Aggregation bias, trade liberalisation and the J-curve in South Africa: Exploring the bilateral real exchange rate – trade balance relationship

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Abstract

This paper investigates the short and long-run effects of openness on South Africa's non-gold merchandise trade balance at the bilateral and aggregate level. Openness is measured using bilateral real exchange rates and a measure of tariff protection, namely collection rates. Bilateral trade balance relationships are estimated for seven countries (France, Germany, Italy, Japan, the Netherlands, the UK and the USA) to test for heterogenous responses in the relationship. The robustness of the results are assessed using the Autoregressive Distributed Lag (ARDL) Approach to cointegration. We find strong evidence of aggregation bias. In all cases a real exchange rate depreciation improves the bilateral (and aggregate) trade balance, but the strength of the relationship differs across regions. We find evidence of J-curve behaviour in the cases of South African bilateral trade with the UK and the USA. Similar behaviour is not found using aggregate level data. Protection is shown to improve the trade balance in some cases, but not others.

1. Introduction

The literature contains an abundance of both theoretical and empirical studies analysing the link between a real exchange rate depreciation (or devaluation) and the trade balance. The general long run expectation is that a real currency depreciation stimulates export demand, and dampens demand for imports, thereby improving the country's trade balance. There is, however, theoretical ambiguity in the real exchange rate – trade balance relationship, as a real depreciation can in fact worsen the trade balance as well. Such ambiguity makes clarification of this relationship an empirical issue. The primary aim of this paper is to empirically establish the real exchange rate – trade balance relationship in the South African case. Following the establishment of this relationship, an investigation of the short run dynamics is performed.

If aggregated exchange rate and trade balance data is used to determine the long run real exchange rate – trade balance relationship, then similar testing using disaggregated/bilateral data should be performed in order to uproot potential aggregation bias inherent in this relationship. Aggregation bias is prevalent if an aggregated result does not adequately account for heterogeneous responses. Furthermore, the timing of this relationship needs to be taken into account. That is, if a real depreciation improves the trade balance, then is this improvement immediate; delayed; or does the trade balance in fact worsen before improving? Given these additional concerns, this paper further investigates the real exchange rate – trade balance relationship on both the aggregate and bilateral level, with an additional focus on the difference between the short run adjustment and the long run equilibrium.

Within the currency depreciation – trade balance relationship, is the related J-curve phenomenon. The J-curve describes the graphic representation that the trade balance may follow as a response to a currency depreciation. That is, after a depreciation, the trade balance may continue to move deeper into a deficit for a number of periods before an improvement starts to occur.

The majority of papers investigating the exchange rate – trade balance relationship (along with any possible J-curve phenomena) do so by employing the ARDL approach to cointegration. Although containing certain shortcomings such as its inability to capture the feedback effects inherent in a flexible exchange rate regime, as well as cater for the existence of endogenous variables interacting simultaneously, this estimation technique is utilised in this investigation. However, in order to account for these feedback effects a vector autoregressive (VAR) cointegration methodology is also used (in the form of the Johanson Maximum Likelihood (ML) approach), as well as the associated vector error-correction model (VECM). The use of both of these methodologies allows for interesting comparison both between them, as well as between this paper and the rest of the literature.

This paper makes five valuable contributions to the exchange rate – trade balance debate. Firstly, it specifically deals with the real exchange rate – trade balance relationship. It is therefore different to a nominal exchange rate analysis, as relative prices are incorporated in the exchange rate variable. Secondly, this analysis is performed on both bilateral and aggregate levels so as to reveal any aggregation bias inherent in the data. Thirdly, on both the bilateral and aggregate levels, the two econometric methodologies employed allow for a distinction to be made between the short run dynamics and the long run equilibria, i.e. a J-curve analysis. The J-curve study also provides for an environment in which potential aggregation bias can be revealed. Fourthly, the specification used includes certain customs duty variables in order to capture the impact of protectionism on the trade balance. Finally, given their respective strengths and weaknesses in this context, use is made of both the ARDL and VECM estimation techniques to test the relationship.

The paper proceeds as follows: Section 2 develops the theoretical background associated with the typical modelling of a trade balance. Section 3 provides a review of the empirical literature. Section 4 outlines the specification of the models used. This paper utilises two econometric methodologies which are explained in Section 5. Section 6 presents an analysis of the data. Section 7 reports the results generated by the two methodologies employed. Section 8 concludes the paper. Section 9 contains the Appendix.

2. Theoretical Background

Theory governing the exchange rate – trade balance relationship is divided into three schools of thought, namely the elasticities, absorption, and monetarist approaches. Each approach provides a different perspective on this link, as each has a unique theoretical framework.

The elasticities approach (as captured in the Bickerdike-Robinson-Metzler (BRM) condition) formulates certain conditions for an improvement in the trade balance (following a currency depreciation), in terms of the demand and supply elasticities of both domestic and foreign exports and imports. That is, according to the Marshall-Lerner condition, a currency depreciation will only lead to an improvement in the trade balance if the sum of the demand elasticities of exports and imports is greater than one: $|E_{DX} + E_{DM}| > 1$. Therefore, following a depreciation of a currency, an improvement in the trade balance is only forthcoming once the elasticities of demand for exports and imports have had time to increase.

Using basic identities from the national accounts, proponents of the absorption approach (e.g. Alexander (1952)) describe how a currency depreciation affects the national income (production) – expenditure differential, by stimulating production and switching expenditure from foreign to domestic goods, improving the trade balance.

Monetarists (such as Johnson (1977) and Frenkel (1978)) argue that it is changes in the supply of and demand for money that impact the trade balance. As the money supply is increased, there is a tendency to increase spending on goods and services, as well as on financial assets. This leads to an increase in imports (as well as a possible decrease in exports as people start to buy would-be-exported-goods). This leads to an increase in demand for foreign currency, facilitating a local currency depreciation, with a resultant impact on the trade balance.

In the framework of the elasticities approach, Rose and Yellen (1989) provide a useful model to evaluate the effect of the real exchange rate on the trade balance. The following two equations represent import demand at home and in a foreign country, respectively[1]:

$$M = M(Y, p_m), \qquad (M_1 > 0, M_2 < 0) \qquad (1)$$

$$M^* = M^*(Y^*, p^*_m), \qquad (M^*_1 > 0, M^*_2 < 0) \qquad , \qquad (2)$$

[1] Comparative statics in parenthesis, where, for example, $M_1 = \partial M/\partial Y$; $M_2 = \partial M/\partial p_m$

where M (M^*) is the import volume by home (foreign) country; Y (Y^*) is real income at home (foreign) country; and p_m is the relative price of imported goods to domestically produced goods (P_m/P) for the home country, both measured in home currency. Similarly, $p_m^* = P_m^*/P^*$ where P_m^* is foreign country's import price in its own currency and P^* the foreign price level.

It is assumed that the supply of exportables only depends upon their relative prices:

$$X = X(p_x), \qquad (X_1 > 0) \tag{3}$$
$$X^* = X^*(p^*_x), \qquad (X^*_1 > 0), \tag{4}$$

where X (X^*) is the supply of home (foreign) exportables; p_x is the home country relative price of exportables, defined as the ratio of the domestic currency price of exportables to the domestic price level (P_x/P), both measured in home currency; p_x^* is similarly defined as the ratio of the foreign currency price of exportables to the foreign price level (P_x^*/ P^*), both measured in foreign currency.

Given that $p_m = P_m/P$, the domestic relative price of imports can be expressed as:

$$p_m = E \cdot (P^*_x / P) = (E \cdot P^* / P) \cdot (P^*_x / P^*) = RER \cdot p^*_x, \tag{5}$$

where E is the nominal exchange rate, defined as the number of units of domestic currency per unit of foreign currency; and RER is the real exchange rate, defined as $RER = EP^*/P$. In a similar fashion to (5), it can be shown that the relative price of imports abroad is:

$$p^*_m = p_x / RER \tag{6}$$

These definitions of p_m and p_m^* are a function of how E is defined.

From (1) and (5): $M = M(Y, RER \cdot p^*_x)$ (7)

From (2) and (6): $M^* = M^*(Y^*, \frac{p_x}{RER})$ (8)

Quantities traded and their relative prices will then be determined by the following two market clearing equilibrium conditions:

$$M = X^* \tag{9}$$

$$M^* = X \tag{10}$$

In the four equations (3), (4), (7), and (8), there exist six unknowns (M, M*, X, X*, p^*_x, p_x). Together with (9) and (10), we can solve for these endogenous variables in terms of the exogenous variables (Y, Y*, RER). Thus the following four trade balance functions can be expressed as follows:

$$M = X^* = f(Y, RER) \qquad (M_1 > 0, M_2 < 0) \tag{11}$$

$$p^*_x = \frac{P^*_x}{P} = k(Y, RER) \qquad ((p^*_x)_1 > 0\ , (p^*_x)_2 > 0) \tag{12}$$

$$X = M^* = g(Y^*, RER) \qquad (X_1 > 0, X_2 > 0\ ) \tag{13}$$

$$p_x = \frac{P_x}{P} = h(Y^*, RER) \qquad ((p_x)_1 > 0, (p_x)_2 > 0) \tag{14}$$

The typical trade balance equation is: $TB = P_x \cdot X - P_m \cdot M$. By normalising on the domestic price (P), this can be represented as $\frac{TB}{P} = p_x \cdot X - p_m \cdot M$. Therefore, the trade balance can be defined as:

$$\frac{TB}{P} = p_x(Y^*, RER) \cdot X(Y^*, RER) - p_m(Y, RER) \cdot M(Y, RER) \tag{15}$$

Accordingly, the trade balance model in its reduced form will be a function of *RER*, Y, and Y*, i.e. TB = TB(RER, Y, Y*). The comparative statics of (15) will reveal the effect of the real exchange rate on the trade balance. This is done by partially differentiating (15) with respect to *RER*:

$$\frac{\partial \frac{TB}{P}}{\partial RER} = \frac{\partial p_x}{\partial RER} \cdot X + p_x \cdot \frac{\partial X}{\partial RER} - \left[\frac{\partial p_m}{\partial RER} \cdot M + \frac{\partial M}{\partial RER} \cdot p_m \right] \tag{16}$$

Given that an increase in *RER* (a real depreciation) increases the relative price of exports; the volume of exports; and the relative price of imports, $\partial p_x/\partial RER$, $\partial X/\partial RER$, and $\partial p_m/\partial RER$ are all greater than zero. Since an increase in *RER* decreases import volume, $\partial M/\partial RER$ is less than zero. These alternating responses show that the effect of a real currency depreciation on the trade balance is ambiguous, and depends on the elasticities of the domestic country's export supply and import demand functions.

The effect of a Nominal Depreciation:

Since RER = EP^*/P, a nominal depreciation will have no impact on the real exchange rate variable if the nominal depreciation results in an equally substantial increase in domestic imported inflation, *P*. If this complete pass-through occurs, then a change in the nominal exchange rate variable will have no effect on the real exchange rate variable (i.e. $\partial RER/\partial E = 0$), resulting in the trade balance normalised by P being similarly unaffected by a nominal depreciation. This, of course, will only be the case if there is balanced trade at the time of the depreciation.

However, if incomplete pass-through occurs, then one can further demonstrate that the above trade balance ambiguity exists by partially differentiating (15) with respect to *E*:

$$\frac{\partial \frac{TB}{P}}{\partial E} = \frac{\partial p_x}{\partial RER} \cdot \frac{\partial RER}{\partial E} \cdot X + p_x \cdot \frac{\partial X}{\partial RER} \cdot \frac{\partial RER}{\partial E} - \left[\frac{\partial p_m}{\partial RER} \cdot \frac{\partial RER}{\partial E} \cdot M + \frac{\partial M}{\partial RER} \cdot \frac{\partial RER}{\partial E} \cdot p_m \right] \quad (17)$$

Since $\partial RER/\partial E$ is either greater than or equal to zero, (17) either has an ambiguous sign for the same reasons as before, or it is equal to zero.

The J-Curve Phenomenon:

Krugman and Obstfeld (2001), agree that the sign of the coefficient of the real exchange rate variable is ambiguous. If there is a real depreciation of the domestic currency, then the increased competitiveness of prices for the domestic country should result in it importing less and exporting more, improving the trade balance (an outcome which these authors refer to as the "volume effect"). However, the higher real exchange rate also tends to increase the value of each unit of import (referred to as the "import value effect"), which would worsen the trade balance.

These authors argue that in the short run, the import value effect dominates, with the volume effect doing so in the long run. If so, then the trade balance will follow a J-curve pattern.

In the model developed above, the effect on the trade balance, following a real depreciation, depends on the elasticities of responsiveness of p_x, p_m, X and M to the *RER*. If the elasticity of p_m is greater than the those of X, M, and p_x following a currency depreciation, then the trade balance response will follow a J-curve pattern. In line with Krugman and Obstfeld (2001), if we assume that in the short run $\partial X/\partial RER$, $\partial M/\partial RER$, and $\partial p_x/\partial RER$ are all equal to zero, and that $\partial p_m/\partial RER$ is greater than zero, then (16) will have a negative value. In the long run, $\partial X/\partial RER$ and $\partial M/\partial RER$ (i.e. the "volume effect") will have time to increase, so that (16) takes on a positive value.

Further theory regarding why a J-curve scenario might exist within this exchange rate – trade balance relationship is extensive. Several factors try to explain the existence of this time delay in the trade balance's response to an exchange rate depreciation. Predominantly among these, and argued by Krueger (1983), are goods in transit and under contract, which tend to dominate the short term impact on the trade balance. One therefore witnesses the existence of certain adjustment lags. After a depreciation, goods in transit are at old prices. Therefore, if a country's trade balance was worsening before a depreciation, it will continue to worsen after it. Once the new prices are realised the trade balance will begin to improve. That is, the J-curve would represent a scenario where a depreciation would lead to an accelerated worsening of the trade balance, before an improvement occurs. Rose and Yellen (1989: pp.53) corroborate this initial trade balance worsening by stating that "the trade balance is likely to decline subsequent to a depreciation if export and import volumes adjust slowly to movements in relative prices, but import prices respond quickly to exchange rate changes". Further evidence of the lagged response of a depreciation on the trade balance has been put forward by Junz and Rhomberg (1973). These include "lags in recognition of the changed situation, in the decision to change real variables, in delivery time, in the replacement of inventories and materials, and in production".

On the origins and implications of a J-curve occurrence in the UK's balance of payments (easily related to the trade balance), Thirwall and Gibson (1992: pp.166) recount how "domestic policy and the achievement of other goals may be upset considerably". Here these authors present two alternative reasons for the J-curve, namely in the form of forward contracts and expectations, respectively. Indeed, the relative weakening of a currency "may not immediately affect the relative prices of traded and non-traded goods if foreign trade is subject to forward contracts". That is, if export prices are fixed in the domestic currency and import in a foreign currency, and both are under contract for a future period of time, then "foreign exchange receipts will suffer as a result of the [depreciation] and the [trade balance] will worsen".

With regards to expectations, these authors warn that if a currency depreciation "is seen as a prelude to further [depreciation], domestic importers will accelerate orders through fear of having to pay more for goods in the home currency later, while foreign importers delay their orders for the exports of the [depreciating] country in the hope of buying them more cheaply later in terms of their own currency". Such behaviour would exacerbate any J-curve pattern.

3. Review of Empirical Literature

Traditionally, the approach used to investigate the impact of an exchange rate movement on the trade balance has been based on the Marshall-Lerner or elasticities condition. Studies using this method include Houthakker and Magee (1969), Khan (1974), Warner and Kreinin (1983), and Bahmani-Oskooee (1986). Alternative studies estimate the link between the trade balance and the exchange rate. Examples of this group include Miles (1979), Bahmani-Oskooee (1985), Himarios (1985, 1989), and Rose (1990). Largely due to differences in variable unit measurement; the development of economies investigated; and data aggregation levels, results have tended to differ.

General Trade Balance Model Specifications:

Based on the theory developed in the previous section, where it was established that the reduced form of a trade balance model can be expressed as TB = TB(RER, Y, Y^*), one can specify a general trade balance linear approximation which takes these variables into account, given by:

$$TB_t = \alpha_0 + \alpha_1 RER_t + \alpha_2 Y_t + \alpha_3 Y_t^* + \varepsilon_t \qquad (18)$$

Miles (1979) was the first aggregated analysis to incorporate variables other than the exchange rate and income variables. Specifically, the variables employed were an attempt to account for the effects of the government's monetary and fiscal policies. Equation (19) represents Miles' primary regression:

$$\Delta(TB/Y)_t = a_0 + a_1\Delta(g_t - g_R) + a_2\Delta(M_t - M_R) + a_3\Delta(G_t - G_R) + a_4\Delta ER_t \qquad (19)$$

where TB_i = the level of the trade balance in country i; Y_i = the level of income in country i; g_i, g_R = growth rates of income in country i and the rest-of the world R; M_i, M_R = the ratio of average level of high-powered money to output in country i and the rest-of the world R; G_i, G_R = the ratio of government consumption to output in country i and the rest-of the world R; and ΔER_i = the rate of change in the nominal exchange rate of country i. With annual data from 14 countries over the period 1956-1972, Miles did not find any evidence that a currency devaluation/depreciation improved the trade balance.

