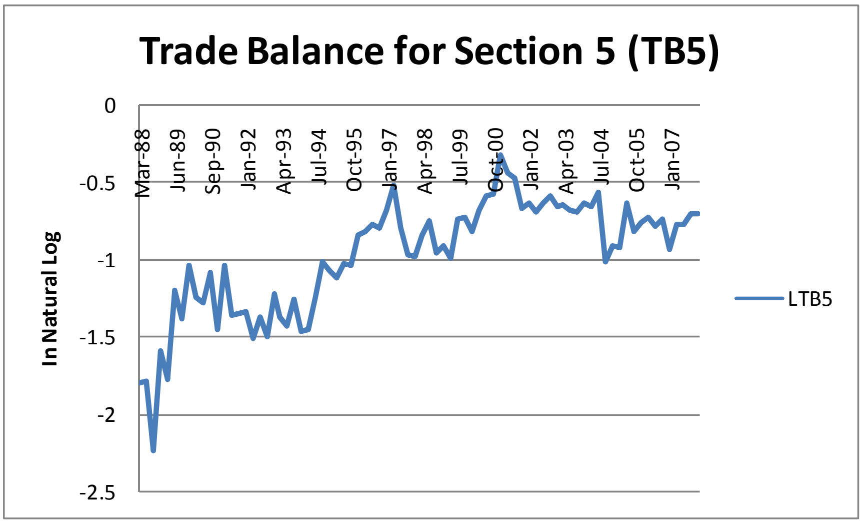
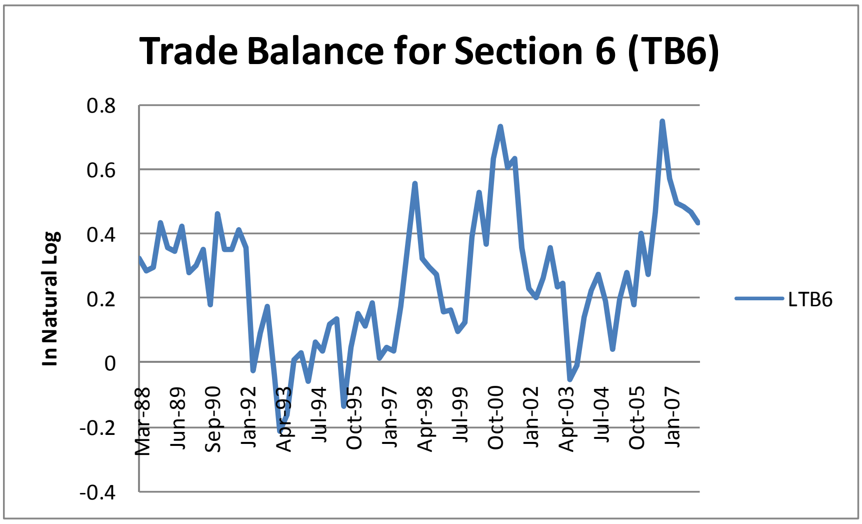
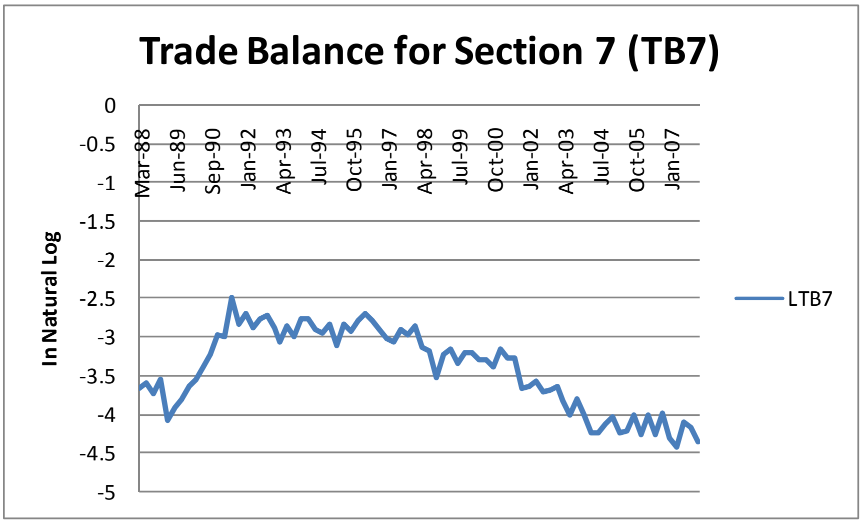
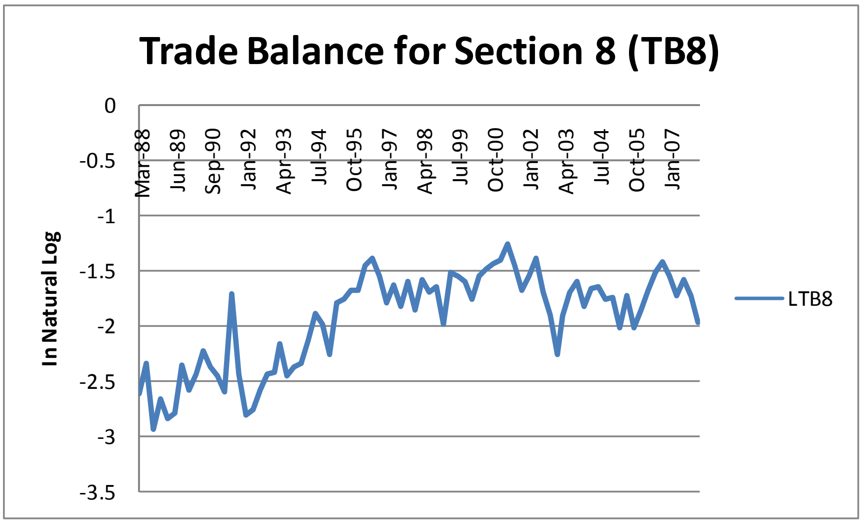
Jan-02
Apr-03
Jul-04
Oct-05
Jan-07
LTB3

