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An Empirical Examination of the J-Curve:

New Zealand's Bilateral Trade with Selected Countries

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Abstract

The J-curve hypothesis holds that the devaluation or depreciation of a country's currency worsens the trade balance in the short run before improving the balance in the long run. This study investigates the short-run and long-run effects of nominal exchange rate changes on the bilateral trade balance between New Zealand, Australia, USA, UK, China, India, Japan and Singapore using quarterly data from 1990 to 2014. The results show some evidence of J-curve effects in the case of New Zealand and China and New Zealand and Japan but with no evidence to support J-curve effects in the case of New Zealand and Australia, USA, UK, India and Singapore. Diagnostic tests, however, suggest that there are some omitted variables in the models.

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1. Introduction

A country's trade performance is associated with many influences such as factor endowments, productivity, exchange rates, consumer preferences, immigration, unemployment, inflation, interest rates, domestic saving and investment, income distribution, the international trade environment and bilateral trade balances. Exchange rate effects, for example, affect trade balances. The J-curve hypothesis holds that in the short run the trade balance worsens after currency depreciation and then rises in the long-run. The J-curve phenomenon was developed by Magee (1973). Magee argued that elasticities change in the in the long run and this leads to an improvement in country's trade balance after the currency devaluation.

The main objective of this study is to examine the short-run and long-run effects of a real depreciation of the New Zealand dollar on its trade balance, using bilateral trade and real exchange rate data from New Zealand and selected trading partners, namely, Australia, the United States, Japan, China, UK, Singapore and India.

This study is organised as follows. Section 2 summarises selected literature on the J-curve effect, Section 3 outlines the methodology while Section 4 covers empirical findings. Initially results concerning New Zealand's bilateral trading relationship with its largest trading partners are reported individually. Panel data that pools trade statistics is analysed and this increases the statistical significance of some of the results and provides some evidence of a J-curve effect.

2. Selected Literature Review

The literature on international trade theory and finance has a long history extending back to at least David Hume, Adam Smith and David Riccardo. David Hume's (1752) in his *The Discourses of Political Economy* developed the price-specie flow mechanism for the adjustment of trade balances. He challenged the Mercantilist policy recommendation for trade balance surplus as trade policy strategy for the domestic economy. Mercantilism was the leading economic system of most industrial countries. According to Mercantilism, the wealth of a nation depended primarily on the ability to possess metals such as silver and gold (Peukert, 2012). Hume argued that a permanent trade surplus was not feasible and made no sense as policy objective; a deficit will cure itself and therefore there was no need to worry about losing reserves and the money supply. Subsequently, Adam Smith (1776) in the *Wealth of Nations* and David Ricardo (1817) in *Principles of Political Economy and Taxation* (1817) adopted similar approaches to Hume.

According to the elasticities approach, the trade balance adjustment path is viewed on the basis of elasticities of demand for imports and exports. This approach is commonly known as Bickerdike-Robinson-Metzler condition (Hooy and Chan 2008) with the Marshall-Lerner condition is further extension of the elasticities approach. According to this approach, if the exchange rate depreciates the currency with the intention of improving the trade balance, the

demand for the nation's imports and exports need to be sufficiently elastic. More specifically, the sum of the absolute values of the two elasticities must be greater than unity (Brown and Hogendorn 2000). On the other hand, if the sum is less than unity, the trade balance worsens when a depreciation occurs (Lerner 1944). In relation to Marshall-Lerner condition, if the trade balance improves in the long-run due to a currency devaluation to a level higher than previously, then, under the J-Curve assumptions, we can consider the Marshall-Lerner condition fully satisfied and conversely (Hacker and Hatemi-J 2004)

Rose and Yellen (1989) investigated the movement of real exchange rate and its impact on the balance of trade. Researchers used 25 years trade data between the United States and six countries (UK. Japan, Canada, Japan, Italy, Germany and France) and concluded that there was no statistical and reliable evidence of a stable J-curve. On the other hand, Wilson (2001) examined the relationship between the real trade balance and the real exchange rate for bilateral trade in merchandise goods between the USA and Japan and Singapore, Korea and found evidence of a J-curve between Malaysia and Singapore. Bahmani-Oskooee and Ratha (2004), in an extensive J-curve literature review on J-curve, concluded that further research is required as there continues to be mixed findings on the presence or absence of a J-curve effect.

Ono and Baak (2014) investigated whether the J-curve and S-curve (J/S) curve existed in Japanese trade, using the data of terms from 1980 to 2008. Using a VAR stability test, the authors found that the J/S curve existed in two sub-periods out of three sub-periods. Accordingly, the authors argued that the J/S curve may stem from China's trade expansion and the increasing importance of oil-exporting countries in Japanese trade. Moreover, the authors found that the J/S curve is observed only in bilateral trade between Japan some countries but there was no existence of J/S curve in Japan's trade with Korea and the United States (Ono, 2014). The authors commented on structural breaks, and in particular the major change in Japan's trading relationship with China and the effects of changes in oil prices.

Bahmani-Oskooee and Harvey (2014) addressed the issue of the existence of the J-curve by attempting to identify the short-run (J-curve) and long-run effects of currency depreciation on the trade balance of Singapore, using cointegration and error-correction modelling techniques. By disaggregating the annual Singapore-US trade flows by commodity, and estimating the trade flows of 64 industries, the authors found some evidence to support short-run significant effects in 48 industries. Moreover, the short-run effects lasted into the long run in just 24 industries. Bahmani-Oskooee and Zhang (2014, 2013) examined the existence of a J-curve in trade balance between China and the UK and Korea and the rest of the world by disaggregating their trade flows by commodity. Using cointegration and an error-correction model (ECM) for each of the industry, the authors found some evidences of a J-curve effect in both cases.