In his critique of Miles' work, Himarios (1985) showed that currency devaluations do in fact affect the trade balance in the traditionally expected direction. Although retaining Miles' framework, Himarios points out certain deficiencies in his analysis. This is done systematically by showing that equation (19) is a restricted version of the following equation:

$$\Delta(TB/Y)_t = \beta_0 + \beta_1 \Delta g_t - \beta_1^* \Delta g_R + \beta_2 \Delta M_t - \beta_2^* \Delta M_R + \beta_3 \Delta G_t - \beta_3^* \Delta G_R$$
$$+ \gamma_0 \Delta ER_{t,i} + \gamma_1 \Delta ER_{t-1,i} + \ldots + \gamma_n \Delta ER_{t-n,i}, \qquad (20)$$

where the β^*s represent foreign variables, and lagged nominal exchange rate variables are included. As a first critique, Himarios (and the majority of the more recent bilateral studies) stress that the results are sensitive to the units of measurement. Secondly, using equation (20) Himarios argues that domestic and foreign variables may not have the same impact on the trade balance as assumed by Miles in equation (19), i.e. Himarios argues that it is not necessarily the case that $\beta_1 = \beta_1^* = a_1$, $\beta_2 = \beta_2^* = a_2$, and $\beta_3 = \beta_3^* = a_3$. Thirdly, it is the real exchange rate (or relative prices) rather than the nominal exchange rate that affects trade flows. This is in line with the derivation of the Rose and Yellen theoretical model. Fourthly, and fundamental in the recent J-curve literature, the lagged values of exchange rates play an important role. Lastly, determining what happens to the trade balance on average is not the same thing as determining what happens to the average trade balance[2].

J-Curve Model Specifications:

The J-curve literature stretches back to Magee's (1973) seminal paper analysing why the US trade balance continued to move deeper into a deficit in 1972 after the US dollar depreciated in 1971. Since then, much attention has focused on this delayed trade balance response. The literature regarding the J-curve phenomenon can be divided into two main categories: (1) earlier papers employing aggregated trade data, and (2) the more recent papers using disaggregated/bilateral trade data. This division is not generally focused on in that part of the literature exploring the exchange rate – trade balance link (i.e. where no J-curve is investigated). Further divisions in the literature include studies focusing on either developed and/or developing country J-curve existence, and the use of more modern developments in econometric techniques.

[2] If the South African trade balance improves and the German trade balance deteriorates by an equal amount following a South African and German depreciation, then the South African depreciation should be judged to the successful and the German depreciation unsuccessful.

Indeed, since the inception of the J-curve enquiry, new econometric estimation techniques have been employed to tackle the issue.

Previous J-curve research employing aggregated trade data showed mixed results. Examples of these include Bahmani-Oskooee (1985), Rosensweig and Koch (1988) and Himarios (1989) who found evidence of the J-curve phenomenon, and Felmingham (1988), Demirden and Pastine (1995) who did not. One often cited reason for the generally mixed results in these studies is the aggregation bias which critics argue is an inherent problem. That is, a country's trade balance could be improving with one trading partner and simultaneously deteriorating with another. The same could be said of the real exchange rate. According to Bahmani-Oskooe and Brooks (1999), aggregate data on each of these variables could suppress the actual movements taking place at the bilateral levels.

The more recent studies using disaggregated/bilateral trade data include Rose and Yellen (1989), Marwah and Klein (1996), Bahmani-Oskooee and Brooks (1999), Bahmani-Oskooee and Kantipong (2001), Bahmani-Oskooee and Goswami (2003), Arora, Bahmani-Oskooee, and Goswami (2003), Bahmani-Oskooee and Artatrana Ratha (2004), and Bahmani-Oskooee, Goswami, and Talukdar (2005). Via the advent of improved econometric estimation techniques, these studies have generally improved on both short and long run measures of trade balance reactions to exchange rates changes.

Bahmani-Oskooee (1985, 1989a)[3] introduced a different method of testing the J-curve without the use of growth rates or differences between domestic and foreign variables. His model takes the following form:

$$TB_t = a_0 + a_1 Y_t + a_2 YW_t + a_3 M_t + a_4 MW_t + \sum \{\beta_i (E/P)_{t-i}\} + \upsilon_t \quad (21)$$

where TB_t is the trade balance defined as the difference between the values of merchandise exports and merchandise imports; Y_t is domestic income; YW_t is world income; M_t is domestic high powered money; MW_t is world high powered money; and (E/P) is the exchange rate

[3] Bahmani-Oskooee 1989a is an errata paper correcting the specification of the exchange rate variable. The original 1985 paper specifies (E/P) with E being the nominal exchange rate expressed as units of foreign currency per unit of domestic currency. Since P is the domestic price level, an increase in E and P results in this variable being inconsistent. The 1989a errata paper therefore re-specifies the E variable as units of domestic currency per unit of foreign currency so as to be consistent with changes in the P variable.

variable[4]. Bahmani-Oskooee found evidence that a currency devaluation improves the trade balance in the long run for all four developing economies studied, with J-curve movements in three of the four cases.

The Terms of Trade

Rather than model nominal or real exchange rate movements on the trade balance, some analyses in the literature have preferred the terms of trade alternative, typically represented as the ratio of export to import prices. Such an approach is consistent with the belief that it is export and import prices, rather than relative price levels that determine trade flows. Felmingham (1988) and Karunaratne (1988) both perform studies of Australia's trade balance – exchange rate relationship. Whilst Karunaratne relates the trade balance to both the real effective exchange rate and the terms of trade, Felmingham only employs the terms of trade. Karunaratne finds a statistically insignificant coefficient for the exchange rate variable. In a critique of this paper, Bahmani-Oskooee (2004) points out that this result may be due to possible multi-collinearity between this explanatory variable and the terms of trade variable.

In excluding an exchange rate explanatory variable, Felmingham hopes to explain the perverse effects of the J-curve by distinguishing between short and long run changes in the trade balance following an exchange rate induced deterioration of the terms of trade. His unrestricted distributed lag model takes the following form:

$$\log B_t = a + \sum_i b_i \log P_{t-i} + c \log y_t + d \log y_t^* + e_t \, , \qquad (22)$$

where B (a trade balance measure) = value of imports/value of exports; p = ratio of export to import prices (i.e. the terms of trade); and y and y^* are domestic and foreign incomes, respectively. This is not the conventional route followed by the literature wherein an exchange rate measure is almost universally preferred to its terms of trade counterpart. Indeed, as Bahmani-Oskooee (2004) argues, "changes in the terms of trade *may not* reflect the changes in a country's exchange rate, and therefore, the latter should explicitly enter the model being estimated".

[4] Bahmani-Oskooee imposes an Almon lag structure on the exchange rate variable. This is a method of weighting the exchange rate distributed lag coefficients devised by the Almon (1965) paper.

The Aggregation concern

An important shortcoming of much of the literature is that most studies are conducted using aggregate trade balance data. Such an approach, which weights and aggregates bilateral relations and draws policy conclusions there from, is bound to confuse important bilateral trade occurrences. If a country has a bilateral trade balance deficit with one trading partner and a surplus with another, then by aggregating these, along with the respective bilateral exchange rates, and testing for an exchange rate – trade balance association, one will clearly be diluting out the bilateral relations and be making generalisations about average outcomes. The need to use bilateral data and discover meaningful patterns of trade with different regions is therefore more conducive to accurate findings. Perverse and unexpected accurate bilateral findings are preferred to generalisations about expected average ones.

With the backdrop of trade value becoming an increasingly larger percentage of GDP in developed economies, Bahmani-Oskooee and Brooks (1999) analyse US import and export elasticities on six bilateral levels. Although not representing even half of US trade value at the time, this bilateral approach revealed different results for different US trading partners, thus stressing the potential of inaccuracy in aggregated studies.

4. Model Specification

The trade balance relationship in South Africa is investigated using the following log-linear model, drawn from Bahmani-Oskooee and Brooks (1999):

$$\ln TB_{i,t} = \theta_1 + \theta_2 \ln Y_{SA,t} + \theta_3 \ln Y_{i,t} + \theta_4 \ln RER_{i,t} + \theta_5 \ln T_t + \varepsilon_t \qquad (23)$$

The analysis is conducted at two levels of aggregation. The aggregate level analysis uses appropriate weights to aggregate South Africa's seven major trading partners into one trading entity. The bilateral analysis disaggregates these seven trading partners into separate trading entities, as done by Bahmani-Oskooee and Goswami (2003). This two-tiered analysis is performed in order to detect any potential aggregation bias. The study also explores the dynamics of adjustment with the particular aim of identifying the presence of a J-curve. To do this, the paper imbeds the long run relationship of (23) into a dynamic model.

In order to avoid unit measurement problems, TB_i is a unit free measure of the bilateral trade balance defined as the ratio of the South African exports to country i over her imports from country i. In the aggregate case, this variable becomes TB_{AGG} and is a unit free measure of the ratio of the value of South Africa's total merchandise exports over her total merchandise imports from all seven countries included in the analysis. The Y_{SA} variable is a measure of South Africa's real income (in index form) and is the same in both the bilateral and aggregate analyses. The Y_i variable is the index of real income of trading partner i (in index form). This variable becomes Y_{AGG} in the aggregate case and is a measure of the aggregate income of the seven trading partners used, measured as a trade weighted average of the indices of their income variables. The RER_i variable is the real bilateral exchange rate between South Africa and the currency of trading partner i (in index form) defined in a way that an increase reflects a real depreciation of the Rand against trading partner i. In the aggregate case, this variable becomes $REER_{AGG}$ and is a real *effective* exchange rate variable.

T is the customs duty variable. It is defined as the average duty on imports, calculated as the ratio of tariffs plus surcharges to merchandise imports. In certain bilateral cases (and the aggregate case), T is separated into two variables independently measuring the ratio of tariffs to merchandise imports and surcharges to merchandise imports, respectively. When tariffs and surcharges are collapsed into one variable it is represented by T1. If two separate customs duty variables are used, then T2 is the tariff (collection rate) measure, and T3 is the surcharge measure. The customs duty variables are flat rates (i.e. identical regardless of the import origin) and so are the same in all bilateral (and the aggregate) analyses. The reason for this separation is that for certain countries, the results appear stronger when tariffs and surcharges are examined separately. The source of inspiration for the inclusion of custom duty variables in the trade balance specification is the Santos-Paulino and Thirwall (2004) paper on the impact of trade liberalisation on exports, imports, and the balance of payments.

The specification used in this analysis attempts to correct for the limitations and measurement difficulties experienced in the literature. In order to remedy the unit measurement problems experienced in some parts of the literature, all variables included are expressed in index form, and are measured in levels rather than growth rates. No distractions from the primary theme of the real exchange rate – trade balance relationship are suffered in the forms fiscal or monetary variables which could potentially complicate matters[5]. In addition to this, and in accordance with the concerns expressed by Bahmani-Oskooee (2004), the real exchange rate is preferred to its terms of trade counterpart[6].

[5]Although popularly included in the earlier analyses, a measure of money supply as an explanatory variable in the determinants of the trade balance's long run equilibrium seems to have lost its place. One possible explanation for this may be its highly correlated nature with the regularly included income variable. This could possibly lead to certain endogeneity concerns. In fact, the post – Rose and Yellen (1989) J-curve literature has not contained studies including a monetary explanatory variable. The earlier studies including such a variable seem to have been perhaps preoccupied with reconciling the Monetary and Absorption approaches in an attempt to guide fiscal and monetary policy, rather than adhere to sound econometric techniques.
[6] A terms of trade variable in the bilateral analyses would require data on individual foreign country export prices which is not available for all countries used.

5. Econometric Methodology

Of primary interest in this analysis is the real exchange rate – trade balance long run equilibrium relationship. The short run dynamics of this relationship allow for the associated J-curve investigation. Both the long run equilibrium relationship and the J-curve investigation provide a setting for the testing of aggregation bias. Therefore, an econometric methodology with the ability to separate long run equilibrium relationships and short run dynamics is required. Use is made of two such methodologies, namely the autoregressive distributed lag (ARDL) approach to cointegration and the vector autoregressive (VAR) cointegration methodology, and the associated vector error-correction modelling (VECM) technique. Each of these has particular strengths and weaknesses in this intertemporal analysis.

The vast majority of J-curve studies have conducted their analyses in a fixed exchange rate environment, within which "variations of OLS estimation are particularly well suited for testing the J-curve" (Demirden and Pastine, 1995). The ARDL approach to cointegration is particularly relevant here, as the signs of the lagged exchange rate variables provide an indication of the J-curves existence. However, inherent in a flexible exchange rate regime are certain feedback effects. That is, changes in the exchange rate will alter the trade balance, but these trade balance changes can, in turn, affect the exchange rate and income variables which themselves are expected to influence the trade balance. Specifically, following a currency movement, if a trade balance deficit becomes a larger percentage of GDP, then a loss of confidence in the domestic economy could occur, manifested by a decrease in demand for the domestic currency, and hence a domestic depreciation. "Feedback effects such as these cannot be captured in the OLS regression and therefore it is not possible to directly interpret the OLS coefficients on the lagged exchange rates as the delayed effect of the exchange rate on the trade balance" (Demirden and Pastine, 1995), as is often done. These lagged exchange rate coefficients in the fixed exchange rate environment represent the partial derivative of the trade balance with respect to the lagged exchange rate, while the quantity of interest is the total derivative. Therefore, an analysis of the real exchange rate – trade balance relationship within a flexible exchange regime requires the specification of an econometric structure that explicitly captures these inherent feedback effects (i.e. one that can deal with the endogeneity bias inherent in the OLS approach). The VAR modelling approach, suggested by Sims (1980), and the corresponding VECM (for analysing the short run effects) allow for an econometric environment conducive to capturing these feedback effects.

A Vector Autoregressive Approach to Cointegration:

An alternative approach used is the multivariate approach to cointegration developed by Johanson and Juselius (1990) known as the full information maximum likelihood (ML) approach. The advantage of this approach is that it allows for a system of equations with endogenous variables to be modelled in a simultaneous framework. This is particularly relevant in the current case, as the exchange rate, trade balance, and income variables are all potentially endogenous. A brief explanation of the approach taken from Enders (2004) will now be discussed. Prior to performing this technique, verification of the order of integration of each time series is required in order to ensure that all endogenous variables are I(1) at most. The technique needs to be modified substantially if there exist any I(2) variables.

The maximum likelihood procedure has a data generating process that is represented as a p-order vector autoregressive model:

$$z_t = A_t z_{t-1} + \ldots + A_p z_{t-p} + \lambda E_t + \Psi D_t + \mu + \varepsilon_t \quad t = 1,\ldots,T;\ \varepsilon_t \text{ is niid}(0,\Sigma) \tag{24}$$

where z_t is the vector of I(1) endogenous variables, x_t; E_t is a vector of exogenous I(1) variables; D_t is a vector of I(0) exogenous variables; and ε_t represents a white noise process. This process can be parameterized as a Vector Error Correction Model (VECM), which accounts for and identifies the short run dynamics of the model:

$$\Delta z_t = \Pi z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta z_{t-i} + \lambda E_t + \Psi D_t + \mu + \varepsilon_t \tag{25}$$

where Π is a long run multiplier matrix, Γ are the short run coefficient matrices for each period i and λ and Ψ are the coefficient matrices on the I(1) and I(0) exogenous variables, respectively. The rank of Π is determined by the number of cointegrating relations, r, between the I(1) endogenous variables. In order to determine the number of cointegrating relations in the model, one uses two tests developed by Johanson (1988), namely the Trace statistic and the Maximal Eigenvalue (λmax) statistic. If r cointegrating relations are established between the I(1) variables, the implication is that there are r combinations between the vector of non-stationary variables, z_t, that are stationary. The matrix Π can be represented as:

$$\Pi = \alpha\beta' \tag{26}$$

where α is the k x r loading matrix representing the speed of adjustment to disequilibrium and β' is the r x k matrix of cointegrating vectors indicating the long-run coefficients of the cointegrating relationships. Therefore, from equation (25), one can express the first RHS variable as:

$$\Pi z_{t-1} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \end{bmatrix} \begin{bmatrix} 1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 \end{bmatrix} \begin{bmatrix} tb_i \\ y_{SA} \\ y_i \\ rer_i \\ t \end{bmatrix}_{t-1} \tag{27}$$

where lower case letters represent the natural logarithm of the variables. The sign of β_4 is of particular interest as it provides the information on the real exchange rate – trade balance relationship.