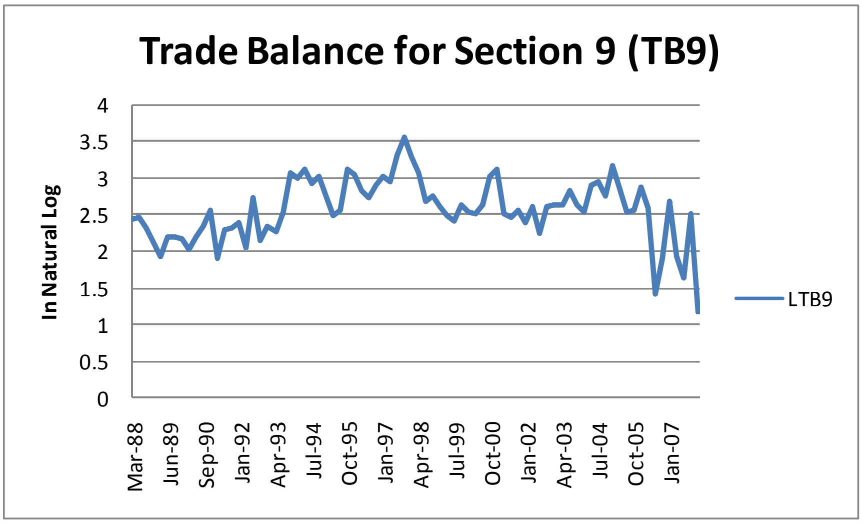

Trade Balance for Section 4 (TB4)
ln Natural Log
6
5
4
3
2
1
0
Mar-88
Jun-89
Sep-90
Jan-92
Apr-93
Jul-94
Oct-95
Jan-97
Apr-98
Jul-99
Oct-00
Jan-02
Apr-03
Jul-04
Oct-05
Jan-07
LTB4


Trade Balance for Section 5 (TB5)
ln Natural Log
0
-0.5
-1
-1.5
-2
-2.5
Mar-88
Jun-89
Sep-90
Jan-92
Apr-93
Jul-94
Oct-95
Jan-97
Apr-98
Jul-99
Oct-00
Jan-02
Apr-03
Jul-04
Oct-05
Jan-07
LTB5


Trade Balance for Section 6 (TB6)
ln Natural Log
0.8
0.6
0.4
0.2
0
-0.2
-0.4
Mar-88
Jun-89
Sep-90
Jan-92
Apr-93
Jul-94
Oct-95
Jan-97
Apr-98
Jul-99
Oct-00
Jan-02
Apr-03
Jul-04
Oct-05
Jan-07
LTB6


Trade Balance for Section 7 (TB7)
In Natural Log
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
-5
Mar-88
Jun-89
Sep-90
Jan-92
Apr-93
Jul-94
Oct-95
Jan-97
Apr-98
Jul-99
Oct-00
Jan-02
Apr-03
Jul-04
Oct-05
Jan-07
LTB7


Trade Balance for Section 8 (TB8)
In Natural Log
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
Mar-88
Jun-89
Sep-90
Jan-92
Apr-93
Jul-94
Oct-95
Jan-97
Apr-98
Jul-99
Oct-00
Jan-02
Apr-03
Jul-04
Oct-05
Jan-07
LTB8


Trade Balance for Section 9 (TB9)
In Natural Log
4
3.5
3
2.5
2
1.5
1
0.5
0
Mar-88
Jun-89
Sep-90
Jan-92
Apr-93
Jul-94
Oct-95
Jan-97
Apr-98
Jul-99
Oct-00
Jan-02
Apr-03
Jul-04
Oct-05
Jan-07
LTB9

4. Results

Table1: Structural Break(s) identified by Lee and Strazicich (2003, 2004) Minimum LM Unit Root Tests

Variable	Inference	Break Point(s) and Model
LREX	Unit Root	
LRGDPA	Stationary	2 breaks: 1993Q2 and 2000Q3 / Model C
LRGDPJ	Unit Root	
LTB0	Unit Root	
LTB1	Unit Root	
LTB2	Unit Root	
LTB3	Unit Root	
LTB4	Stationary	1 break: 1995Q1 / Model A
LTB5	Stationary	2 breaks: 2001Q2 and 2004Q2 / Model A
LTB6	Unit Root	
LTB7	Stationary	1 break: 1995Q4 / Model C
LTB8	Stationary	1 break: 1994Q4 / Model A
LTB9	Stationary	1 break: 2006Q1 / Model A

The UN Standard International Trade Classification (SITC)
1-digit classification (10 sections):

0: food and live animals
1: beverages and tobacco
2: crude materials, inedible, except fuels
3: mineral fuels, lubricants and related materials
4: animal and vegetable oils, fats and waxes
5: chemicals and related products
6: manufactured goods classified chiefly by material
7: machinery and transport equipment
8: miscellaneous manufactured articles
9: commodities and transactions not classified elsewhere in the "SITC"

Table 1 summarises the Lee and Strazicich Minimum LM Unit Root Tests. Both one and two breaks are considered for each sample of data from 1988Q1 to 2007Q4. [All test results are provided in Appendix (A)]

The results suggest that two significant breaks occurred at 1993Q2 and 2000Q3 in RGDPA data. The test detected that the level (intercept) and the trend (slope) changed simultaneously at the two points (Model C). This occurred after Australia experienced a recession in 1990/91 and when the Australian economy expanded with high labour productivity throughout the 1990s. The test detected a significant level and trend change at 1993Q2 as well. The test also detected a significant level and trend change at 2000Q3. This occurred when Australian experienced major tax reform (implementation of GST) and other cost pressers such as the oil price increase in 2000. A structural break point with Model C (both level and trend change) was also detected in Trade Balance for Section 7. The Australian government initiated trade reforms on the Passenger Motor Vehicle industry in the late 1980s, other reforms such as industrial relations reform, taxation reform, regulatory reforms had been implemented between 1988 and 1995 (Sanidas and Jayanthakumaran 2003). The break point of 1995 Q4 could be the result of the reforms.