Dash (2013) is a J-curve analysis of bilateral trade between India and her four major trading partners (the USA, UK, Japan and Germany) was identified. Using a cointegrating vector error correction (VEC) model, Dash found a long-run equilibrium relationship involving the trade balance, domestic income, foreign income and the real exchange rate. The study also applied generalised impulse response functions to trace the effect of a one-time shock to the real exchange rate on the trade balance. The J-curve effect was visible in India's bilateral trade with both Japan and Germany and the Marshall-Lerner condition appeared to hold for India-Germany trade. Dash did not find a J-curve effect in India's trade with the US and the UK. There was, however, an S-curve effect in India-UK trade.

Kyophilavong *et al.* (2013) applied the ARDL bounds-testing approach to examine the J-curve effect in Laos, using quarterly data between 1990 and 2010. The empirical results found that the J-curve existed for Laos. Moreover, real depreciation had a positive but insignificant impact on the trade balance in the long-run. In addition, domestic income played an important role in improving the trade balance in the short run as well as in long run.

Dollery and Wijeweera (2012) used quarterly Australian data between 1988 and 2011 to examine whether J-curve effects are different between the goods sector and the services sector. Using error-correction modelling together with an ARDL specification, they found some evidence of the existence of a J-curve effect in the services sector. However, there was no statistical support for the J-curve effects in the goods sector.

Bahmani-Oskooee, Xu and Saha (2017) reviewed literature on Korean trade and devaluation and did not find provide significant effects. They then worked on the bilateral trade between Korea and US and investigated the response of the trade balance of 69 industries to currency depreciation by using error-correction modelling and found that the trade balance of 48 industries was affected significantly by changes in the real exchange rate in the short run. However, short-run effects translate to long-run favourable effects in just 24 industries. Bahmani-Oskooee, Iqbal and Nosheen (2016) performed a similar disaggregated analysis for trade between Pakistan and the US for 45 industries. They found significant short-run effects of currency depreciation on the trade balance of 17 industries which lasted into the long run in 15 industries only.

The only published empirical research for the existence of J-curve in New Zealand appears to be the paper by Narayan (2004). In this paper, the cointegration relationship between the trade balance and real effective exchange rate (REER), foreign income and domestic income for New Zealand during the period 1970-2000 was identified. It also examined the direction of the casual relationship between the above variables by applying impulse response analysis to determine whether shocks to the REER induced the trade balance to follow a J-curve pattern. Although the results found no cointegration relationship, there was a casual connection in both directions between the trade balance and foreign income. New Zealand's trade balance exhibited a J-curve pattern when there was a depreciation of the New Zealand dollar.

3. Methodology: The Trade Balance Model

In our study, the main purpose is to identify the J-curve hypothesis for New Zealand with its major trading partners Australia, China, USA, UK, Japan, Singapore and India. Disaggregated quarterly data from 1990:1 to 2014:4 is used. We follow the trade balance model of Bahmani-Oskooee and Brooks (1999) where the trade balance is related to a measure to real income and the bilateral real exchange rate, specifically,

$$lnTB_{p,t} = \alpha + \beta_1 lnY_{NZ,t} + \beta_2 lnY_{p,t} + \beta_3 lnREX_{p,t} + \mu_t \qquad (1)$$

where TB_p is the trade balance between New Zealand and its trading partner p defined as the ratio of New Zealand's exports to country p over its imports from country p. Y_{NZ} and Y_P is a measure of New Zealand's and its trading partner country p's domestic real income. An index of industrial production is used for these two variables. REX_p is the bilateral real exchange rate between New Zealand and trading partner p. It is defined as an increase in REX_p reflects a real depreciation of New Zealand dollar against the national currency of trading partner p. Since the trade balance TB_p is defined as a ratio of exports to imports, if an increase in New Zealand industrial production Y_{NZ} raises imports, the expected sign of coefficient β_1 is negative and conversely. By the same token, the coefficient β_2 could be either negative or positive. Finally, if real depreciation of New Zealand dollar (or an increase in REX_p) raises exports and reduces imports, the coefficient β_3 should be positive. It has been argued that the domestic income coefficient should be negative and the foreign income coefficient positive (Bahmani-Oskooee 2013, 2014 and Wijeweera 2013). But it has also been argued the income effects are ambiguous (Dash 2013).

Since equation (1) only yields the long-run estimates for each of the variables, the short-run dynamics need to be included. According to Pesaran and Shin (1995) and Arora *et al.* (2010), ECM can be used to specify equation (1) as:

$$\Delta lnTB_{p,t} = \alpha + \sum_{i=1}^{n} \beta_{1i} \Delta lnTB_{p,t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta lnY_{NZ,t-i} + \sum_{i=1}^{n} \beta_{3i} \Delta lnY_{p,t-i} + \sum_{i=1}^{n} \beta_{4i} \Delta lnREX_{p,t-i}$$
$$+ \gamma_1 lnTB_{p,t-1} + \gamma_2 lnY_{NZ,t-1} + \gamma_3 lnY_{p,t-1} + \gamma_4 lnREX_{p,t-1} + \epsilon_t \qquad (2)$$

Before the two equations are been estimated, Johansen cointegation tests will be used initially to identify if there is long-run relationship among the variables. If the variables are not cointegrated, the variables can be applied to a vector autoregression model (VAR) in difference form. If the variables are integrated, an error-correction model (ECM) will then be estimated.

4. Empirical Findings

Figures 1 to 7 show New Zealand's bilateral exchange rate (*REX*) and trading balance (*TB*) with seven trading partners: Australia, China, USA, UK, Japan, Singapore and India between 1990 and 2014. Visually, the overall trend in both series can be observed. However, the trend of each series is different. It can be seen, for example, from Figures 4 and 6 that New Zealand-China and New Zealand-Australia *REX* were relatively constant. However, New Zealand's *TB* with both countries became more positive with a very sharp increase for China occurring from about 2009 following the New Zealand-China Free Trade Agreement coming into effect on 1 October 2008. This raises the issue of whether the period covered should be shortened. There are also potential discontinuities in New Zealand's trade with Britain since some exports to Britain, such as butter, are now dispatched through ports on the European continent. In addition, there seems to be seasonal fluctuations in *TB* between New Zealand and most of the countries. This partly reflects the agricultural basis of New Zealand's exports, with production varying between seasons.