With regard to intercepts and trends used in the long and corresponding short run models, after testing for the optimal order of the unrestricted VAR via the use of the Akaike and Schwarz information criterion, the approach used was to commence estimation with unrestricted intercepts and restricted trends, and then test down via a just-identifying restriction. For both the aggregate and bilateral cases, it was not possible to reject the null hypothesis of setting the trend coefficient equal to zero.

Once the trends in our models were eliminated, we were able to further test for the most economically meaningful and parsimonious model by imposing zero over-identifying restrictions on each of the variables in the model in turn. That is, once the standard error statistical inspections on the coefficients are performed, the log-likelihood ratio test is used to test the statistical significance of the over-identifying restrictions. In most cases (barring a few exceptions where the coefficient of the foreign income variable of a relatively smaller trading partner could be set equal to zero), one could reject these zero restrictions.

Economic theory and the recognition of a significant statistical relationship by Microfit 4.1 for some of the countries used suggests that more than one cointegrating vector can indeed exist in this model. Apart from explaining the trade balance, one could also expect the endogenous variables employed to explain both the behaviour of the real exchange rate variable, and the domestic income variable (given that South Africa is a relatively small country compared to these major trading partners). When the cointegration tests used suggested the presence of more than one cointegrating vector, attempts were made at setting the just-identifying restriction on the real exchange rate variable (and the domestic income variable, separately) equal to one. However, neither were the coefficients of the second cointegrating vector ever statistically significant, nor were their signs economically logical. In addition to this, the presence of the second cointegrating vector distorted the results of the first, which is the more important vector for both the real exchange rate – trade balance and J-curve analyses[7]. For this purpose, we ignored the second vector (when it arose) and focused on the economic significance and relevance of the coefficients of the variables when the sole just-identifying restriction employed was setting the trade balance coefficient equal to one. Hence the single row and column vectors in equation (27).

The existence of a South African J-curve within this framework is ascertained by means of generalized impulse response functions, generated by the VECM already mentioned. A generalized impulse response function is produced for each trading entity wherein the equation for the real exchange rate is shocked by one standard error with the resultant trade balance and real exchange rate functions illustrated. The shock to the real exchange rate is a real depreciation of the Rand, represented graphically by an upward shock. Therefore, a J-curve is present if the corresponding shock to the trade balance is immediately negative/downward, followed by an upward movement/improvement.

An Autoregressive Distributed-Lag Approach to Cointegration:

The problem with the VECM estimation technique is that the variables are not clearly non-stationary. As will be discussed in the data analysis section, because the tests for stationarity of the data are weak, discrepancy regarding the order of integration exists for certain variables. There is therefore the possibility of non-stationarity in the data which the ARDL approach is able

[7] The strange results reported by the 2nd cointegrating vector (when it occurred) may be due to the indeterminate order of integration of the various trade balance time series. That is (and as will be shown in the data analysis section), given the trade balance ADF tests, one cannot conclude with absolute certainty that the trade balance for some countries is I(1). Since we treat it as such, one could argue that if in some of the countries' cases it is actually I(0), then including it in the model as an I(1) endogenous variable could lead to misleading results. The same will be shown to be true for certain real exchange rate variables. This provides further justification for the use of the ARDL approach.

to deal with. Use is made of Pesaran and Shin (1995) and Pesaran et al. (1996) in specifying equation (23) as an Autoregressive Distributed Lag model as in equation (28):

$$\Delta \ln TB_{i,t} = \theta_1 + \sum_{j=1}^{n} \theta_{2j} \Delta \ln TB_{i,t-j} + \sum_{j=1}^{n} \theta_{3j} \Delta \ln Y_{SA,t-j} + \sum_{j=1}^{n} \theta_{4j} \Delta \ln Y_{i,t-j} + \sum_{j=1}^{n} \theta_{5j} \Delta \ln RER_{i,t-j}$$
$$+ \sum_{j=1}^{n} \theta_{6j} \Delta \ln T_{t-j} + \beta_1 \ln TB_{i,t-1} + \beta_2 \ln Y_{SA,t-1} + \beta_3 \ln Y_{i,t-1} + \beta_4 \ln RER_{i,t-1} + \beta_5 \ln T + \sigma_t \qquad (28)$$

Pesaran and Shin's method avoids classification of the variables used into I(0) and I(1), and unlike standard cointegration tests, there is no need for pre-estimation unit-root testing. Their approach involves two steps in estimating equation (28). The first is to establish cointegration among the variables so that the inclusion of the lagged level of the variables (the β's) is justified. Thus, one first tests the null hypothesis of H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ against the alternative of H_1: $\beta_1 \neq 0$, $\beta_2 \neq 0$, $\beta_3 \neq 0$, $\beta_4 \neq 0$, $\beta_5 \neq 0$. This is determined by performing a variable addition test on the lagged level variables. Cointegration is determined by way of the familiar F-test, with upper and lower bound critical F-statistics (covering all possible classifications of the variables into I(1) and I(0) or even fractionally integrated) having been re-tabulated by Pesaran et al (1996). Once this is determined, the second step is to estimate an error-correction model outlined by equation (28).

This approach is particularly useful for the purposes of this analysis as it allows one to distinguish both long and short relationships. It is the short run coefficient estimates which give insight into potential J-curve existence. From (28), the short run effects of a real exchange-rate change are inferred by the sign and significance of the estimates of the θ_5's and the long-run effects are inferred by the sign and significance of β_4. Given our specification of the variables, following a real depreciation, negative values obtained by the first few estimates of θ_5's followed by positive values will reveal the existence of a J-curve phenomenon. The order of augmentation, n, is determined by the need to render the error term white noise (σ_t), and is chosen by the set of all feasible lag structure combinations by means of the Akaike information criterion. If the information criterion does not allocate sufficient lags to the real exchange-rate variable, then at least the short run direction of the trade balance, following an exchange rate depreciation will be revealed. This short-run movement can then be compared with the direction of the long-run coefficient to infer the existence of a J-curve.

6. Data Analysis

Data Sources and Measures[8]:

The data on the key macroeconomic variables on the seven countries used in this study are obtained from the International Monetary Fund's (IMF) International Financial Statistics (IFS) database. The variables obtained from this database include the foreign income variables, the nominal exchange rate variables, and the foreign price level variables. The IMF's Direction of Trade Statistics (DOTS) database is the source of the bilateral trade data (i.e. the bilateral non-gold merchandise export and import values) used in the various bilateral trade balances studied. The decision regarding the countries to be used in this paper was made by utilizing the TIPS database and identifying South Africa's major trading partners[9]. Local data used for the South African income variable and the domestic customs duties variables were obtained from the South African Reserve Bank's (SARB) Quarterly Bulletin. This study uses quarterly data starting from the first quarter of 1961 to the second quarter of 2004. All variables included were transformed into an index measure, with 2000Q1 = 100.

For each trading partner, the industrial production index (seasonally adjusted) is used as a proxy for each country's income. The bilateral nominal exchange-rate variables between South Africa and the USA, and the USA and the other six countries were cross multiplied in order to obtain seven bilateral South African nominal exchange-rate variables, defined as NER_j = (ZAR/Currency of country j). These seven nominal exchange rate variables were then converted into real measures by means of including the domestic and foreign price levels. The price level variables used were the domestic and foreign consumer price indices (CPI). Each real bilateral exchange-rate variable with trading partner j was calculated as RERj = ($P_j.NER_j/P_{sa}$), meaning that an increase in this variable represents a real depreciation of the South African Rand relative to trading partner j. The aggregate effective real exchange rate variable is measured as the weighted average of the indices of the real bilateral exchange rates defined in a such a way that an increase reflects a real depreciation of the Rand against all seven trading partners. The domestic income variable used is Gross Domestic Product at market prices (constant 2000 prices), seasonally adjusted at an annual rate.

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[8] Data sources and codes for the various country variables can be found in Table 9 in the Appendix.
[9] China was calculated as being in this major trading partner category, but relevant data over the period used was unreliable and scarce.

In order to account for certain structural breaks in the data, as well as improve on the normality diagnostics of the models, certain dummy variables were used. These dummies varied from one country to the next. The most common dummies used are D79, D94, and D01, capturing the oil price shock; South African liberalization; and the significant Rand depreciation, respectively. Each of these dummies take on a value of zero up to the appointed year, and a value of one after and including it. In the South Africa – Japan trade analysis, a D97 dummy is used to capture shifts in this bilateral trade relation resulting from the 1997 Asian financial crisis[10]. Dummies other than these appearing in models are for reasons of capturing unexplained residual spikes which lead to problems of heteroscedasticity and serial correlation.

In all eight VECM models and in six out of the eight ARDL models, the natural logarithm of the oil price (LOILP) is used as an exogenous I(1) variable[11]. This variable was also obtained from the IFS database. Without this variable, which accounts for significant supply-side shocks, the signs of the coefficient estimates are often inconsistent with our theoretical expectations and are statistically insignificant. The inclusion of this variable in our models is therefore mandatory. It should be noted that substitutes for this variable in the form of a commodity price index (both including and excluding gold), and a gold price index were sampled, but with less satisfactory results.

Unit Root Tests:

Although not required for the ARDL methodology, a necessary condition for the Johanson technique is that all endogenous variables in the cointegrating vectors are integrated of the order I(1) at most. That is, regardless of whether the first differenced series has a trend or not, it should be mean-reverting (i.e. not have a unit root). The order of integration of each time series was determined by viewing time series plots in order to account for any trends and/or structural breaks; the use of correlograms; and Augmented Dickey Fuller (ADF) unit root tests. The ADF unit root tests can be found in Table 10 in the Appendix. The weaknesses inherent in the standard ADF tests are well documented. An important weakness, and one relevant to our analysis, is the test's inability to distinguish between trends and structural breaks. This imprecision could result in the reporting of incorrect results, and as such, we report results both with and without a trend, for occasions warranting such discretion.

[10] This dummy variable is also included by Onafowora (2003) in their Asian J-curve study.
[11] Note that generalised impulse response functions cannot be generated when I(1) exogenous variables are included in the model. For this purpose, we include the oil price index as an I(1) endogenous variable when generating these functions. The VECM results are basically identical when this is done.

As presented, the majority of endogenous variables in the model are I(1). However, there are some inconsistencies. Firstly, the trade balance variables for France, Germany, Japan, the Netherlands and Aggregate could be interpreted as being I(0). For some other countries, the results are also close. The real exchange rate variables for France, Germany, and Aggregate could also be regarded as I(0)[12]. As mentioned, this discussion regarding the order of integration of the trade balance variable could be responsible for the distorted results of the occasional second cointegrating vector. Given the weakness of these stationarity tests, the investigation proceeds under the assumption that these variables are I(1), if only for comparison purposes with the ARDL approach, which is better able to deal with this problem.

Trading Partners:

The seven trading partners used in this analysis were identified, using the TIPS database, as the countries with whom South African non-gold merchandise trade value (imports plus exports) was the largest in the period 1988-2005 (the longest data availability period). Together they account for 46% of South African trade value over this period. Even though the current analysis extends over the period 1961Q1-2004Q2, the use of these 7 countries is maintained. These countries are France, Germany, Italy, Japan, the Netherlands, the UK, and the USA.

Table 1 presents the total non-gold merchandise trade (imports plus exports) of each of the seven trading partners used in this study over the period 1961Q1 – 2004Q2. The weightings of these seven countries were calculated by dividing each country's total trade by the total of all seven. These weightings were then used throughout the analysis in order to calculate the aggregate trade balance, real exchange rate, and income values. From table 1 it is evident that Germany, the UK, and the USA have been South Africa's dominant trade partners over the period. The lack of availability of developing country bilateral trade data has lead to the exclusion of such trading partners in this analysis.

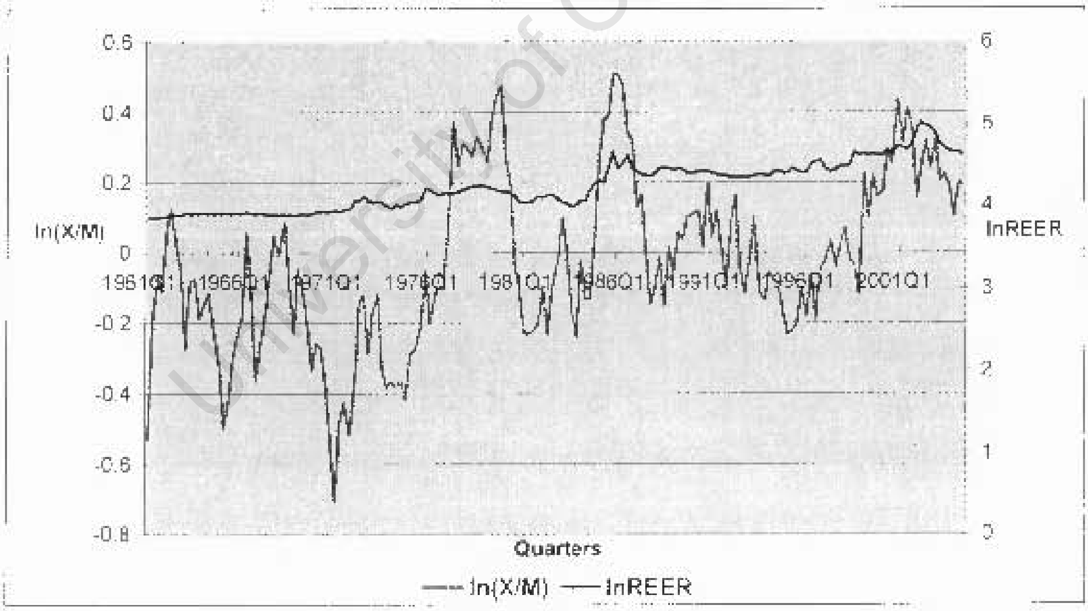
[12] The cases of Japan and the Netherlands are very close here.

Table 1: South Africa's Trade with Major Trading Partners 1961Q1- 2004Q2 (Millions of U.S. Dollars)

Trading Partner	Exports	Imports	Total Trade	Weighting
France	21947	25550	47497	6.74%
Germany	57475	90932	148408	21.07%
Italy	57258	21762	79020	11.22%
Japan	65305	52278	117583	16.69%
Netherlands	12320	13458	25778	3.66%
UK	67791	68480	136271	19.35%
USA	78650	71156	149806	21.27%
Total	360746	343616	704363	

The real effective exchange rate and aggregate trade balance between South Africa and these seven trading partners is illustrated in Figure 1 below. The South African trade balance with the aggregate of these seven trading partners was in a deficit 58.62%[13] of the time over this period. It has, however, been in a surplus since approximately 1999, which marked the beginning of a period of Rand depreciation. Figures 10 to 16 in the appendix present the seven individual bilateral real exchange rate and trade balance time series plots.

Figure 1: Plots of Real Effective Exchange Rate and Trade Balance with the Aggregate of 7 Trading Partners



Of particular interest when comparing these real exchange rate and trade balance plots are the movements of the trade balance during periods of noticeable real depreciation in the Rand. In the aggregated case of Figure 1, a minor depreciation around 1972/73 is associated with an improvement in the trade balance. This was also the case in all bilateral cases except the USA.

[13] This is calculated as the percentage of quarters that the aggregate trade balance reported a deficit.

Similarly, the noticeable aggregate real depreciation occurring around 1985/86 occurred concurrently with a significant improvement in the aggregate trade balance. A similar result is evident in every bilateral case. The significant Rand depreciation of 2001 resulted in the aggregated trade balance experiencing a considerable improvement. This improvement, however, was only experienced in the bilateral cases of the Netherlands, the UK, and the USA. That is, in the remaining four bilateral cases, the substantial Rand depreciation of 2001 was associated with a worsening in these bilateral trade balances. The post 2001 appreciation of the Rand was associated with a worsening of the aggregate (as well as six of the bilateral) trade balance. It is only in the case of the USA, where this Rand appreciation was associated with a trade balance improvement.

The aggregate and bilateral trade balances display deficits for most of the period except in the cases of Italy and Japan. In comparing the pre and post-1994 liberalisation era's, one notices post-1994 trade balance improvements in the cases of the aggregate, Germany, Japan, the Netherlands, the UK, and the USA. That is, the post-liberalisation bilateral trade balances with France and Italy did not experience an improvement.

Apart from certain perverse associations between the real exchange rate and the trade balance, the general relationship in consistent with expectations. The evidence of heterogenous responses suggests aggregation bias problems in the aggregate analysis.

7. Results[14]

ARDL Results:

The procedure for choosing an ARDL model is a two step process. In the first step, the two step approach to cointegration developed by Pesaran and Shin (1995) is employed. Pesaran and Shin's approach requires the determination of an F-statistic for each lag length imposed on the first differenced variables in equation (28). If there is an F-statistic greater than the upper bound critical value in Pesaran et al's (1996) table, then cointegration is said to exist, and the second step in the ARDL modelling process can commence. In the second step, an ARDL model is chosen by the AIC based on the number of lags chosen by the F-statistic in the first step.