On other hand, break points for the level (Model A) were detected in TB4, TB5, TB8 and TB9. The timing of break points varies from a trade section to a trade section.[13]

[13]Events and policy changes will be investigated for each trade section further in future studies. However, particular attention has been paid to TB7 (machinery and transport equipments) as it is the major Japanese export to Australia. The major Australian export to Japan can be seen in TB2 (crude materials and inedible). TB9 is excluded from further analyses as they are commodities and transactions not classified elsewhere in the "SITC"

Table 2: F-statistics for testing the existence of a long-run relationship among variables:

Trade Balance	Equation *	F-statistic
LTB0	F(LTB0|LRGDPA, LRGDPJ, LREX)	2.6094
	F(LRGDPA|LTB0, LRGDPJ, REX) (Model C)	3.8207
	F(LRGDPJ|LTB0, LRGDPA, LREX)	3.0261
	F(LREX|LTB0, LRGDPA, LRGDPJ)	0.25528
LTB1	F(LTB1|LRGDPA, LRGDPJ, LREX)	5.7407***
	F(LRGDPA|LTB1, LRGDPJ, REX) (Model C)	2.6913
	F(LRGDPJ|LTB1, LRGDPA, LREX)	2.6430
	F(LREX|LTB1, LRGDPA, LRGDPJ)	2.5200
LTB2	F(LTB2|LRGDPA, LRGDPJ, LREX)	3.9594**
	F(LRGDPA|LTB2, LRGDPJ, REX) (Model C)	8.9629***
	F(LRGDPJ|LTB2, LRGDPA, LREX)	1.7902
	F(LREX|LTB2, LRGDPA, LRGDPJ)	0.31058
LTB3	F(LTB3|LRGDPA, LRGDPJ, LREX)	2.5377
	F(LRGDPA|LTB3, LRGDPJ, REX) (Model C)	4.6320
	F(LRGDPJ|LTB3, LRGDPA, LREX)	1.6312
	F(LREX|LTB3, LRGDPA, LRGDPJ)	0.21183
LTB4	F(LTB4|LRGDPA, LRGDPJ, LREX)	6.3895***
	F(LRGDPA|LTB4, LRGDPJ, REX) (Model C)	9.0079***
	F(LRGDPJ|LTB4, LRGDPA, LREX)	1.3862
	F(LREX|LTB4, LRGDPA, LRGDPJ)	0.12820
LTB5	F(LTB5|LRGDPA, LRGDPJ, LREX)	4.4974
	F(LRGDPA|LTB5, LRGDPJ, REX) (Model C)	4.6661
	F(LRGDPJ|LTB5, LRGDPA, LREX)	2.1058
	F(LREX|LTB5, LRGDPA, LRGDPJ)	0.41001
LTB6	F(LTB6|LRGDPA, LRGDPJ, LREX)	3.6583
	F(LRGDPA|LTB6, LRGDPJ, REX) (Model C)	4.7700
	F(LRGDPJ|LTB6, LRGDPA, LREX)	2.0505
	F(LREX|LTB6, LRGDPA, LRGDPJ)	0.11433
LTB7	F(LTB7|LRGDPA, LRGDPJ, LREX) (Model C)	4.7188
	F(LRGDPA|LTB7, LRGDPJ, REX) (Model C)	3.7214
	F(LRGDPJ|LTB7, LRGDPA, LREX)	2.2273
	F(LREX|LTB7, LRGDPA, LRGDPJ)	0.72320
LTB8	F(LTB8|LRGDPA, LRGDPJ, LREX)	5.8736***
	F(LRGDPA|LTB8, LRGDPJ, REX) (Model C)	5.8494**
	F(LRGDPJ|LTB8, LRGDPA, LREX)	2.2840
	F(LREX|LTB8, LRGDPA, LRGDPJ)	0.51878

The critical bounds[14]
4.268 – 5.415 and 5.795 – 7.053 are utilised for the 5% significant level (**) and the 1% significant level (***) respectively for Model C
3.626 – 4.538 and 4.848 - 5.842 are utilised for the 5% indignant level (**) and the 1% significant level (***) respectively for other models

* Potential structural breaks are included in the above tests

[14] Narayan and Narayan (2005)'s critical values are utilised

Table 2 suggests that there exists a long-run relationship among the test variables when TB1, TB2, TB4 and TB8 are assigned as a dependent variable. Furthermore, variables, RGDPA, RGDPJ and REX can be treated as the long-run forcing variables of TB1, TB2, TB4 and TB8. Table 2 also suggests that there exists a long-run relationship among the test variables (RGDPA, TB2, RGDPJ, REX); (RGDPA, TB4, RGDPJ, REX); and (RGDPA, TB8, RGDPJ, REX) when RGDPA is assigned as a dependent variable. Thus, RGDPA and TB2 can be interpreted that they affect interactively each other. Similarly, TB4 and RGDPA, TB8 and RGDPA also affect interactively each other. However, the above results show that TB7 (machinery and transport equipment) which is Japan's major export to Australia, does not hold a stable long-run relationship with the exogenous variables.[15]

Table 3: Short-run and long-run estimates using the ARDL Approach:

Dependent Variable	Short-run coefficient estimates (t-ratio)				Long-run coefficient estimâtes (t-ratio)
	Δ In REX_t	Δ In REX_{t-1}	Δ In REX_{t-2}	Δ In REX_{t-3}	In REX
TB1	1.8608 (1.0387)	-3.9350*** (3.0193)			0.026366 (0.042295)
TB2	0.21819 (0.64240)	-0.93220*** (-2.7382)			0.71401 (0.64240)
TB4	-3.4368** (-2.6306)				0.66237 (1.5554)
TB8	0.40827 (0.74004)	0.87446** (2.1193)			0.74084*** (5.2644)

Table 3 indicates that there is an evidence of a J-curve in TB1, TB2 and TB4. The depreciation of the Australian dollar led to a deterioration of the trade balance in the short-run and then, the trade balances improved in the long-run. There is a clear sign of a transformation of J in three trade balances; they are namely TB1, TB2 and TB4.

[15] A potential endogeneity problem between trade balances (TBi) and real GDP for Australia is pointed out by the reviewer, however, endogeneity tests have not been conducted due to the limitation of data availability.

In regard to TB8, the coefficients of REX remained positive in both the short-run and long-run. TB8 did not show a sign of J curve formation. The results show that the Australian major export trade section, TB2 (crude materials, inedible, except fuels) formed a J-curve for its trade balance.