Figure 1: New Zealand -Australia Bilateral Real Exchange Rate and Trade Balance

Figure 2: New Zealand-China Bilateral Real Exchange Rate and Trade Balance

Figure 3: New Zealand-US Bilateral Exchange Rate and Trade Balance

Figure 4: New Zealand-UK Bilateral Real Exchange Rate and Trade Balance

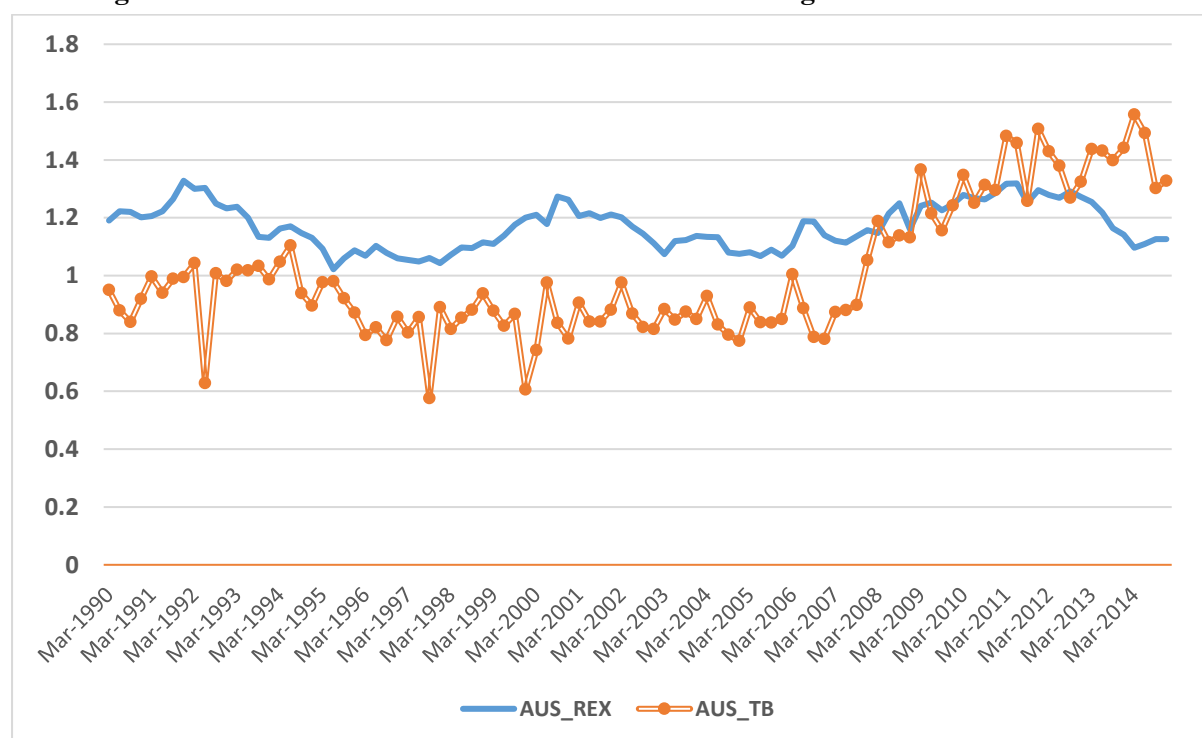**Figure 5: New Zealand-Japan Bilateral Real Exchange Rate and Trade Balance**