The literature reports two ways for choosing the lag of the ARDL model, given by equation (28), based on the F-statistics of different lag lengths. Indeed, Bahmani-Oskooee and Brooks (1999) have shown that the results of the F-test in this first step are sensitive to the number of lags imposed on each first differenced variable in (28). Therefore, we calculate the F-statistic by changing the order of lags and report the results in Table 2 below.

Table 2: The Results of the F-Test for Cointegration Among the Variables of Bilateral Trade Bal between South Africa and her Trading Partners

Trading Partner	95% Critical Interval	Calculated F-statistic for Different Lag Length Imposed on First-Differenced Variables					
		2 lags	3 lags	4 lags	6 lags	8 lags	10 lags
France	2.476 - 3.646	5.43*	4.70	4.34	3.68	2.61	2.06
Germany	2.850 - 4.049	4.84*	2.99	3.89	2.18	2.29	3.01
Italy	2.365 - 3.553	5.11	5.35	5.56*	3.62	3.49	3.46
Japan	2.649 - 3.805	5.96*	4.19	4.08	4.72	3.91	5.57
Netherlands	2.272 - 3.447	6.92*	4.24	4.72	4.40	4.26	4.44
UK	2.365 - 3.553	5.06	5.15*	5.53	4.69	4.05	2.97
USA	2.365 - 3.553	4.44	5.44*	3.74	3.69	4.10	3.50
Aggregate	2.476 - 3.646	4.77	4.73	4.78	4.12	4.61	5.04*

*Highest F-stat

Ideally, given the number of lags chosen by the F-statistic in the first step of the ARDL modelling procedure, one would want the AIC to select a model with the longest possible lags on the real exchange rate variable, so as to compare the signs of the coefficients over a number of quarters. Therefore, as long as the F-statistic is above the upper bound, one can choose the

[14] This section reports the long-run equilibrium and short-run dynamic results for the ARDL and Johansen methodologies respectively. Results pertaining to the corresponding ARDL and VECM structures, diagnostics, and dummy variables included, can be found in tables 11, 12, 13, and 14, in the Appendix.

longest lag, in an attempt to maximise the number of lags chosen by the AIC, so that the coefficients will reveal J-curve information. Alternatively, one could simply choose the lag number given by the highest F-stat, as is done by Bahmani-Oskooee and Ratha (2004). In our case, the highest F-stats are most regularly associated with the lower lag levels, and by testing higher lag order models, the results chosen by the AIC do not provide longer lags for the exchange rate variable. Therefore, we follow Bahmani-Oskooee and Ratha (2004) and set the lag order in accordance with the highest F-statistic. This means that in most of our cases, one cannot make conclusions regarding the existence of a J-curve based on these coefficient's lagged signs. Instead, one has to compare the short run ECM results of the exchange rate variable to the long-run coefficient. That is, from equation (28), in most cases, the existence of a J-curve will be revealed by comparing the first differenced *RER* θ-coefficient with its long run *RER* β-coefficient counterpart. That is, if the coefficient estimates are such that $\theta_5 < 0$, and $\beta_4 > 0$, then there is J-curve evidence.

From Table 3 we see that the long run real exchange rate variables for all eight trading entities are positive and highly significant at the 5% level. That is, regardless of the short run dynamics (presented in Table 4), in the long run, the real exchange rate has a significantly positive association with the trade balance. A real exchange rate depreciation therefore improves the trade balance and is in accordance with our expectations. Although all carry the expected positive sign, the sizes of the real exchange rate coefficients differ across countries. On the bilateral levels, a 1% real depreciation of the Rand is associated with an improvement in these trade balances, ranging from 0.628% to 1.398%. Given the respective weightings, the aggregate trade balance improves by 0.69% following a 1% aggregate real depreciation. The majority of bilateral real exchange rate coefficients are greater than the aggregate one. Herein lies the problem of aggregating bilateral relations. The relatively large coefficients of two of the three major trading partners are not adequately captured in the aggregate coefficient. This discrepancy can be ascribed to the influence of the German coefficient, which has the second largest weighting and smallest real exchange rate coefficient. Therefore, by aggregating the real exchange rate coefficients into an effective measure the influence of important bilateral relations have been diluted.

Both the foreign and domestic income variables largely conform with expectations, with one exception. Table 3 reports that for all countries except Japan, the coefficients of the foreign income variables are positive and the domestic income variables are negative. Ambiguity in these income variables is possible, but with the traditional direction (assumed in the theoretical background) expected. That is, since an increase in Y tends to raise imports, one would expect its coefficient estimate to be negative. However, if the increase in Y is due to an increase in the production of import-substitute goods, then it is possible for the relationship between domestic income and the trade balance to be positive (Bahmani-Oskooee and Kantipong, 2001). Similarly, the coefficient estimate Y^* is expected to be positive. As foreign income increases, one would expect an increase in demand for domestic exports, improving the domestic trade balance. However, if foreign income increases due to an increase in the production of substitutes for domestically produced goods, then domestic exports may decrease, resulting in Y^* having a negative coefficient estimate. The direction of the aggregate coefficient Y coefficient conforms with the traditional direction. This is further evidence of aggregation bias, as the perverse Japanese bilateral case is not captured when aggregating the data. Given the strong statistical significance in this case, analysis of the exact composition of trade between South Africa and Japan is required in order to establish if the increases in South African and Japanese respective incomes are due to increases in the production of substitutes for each others goods, as would be the explanation for this outcome.

The inclusion of customs duty variables in our trade balance models is an added value of this paper. Due to the Lerner Symmetry Theorem and the possibility of reciprocal/retaliatory protection, the signs of these variables may also be ambiguous. That is, protection resulting in any form of import tax (and thus reducing imports, and improving the trade balance), may also result in a tax on imported intermediate goods used in the export market, or reciprocal/retaliatory protection, (thus also reducing exports, and worsening the trade balance). Nonetheless, the inclusion of these variables does provide information regarding the different effects of tariffs and surcharges on the South African trade balance (when these variables are separated). Using a similar measure of protection, Edwards and Lawrence (2006) found that in the South African case, tariffs often lead to higher intermediate input prices, which, if used in the export market, reduced the profits of exporters. Therefore, tariffs tended to worsen the trade balance. On the other hand, surcharges were imposed to overcome this trade balance problem, and tended to be successful in doing so.

When T1 is used rather than T2 and T3 we see that it is never statistically significant. The individual effects of tariffs and surcharges is unfortunately unknown in these cases as the overall results were less satisfactory when separating these customs duty variables in these cases. Given the theory discussed above, and the work already done on South African protectionist policy, one would expect the tariffs (T2) variables to be negative more often than surcharges (T3) variables. This would especially be the case if higher tariffs were charged on imported goods used in the export market, as apposed to the flat-rate system of surcharges. In the aggregate case, the imposition of tariffs has a highly significant negative association with the trade balance. None of the bilateral T2 coefficients are statistically significant, with only one (the UK) being negative. As a strongly weighted contributor to the aggregate case, this UK coefficient is diluting out the other three positive T2 coefficients of France, Italy, and Japan, resulting in a biased aggregated variable.

The aggregate surcharge variable is positive although not statistically significant. Two of the four bilateral T2 coefficients are also positive and statistically significant. This is strong evidence that surcharges do in fact improve the trade balance. However, one cannot generalise from this result, as two of the bilateral T2 coefficients are negative, resulting in further evidence of a biased aggregate coefficient.

Therefore, with regards to the customs duty variables, there is no strong evidence of a consistent relationship with the trade balance. This inconsistency may be ascribed to two sources. Firstly, collection rates could underestimate the true level of domestic protection. Secondly, trade agreements since 2000 have tended to aggregate collection rates which do not adequately capture bilateral protection.

As mentioned, one can elicit J-curve information from the ARDL results in one of two ways. Firstly, if the AIC chooses a model with sufficient lags on the real exchange rate variable, then one can compare the signs of these coefficients. Given our specification, negative values for the first few lags followed by positive ones would reveal the existence of a J-curve. Alternatively, if the AIC does not select a model with lagged real exchange rate variables, then one can compare the short run dynamics of the real exchange rate variable, reported in Table 4 below, with those of their long run equilibrium counterparts, reported in Table 3.

It is only with Italy, the UK, and the Aggregate of the trading partners that J-curve information can be extracted via the first above mentioned method. That is, it is only for these partners that the AIC chose a model with more than one lag on the real exchange rate variable. For all three of these, the first differenced/lagged once real exchange rate variable's sign is positive, and remains so for Italy and the Aggregate. Therefore, for Italy and the Aggregate, the trade balance appears to immediately improve following a real exchange rate depreciation, and continues to improve into the long run, thus revealing the non-existence of a J-curve in these cases. In the case of the UK, we see that the trade balance appears to improve at first (albeit an insignificant movement), and then reacts negatively (and highly significantly) to the depreciation. This is then followed by a long run improvement as we expect. Therefore, in the case of the UK, there does appear to be some evidence of J-curve movement, albeit delayed, following a real depreciation.

For the remaining five countries, one has to apply the second method mentioned above and compare the short run dynamics (the θ_5's) with the long run equilibrium coefficients (the β_4's) of (28). As can be seen, for all of these except the USA, the tendency is for the trade balance to improve immediately ($\theta_5 > 0$) following a depreciation (and in most cases very significantly so), and continue to do so in the long run ($\beta_4 > 0$). That is, for France, Germany, Japan, and the Netherlands, there appears to be no J-curve phenomenon, as a currency depreciation tends to create both an immediate and sustained improvement in the trade balance.

Although not significant at the 10% level, the short run/immediate tendency for the USA trade balance is to worsen ($\theta_5 < 0$) following a real exchange rate depreciation. This negative shock is then cancelled out as the variables find their long run equilibrium, which in this case for the trade balance – real exchange rate relationship is positive ($\beta_4 > 0$). Therefore, the ARDL results report that there is evidence of a possible J-curve pattern in South African bilateral trade with the USA and the UK. If one were to only observe the aggregate case, then the important short run bilateral trade dynamics of these two major trading partners would not have been revealed.

The ECM(-1) terms are all of the expected negative sign and highly statistically significant at at least the 5% level[15]. This indicates convergence to the long run solution of equation (26). In the cases of France, Italy and the Netherlands, we see these terms taking on values either less than or equal to -0.5 indicating that the speed of adjustment of the trade balance back toward its long run growth path, following any shock from equilibrium (such as a currency depreciation), is relatively fast. The five remaining trading partners experience a similar equilibrium reversion following a shock, but take slightly longer.

[15] Indeed, they are all significant at the 1% level, and as will be shown, are in agreement with the VECM methodology.

A further point of interest is the positive effect of the oil price on the trade balance. An increase in the price of oil would typically lead to an increase in the import bill, which would worsen the trade balance. However, the oil price often tends to be positively correlated with that of gold and other commodities. Therefore, an increase in the oil price could also lead to an increase in South African export revenue. These two countervailing forces allows the oil price coefficient to have a theoretically ambiguous sign. In the case of this analysis, it appears that the latter explanation prevails. As will be shown, the coefficient estimates of the oil price variables are in agreement with those of the VECM methodology.

Table 3: Estimated Long Run Coefficients for the AIC Selected ARDL

Trading Partner	Dependent Variable	Constant	LY*	LYsa	LRER	LT1	LT2	LT3	Loilp
France	LFTB	-0.609 (2.929)	0.119 (0.629)	-2.275* (0.569)	1.094* (0.347)	-	0.518 (0.313)	0.077* (0.027)	0.572* (0.082)
Germany	LGTB	0.536 (1.37)	0.946 (0.866)	-1.499* (0.648)	0.628* (0.317)	-0.229 (0.145)	-	-	-
Italy	LITB	-0.416 (1.960)	2.234* (0.826)	-4.361* (0.989)	1.226* (0.316)	-	0.394 (0.254)	0.056** (.028)	0.499* (0.112)
Japan	LJTB	-1.437 (2.547)	-1.272* (0.361)	1.112 (0.736)	0.648* (0.206)	-	0.064 (0.263)	-0.036 (0.068)	-
Netherlands	LNTB	-0.352 (1.389)	0.064 (0.509)	-1.299* (0.646)	0.749* (0.270)	0.216 (0.170)	-	-	0.071 (0.099)
UK	LUKTB	-6.023 (3.635)	1.346 (1.118)	-0.836 (0.795)	1.114* (0.358)	-	-0.210 (0.336)	-0.060 (0.037)	0.173 (0.139)
USA	LUSATB	0.395 (2.338)	2.477* (0.995)	-4.896* (1.487)	1.398* (0.395)	0.242 (0.189)	-	-	0.772* (0.155)
Aggregate	LAGGTB	3.994* (1.464)	0.321 (0.673)	-1.372** (0.810)	0.690* (0.249)	-	-0.643* (0.205)	0.012 (0.019)	0.184* (0.069)

* = Significant at the 5% level
** = Significant at the 10% level
Standard Errors in parenthesis
Example of dependent variable abbreviation: LUSATB = log of the bilateral South African – USA trade balance.

Table 4: Short Run Dynamics - Error Correction Representation for AIC selected ARDL

Trading Partner	Dependent Variable	DC	DLTB	DLY*	DLYsa	DLRER	DLRER1	DLRER2	DLT1	DLT2	DLT3	DLOILP	ECM(-1)
France	DLFTB	-0.325 (1.562)	-	0.064 (0.335)	-1.211* (0.344)	0.582* (0.203)	-	-	-	-0.198 (0.179)	0.041* (0.015)	0.305* (0.057)	-0.532* (0.068)
Germany	DLGTB	0.171 (0.430)	-0.178* (0.073)	0.306 (0.287)	-3.473* (1.229)	0.203* (0.102)	-	-	0.154 (0.087)	-	-	-	-0.324* (0.063)
Italy	DLITB	-0.207 (0.976)	-	1.110 (0.458)	-2.167* (0.614)	0.175 (0.344)	0.132 (0.348)	0.767* (0.344)	-	-0.233 (0.154)	0.028** (0.014)	0.248* (0.068)	-0.497* (0.068)
Japan	DLJTB	-0.523 (0.924)	-	-0.163 (0.931)	-1.391* (1.396)	0.236* (0.080)	-	-	-	-0.0234 (0.096)	-0.013 (0.025)	-	-0.364* (0.055)
Netherlands	DLNTB	-0.202 (0.798)	-	0.037 (0.291)	-0.745* (0.376)	0.429* (0.162)	-	-	-0.087 (0.131)	-	-	0.041 (0.057)	-0.573* (0.068)
UK	DLUKTB	-2.200 (1.417)	-0.247* (.0800)	1.157 (0.879)	-3.061* (1.492)	0.258 (0.286)	-0.574* (0.285)	-	-	-0.077 (0.122)	0.016 (0.024)	0.063 (0.051)	-0.365* (0.079)
USA	DLUSATB	0.106 (0.623)	-0.178* (0.073)	0.664* (0.262)	-1.312* (0.381)	-0.159 (0.276)	-	-	0.065 (0.052)	-	-	0.207* (0.046)	-0.268* (0.052)
Aggregate	DLAGGTB	1.361 (0.504)	-	0.893 (0.852)	-2.673* (0.802)	0.371* (0.166)	0.081 (0.171)	0.468* (0.171)	-	-0.050 (0.071)	0.004 (0.006)	0.063* (0.027)	-0.341* (0.057)

* = Significant at the 5% level
** = Significant at the 10% level
Standard Errors in parenthesis
Note: For certain trading partners, the lags of other variables did exist, but for ease of exposition/J-curve necessity, we only report lagged RER variables. These can be found in the appendix.

Example of dependent variable abbreviation: DLUSATB = First difference of the log of the bilateral South African – USA trade balance.

VECM Results

Given the discrepancy regarding the order of integration of certain trade balance and real exchange rate variables, the ARDL results presented above (with this techniques ability to deal with this discrepancy) are the preferred and more robust results of this study. As will be shown, however, the additional use of VECM modelling is both corroborative and revealing of additional short run dynamics. The orders of the various VECM's were chosen prior to testing for cointegration by means of the Akaike information criterion. On the basis of this information criterion, the optimal lag length for each VECM was chosen. Given that the results of the ADF – unit root tests allowed for the interpretation of all included variables to be stationary once first differenced, i.e. I(1), we were able to proceed with the Johansen (1998) cointegration tests procedures. The cointegration test results based on the Maximal Eigenvalue and Trace of the stochastic matrix can be found in tables 5 and 6, respectively, below. Whilst tables 5 and 6 both report the existence of two cointegrating vectors in the cases of France and the USA, table 6 reports the existence of two, and even more cointegrating vectors in every other case except Germany. As mentioned, these outcomes could be based on the inherent weaknesses of the ADF testing procedure, especially in the case of the trade balance (and some real exchange rate) variables, which could be classified as I(0). The problem with the cointegration tests may be that they are picking up the fact that some of the endogenous variables are not I(1). Therefore, we ignore the possibility of more than one cointegrating vector in every case, and proceed under the assumption that all variables are I(1).