Following the establishment of the existence a long-run relationship, the error correction model with the long-run coefficients are estimated based on the Schewarz Bayesian Criterion (SBC)[16]

[16] There is a focus on the J-curve formation of trade balances; Error Correction Models for RGDPA are presented in Appendix.

Table 4: Estimated Long –Run Coefficients with Error Correction Model

4-A

Estimated Long-Run Coefficients with ECM ARDL(3,4,0,2) selected based on Schwarz Bayesian Criterion **Dependent variable: LTB 1**	
Regressor	Coefficient (t-ratio)
LRGDPA	25.9829 (2.7835)***
LRGDPJ	-5.7873 (-0.70472)
LREX	0.026366 (0.042295)
Intercept	-84.8406 (-1.2112)
Trend	-0.17245 (-1.7025)
ECM $_{t-1}$	-0.58783 (-4.3090)***
DW-statistic	2.1328
R-Bar-Squared	0.57613

4-B

Estimated Long-Run Coefficients with ECM ARDL(0,0,0,1) selected based on Schwarz Bayesian Criterion **Dependent variable: LTB 2**	
Regressor	Coefficient (t-ratio)
LRGDPA	-1.0796 (0.90641)
LRGDPJ	-1.2036 (1.0389)
LREX	0.21819 (0.64240)
Intercept	10.8826 (1.1882)
Trend	0.021574 (1.6440)
ECM $_{t-1}$	-1.0000
DW-statistic	1.6197
R-Bar-Squared	0.41257

4-C

Estimated Long-Run Coefficients with ECM ARDL(0,0,0,1) selected based on Schwarz Bayesian Criterion **Dependent variable: LTB 4**	
Regressor	Coefficient (t-ratio)
LRGDPA	-2.5257 (-0.42739)
LRGDPJ	-0.74315 (-0.14078)
LREX	0.66237 (1.5534)
Intercept	20.7431 (0.46155)
Trend	0.012594 (0.20363)
D(1995Q1)	0.71062 (2.0004)***
ECM $_{t-1}$	-1.0000
DW-statistic	2.2081
R-Bar-Squared	0.58642

Table 4 shows that the existence of a long-run impact of each regressor to the bilateral trade balance, 4-A for TB1, 4-B for TB2 and TB-C for TB4. There are no signs of autocorrelations in the above tests.

4.1. Dependent variable: TB1 (beverages and tobacco)

A coefficient of REX is a positive sign, which indicates that a depreciation of the Australian dollar improves its trade balance in the long-run. It is however, not statistically significant. One per cent depreciation in the Australian dollar leads to a 2.6% increase in TB1. Japanese national income does not seem to affect the trade balance positively while the Australian national income is positively associated with the trade balance. The ECM_{t-1} represents the speed of adjustment to restore equilibrium in the dynamic model. The coefficient of ECM_{t-1}, -0.58783 suggests that deviation from the long-term trade balance for TB1 path is corrected by about 59 per cent in the following quarter, the adjustment taking place relatively quickly.

4.2. Dependent variable: TB2 (crude materials, inedible, except fuels)

The coefficient of REX is 0.21819. It indicates that one per cent depreciation in the Australian dollar leads 21.8% increase in TB2. It is however, not statistically significant. Japanese national income does not seem to be affecting the trade balance positively and the Australian national income seems to be negatively associated with the trade balance. The coefficient of ECM_{t-1}, -1.00 suggests that deviation from the long-term trade balance for TB2 path is corrected by 100 per cent in the following quarter. A reaction of adjustment to a deviation is so sensitive.

4.3. Dependent variable: TB4 (animal and vegetable oils, fats and waxes)

The coefficient of REX is 0.66237, which indicates that one per cent of depreciation of the Australian dollar improves its trade balance by 66% in the long-run. It is however, not statistically significant. Japanese national income does not seem to be affecting the trade balance positively and the Australian national income seems to be negatively associated with the trade balance. The coefficient of ECM_{t-1}, -1.00 suggests that deviation from the long-term trade balance for TB4 path is corrected by 100 per cent in the following quarter. A reaction of adjustment to a deviation is immediately occurring.

5. Summary and Conclusion

This study examined the existence of the relationship between the disaggregated bilateral trade balances and real exchange rates between Australia and Japan in the period from 1988 and 2007. This paper incorporated structural breaks with the utilisation of the minimum Lagrange Multiplier unit root tests (Lee and Strazicich 2003, 2004). The ARDL approach to a cointegration with error correction model was used to estimate the speed of adjustment. Furthermore the ARDL approach demonstrated its applicability to investigate the formation of a "J-curve' as it presents both short-run and long-run estimates. The empirical results weakly indicate that a J-curve did exist in the bilateral trade balance for Tree trade balances, namely TB1 (beverages and tobacco), TB2 (crude materials, inedible, except fuels) and TB4 (animal and vegetable oils, fats and waxes) between Australia and Japan in the period from 1988 to 2007. Even though all estimated coefficients are not statistically significant, this study was able to establish that the impact of the Australian dollar's depreciation on the trade balance may vary from one trade section to another trade section. In an analysis of 10 disaggregated trade sections, TB1, TB2 and TB4 followed a J-curve in the period from 1988 to 2007. No stable long-run relationship among test variables was observed in other trade sections. In addition to the above, an increase in Australian national income tends to lead to a deterioration of trade balance of Section 2 (weakly), thus the trade balance deteriorates with an increase in Australia's national income level. This interactive (negative) relationship between trade balance and Australia's national income were observed in the trade balance for Section 4 as well. Japanese national income level does not seem to contribute to the improvement of Australian trade balances. This study found that the balances for Trade Section 1, 2 and 4 sensitively react to depreciations in the Australian dollar.

Trade Section 2 (crude materials, inedible, except fuels) is the major Australian export to Japan, and the trade balance reacted sensitively to the depreciation of Australian dollar. It formed a J-curve. However, for Trade Section 7 (machinery and transport equipment), which is the major Japanese export to Australia, and the trade balance did not react sensitively to the depreciation of Australian dollar.

From those conclusions, a question arises as to what factors make the trade balance sensitive / insensitive to the currency movement? It could be because firms are engaged in longer term trade contracts or that Multinational Corporations enforce their market power over their imports and exports as Magee (1973) suggested. Those questions will be investigated by the use of firm level data in future studies.