Figure 6: New Zealand-Singapore Bilateral Real Exchange Rate and Trade Balance

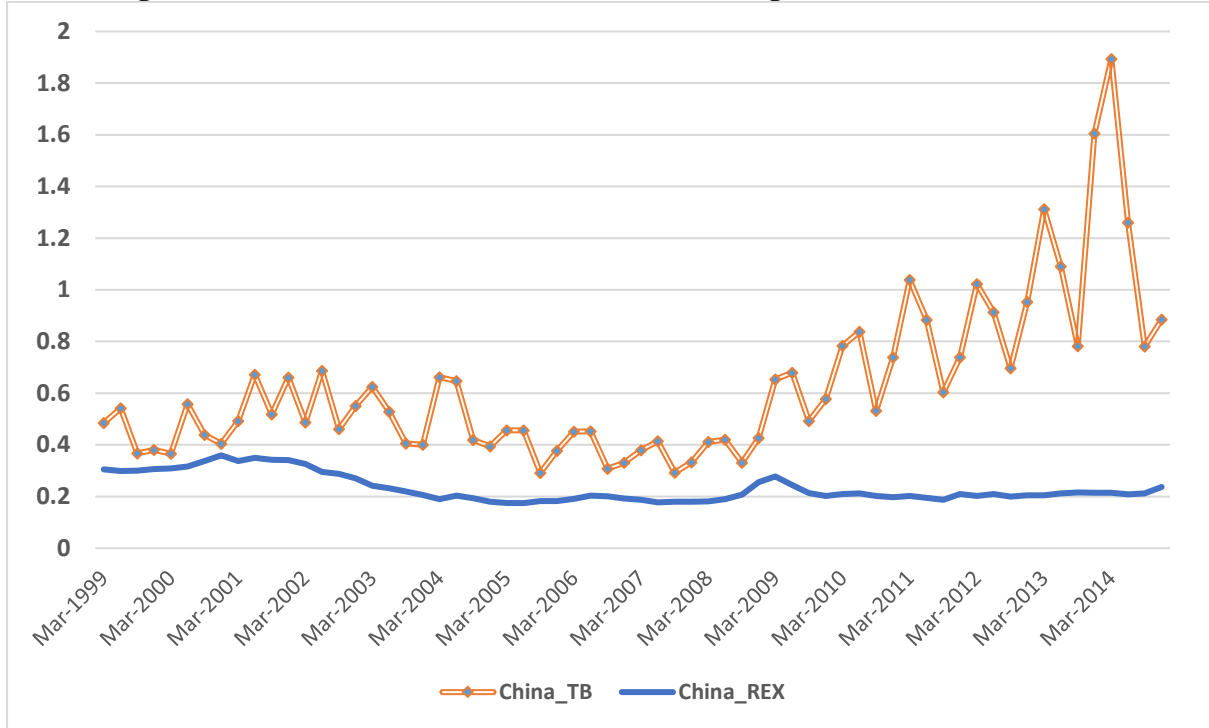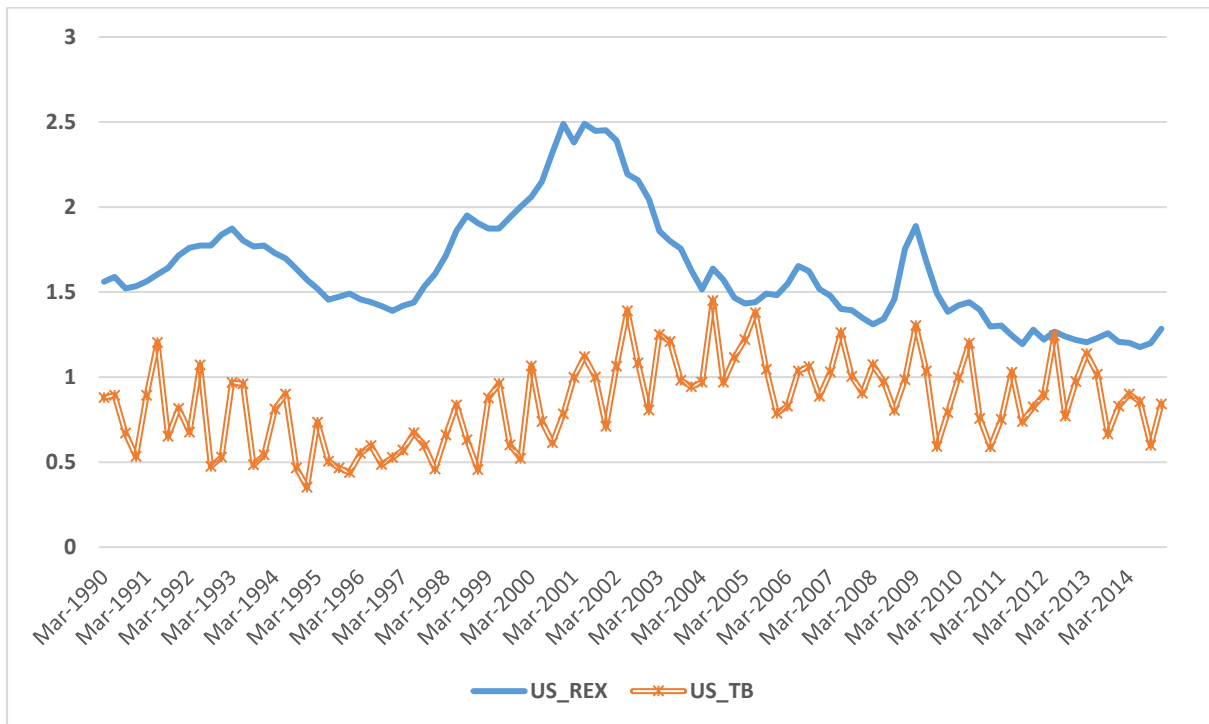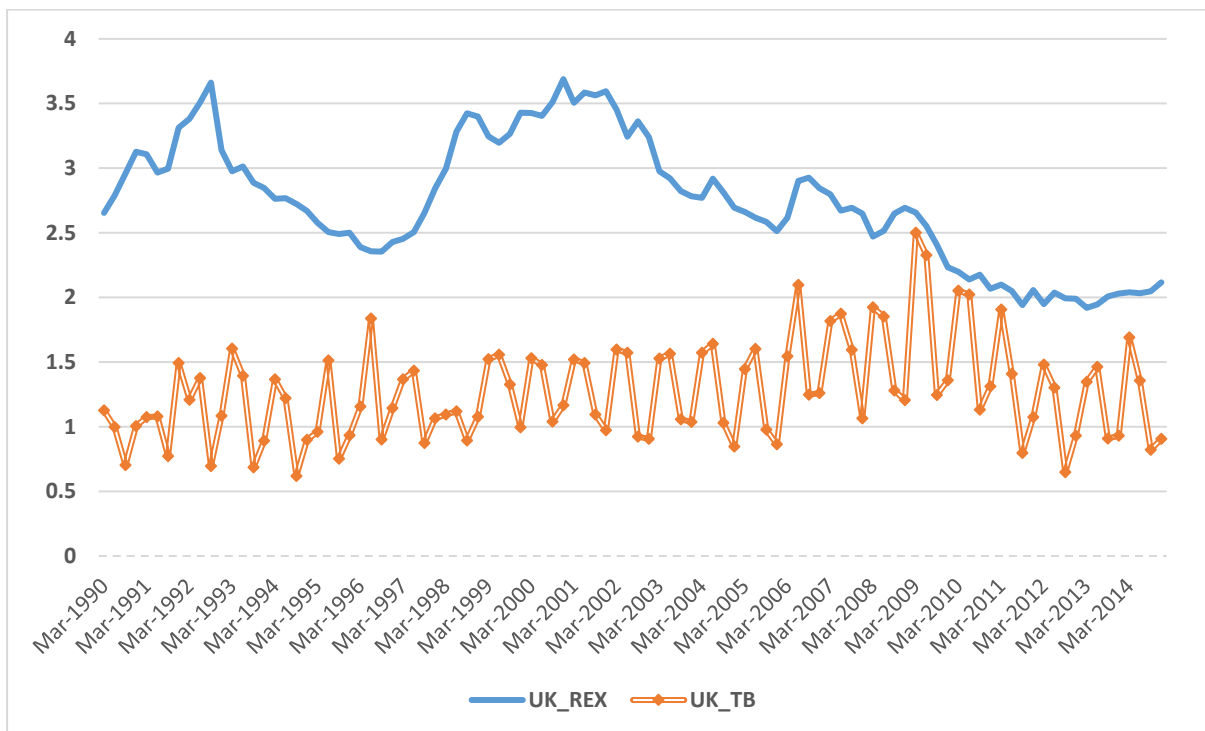