Given this single cointegrating vector linking the variables, we are able to obtain a meaningful economic interpretation by normalising the vectors on ln(X/M) and statistically significantly placing a zero restriction on the trend terms. Based on the LR test of restrictions, Table 15 in the appendix provides a detailed report of zero restrictions on each variable for each country (including the trend terms). These tests of zero restrictions reveal that in all cases, the real exchange rate variables cannot be excluded from the models. The income variables of the larger trading partners logically have a stronger influence on the trade balance than the smaller trading partners. It is therefore the larger trading partner income variables which appear to be more robust, and cannot be restricted to zero[16]. The results of the estimated coefficients of the cointegrating vector were obtained via the Johansen technique and can be found in table 7 below.

The important results in this table are the reported statistically significant, positive long-run relationships between the real exchange rate variables and their respective trade balances. This is to be

[16] Note that the p-value of the LR test of restrictions for Germany is very close to being significant at the 10% level.

expected if a real currency depreciation leads to an increase in exports and a decrease in imports. This result concurs with the similar long-run ARDL analysis of table 3. There is again evidence of aggregation bias in these results as the differing sizes of the real exchange rate coefficients are not adequately represented in the aggregate coefficient. On the bilateral levels, a 1% real depreciation of the Rand is associated with an improvement in these trade balances, ranging from 0.445% to 2.015%. The aggregate trade balance improves by 0.845% following a 1% aggregate real depreciation. This is a wider range than in the ARDL case, but with the aggregate trade balance improvement being not too dissimilar in magnitude.

The domestic income variables appear to be largely in agreement with the ARDL results, barring those of Japan and England. The signs of the domestic income variable for these countries has changed. Whilst the domestic income variable in the Japanese model was positive and insignificant in the ARDL results, it is now negative (as theoretically expected) and significant. In the case of the UK, the same variable was negative and insignificant and is now positive and statistically significant. This perverse result is not captured in the aggregate coefficient. Although the Y-variables reported in the vector approach do appear to be rather high, most of them cannot be restricted to zero as Table 15 reports. Both the ARDL and Johansen methodologies are in agreement regarding the signs of the foreign income variables in the different models. That is, all are positive (as expected), except for Japan.

With regards to customs duty variables, the estimates for the T1 variables of the different methodologies are in complete agreement. The T2 variable experienced a change in sign in the Italian and UK models. These estimates were, however, statistically insignificant both before and after the change in sign/methodology, resulting in no real cause for concern here. The only discrepancy with regard to the T3 estimates arose in the case of the Aggregate model, where the coefficient sign changed, but remained statistically insignificant. In accordance with previous South African research, the aggregate of the T2 coefficient is still negative and statistically significant.

According to the Granger Representation Theorem, since our I(1) variables are cointegrated, one can equivalently represent them in an error correction model (Enders 2004). This allows for the investigation of the short run dynamics wherein the J-curve phenomenon is particularly relevant. Table 8 below presents the VECM model for each country. The ECM(-1) terms are all negative and highly statistically significant indicating that adjustment to the long run equilibrium occurs. Although the short run real exchange rate coefficients shown here do provide an indication of the short run direction of the trade balance following a shock in the system, of greater policy importance would be the length of time/number of quarters it takes for equilibrium to be reverted to once a depreciation of a currency has occurred. We therefore proceed to examine the short run dynamic responses of the trade balance to a one standard error real depreciation of a currency by generating generalised impulse response functions for each country's bilateral trade with South Africa, and trace any possible J-curve effects. Following a real depreciation, an initial worsening of one of South Africa's bilateral trade balances followed by an improvement would provide evidence of a J-curve. Importantly, if there is found to be no J-curve on the Aggregate level, but at least one on a bilateral level, then we will be in a position to conclude that aggregation bias is indeed a problem. In addition to this, by finding variation across countries one is able to anticipate that aggregation would in all probability lead to biased results.

Figures 2 to 9 below display the generalised impulse response functions for each of the seven trading partners, as well as the aggregate of these partners. In each case, given our specification, the initial upward shock in the real exchange rate function represents a real exchange rate depreciation, with the resultant impact on the trade balance function plotted along side it. These results show that in the cases of bilateral trade with France, Germany, and Italy, a real exchange rate depreciation results in both an immediate and sustained improvement in the trade balance. In the cases of Japan and the Netherlands, a real depreciation leads to a delayed (or even an initial slight worsening) improvement in the trade balance. True J-curve features are found in South African bilateral relations with the UK, where there is a definite initial worsening in the trade balance. The case of USA bilateral trade does not report any delayed improvement in the trade balance, but there is some initial worsening, albeit very temporary. In addition to these results, we also see that the Aggregate response function displays no evidence of a J-curve. There thus appears to be evidence of inherent aggregation bias in the aggregated data.

Table 5: Johansen's Maximum Likelihood Cointegration Procedure

Cointegration LR Test based on the Maximum Eigen Values of the Stochastic Matrix: lnTB, Ysa, Y*, RER, T1/T2,T3

Trading Partner	Order of VAR	Eigen-values in descending order	Likelihood ratio statistic	5% Critical Value	Hypothesis Tests for No. of Cointegrating Vectors r H_0:	H_1:	Reject/Cannot Reject H_0 in favour of H_1
France	2	0.24121	47.4774	46.97	r=0	r=1	reject
		0.21492	41.6198	40.89	r<=1	r=2	reject
		0.15235	28.4301	34.7	r<=2	r=3	cannot reject
		0.13027	24.0065	28.72	r<=3	r=4	cannot reject
		0.063829	11.3447	22.16	r<=4	r=5	cannot reject
		0.042548	7.4784	15.44	r<=5	r=6	cannot reject
Germany	1	0.21709	42.3392	40.89	r=0	r=1	reject
		0.1759	33.4686	34.7	r<=1	r=2	cannot reject
		0.09377	17.0339	28.72	r<=2	r=3	cannot reject
		0.052898	9.4023	22.16	r<=3	r=4	cannot reject
		0.033447	5.8854	15.44	r<=4	r=5	cannot reject
Italy	2	0.25683	51.0549	46.97	r=0	r=1	reject
		0.18396	34.9656	40.89	r<=1	r=2	cannot reject
		0.13559	25.0608	34.7	r<=2	r=3	cannot reject
		0.10442	18.9684	28.72	r<=3	r=4	cannot reject
		0.09022	16.2631	22.16	r<=4	r=5	cannot reject
		0.044747	7.8739	15.44	r<=5	r=6	cannot reject
Japan	5	0.28173	55.9232	46.97	r=0	r=1	reject
		0.21155	40.1685	40.89	r<=1	r=2	cannot reject
		0.17133	31.7609	34.7	r<=2	r=3	cannot reject
		0.14304	26.0884	28.72	r<=3	r=4	cannot reject
		0.090398	16.0125	22.16	r<=4	r=5	cannot reject
		0.049583	8.5943	15.44	r<=5	r=6	cannot reject
Netherlands	2	0.24616	48.6032	40.89	r=0	r=1	reject
		0.17536	33.1624	34.7	r<=1	r=2	cannot reject
		0.14569	27.0828	28.72	r<=2	r=3	cannot reject
		0.078796	14.1167	22.16	r<=3	r=4	cannot reject
		0.052118	9.2063	15.44	r<=4	r=5	cannot reject
UK	2	0.27991	56.482	46.97	r=0	r=1	reject
		0.2108	40.7187	40.89	r<=1	r=2	cannot reject
		0.17884	33.8898	34.7	r<=2	r=3	cannot reject
		0.13807	25.5556	28.72	r<=3	r=4	cannot reject
		0.083394	14.9774	22.16	r<=4	r=5	cannot reject
		0.05151	9.096	15.44	r<=5	r=6	cannot reject
USA	2	0.25688	51.0659	40.89	r=0	r=1	reject
		0.2076	40.0232	34.7	r<=1	r=2	reject
		0.086182	15.5013	28.72	r<=2	r=3	cannot reject
		0.064522	11.472	22.16	r<=3	r=4	cannot reject
		0.051473	9.0894	15.44	r<=4	r=5	cannot reject
Aggregate	2	0.24263	47.7991	46.97	r=0	r=1	reject
		0.20928	40.388	40.89	r<=1	r=2	cannot reject
		0.17123	32.3042	34.7	r<=2	r-3	cannot reject
		0.13706	25.3554	28.72	r<=3	r=4	cannot reject
		0.075345	13.4736	22.16	r<=4	r=5	cannot reject
		0.035579	6.2311	15.44	r<=5	r=6	cannot reject

Table 6: Johansen's Maximum Likelihood Cointegration Procedure

Cointegration LR Test based on the Trace of the Stochastic Matrix: lnTB, Ysa, Y*, RER, T1/T2,T3

Trading Partner	Order of VAR	Eigen-values in descending order	Likelihood ratio statistic	5% Critical Value	Hypothesis Tests for No. of Cointegrating Vectors r		Reject/Cannot Reject H_0 in favour of H_1
					H0:	H1:	
		0.24121	160.3569	128.79	r=0	r>=1	reject
		0.21492	112.8795	97.83	r<=1	r>=2	reject
France	2	0.15235	71.2597	72.1	r<=2	r>=3	cannot reject
		0.13027	42.8296	49.36	r<=3	r>=4	cannot reject
		0.063829	18.8231	30.77	r<=4	r>=5	cannot reject
		0.042548	7.4784	15.44	r<=5	r>=6	cannot reject
		0.21709	108.1294	97.83	r=0	r>=1	reject
		0.1759	65.7902	72.1	r<=1	r>=2	cannot reject
Germany	1	0.09377	32.3216	49.36	r<=2	r>=3	cannot reject
		0.052898	15.2877	30.77	r<=3	r>=4	cannot reject
		0.033447	5.8854	15.44	r<=4	r>=5	cannot reject
		0.25683	154.1868	128.79	r=0	r>=1	reject
		0.18396	103.1319	97.83	r<=1	r>=2	reject
Italy	2	0.13559	68.1663	72.1	r<=2	r>=3	cannot reject
		0.10442	43.1054	49.36	r<=3	r>=4	cannot reject
		0.09022	24.137	30.77	r<=4	r>=5	cannot reject
		0.044747	7.8739	15.44	r<=5	r>=6	cannot reject
		0.28173	178.5478	128.79	r=0	r>=1	reject
		0.21155	122.6246	97.83	r<=1	r>=2	reject
Japan	5	0.17133	82.4561	72.1	r<=2	r>=3	reject
		0.14304	50.6952	49.36	r<=3	r>=4	reject
		0.090398	24.6068	30.77	r<=4	r>=5	cannot reject
		0.049583	8.5943	15.44	r<=5	r>=6	cannot reject
		0.24616	132.1714	97.83	r=0	r>=1	reject
		0.17536	83.5682	72.1	r<=1	r>=2	reject
Netherlands	2	0.14569	50.4058	49.36	r<=2	r>=3	reject
		0.078796	23.323	30.77	r<=3	r>=4	cannot reject
		0.052118	9.2063	15.44	r<=4	r>=5	cannot reject
		0.27991	180.7195	128.79	r=0	r>=1	reject
		0.2108	124.2375	97.83	r<=1	r>=2	reject
UK	2	0.17884	83.5189	72.1	r<=2	r>=3	reject
		0.13807	49.6291	49.36	r<=3	r>=4	reject
		0.083394	24.0734	30.77	r<=4	r>=5	cannot reject
		0.05151	9.096	15.44	r<=5	r>=6	cannot reject
		0.25688	127.1517	97.83	r=0	r>=1	reject
		0.2076	76.0859	72.1	r<=1	r>=2	reject
USA	2	0.086182	36.0626	49.36	r<=2	r>=3	cannot reject
		0.064522	20.5614	30.77	r<=3	r>=4	cannot reject
		0.051473	9.0894	15.44	r<=4	r>=5	cannot reject
		0.24263	165.5514	128.79	r=0	r>=1	reject
		0.20928	117.7523	97.83	r<=1	r>=2	reject
Aggregate	2	0.17123	77.3643	72.1	r<=2	r>=3	reject
		0.13706	45.0601	49.36	r<=3	r>=4	cannot reject
		0.075345	19.7047	30.77	r<=4	r>=5	cannot reject
		0.035579	6.2311	15.44	r<=5	r>=6	cannot reject

Table 7: Estimated Cointegrating Coefficients Derived by Normalising on ln (X/M)

Trading Partner	ln (X/M)	lnYsa	lnY*	lnRER	lnT1	lnT2	lnT3	lnOILP
France	1.00	- 3.211** (0.952)	1.283 (0.976)	2.015** (0.734)	-	1.442** (0.567)	0.011* (.062)	0.620 (0.0970)
Germany	1.00	- 2.880* (0.864)	2.420 (1.036)	0.445* (0.309)	- 0.346* (0.162)	-	-	0.189 (0.090)
Italy	1.00	- 4.259 (1.970)	2.593 (1.799)	1.704* (0.432)	-	- 0.495 (0.450)	0.153* (0.047)	0.894 (0.129)
Japan	1.00	-2.383** (1.323)	- 0.850*** (0.687)	1.758* (0.309)	-	0.533* (0.253)	- 0.136* (0.052)	0.263 (0.089)
Netherlands	1.00	- 1.879*** (0.789)	0.471 (0.635)	0.981** (0.333)	0.470 (0.278)	-	-	0.218 (0.140)
UK	1.00	2.145*** (1.141)	4.776** (2.051)	1.293*** (0.401)	-	0.082* (0.501)	- 0.096* (0.061)	0.589 (0.215)
USA	1.00	- 3.698** (1.712)	2.756** (1.190)	0.791* (0.352)	0.638* (0.219)	-	-	0.996 (0.155)
Aggregate	1.00	-3.198** (1.194)	1.7622* (1.1488)	0.845** (0.239)	-	- 0.721** (0.223)	- 0.012 (0.028)	0.299 (0.096)

Standard errors in parenthesis.
From Table 15 in Appendix:
* = reject H_0: coefficient estimate = 0 at the 1% level.
** = reject H_0: coefficient estimate = 0 at the 5% level.
*** = reject H_0: coefficient estimate = 0 at the 10% level.
Otherwise cannot reject H_0: coefficient estimate = 0.

Table 8: Vector Error Correction Model Estimates

Trading Partner	Dependent Variable	Intercept	dLTB1	dLY*1	dLSAY1	dLRER1	dLT1	dLT2	dLT3	dLOILP1	Ecm(-1)
France	dLFTB	-4.304* (0.778)	-0.048 (0.080)	0.270 (0.652)	-1.680 (1.775)	0.289 (0.390)	-	-0.441* (0.197)	0.012 (0.034)	0.023 (0.133)	-0.414* (0.077)
Germany[*1]	dLGTB	0.213* (0.036)	-	-	-	-	-	-	-	-	-0.342* (0.056)
Italy	dLITB	-0.173* (0.067)	-0.0995 (0.084)	0.067 (0.786)	-0.948 (1.843)	0.535 (0.389)	-	0.091 (0.189)	-0.003 (0.034)	0.011 (0.137)	-0.142* (0.058)
Japan[*2]	dLJTB	0.471* (0.150)	-0.025 (0.089)	0.439 (0.991)	-3.536* (1.514)	-0.702* (0.299)	-	-0.407* (0.158)	0.035 (0.026)	-0.144 (0.102)	-0.337* (0.078)
Netherlands	dLNTB	-1.209* (0.193)	-0.0411 (0.0777)	1.492 (1.042)	-0.914 (1.726)	-0.376 (0.348)	-0.050 (0.136)	-	-	-0.136 (0.123)	-0.539* (0.082)
UK	dLUKTB	-6.138* (0.985)	-0.261* (0.0689)	1.965* (0.844)	-1.128 (1.362)	-0.543* (0.273)	-	-0.058 (0.137)	-0.002 (0.025)	-0.041 (0.099)	-0.330* (0.054)
USA	dLUSATB	-1.321* (0.253)	-0.218* (0.069)	0.897 (0.999)	-0.011 (1.375)	0.124 (0.279)	-0.079 (0.107)	-	-	-0.076 (0.100)	-0.265* (0.048)
Aggregate	dLAGGTB	1.306* (0.268)	-0.056 (0.075)	1.381* (0.676)	-1.668* (0.750)	0.177 (0.178)	-	0.108E-6 (0.083)	0.010 (0.014)	-0.007 (0.056)	-0.266* (0.054)

*Significant at the 5% level and standard Errors in parenthesis.
[*1] The order of the VAR selected by the AIC information criterion is 1. There is therefore no space for first differenced variables.
[*2] Order of the VAR selected by the AIC information criterion for Japan is 5 and only the first lagged values are reported.
Note: Eg. dLX1 = LX(-1)-LX(-2)

Figure 2: Generalized Impulse Response(s) to one S.E. shock in the Real Exchange Rate Equation for Aggregate