Appendix

(A) The structural break tests

Minimum LM Unit root Test with One Structural Break
Lee-Strazicicich (2004) approach

Model A: (Level Change)

Variable	No. of lags (max = 8)	Break Point	Test Statistic
LREX	7	1995Q1***	-3.2751
LRGDPA	5	1997Q1***	-2.3550
LRGDPJ	6	1992Q4	-1.5093
LTB0	5	1997Q4	-3.2304
LTB1	7	1996Q1***	-2.2566
LTB2	1	1991Q4	-3.3022
LTB3	1	2004Q4	-5.4449***
LTB4	**0**	**1995Q1*** **	**-9.0410*** **
LTB5	7	2004Q2***	-3.4586
LTB6	0	1992Q3	-3.4956
LTB7	8	2001Q2***	-2.2782
LTB8	**0**	**1994Q4** **	**-5.0184*** **
LTB9	**0**	**2006Q1*** **	**-4.6452*** **

Critical Values of the One-Break Minumun LM Test for Model A
1%: -4.239 5%: -3.566
The above critical values taken from Lee and Strazicich (2004)

*** Significant at 1%
** Significant at 5%

Minimum LM Unit root Test with One Structural Break
Lee-Strazicicich (2004) approach

Model C: (Regime Change: Level (D) and Trend Change (DT) simultaneously)

Variable	No. of lags (max = 8)	Break Point	Test Statistic
LREX	8	D: 1997Q2 DT: 1997Q2***	-3.8444
LRGDPA	5	D: 1995Q4 DT:1995Q4 ***	-4.2744
LRGDPJ	6	D: 1996Q4 DT: 1996Q4***	-2.9458
LTB0	8	D: 2000Q1 DT: 2000Q1***	-3.9915
LTB1	7	D: 1996Q3*** DT: 1996Q3***	-4.1943
LTB2	1	D: 1992Q4 DT: 1992Q4	-3.4558
LTB3	0	D: 2003Q2 DT: 2333Q2	-9.1995***
LTB4	0	D: 1995Q4 DT: 1995Q4	-9.9470***
LTB5	7	D: 2001Q2 DT: 2001Q2	-4.1415

LTB6	0	D: 1992Q3 DT: 1992Q3	-3.6578
LTB7	**8**	**D: 1995Q4***** **DT: 1995Q4*****	**-5.2166*****
LTB8	0	D: 1994Q4 DT: 1994Q4	-5.6966***
LTB9	0	D: 2006Q1*** DT: 2006Q1	-5.2946***

Critical values taken from Lee and Strazicich (2004)

<u>Minimum LM Unit root Test with Two Structural Break</u>
Lee-Strazicicich (2003) approach

Model A: (Level Change)

Variable	No. of lags (max = 8)	Break Point	Test Statistic
LREX	7	D1: 1995Q1*** D2: 1997Q2	-3.5644
LRGDPA	5	D1: 1993Q1 D2: 1997Q1***	-2.6620
LRGDPJ	6	D1: 1993Q4*** D2: 2001Q2***	-1.8142
LTB0	8	D1: 1997Q4 D2: 2006Q1	-4.0520
LTB1	8	D1: 1993Q3 D2: 1996Q1***	-2.9628
LTB2	1	D1: 1991Q4 D2: 2003Q4	-4.2096**
LTB3	1	D1: 2001Q2 D2: 2004Q4	-5.7770**
LTB4	0	D1: 1992Q1 D2: 1995Q1***	-9.4825***
LTB5	**7**	**D1: 2001Q2**** **D2: 2004Q2*****	**-4.7201*****
LTB6	0	D1: 1991Q4*** D2: 2001Q2	-4.0249**
LTB7	8	D1: 1999Q1 D2: 2001Q2**	-2.5490
LTB8	0	D1: 1994Q4** D2: 2002Q1	-5.9005***
LTB9	0	D1: 1993Q1 D2: 2006Q1***	-4.9933***

Critical values taken from Lee and Strazicich (2003)

Model C: (Regime Change: Level and Trend Change simultaneously)

Variable	No of lags (max = 8)	Break Point	Test Statistic	(T_{B1}/T, T_{B2}/T)
LREX	8	D1: 1995Q1*** DT1: 1995Q1** D2: 2002Q1 DT2: 2002Q1***	-4.9766	(0.4, 0.8)
LRGDPA	**6**	**D1 : 1993Q2*** DT1: 1993Q2*** D2 : 2000Q3*** DT2: 2000Q3*****	**-6.6559*****	**(0.2, 0.6)**
LRGDPJ	6	D1: 1992Q4** DT1: 1992Q4*** D2: 2000Q1 DT2: 2000Q1***	-4.8041	(0.2, 0.6)
LTB0	8	D1: 1995Q2** DT1: 1995Q2 D2 2003Q1*** DT2: 2003Q1***	-5.6542**	(0.4, 0.8)
LTB1	1	D1: 1992Q4*** DT1: 1992Q4*** D2 1997Q3 DT2: 1997Q3***	-9.2830***	(0.2, 0.4)
LTB2	0	D1: 1992Q1 DT1: 1992Q1*** D2 2004Q1 DT2: 2004Q1***	-8.4648***	(0.2, 0.8)
LTB3	0	D1: 2001Q2 DT1: 2001Q2*** D2 2005Q2 DT2: 2005Q2***	-9.7945***	(0.6, 0.8)
LTB4	0	D1: 1991Q4 DT1: 1991Q4*** D2 1994Q1 DT2: 1994Q1	-10.4491***	(0.2, 0.4)
LTB5	7	D1: 1998Q1 DT1: 1998Q1 D2 2004Q2*** DT2: 2004Q2	-4.8050	(0.6, 0.8)
LTB6	6	D1: 1992Q4** DT1: 1992Q4 D2 2002Q3 DT2: 2002Q3***	-4.6332	(0.2, 0.8)
LTB7	8	D1: 1993Q4** DT1: 1993Q4** D2 2001Q2*** DT2: 2001Q2	-7.3334***	(0.4, 0.6)
LTB8	0	D1: 1991Q4 DT1: 1991Q4 D2 1996Q3 DT2: 1996Q3	-6.2238***	(0.2, 0.4)
LTB9	0	D1: 1997Q3 DT1: 1997Q3 D2 2003Q2 DT2: 2003Q2***	-6.8566***	(0.4, 0.8)