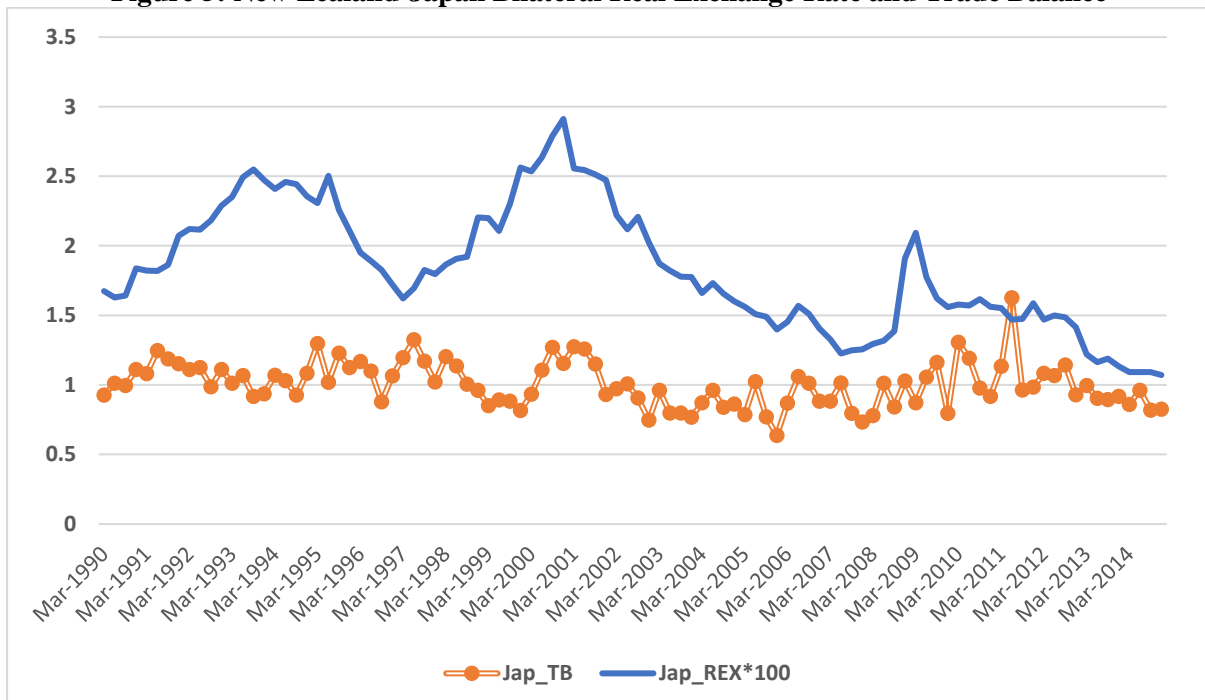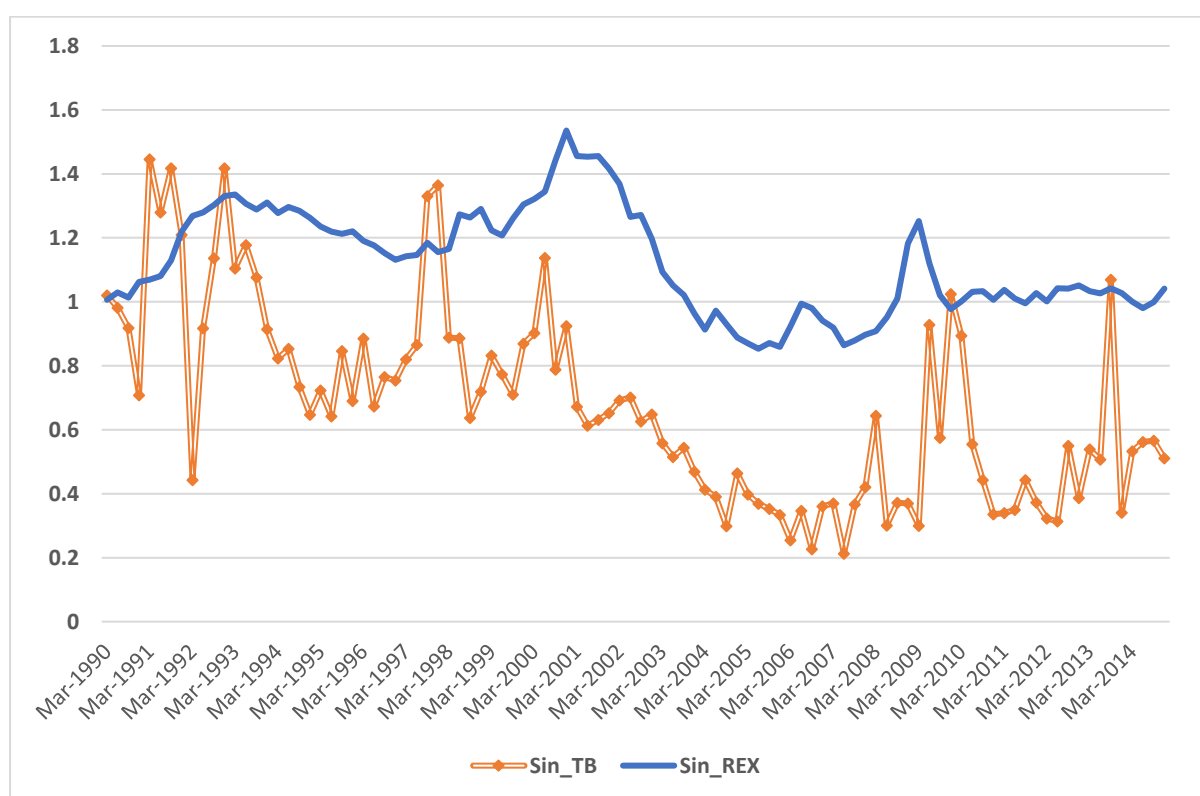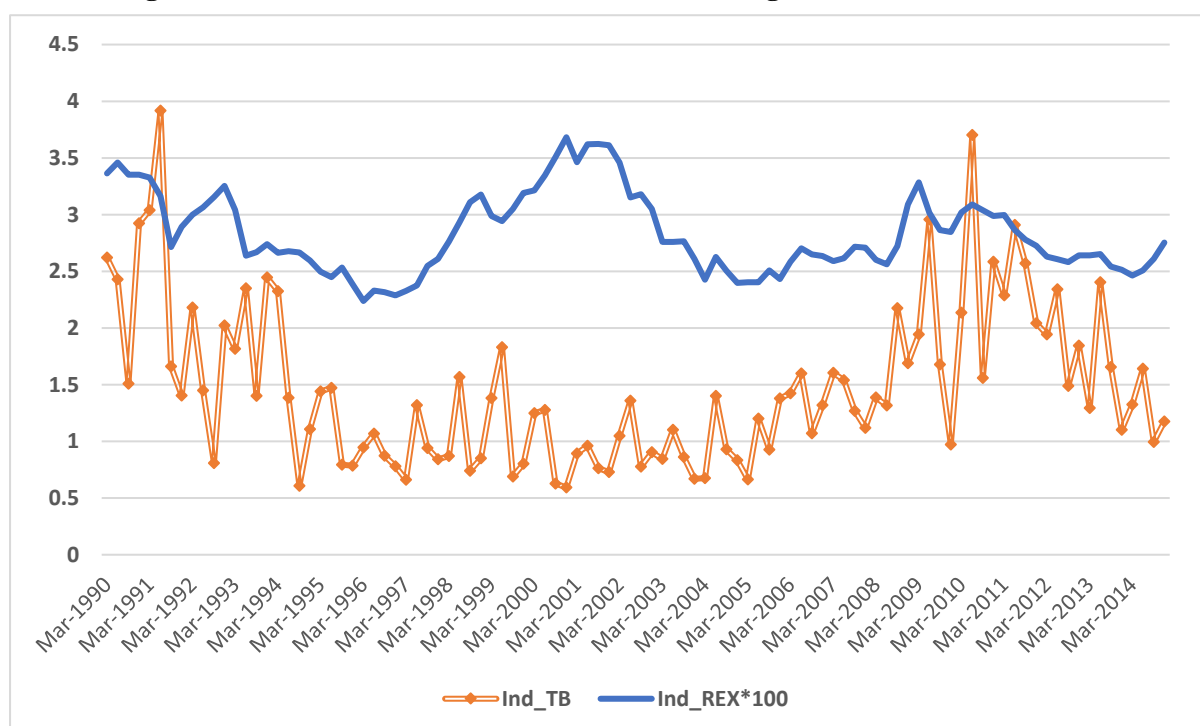**Figure 7: New Zealand-India Bilateral Real Exchange Rate and Trade Balance**