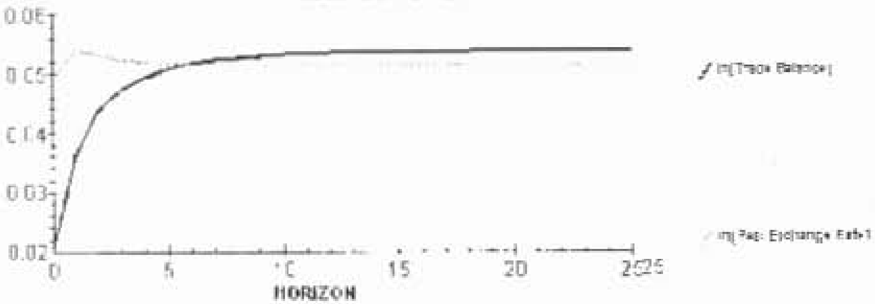


Figure 3: Generalized Impulse Response(s) to one S.E. shock in the Real Exchange Rate Equation for Germany

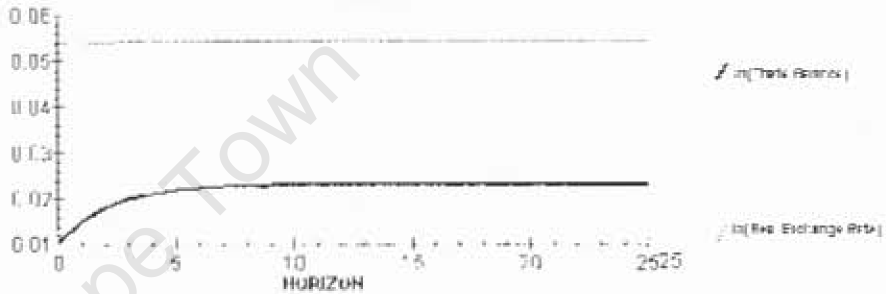


Figure 4 : Generalized Impulse Response(s) to one S.E. shock in the Real Exchange Rate Equation for France

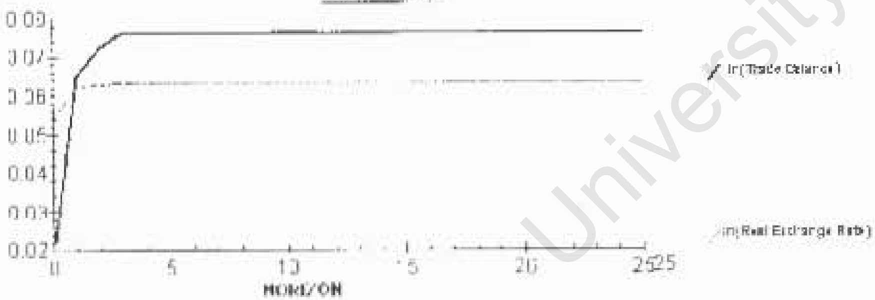


Figure 5: Generalized Impulse Response(s) to one S.E. shock in the Real Exchange Rate Equation for Italy

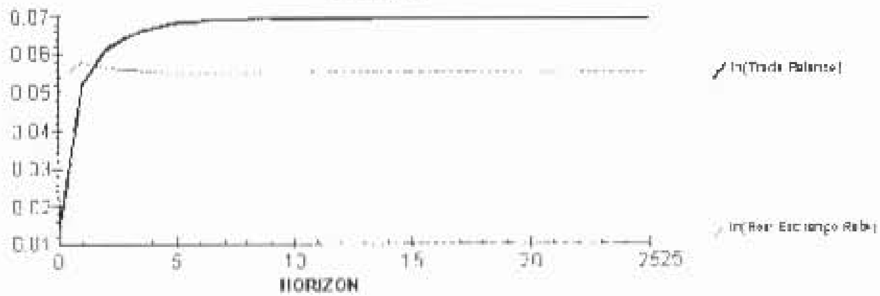


Figure 6: Generalized Impulse Response(s) to one S.E. shock in the Real Exchange Rate Equation for Japan

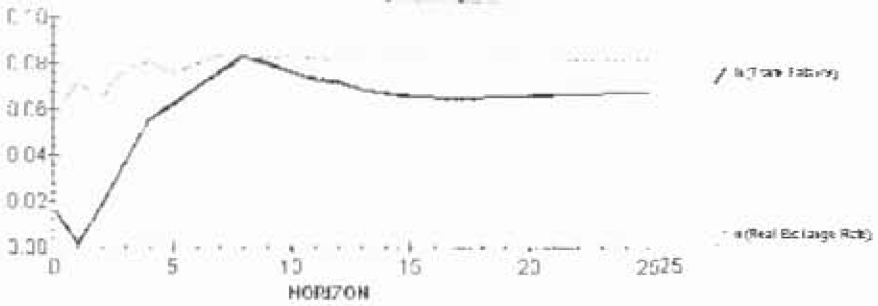


Figure 7 Generalized Impulse Response(s) to one S.E. shock in the Real Exchange Rate Equation for The UK

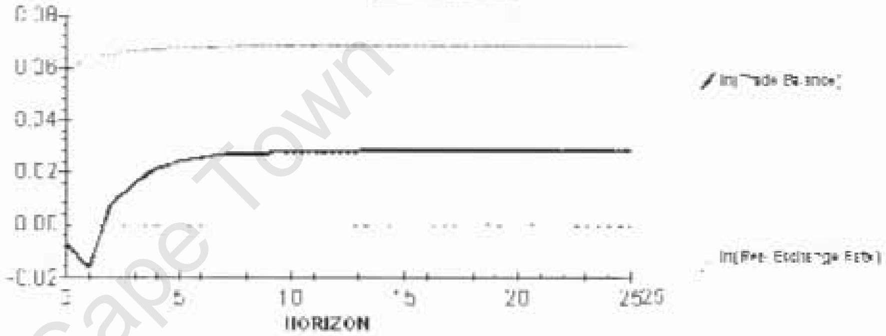


Figure 8: Generalized Impulse Response(s) to one S.E. shock in the Real Exchange Rate Equation for The Netherlands

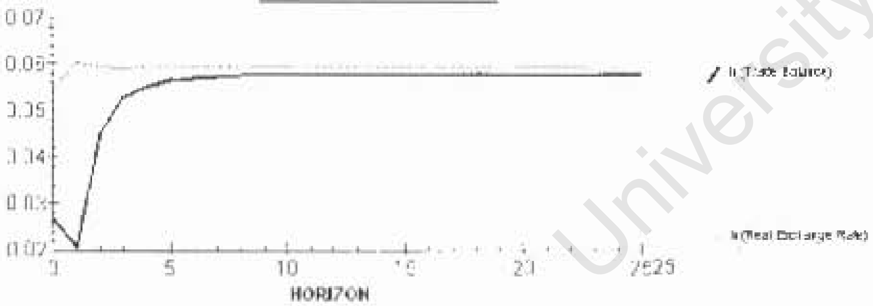
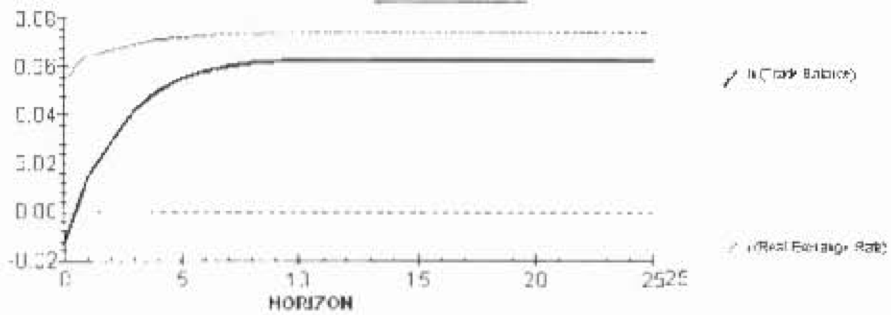


Figure 9: Generalized Impulse Response(s) to one S.E. shock in the Real Exchange Rate Equation for The USA



8. Conclusion

This paper has investigated the long run equilibrium and short run dynamics of the real exchange rate - trade balance relationship on both aggregate and bilateral levels. The reason for this was to detect potential aggregation bias, which was found to be evident in both time periods. With the inclusion of customs duty variables, the model specification employed is more encompassing than is traditionally the case in such a study. Both the ARDL and VECM approaches to cointegration were utilised to test the robustness of the results.

Regardless of the methodology used, we are able to conclude that our cointegration analysis found that there is a long run steady-state relationship among the trade balance, the real exchange rate, domestic income, foreign income, and the customs duty variables included. Both econometric methodologies found a statistically significant positive long run relationship between the real exchange rate and the trade balance, on both bilateral and aggregate levels. Aggregation bias was, however, still prevalent in this case, as variation between bilateral coefficient estimates were not adequately reflected in the aggregate estimate. Further evidence of aggregation bias was revealed in the case of the income variables, whereby perverse (yet theoretically plausible) bilateral findings were not reflected in the aggregate estimate. The customs duty variables included mostly conform with previous South African research, in that tariffs tend to worsen (and surcharges tend to improve) the trade balance in the aggregate case. Certain bilateral results are in disagreement here, thus revealing further aggregation bias.

The adjustment to long run equilibrium also differed across countries, with a J-curve response being evidenced in some case, but not all. Both methodologies find evidence of J-curve tendencies in the bilateral cases of South African trade with the UK and USA. Using the VECM approach (and its ability to capture feedback effects) we also find delayed short run trade balance responses in the cases of Japan and the Netherlands. None of these short run findings are captured in either aggregate case.

Although only seven of South Africa's major trading partners were included in this study, the results are robust enough to make extrapolated conclusions about South Africa's international trade with the rest of the world. That is, trade policy findings and recommendations regarding South Africa's aggregated trade need to be viewed with scepticism, as they are ignoring potentially significant bilateral relations.

References:

Alexander, Sidney S. (April 1952) "The effects of a Devaluation on the Trade Balance.", I.M.F. Staff Papers 2, no.2: 263-78.

Arora, S., Bahmani-Oskooee, M. and Goswami, G. G. (2003), "Bilateral J-curve between India and her trading partners", Applied Economics, 35, 1037–41.

Bahamani-Oskooee, M. (1985). "Devaluation and the J-curve: Some evidence from LDCs." The Review of Economics and Statistics, 67(3), 500-504.

Bahmani-Oskooee, M. (1986) "Determination of international trade flows: the case of developing countries", Journal of Development Economics, 20, 107–23.

Bahamani-Oskooee, M. (1989). "Devaluation and the J-curve: Some evidence from LDCs:Errata." The Review of Economics and Statistics, 71(3), 553-554.

Bahmani-Oskooe, M. (1991). "Is there a Long-Run relation between the trade balance and the Real Effective Exchange Rate of LDCs?" Economic Letters, 36, 43-47.

Bahmani-Oskooee, M. and Malixi, M. (1992) "More evidence on the J-curve from LDCs", Journal of Policy Modelling, 14, 641–53.

Bahmani-Oskooee, M. and Alse, J. (1994) "Short-run versus long-run effects of devaluation: error correction modelling and cointegration", Eastern Economic Journal, 20(4), 453–64.

Bahmani-Oskooee, M. and Brooks, T. J. (1999) "Bilateral J-curve between US and her trading partners", Weltwirtschaftliches Archiv, 135, 156–65.

Bahmani-Oskooee, M. and Kantipong. (2001) "Bilateral J-curve between Thailand and her trading partners", Journal of Economic Development, 26, 107–17.

Bahmani-Oskooee, M. and Goswami, G. G. (2003) "A disaggregated approach to test the J-curve phenomenon: Japan vs. her major trading partners", Journal of Economics and Finance, 27, 102–13.

Bahmani-Oskooee, M. and Artatrana, R. (2004a) "The J-curve dynamics of US bilateral trade", Journal of Economics and Finance, forthcoming.

Bahmani-Oskooee, M., Goswami, G., Talukdar, B., (2005), "The Bilateral J-curve: Australia versus her 23 trading partners", Blackwell Publishing Ltd/University of Adelaide and Flinders University.

Boyd, D et al. (2001), "Real Exchange rate effects on the balance of trade: Cointegration and the Marshall-Lerner condition," International Journal of Finance and Economics,6, 187-200.

Demirden, T. and Pastine, I. (1995) "Flexible exchange rates and the J-curve: an alternative approach", Economics Letters, 48, 373–7.

Enders, W., (2004) "Applied Econometric Time Series" 2nd Edition, Wiley International Edition.

Felmingham, B. S. (1988) "Where is the Australian J-curve?" Bulletin of Economic Research, 40(1), 43–56.

Frenkel, Jacob A and Johnson, Harry G (1978). "A Monetary approach to the exchange rate: Doctrinal aspects and empirical evidence".

Himarios, D. (1985) "The effects of Devaluation on the Trade Balance: A critical view and re-examination of Miles' new results" *Journal of International Money and Finance 4,* 553-563.

Himarios, D. (1989) "Do devaluations improve the trade balance? The evidence revisited", Economic Enquiry, 27, 143–68.

Houthakker, Hendrik S. and Stephen Magee (1969) "Income and Price Elasticities in World Trade", *Review of Economics and Statistics 51,* 111-125.

Johnson, Harry G (1977). "The Monetary approach to BOP Theory and Policy: Explanation and Policy Implications". Economica, vol 44, no. 175, pp. 217-229.

Junz, H, and Rhomberg, R R, "Price competitiveness in export trade among industrial countries," *American Economic Review*, Papers and Proceedings 63 (May1973), 412-418.

Khan, Mohsin, (1974) "Import and Export Demand in Developing countries", IMF Staff Papers 21, 678-693.

Krueger, Anne D., Exchange rate determination (Cambridge: Cambridge University Press, 1983).

Lerner, Abba P. (1936). "The Symmetry between Import and Export Taxes," *Economica* 3, (August), pp. 306-313

Magee, S. P. (1973), "Currency contracts, pass through and devaluation", Brooking Papers on Economic Activity, 1, 303–25.

Marwah, K. and Klein, L. R. (1996) "Estimation of J-curve: United States and Canada", Canadian Journal of Economics, 29, 523–39.

Meade, E. E. (1988). "Exchange rates, adjustment, and the J-curve", Federal Reserve Bulletin, October, 633–44.

Miles, M.A. (1979). "The effects of devaluation on the trade balance and the balance of payments: some new results". Journal of Political Economy, 87(3), 600-620.

Onafowora, O., (2003). "Exchange rate and trade balance in east Asia: is there a J-curve?". Economics Bulletin", vol 5, No.18 pp.1-13.

Pesaran, M. H. and Shin, Y. (1995) "An autoregressive distributed lag modeling approach to cointegration analysis", in Centennial Volume of Rangar Frisch (Eds) S. Strom, A. Holly, and P. Diamond, Cambridge University Press, Cambridge.

Pesaran, M. H., Y. Shin, and R. J. Smith. 1996. "Testing for the Existence of a Long-Run Relationship." DAE Working Paper No. 9622, Department of Applied conomics, University of Cambridge.

Rose, A. K. and Yellen, J. L. (1989) "Is there a J-curve?", Journal of Monetary Economics, 24 53–68.

Rose, A. K. (1990) "Exchange rates and the trade balance: some evidence from developing countries", *Economic Letters 34,* 271-275.

Rosensweig, J. A. and Koch, P. D. (1988) "The US dollar and the 'Delayed J-curve'", Economic Review, July/August, Federal Reserve of Atlanta.

Santos-Paulino, A. and Thirlwall, A.P. (2004) "The impact of Trade Liberalisation on exports, imports and the balance of payments of developing countries", The Economic Journal, 114 (February), Blackwell Publishing.

Sims, C., (1980), Macroeconomics and Reality, Econometrica 48, 1-48.

Thirwall, A.P. and Heather D. Gibson (1992), "Balance of Payments and the UK experience", 4th edition.

Warner, Dennis and Mordechai E. Kreinin (1983) "Determinants of International Trade Flows, *Review of Economics and Statistics 65,* 96-104.

9. Appendices

Table 9: Data Sources and Codes for Country Variables

Country	CPI	Exports to SA	Imports from SA	Income	Dollar denominated Nominal Exchange Rate
France	13264...ZF..	13270...DZD199	13271...DZD199	13266...CZF..	132..RF.ZF
Germany	13464H...ZF..	13470...DZD199	13471...DZD199	13466...CZF..	134...RF.ZF
Italy	13664...ZF..	13670...DZD199	13671...DZD199	13666...CZF..	136..RF.ZF
Japan	15864...ZF..	15870...DZD199	15871...DZD199	15866...CZF..	158..RF.ZF
Netherlands	13864...ZF..	13870...DZD199	13871...DZD199	13866...CZF..	138...RF.ZF
UK	11264...ZF..	11270...DZD199	11271...DZD199	11266...CZF..	112...RH.ZF
USA	11164...ZF..	11170...DZD199	11171...DZD199	11166...CZF..	
South Africa	19964...ZF..			RB6006D	199...WF.ZF

Table 10: Augmented Dickey Fuller (ADF) Unit Root Tests: Quarterly Data: 1961Q1 - 2004Q2

FRANCE

	Levels				First Difference			
Variable	Trend	Lag Length Trend/No Trend*	ADF Test	95% Critical Value	Trend	Lag Length	ADF Test	95% Critical Value
LTB	Indeterminate	2(AIC, SBC, HQC) / 2(AIC, SBC, HQC)	-3.282/ -3.290	-3.437/ -2.879	NO	2(AIC, HQC), 1(SBC)	-10.573	-2.879
LRER	Indeterminate	3(AIC, HQC), 1(SBC)/3(AIC), 1(SBC,HQC)	-4.213/ -1.8299	-3.437/ -2.8786	NO	2(AIC), 1(SBC,HQC)	-9.093	-2.879
LY	YES	1(AIC, SBC, HQC)	-2.109	-3.437	NO	1(AIC, SBC, HQC)	-9.659	-2.879

* = Results for both trend and no trend are given when it is indeterminate whether a trend exists.