Critical values taken from Lee and Strazicich (2003)

(B) Selected Error Correction Representation

Estimated Long-run Coefficients with ECM ARDL(1,0,0,1) selected based on Schwarz Bayesian Criterion **Dependent variable: LRGDA**	
Regressor	Coefficient (t-ratio)
LTB2	-0.0056774 (-1.4576)
LRGDPJ	-0.19710 (4.4877)***
LREX	0.016347 (1.4410)
Intercept	1.6661 (5.0449)***
D(1993Q2)	0.013026 (4.0801)***
D(2000Q3)	-0.0033466 (-1.0831)
Trend	0.0022779 (4.8067)***
D(1993Q2)	-0.022705 (-4.2973)***
D(2000Q3)	-0.11275 (-1.9810)
ECM $_{t-1}$	-0.19177 (-4.7344)***
DW-statistic	2.0294
R-Bar-Squared	0.43937

Estimated Long-run Coefficients with ECM ARDL(1,0,0,1) selected based on Schwarz Bayesian Criterion **Dependent variable: LRGDA**	
Regressor	Coefficient (t-ratio)
LTB4	-0.0004627 (-0.46207)
LRGDPJ	-0.21049 (-4.7946)***
LREX	0.015204 (1.2653)
Intercept	1.7642 (5.3286)***
D(1993Q2)	0.014258 (4.2904)***
D(2000Q3)	-0.0046565 (-1.5362)
Trend	0.0023803 (4.9886)***
D(1993Q2)	-0.023355 (-4.3257)***
D(2000Q3)	-0.0088509 (-1.5890)
ECM $_{t-1}$	-0.20333 (-5.0163)***
DW-statistic	1.8913
R-Bar-Squared	0.42294

Estimated Long-run Coefficients with ECM ARDL(1,0,0,1) selected based on Schwarz Bayesian Criterion **Dependent variable: LRGDA**	
Regressor	Coefficient (t-ratio)
LTB8	0.0027409 (0.96079)
LRGDPJ	-0.22627 (-4.8028)***
LREX	0.0414613 (1.2894)
Intercept	1.9062 (5.2121)***
D(1993Q2)	0.013205 (4.0770)***
D(2000Q3)	-0.0043538 (-1.4455)
Trend	0.0025604 (4.9814)***
D(1993Q2)	-0.022485 (-4.1970)***
D(2000Q3)	-0.0092592 (-1.6734)
ECM $_{t-1}$	-0.22069 (-4.9461)***
DW-statistic	1.9791
R-Bar-Squared	0.42915

(C) Structural Break(s) identified by Lee and Strazicich (2003, 2004) Minimum LM Unit Root Tests for Terms of Trade

Variable	Inference	Break Point(s) and Model
LTOT	Unit Root	
TOT0	Unit Root	
TOT1	Unit Root	
TOT2	Stationary	1 break: 2003Q3 / Model A
TOT3	Unit Root	
TOT4	Unit Root	
TOT5	Unit Root	
TOT6	Unit Root	
TOT7	Unit Root	
TOT8	Unit Root	
TOT9	Stationary	1 break: 2004Q3 / Model C

The structural break tests

Minimum LM Unit root Test with One Structural Break
Lee-Strazicicich (2004) approach

Model A: (Level Change)

Variable	No. of lags (max = 8)	Break Point	Test Statistic
LTOT	8	2005Q1***	-2.7787
LTOT0	0	2006Q1	-1.9090
LTOT1	0	2002Q1	-0.9949
LTOT2	**8**	**2003Q3*** **	**-3.9871** **
LTOT3	2	2004Q1	-3.8661
LTOT4	8	1998Q4**	-1.6799
LTOT5	0	1994Q4**	-1.2344
LTOT6	8	2004Q1	-1.9429
LTOT7	7	1999Q1	-0.7584
LTOT8	8	1998Q3	-1.8538
LTOT9	8	1994Q1	-2.1784

Critical Values: 1%: -4.239 5%: -3.566
The above critical values taken from Lee and Strazicich (2004)
*** Significant at 1%
** Significant at 5%

Minimum LM Unit root Test with One Structural Break
Lee-Strazicicich (2004) approach

Model C: (Regime Change: Level (D) and Trend Change (DT) simultaneously)

Variable	No. of lags (max = 8)	Break Point	Test Statistic
LTOT	8	D: 1999Q3 DT: 1999Q3	-3.9345
LTOT0	4	D: 1996Q1 DT: 1996Q1**	-3.8821
LTOT1	4	D: 2000Q2 DT: 2000Q2***	-4.4137
LTOT2	7	D: 2003Q3*** DT: 2003Q3	-3.4241
LTOT3	2	D: 2005Q2 DT: 2005Q2***	-4.5589**
LTOT4	3	D: 2002Q3 DT: 2002Q3	-3.8303
LTOT5	8	D: 1995Q2 DT: 1995Q2***	-3.7479
LTOT6	8	D: 2005Q2** DT: 2005Q2***	-3.7967
LTOT7	7	D: 1998Q1 DT: 1998Q1***	-2.5187
LTOT8	8	D: 2000Q1 DT: 2000Q1**	-3.7586
LTOT9	**8**	**D: 2004Q3*** ** **DT: 2004Q3*** **	**-6.8789*** **

Critical values taken from Lee and Strazicich (2004)

Minimum LM Unit root Test with Two Structural Break
Lee-Strazicicich (2003) approach

Model A: (Level Change)