Sources: International Financial Statistics (IFS), 2016. NZ Statistics, 2016. Authors' estimates.

Seasonal fluctuations in trade also occur for other countries and have sometimes been explicitly controlled using commands such as Eviews X-12 seasonal adjustment and a Hodrick_Prescott filter. For instance, Ono and Baak (2014) apply X-12 using an additive component and a Hodrick-Prescott filter to their variables while Dash (2013) deseasonalised the main variables using Eviews X-11 (historical method). We used Eviews more recent X-13 command to extract trends.

In order to estimate the long-run and short-run effects of *REX* on *TB*, quarterly data (1990:1-2014:4) are used in the trade balance model equations (1) and (2). All data are obtained from the *International Financial Statistics* (IFS), OECD Statistics and Statistics New Zealand Data for industrial production in China covers the period 1999:1 and 2014:4 due to data availability: hence the analysis for China is from 1999 rather than 1990.

Tables 1a to 1g present the basic descriptive statistics of each model. Initially, optimal lags of each model have been selected by comparing their Akaike's Information Criterion (AIC). In order to investigate if there is long-run relationship (or equilibrium) between TB and REX especially, Johansen cointegration tests have been estimated. Table 2 shows the results from the Johansen cointegration tests before trends in the data were identified. According to the trace and maximum eigenvalue statistics, we could conclude that there exists a cointegrating relationship between TB and REX when New Zealand trades with all the partners.

Cointegration exists for Australia only using Eviews option two, but this seems appropriate for the data. Table 2 reveals the long-run estimated coefficients of each variable. The ln(rex) coefficient is positive, as expected, for all countries except China. The coefficient is significant at a five percent level for China, Singapore and the UK, but the coefficient is not significant at a five percent level for Australia, India, Japan, or the United States. It can be found that trade balance *ln(TB)* is significantly and positively influenced by the bilateral exchange rate *ln(REX)* in the long-run when New Zealand trades with Singapore and the UK. In other words, in at least two cases, real depreciation of New Zealand dollar improves the New Zealand's trade balance with each country in the long-run.

In contrast, the long-run effect of *ln(REX)* is positive, but insignificant for Australia, India, Japan and the US. Additionally, a negative value has been observed in the coefficient of New Zealand-China *ln(REX)* and this is significant. The coefficients of other two variables - New Zealand and its trading partner's industrial production - *ln(Y_NZ)* and *ln(Y_TP)*, show a different effect on *ln(REX)*. Specifically, *ln(Y_NZ)* is more significant in explaining the variations in *ln(REX)* than *ln(Y_TP)*. For instance, the coefficient of *ln(Y_NZ)* is significant in the cases of the US, UK, Japan and India and Singapore.