GERMANY

	Levels				First Difference			
Variable	Trend	Lag Length	ADF Test	95% Critical Value	Trend	Lag Length	ADF Test	95% Critical Value
LTB	NO	4(AIC, SBC, HQC)	-4.167	-2.879	NO	4(AIC), 2(SBC, HQC)	-10.364	-2.879
LRER	YES	3(AIC, SBC,HQC)	-3.700	-3.437	NO	2(AIC, SBC, HQC)	-6.359	-2.879
LY	YES	2(AIC), 1(SBC, HQC)	-2.551	-3.437	NO	1(AIC, SBC, HQC)	-6.989	-2.879

ITALY

	Levels				First Difference			
Variable	Trend	Lag Length	ADF Test	95% Critical Value	Trend	Lag Length	ADF Test	95% Critical Value
LTB	NO	2(AIC, SBC,HQC)	-1.600	-2.879	NO	1(AIC, SBC, HQC)	-12.358	-2.879
LRER	YES	2(AIC, HQC), 1(SBC)	-3.115	-3.437	NO	2(AIC, HQC), 1(SBC	-9.516	-2.879
LY	YES	2(AIC, HQC), 1(SBC)	-2.246	-3.437	NO	1 (AIC, SBC, HQC)	-7.924	-2.879

JAPAN

	Levels				First Difference			
Variable	Trend	Lag Length	ADF Test	95% Critical Value	Trend	Lag Length	ADF Test	95% Critical Value
LTB	NO	4(AIC), 1(SBC,HQC)	-4.208	-2.879	NO	2(AIC, SBC, HQC)	-10.029	-2.879
LRER	YES	3(AIC,SBC,HQC)	-3.399	-3.437	NO	2(AIC,SBC,HQC)	-5.897	-2.879
LY	YES	4(AIC,HQC), 1(SBC)	-1.951	-3.437	NO	3(AIC), 1(SBC,HQC)	-4.923	-2.879

NETHERLANDS

	Levels				First Difference			
Variable	Trend	Lag Length Trend/No Trend	ADF Test	95% Critical Value	Trend	Lag Length	ADF Test	95% Critical Value
LTB	Indeterminate	4(AIC, HQC), 2(SBC)/4(AIC),	-3.472/ -1.2902	-3.437/ -2.8786	NO	3(AIC,HQC), 2(SBC)	-7.782	-2.879

		3(SBC,HQC)						
LRER	YES	3(AIC,HQC), 1(SBC)	-3.424	-3.437	NO	2(AIC,HQC), 1(SBC)	-6.357	-2.879
LY	YES	3(AIC), 1(SBC,HQC)	-2.352	-3.437	NO	2(AIC, SBC, HQC)	-5.523	-2.879

UK

	Levels				First Difference			
Variable	**Trend**	**Lag Length**	**ADF Test**	**95% Critical Value**	**Trend**	**Lag Length**	**ADF Test**	**95% Critical Value**
LTB	NO	2 (AIC, SBC, HQC)	-2.195	-2.879	NO	4 (AIC), 1(SBC, HQC)	-14.972	-2.879
LRER	YES	3 (AIC, HQC), 1 (SBC)	-3.301	-3.437	NO	4 (AIC), 1 (SBC), 2 (HQC)	-6.523	-2.879
LY	YES	1 (AIC, SBC, HQC)	-3.183	-3.437	NO	1 (AIC, SBC, HQC)	-8.462	-2.879

USA

	Levels				First Difference			
Variable	**Trend**	**Lag Length Trend/No Trend**	**ADF Test**	**95% Critical Value**	**Trend**	**Lag Length**	**ADF Test**	**95% Critical Value**
LTB	Indeterminate	1(AIC, SBC, HQC)/ 1(AIC, SBC, HQC)	-2.719/ -1.9426	-3.437/ -2.8786	NO	1(AIC,SBC,HQC)	-11.099	-2.879
LRER	NO	3(AIC, SBC, HQC)	-2.2631	-2.8786	NO	2(AIC,SBC,HQC)	-5.586	-2.879
LY	YES	4(AIC), 1(SBC,HQC)	-3.296	-3.437	NO	3(AIC,HQC), 1(SBC)	-5.708	-2.879

AGGREGATE

	Levels				First Difference			
Variable	**Trend**	**Lag Length**	**ADF Test**	**95% Critical Value**	**Trend**	**Lag Length**	**ADF Test**	**95% Critical Value**
LTB	NO	1(AIC,SBC,HQC)	-2.919	-2.879	NO	1(AIC,SBC,HQC)	-10.292	-2.879
LRER	YES	3(AIC,SBC,HQC)	-4.119	-3.437	NO	2(AIC,SBC,HQC)	-6.185	-2.879
LY	YES	4(AIC), 1(SBC,HQC)	-2.598	-3.437	NO	3(AIC), 1(SBC,HQC)	-5.628	-2.879

COMMON VARIABLES

	Levels				First Difference			
Variable	**Trend**	**Lag Length**	**ADF Test**	**95% Critical Value**	**Trend**	**Lag Length**	**ADF Test**	**95% Critical Value**
LSAY	YES	4(AIC), 2(SBC,HQC)	- 3.0751	-3.437	NO	2(AIC,SBC,HQC)	- 4.9059	-2.879
LT1	YES	4(AIC,SBC,HQC)	- 2.2728	-3.437	NO	3(AIC,SBC,HQC)	- 6.3454	-2.879
LT2	YES	4(AIC,SBC,HQC)	- 2.2885	-3.437	NO	4(AIC), 3(SBC,HQC)	- 7.2974	-2.879
LT3	NO	1(AIC,SBC,HQC)	-2.636	-2.879	NO	1(AIC,SBC,HQC)	- 8.5166	-2.879
LOILP	YES	1(AIC,SBC,HQC)	- 1.7264	-3.437	NO	4(AIC), 2(SBC,HQC)	- 6.8892	-2.879

Figure 10: Plots of Bilateral Real Exchange Rate and Trade Balance with France

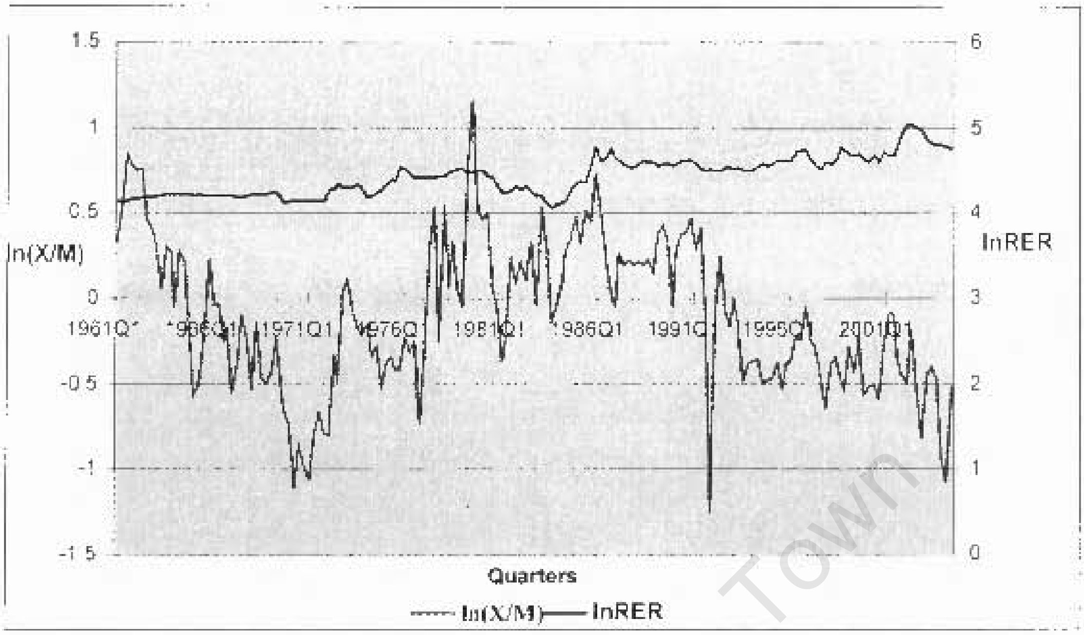


Figure 11: Plots of Bilateral Real Exchange Rate and Trade Balance with Germany

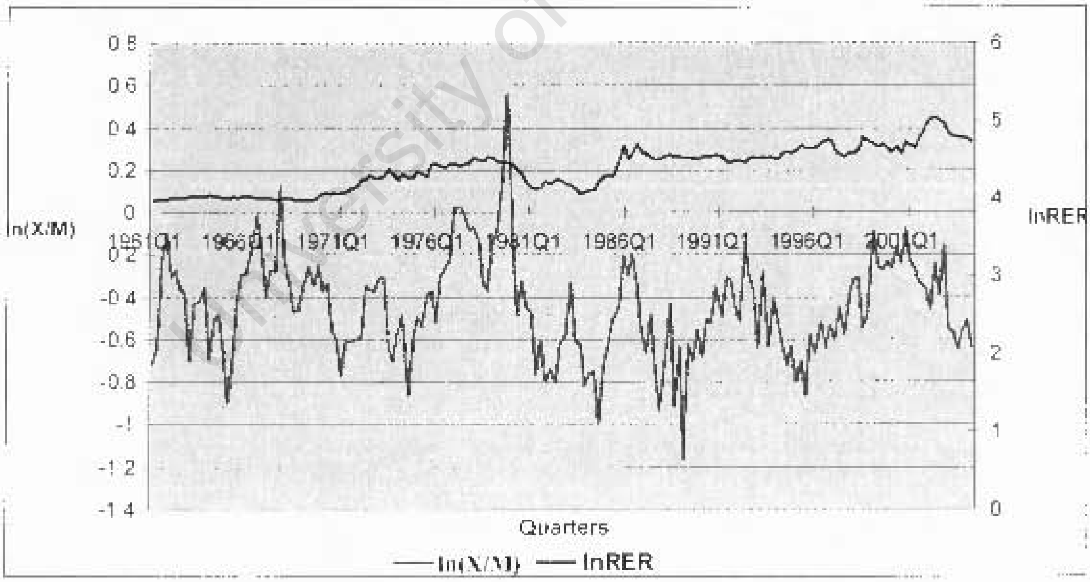


Figure 12: Plots of Bilateral Real Exchange Rate and Trade Balance with Italy

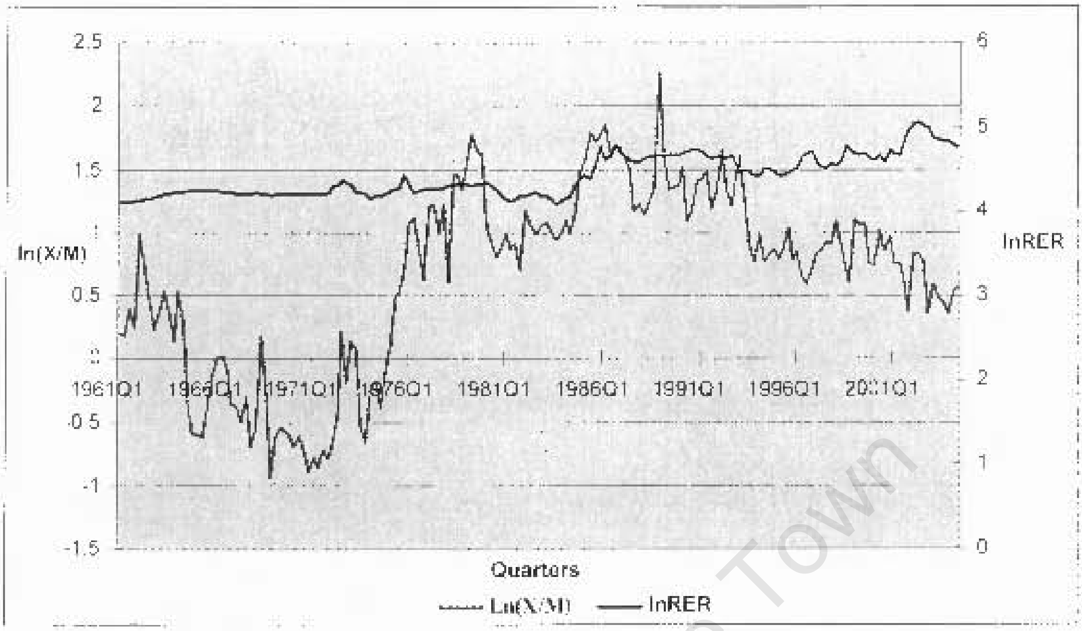


Figure 13: Plots of Bilateral Real Exchange Rate and Trade Balance with Japan

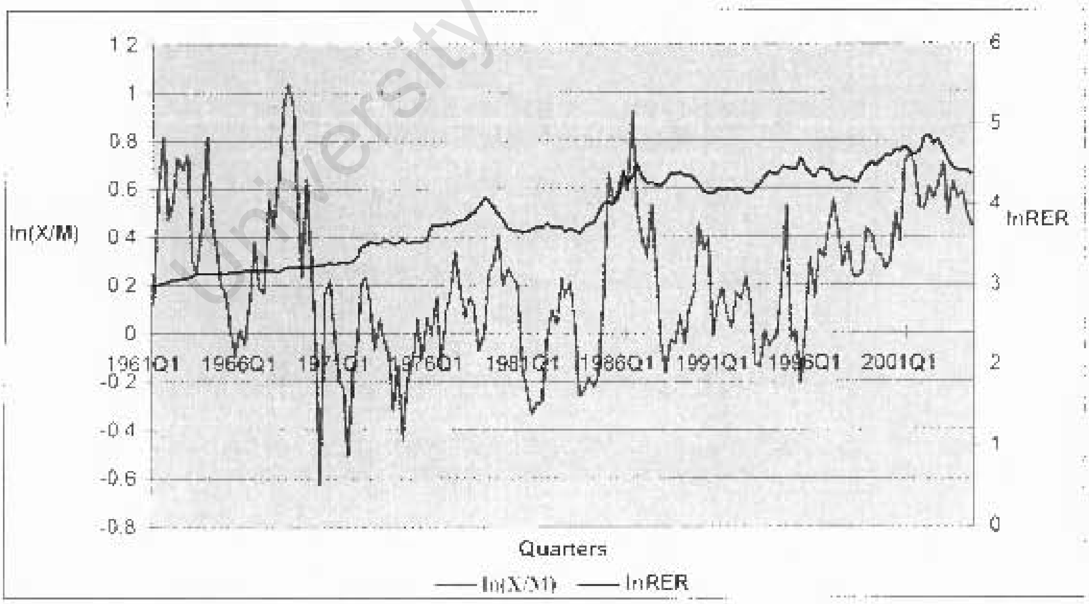


Figure 14: Plots of Bilateral Real Exchange Rate and Trade Balance with the Netherlands

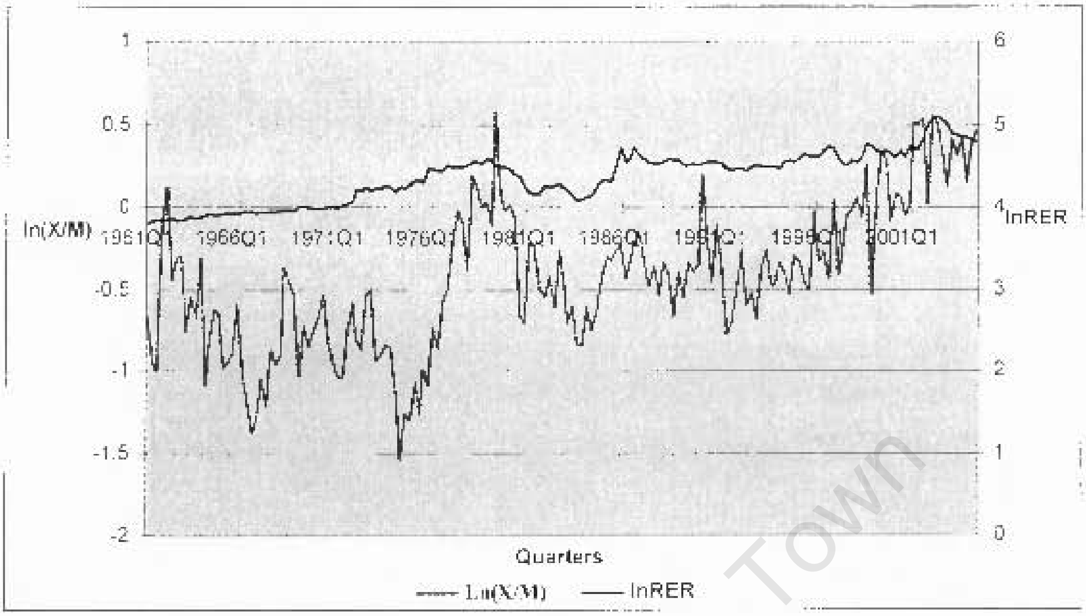


Figure 15: Plots of Bilateral Real Exchange Rate and Trade Balance with the United Kingdom