Variable	No. of lags (max = 8)	Break Point	Test Statistic
LTOT	8	D1: 1992Q3 D2: 2005Q1***	-3.0523
LTOT0	1	D1: 1997Q2 D2: 2006Q1	-2.1885
LTOT1	3	D1: 1999Q1** D2: 2001Q1	-1.4464
LTOT2	8	D1: 1995Q4** D2: 2003Q3***	-4.2822**
LTOT3	2	D1: 2004Q1 D2: 2005Q4**	-4.1522**
	8	D1: 2002Q3 D2: 2004Q3	-1.9015
LTOT5	1	D1: 2001Q2 D2: 2003Q4***	-1.5857
LTOT6	8	D1: 1995Q1 D2: 2004Q1	-2.1956
LTOT7	8	D1: 1995Q1 D2: 1999Q1	-1.0171
LTOT8	8	D1: 1998Q3 D2: 2005Q4	-2.0812
LTOT9	8	D1: 1994Q1 D2: 2004Q4***	-2.4689

Critical values taken from Lee and Strazicich (2003)

Model C: (Regime Change: Level and Trend Change simultaneously)

Variable	No of lags (max = 8)	Break Point	Test Statistic	$(T_{B1}/T, T_{B2}/T)$
LTOT	8	D1: 1992Q4 DT1: 1992Q4*** D2: 2000Q3 DT2: 2000Q3	-5.2884	(0.2, 0.6)
LTOT0	4	D1 : 1998Q4 DT1: 1998Q4 D2 : 2003Q4 DT2: 2003Q4**	-4.3856	(0.4, 0.8)
LTOT1	4	D1: 2000Q2 DT1: 2000Q2*** D2: 2003Q1*** DT2: 2003Q1	-5.7597**	(0.6, 0.8)
LTOT2	3	D1: 2001Q1*** DT1: 2001Q1 D2 2005Q2*** DT2: 2005Q2**	-5.5900	(0.6, 0.8)
LTOT3	2	D1: 2000Q2 DT1: 2000Q2 D2 2003Q2 DT2: 2003Q2***	-4.9857	(0.6, 0.8)
LTOT4	3	D1: 1997Q1 DT1: 1997Q1 D2 2004Q3 DT2: 2004Q3***	-5.5754	(0.4, 0.8)
LTOT5	8	D1: 1995Q2 DT1: 1995Q2*** D2 2002Q1 DT2: 2002Q1**	-4.2510	(0.2, 0.6)
LTOT6	8	D1: 1995Q2 DT1: 1995Q2 D2 2005Q3 DT2: 2005Q3***	-4.3766	(0.2, 0.8)
LTOT7	4	D1: 1995Q3 DT1: 1995Q3*** D2 2001Q2*** DT2: 2001Q2	-5.3148	(0.4, 0.6)
LTOT8	3	D1: 2001Q4** DT1: 2001Q4*** D2 2004Q4 DT2: 2004Q4***	-4.7553	(0.6, 0.8)
LTOT9	8	D1: 1999Q4*** DT1: 1999Q4 D2 2004Q3*** DT2: 2004Q3***	-7.5071***	(0.6, 0.8)

(D) Real Exchange Rate versus Terms of Trade

Ordinary Least Squares Estimation

****

Dependent variable is DLTTB
75 observations used for estimation from 1989Q2 to 2007Q4

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INPT	-.028799	.027923	-1.0314[.307]
DLTTB(-1)	-.28143	.12076	-2.3304[.023]
DLTTB(-2)	-.069319	.12901	-.53733[.593]
DLTTB(-3)	-.035393	.12443	-.28445[.777]
DLTTB(-4)	.29606	.11908	2.4861[.016]
DLRGDPA(-1)	-.70243	1.6949	-.41444[.680]
DLRGDPA(-2)	-.51160	1.5460	-.33093[.742]
DLRGDPA(-3)	.24472	1.5259	.16038[.873]
DLRGDPA(-4)	2.0947	1.4913	1.4046[.165]
DLRGDPJ(-1)	3.2000	1.0798	2.9635[.004]
DLRGDPJ(-2)	1.1665	1.1052	1.0554[.296]
DLRGDPJ(-3)	1.6300	1.0675	1.5270[.132]
DLRGDPJ(-4)	-1.1552	1.1955	-.96632[.338]
DLREX(-1)	-.14512	.18625	-.77917[.439]
DLREX(-2)	-.25137	.18197	-1.3814[.172]
DLREX(-3)	-.20894	.19035	-1.0977[.277]
DLREX(-4)	-.0032796	.19176	-.017103[.986]

****

R-Squared	.36683	R-Bar-Squared	.19217
S.E. of Regression	.075537	F-stat. F(16, 58)	2.1002[.021]
Mean of Dependent Variable	.0051591	S.D. of Dependent Variable	.084043
Residual Sum of Squares	.33094	Equation Log-likelihood	96.9535
Akaike Info. Criterion	79.9535	Schwarz Bayesian Criterion	60.2549
DW-statistic	1.8689		

****

Ordinary Least Squares Estimation

****

Dependent variable is DLTTB
75 observations used for estimation from 1989Q2 to 2007Q4

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INPT	.0014558	.027406	.053120[.958]
DLTTB(-1)	-.25351	.12635	-2.0064[.049]
DLTTB(-2)	-.12182	.13634	-.89350[.375]
DLTTB(-3)	-.083384	.13201	-.63164[.530]
DLTTB(-4)	.21641	.12415	1.7431[.087]
DLRGDPA(-1)	-2.1490	1.7477	-1.2296[.224]
DLRGDPA(-2)	-1.1555	1.5873	-.72797[.470]
DLRGDPA(-3)	-.097544	1.5679	-.062213[.951]
DLRGDPA(-4)	1.9662	1.5096	1.3025[.198]
DLRGDPJ(-1)	3.0580	1.0826	2.8247[.006]
DLRGDPJ(-2)	.56242	1.0906	.51571[.608]
DLRGDPJ(-3)	1.4799	1.0722	1.3801[.173]
DLRGDPJ(-4)	-2.0196	1.2388	-1.6303[.108]
DLTOT(-1)	-.051626	.50633	-.10196[.919]
DLTOT(-2)	.60270	.56693	1.0631[.292]
DLTOT(-3)	-.23343	.55310	-.42204[.675]
DLTOT(-4)	.44897	.49342	.90992[.367]

****

R-Squared	.34418	R-Bar-Squared	.16326
S.E. of Regression	.076877	F-stat. F(16, 58)	1.9024[.039]
Mean of Dependent Variable	.0051591	S.D. of Dependent Variable	.084043
Residual Sum of Squares	.34278	Equation Log-likelihood	95.6351
Akaike Info. Criterion	78.6351	Schwarz Bayesian Criterion	58.9364
DW-statistic	1.7966		