Table 1a: Descriptive Statistics: NZ-Australia

	Y_AUS	Y_NZ	TB	REX
Mean	85.42	92.83	1.01	1.17
Median	86.24	93.70	0.93	1.16
Maximum	112.23	109.53	1.56	1.33
Minimum	64.78	71.52	0.58	1.02
Std. Dev.	13.51	9.85	0.23	0.08
Skewness	0.12	-0.47	0.76	0.15
Kurtosis	2.01	2.19	2.62	1.94
Jarque-Bera	4.35	6.42	10.26	5.06
Probability	0.11	0.04	0.01	0.08
Sum	8542.02	9282.62	100.90	117.12
Sum Sq. Dev.	18059.06	9609.97	5.14	0.59
Observations	100	100	100	100

Table 1b: Descriptive Statistics: NZ-China

	TB	Y_CHN	Y_NZ	REX
Mean	0.63	112.96	98.92	0.23
Median	0.53	113.03	100.13	0.21
Maximum	1.89	118.95	109.53	0.36
Minimum	0.29	106.43	86.22	0.17
Std. Dev.	0.31	3.44	5.35	0.05
Skewness	1.87	-0.02	-0.46	1.00
Kurtosis	7.12	1.71	2.51	2.58
Jarque-Bera	82.39	4.43	2.90	11.05
Probability	0.00	0.11	0.23	0.00
Sum	40.02	7229.28	6331.00	14.88
Sum Sq. Dev.	6.09	746.59	1802.75	0.18
Observations	64	64	64	64

Table 1c: Descriptive Statistics: NZ-US

	Y_NZ	Y_US	TB	REX
Mean	92.83	93.88	0.85	1.63
Median	93.70	98.93	0.85	1.55
Maximum	109.53	113.48	1.45	2.49
Minimum	71.52	66.36	0.35	1.18
Std. Dev.	9.85	14.29	0.25	0.33
Skewness	-0.47	-0.68	0.15	0.94
Kurtosis	2.19	2.09	2.34	3.41
Jarque-Bera	6.42	11.20	2.15	15.43
Probability	0.04	0.00	0.34	0.00
Sum	9282.62	9388.40	84.80	162.70
Sum Sq. Dev.	9609.97	20202.48	6.12	10.54
Observations	100	100	100	100

Table 1d: Descriptive Statistics: NZ-UK

	TB	Y_NZ	Y_UK	REX
Mean	1.27	92.83	103.72	2.74
Median	1.21	93.70	104.69	2.71
Maximum	2.50	109.53	115.38	3.69
Minimum	0.62	71.52	89.57	1.92
Std. Dev.	0.38	9.85	6.35	0.49
Skewness	0.71	-0.47	-0.21	0.06
Kurtosis	3.35	2.19	2.00	2.08
Jarque-Bera	8.92	6.42	4.90	3.60
Probability	0.01	0.04	0.09	0.17
Sum	126.95	9282.62	10371.52	274.32
Sum Sq Dev.	14.32	9609.97	3992.10	23.58
Observations	100	100	100	100

Table 1e: Descriptive Statistics: NZ-Japan

	REX	TB	Y_JPN	Y_NZ
Mean	0.01	1.84	101.53	92.83
Median	0.01	1.79	101.27	93.70
Maximum	0.02	2.91	118.48	109.53
Minimum	0.01	1.07	79.22	71.52
Std. Dev.	0.00	0.45	6.34	9.85
Skewness	0.59	0.29	-0.22	-0.47
Kurtosis	2.87	2.18	4.53	2.19
Jarque-Bera	5.78	4.19	10.60	6.42
Probability	0.06	0.12	0.00	0.04
Sum	1.48	183.84	10153.39	9282.62
Sum Sq. Dev.	0.00	19.82	3981.64	9609.97
Observations	100	100	100	100

Table 1f: Descriptive Statistics: NZ-Singapore

	Y_SGP	Y_NZ	TB	REX
Mean	59.44	92.83	0.68	1.12
Median	52.50	93.70	0.65	1.09
Maximum	107.67	109.53	1.45	1.54
Minimum	24.33	71.52	0.21	0.85
Std. Dev.	25.86	9.85	0.30	0.16
Skewness	0.49	-0.47	0.64	0.32
Kurtosis	1.97	2.19	2.73	2.22
Jarque-Bera	8.33	6.42	7.22	4.27
Probability	0.02	0.04	0.03	0.12
Sum	5944.33	9282.62	67.99	112.38
Sum Sq. Dev.	66186.46	9609.97	9.11	2.65
Observations	100	100	100	1.12

Table 1g: Descriptive Statistics: NZ-India

	TB	Y_IDA	REX	Y_NZ
Mean	1.47	61.48	2.83	92.83
Median	1.34	53.13	2.72	93.70
Maximum	3.92	113.52	3.68	109.53
Minimum	0.59	26.10	2.24	71.52
Std. Dev.	0.70	27.77	0.35	9.85
Skewness	1.16	0.46	0.58	-0.47
Kurtosis	4.14	1.83	2.45	2.19
Jarque-Bera	27.64	9.18	6.89	6.42
Probability	0.00	0.01	0.03	0.04
Sum	146.78	6148.22	283.16	9282.62
Sum Sq. Dev.	48.87	76361.12	12.33	9609.97
Observations	100	100	100	100

Table 2: Results from Johansen Cointegration Tests
Unsmoothed Data

Countries	Australia	China	India	Japan	Singapore	US	UK
Eviews option	2	3	3	3	3	3	3
Lag	4	5	3	6	3	3	1
Trace test	1	1	1	1	1	1	1
Max e value	1	1	1	1	1	1	1
C	3.17	-	-	-	-	-	-
	(9.91)						
Ln(REX)	3.59	-1.79	0.12	0.23	1.62	1.25	0.60
	(4.21)	(0.30)	(0.45)	(0.14)	(0.32)	(2.03)	(0.19)
Ln(Y_TP)	2.29	-23.09	2.06	-0.22	-0.080	28.20	-1.25
	(3.71)	(2.20)	(0.22)	(0.32)	(0.172)	(6.61)	(0.59)
Ln(Y_NZ)	-2.76	-2.07	-9.31	-2.33	-2.73	-46.98	1.53
	(5.21)	(1.56)	(1.00)	(0.53)	(0.76)	(10.72)	(0.31)

Table 2a shows the results after the trend of the series was found. The results suggest that there were cointegrating relationships with all the countries except China. The trend for China's national income could not be calculated over the short period data was available Using trend data, no cointegrating relationship between New Zealand's trade balance and real exchange rate with China was found. The long-run ln(REX) variable in Table 2a is significant at a five percent level only for Singapore and the United Kingdom, although both these variables are positive in accordance with theoretical expectations.