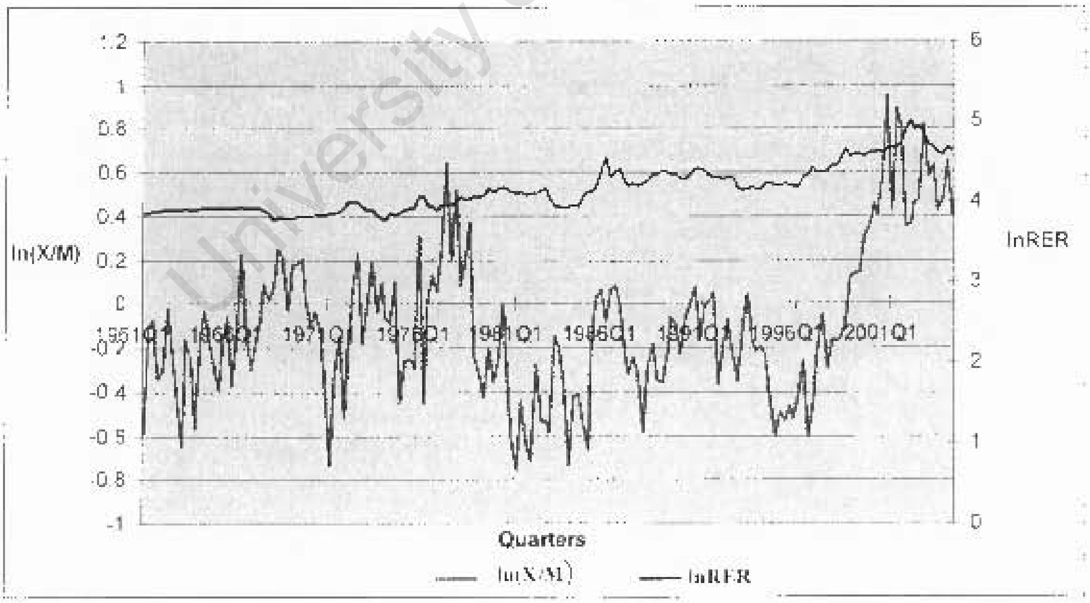


Figure 16: Plots of Bilateral Real Exchange Rate and Trade Balance with the USA

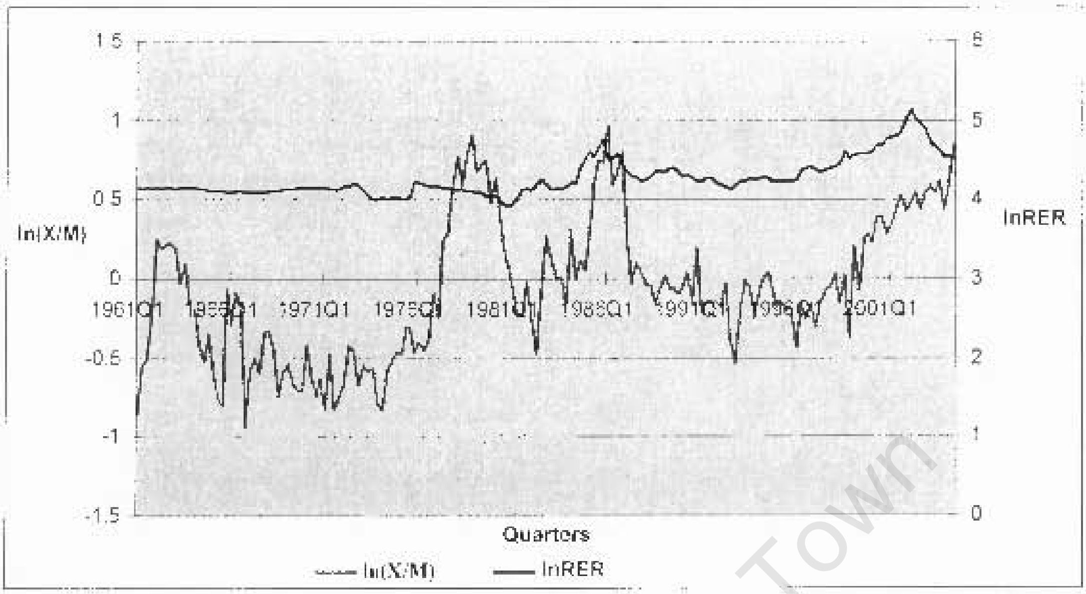


Table 11: Additional ARDL Results (Structure and Diagnostics)

Trading Partner:	France	
AIC ARDL Structure:	ARDL(1,0,0,0,2,0)	
Diagnostics:	**LM Version**	**F Version**
Serial Correlation:	CHSQ(4)= 2.7498[0.601]	F(4,158)= 0.64176[0.633]
Functional Form:	CHSQ(1)= 0.25930[0.611]	F(1,161)= 0.24309[0.623]
Normality:	CHSQ(2)= 75.5235[0.000]	Not applicable
Heteroscedasticity:	CHSQ(1)= 0.0016319[0.968]	F(1,170)= 0.0016129[0.968]
Trading Partner:	Germany	
AIC ARDL Structure:	ARDL(2,0,1,0,1)	
Diagnostics:	**LM Version**	**F Version**
Serial Correlation:	CHSQ(4)= 6.7211[0.151]	F(4,159)= 1.6164[0.173]
Functional Form:	CHSQ(1)= 1.3633[0.243]	F(1,162)= 1.2943[0.257]
Normality:	CHSQ(2)= 15.5023[0.000]	Not applicable
Heteroscedasticity:	CHSQ(1)= 0.18921[0.664]	F(1,170)= 0.18722[0.666]
Trading Partner:	Italy	
AIC ARDL Structure:	ARDL(1,0,0,3,1,0)	
Diagnostics:	**LM Version**	**F Version**
Serial Correlation:	CHSQ(4)= 0.56699[0.967]	F(4,153)= 0.12800[0.972]
Functional Form:	CHSQ(1)= 1.5727[0.210]	F(1,156)= 1.4566[0.229]
Normality:	CHSQ(2)= 44.8775[0.000]	Not applicable
Heteroscedasticity:	CHSQ(1)= 0.10153[0.750]	F(1,168)= 0.10039[0.752]
Trading Partner:	Japan	
AIC ARDL Structure:	ARDL(1,2,2,0,0,0)	
Diagnostics:	**LM Version**	**F Version**
Serial Correlation:	CHSQ(4)=3.9272[0.416]	F(4,156)=0.91673[0.456]
Functional Form:	CHSQ(1)=0.61289[0.434]	F(1,159)=0.57193[0.451]
Normality:	CHSQ(2)=2.4279[0.297]	Not applicable
Heteroscedasticity:	CHSQ(1)=0.35907[0.549]	F(1,169)=0.35562[0.552]
Trading Partner:	Netherlands	
AIC ARDL Structure:	ARDL(1,0,0,0,1)	
Diagnostics:	**LM Version**	**F Version**
Serial Correlation:	CHSQ(4)=6.9888[0.136]	F(4,157)=1.6624[0.161]
Functional Form:	CHSQ(1)=1.3767[0.241]	F(1,160)=1.2910[0.258]
Normality:	CHSQ(2)=2.0924[0.351]	Not applicable
Heteroscedasticity:	CHSQ(1)=0.049456[0.824]	F(1,170)=0.048895[0.825]
Trading Partner:	UK	
AIC ARDL Structure:	ARDL(3,0,1,2,0,3)	
Diagnostics:	**LM Version**	**F Version**
Serial Correlation:	CHSQ(4)= 3.0345[0.552]	F(4,148)= 0.66844[0.615]
Functional Form:	CHSQ(1)= 0.087272[0.768]	F(1,151)= 0.077104[0.782]
Normality:	CHSQ(2)= 1.4118[0.494]	Not applicable
Heteroscedasticity:	CHSQ(1)= 0.46785[0.494]	F(1,169)= 0.46365[0.497]

Trading Partner:	USA	
AIC ARDL Structure:	ARDL(2,0,0,1,0)	
Diagnostics:	**LM Version**	**F Version**
Serial Correlation:	CHSQ(4)=1.8782[0.758]	F(4,156)=0.43312[0.785]
Functional Form:	CHSQ(1)=2.8209[0.093]	F(1,159)=2.6670[0.104]
Normality:	CHSQ(2)= 4.1003[0.129]	Not applicable
Heteroscedasticity:	CHSQ(1)= 0.081762[0.775]	F(1,169)= 0.080844[0.777]
Trading Partner:	Aggregate	
AIC ARDL Structure:	ARDL(1,2,9,3,3,0)	
Diagnostics:	**LM Version**	**F Version**
Serial Correlation:	CHSQ(4)= 1.9868[0.738]	F(4,135)= 0.41389[0.798]
Functional Form:	CHSQ(1)= 1.1045[0.293]	F(1,138)= 0.93570[0.335]
Normality:	CHSQ(2)= 0.58374[0.747]	Not applicable
Heteroscedasticity:	CHSQ(1)= 0.019862[0.888]	F(1,162)= 0.019622[0.889]

Table 12: Additional ARDL Results (ARDL Dummy Variables)

Country	Dummy	Purpose
France	None	
Germany	None	
Italy	D75	Required for Cointegration
Japan	None	
Netherlands	D76 D94 D98	Cointegration, Functional Form, Serial Correlation, Normality and significance of Income variables
UK	D79	Makes RER Significant
USA	D66 D67	Corrects Normality Diagnostic Corrects Normality Diagnostic
Aggregate	None	

Table 13: Additional VECM Results (VECM Diagnostics)

France

	LM Version	F Version
Serial Correlation:	CHSQ(4)= 1.5620[0.816]	F(4,156)= 0.35743[0.839]
Functional Form:	CHSQ(1)= 2.5858[0.108]	F(1,159)= 2.4268[0.121]
Normality:	CHSQ(2)= 56.6201[0.000]	Not applicable
Heteroscedasticity:	CHSQ(1)= 1.2986[0.254]	F(1,170)= 1.2933[0.257]

Germany

	LM Version	F Version
Serial Correlation:	CHSQ(4)= 6.8069[146]	F(4,164)= 1.6793[157]
Functional Form:	CHSQ(1)= 0.077707[0.780]	F(1,167)= 0.075045[0.784]
Normality:	CHSQ(2)= 5.8929[0.053]	Not applicable
Heteroscedasticity:	CHSQ(1)= 0.20752[0.649]	F(1,171)= 0.20537[0.651]

Italy

	LM Version	F Version
Serial Correlation:	CHSQ(4)=8.1108[088]	F(4,155)=1.9177[110]
Functional Form:	CHSQ(1)=1.5865[208]	F(1,158)=1.4710[0.227]
Normality:	CHSQ(2)=46.5420[0.000]	Not applicable
Heteroscedasticity:	CHSQ(1)=0.58209[0.445]	F(1,170)=0.57727[0.448]

Japan

	LM Version	F Version
Serial Correlation:	CHSQ(4)=3.6902[0.450]	F(4, 132)=0.73665[0.569]
Functional Form:	CHSQ(1)=3.6312[0.057]	F(1,135)=2.9644[0.087]
Normality:	CHSQ(2)=0.64590[0.724]	Not applicable
Heteroscedasticity:	CHSQ(1)=1.2944[0.255]	F(1,167)=1.2889[0.258]

Netherlands

	LM Version	F Version
Serial Correlation:	CHSQ(4)=6.3990[0.171]	F(4,154)=1.4877[0.209]
Functional Form:	CHSQ(1)=0.1142E-3[0.991]	F(1,157)=0.1042E-3[0.992]
Normality:	CHSQ(2)=0.34846[0.840]	Not applicable
Heteroscedasticity:	CHSQ(1)=0.027444[0.868]	F(1,170)=0.027129[0.869]

UK

	LM Version	F Version
Serial Correlation:	CHSQ(4)=8.9553[0.062]	F(4,153)=2.1009[0.083]
Functional Form:	CHSQ(1)=2.4143[0.120]	F(1,156)=2.2209[0.138]
Normality:	CHSQ(2)= 6.6702[0.036]	Not applicable
Heteroscedasticity:	CHSQ(1)=0.0062355[0.937]	F(1,170)=0.0061632[0.938]

USA

	LM Version	F Version
Serial Correlation:	CHSQ(4)=1.1419[0.888]	F(4,154)=0.25731[0.905]
Functional Form:	CHSQ(1)=1.8330[0.176]	F(1,157)=1.6911[0.195]
Normality:	CHSQ(2)=3.4741[0.176]	Not applicable
Heteroscedasticity:	CHSQ(1)=1.0560[0.304]	F(1,170)=1.0502[0.307]

Aggregate

	LM Version	F Version
Serial Correlation:	CHSQ(4)=2.3643[0.669]	F(4,156)=0.54356[0.704]
Functional Form:	CHSQ(1)=0.086834[0.768]	F(1,159)=0.080311[0.777]
Normality:	CHSQ(2)=0.69454[0.707]	Not applicable
Heteroscedasticity:	CHSQ(1)=0.24260[0.622]	F(1,170)=0.24012[0.625]

Table 14: Additional VECM Results (VECM Dummy Variables)

Country	Dummy	Purpose
France	Only Seasonal	
Germany	Only Seasonal	
Italy	D01, seasonal	Without D01 the foreign and domestic income variables are 1.5 times and 4 times bigger, respectively, than the reported values.
Japan	D66,D67, Seasonal, D97	Without D66 and D67, there is a heteroscedasticity diagnostic problem. These dummies capture significant spikes in the residual plot and deflate the domestic and foreign income variables, as well as their standard errors. Makes Japanese income variable significant.
Netherlands	D76 D94 D98 Seasonal	Makes foreign income variable statistically significant. Remedies serial correlation problem. Gives foreign income variable the theoretically correct sign
UK	D76 D79 D94 Seasonal	Serial correlation and Normality diagnostic correction. Deflates standard errors of Income Variables. Corrects theoretically expected signs of income and exchange rate variables.
USA	D66,D67 D79 Seasonal	Without D66 and D67, there is a Normality diagnostic problem. These dummies capture significant spikes in the residual plot. Corrects theoretically expected signs and significance of income variables and allows for the statistical rejection of the trend.
Aggregate	Only Seasonal	

Table 15:Table of Zero-Restrictions

H_O:	$Y^* = 0$	$Y_{SA} = 0$	$RER_I = 0$	$T1 = 0$	$T2 = 0$	$T3 = 0$	TREND=0
France	Cannot Reject (0.132)	Reject** (0.035)	Reject** (0.048)	-	Reject** (0.034)	Reject* (0.000)	Cannot reject (0.141)
Germany	Cannot Reject (0.104)	Reject* (0.000)	Reject* (0.000)	Reject* (0.003)	-	-	Cannot reject (0.822)
Italy	Cannot reject (0.311)	Cannot Reject (0.134)	Reject* (0.000)	-	Cannot Reject (0.484)	Reject* (0.007)	Cannot reject (0.552)
Japan	Reject*** (0.066)	Reject** (0.032)	Reject* (0.000)	-	Reject* (0.000)	Reject* (0.000)	Cannot reject (0.087)
Netherlands	Cannot reject (0.628)	Reject*** (0.062)	Reject** (0.025)	Cannot reject (0.227)	-	-	Cannot reject (0.540)
UK	Reject** (0.023)	Reject*** (0.0830)	Reject*** (0.063)	-	Reject* (0.000)	Reject* (0.000)	Cannot reject (0.453)
USA	Reject** (0.015)	Reject** (0.014)	Reject* (0.000)	Reject* (0.006)	-	-	Cannot reject (0.479)
Aggregate	Reject* (0.000)	Reject** (0.013)	Reject** (0.048)	-	Reject** (0.028)	Cannot reject (0.882)	Cannot reject (0.786)

p-value of LR test of restrictions in parenthesis.

* = significant at the 1% level; ** = significant at the 5% level; *** = significant at the 10% level.

Note: Placing a zero restriction on the oil price variable was universally rejected at the 1% level of significance