****

Ordinary Least Squares Estimation

****

Dependent variable is DLTTB
75 observations used for estimation from 1989Q2 to 2007Q4

****

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
INPT	-.018683	.028422	-.65734[.514]
DLTTB(-1)	-.31491	.12781	-2.4640[.017]
DLTTB(-2)	-.18443	.14318	-1.2881[.203]
DLTTB(-3)	-.073083	.13525	-.54037[.591]
DLTTB(-4)	.25922	.12471	2.0786[.042]
DLRGDPA(-1)	-1.6009	1.7532	-.91314[.365]
DLRGDPA(-2)	-1.0748	1.5771	-.68148[.498]
DLRGDPA(-3)	.079781	1.5512	.051431[.959]
DLRGDPA(-4)	1.9300	1.5025	1.2845[.204]
DLRGDPJ(-1)	3.4503	1.0942	3.1534[.003]
DLRGDPJ(-2)	1.1197	1.1262	.99428[.325]
DLRGDPJ(-3)	1.7918	1.0869	1.6486[.105]
DLRGDPJ(-4)	-1.7235	1.2491	-1.3798[.173]
DLTOT(-1)	.13732	.52860	.25979[.796]
DLTOT(-2)	.91125	.60130	1.5155[.135]
DLTOT(-3)	-.21535	.58598	-.36751[.715]
DLTOT(-4)	.34241	.52714	.64956[.519]
DLREX(-1)	-.15593	.20644	-.75534[.453]
DLREX(-2)	-.34563	.19783	-1.7471[.086]
DLREX(-3)	-.21745	.19999	-1.0873[.282]
DLREX(-4)	-.10681	.20208	-.52853[.599]

****

R-Squared	.41195	R-Bar-Squared	.19415
S.E. of Regression	.075444	F-stat. F(20, 54)	1.8914[.033]
Mean of Dependent Variable	.0051591	S.D. of Dependent Variable	.084043
Residual Sum of Squares	.30736	Equation Log-likelihood	99.7255
Akaike Info. Criterion	78.7255	Schwarz Bayesian Criterion	54.3919
DW-statistic	1.8624		

****

(E) F-statistics for testing the existence of a long-run relationship among variables:
(70 observations: 1990Q3 – 2007Q4)

Trade Balance	Equation *	F-statistics
LTB0	F(LTB0|LRGDPA, LRGDPJ, LTOT0)	1.2624
	F(LRGDPA|LTB0, LRGDPJ, LTOT0) (Model C)	3.4343
	F(LRGDPJ|LTB0, LRGDPA, LTOT0)	3.1280
	F(LTOT0|LTB0, LRGDPA, LRGDPJ)	1.3279
LTB1	F(LTB1|LRGDPA, LRGDPJ, LTOT1)	3.9460
	F(LRGDPA|LTB1, LRGDPJ, LTOT1) (Model C)	4.1191
	F(LRGDPJ|LTB1, LRGDPA, LTOT1)	2.0575
	F(LTOT1|LTB1, LRGDPA, LRGDPJ)	1.6918
LTB2	F(LTB2|LRGDPA, LRGDPJ, LTOT2)	3.0152
	F(LRGDPA|LTB2, LRGDPJ, LTOT2) (Model C)	5.4885**
	F(LRGDPJ|LTB2, LRGDPA, LTOT2)	1.3693
	F(LTOT2|LTB2, LRGDPA, LRGDPJ)	3.0984
LTB3	F(LTB3|LRGDPA, LRGDPJ, LTOT3)	2.6555
	F(LRGDPA|LTB3, LRGDPJ, LTOT3) (Model C)	4.7559
	F(LRGDPJ|LTB3, LRGDPA, LTOT3)	1.6611
	F(LTOT3|LTB3, LRGDPA, LRGDPJ)	4.3628
LTB4	F(LTB4|LRGDPA, LRGDPJ, LTOT4)	4.6798**
	F(LRGDPA|LTB4, LRGDPJ, LTOT4) (Model C)	3.7674
	F(LRGDPJ|LTB4, LRGDPA, LTOT4)	1.6117
	F(LTOT4|LTB4, LRGDPA, LRGDPJ)	1.5123
LTB5	F(LTB5|LRGDPA, LRGDPJ, LTOT5)	1.3258
	F(LRGDPA|LTB5, LRGDPJ, LTOT5) (Model C)	5.6310**
	F(LRGDPJ|LTB5, LRGDPA, LTOT5)	2.6566
	F(LTOT5|LTB5, LRGDPA, LRGDPJ)	2.2857
LTB6	F(LTB6|LRGDPA, LRGDPJ, LTOT6)	2.9575
	F(LRGDPA|LTB6, LRGDPJ, LTOT6) (Model C)	4.9185
	F(LRGDPJ|LTB6, LRGDPA, LTOT6)	3.8785
	F(LTOT6|LTB6, LRGDPA, LRGDPJ)	1.2669
LTB7	F(LTB7|LRGDPA, LRGDPJ, LTOT7) (Model C)	2.0798
	F(LRGDPA|LTB7, LRGDPJ, LTOT7) (Model C)	5.8970**
	F(LRGDPJ|LTB7, LRGDPA, LTOT7)	1.6298
	F(LTOT7|LTB7, LRGDPA, LRGDPJ)	3.4784
LTB8	F(LTB8|LRGDPA, LRGDPJ, LTOT8)	3.7379
	F(LRGDPA|LTB8, LRGDPJ, LTOT8) (Model C)	3.9733
	F(LRGDPJ|LTB8, LRGDPA, LTOT8)	1.6927
	F(LTOT8|LTB8, LRGDPA, LRGDPJ)	2.2658

The critical bounds
4.268 – 5.415 and 5.795 – 7.053 are utilised for the 5% significant level (**) and the 1% significant level (***) respectively for Model C
3.626 – 4.538 and 4.848 - 5.842 are utilised for the 5% indignant level (**) and the 1% significant level (***) respectively for other models

* Potential structural breaks are included in the above tests

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