Before estimating the short-run trade balance models, Granger causality tests have been used to identify if the bilateral exchange rate helps in the prediction of the trade balance. Table 3 presents the null hypothesis, corresponding F-statistics and the *p*-value for the Granger causality tests. The Granger causality results are disappointing as they indicate that REX does not help explain variations in New Zealand's trade balance. However, for Australia and Singapore the hypothesis that the trade balance does not Granger-cause the real exchange rate can be rejected.

Table 2a: Results from Johansen Cointegration Tests
Trend all Four Variables

Countries	Australia	China	India	Japan	Singapore	US	UK
Eviews option	2	None	3	3	3	3	3
Lag	2		1	3	3	2	3
Trace test	1		1	2	1	2	1
Max e'value	1		1	1	1	1	1
C	12.94 (12.51)	-		-		-	
Ln(REX)	-2.82 (5.28)		0.37 (0.43)	0.14 (0.11)	1.84 (0.44)	-0.20 (0.42)	0.41 (0.18)
Ln(Y_TP)	2.32 (4.50)	No trend var possible	1.83 (0.23)	-1.28 (0.40)	0.34 (0.22)	8.72 (1.35)	-0.13 (0.54)
Ln(Y_NZ)	-5.48 (6.38)		-7.96 (1.03)	-1.04 (0.23)	-5.03 (1.00)	-14.33 (2.20)	0.98 (0.28)

Table 3: Pairwise Granger Causality Tests
using Lags as per Cointegration, including Trended Data

	Without Trend			With Trend		
Null hypothesis:	Obs	F-statistic	P-value	Lags	F-statistic	P-value
NZ-Australia, lags 2				2		
REX does not GC TB	96	1.01379	0.4048	98	3.89883	**(0.0237)**
TB does not GC REX	96	3.28427	**(0.0148)**	98	6.56392	**(0.0022)**
NZ-China, lags 5				NA		
REX does not GC TB	59	2.20687	0.0689		NA	NA
TB does not GC REX	59	0.33043	0.8921		NA	NA
NZ-India, lags 3						
Null hypothesis:	Obs			1		
REX does not GC TB	97	0.34566	0.7924	98	0.53279	0.4672
TB does not GC REX	97	0.43394	0.7292	98	2.03229	0.1573
NZ-Japan, lags 3	Obs			3		
REX does not GC TB	97	1.88996	0.1369	96	4.15980	0.0083
TB does not GC REX	97	1.20387	0.3130	96	2.21249	0.0922
NZ-Singapore, lags 3				3		
REX does not GC TB	97	2.06695	0.1102	96	1.99050	0.1211
TB does not GC REX	97	4.32922	**(0.0067)**	**96**	5.80586	0.0011
NZ-US, lags 3				2		
REX does not GC TB	97	0.15446	0.9266	97	9.11833	**(0.0002)**
TB does not GC REX	97	1.38073	0.2538	97	4.45590	**(0.0142)**
NZ-UK, lags 3				3		
REX does not GC TB	99	0.00153	0.9689	96	1.53472	0.2110
TB does not GC REX	99	0.01569	0.9006	96	1.72095	0.1684

Note

The number inside the parenthesis shows GC which are significant.

The Granger causality results in Table 3 for the trends in the data show that the null hypothesis that the real exchange rate Granger causes New Zealand's trade balance with Australia, Japan, and the United States is now supported, but not with India, Singapore or the United Kingdom. There has therefore been some improvement in the results from using the trend data, particularly in terms of Granger causality, but they are still disappointing.

We switch, nevertheless, to a short-run model (Table 4) using an error-correction equation to evaluate the short-run effects of the J-curve. From the results in Table 4, which are initially not adjusted for trends, show that coefficients on the ECM term in all the cases have a negative sign, although for India and the UK the coefficient is not significant. This means that the ECM term have corrected the system disequilibrium by at least 14 percent per quarter in the case of China. The J-curve hypothesis is negative on the short run coefficients for $\Delta lnREX$ followed by positive ones for lnREX in the long -term. This is observed for Australia, India, Singapore, US and UK. However, there are no cases where the REX statistics are statistically significant in both the short and long run (Bahmain-Oskooee and Zhang 2013).

Table 4: Short Run Estimated Coefficients before Trend

Variable	Australia	China	India	Japan	Singapore	US	UK
Δln(TB)(-1)	-0.46 (0.11)		-0.47 (0.11)	-0.29 (0.09)	-0.24 (0.09)	-0.73 (0.08)	-0.67 (0.08)
Δln(REX)(-1)	-0.46 (0.10)		0.97 (0.62)	--	-1.13 (0.69)	-	-0.29 (0.39)
Δln(TP y)(-1)	-		2.58 (0.59)	0.85 (0.35)	-	-	-
Δln(NZ y)(-1)	-			-	-	-	-
Δln(TB)(-2)	-0.27 (0.10)	-0.23 (0.10)		-	-	-0.85 (0.07)	-0.72 (0)
Δln(REX)(-2)	-0.84 (0.42)			-	-	-	-
Δln(TP y)(-2)	-		-0.43 (0.10)	1.10 (0.35)	-	-	-
Δln(NZ y)(-2)	-			-	-	-	-1.94 (0.79)
Δln(TB)(-3)	-		-0.21 (0.10)	-	-	-0.60 (0.08)	-0.67 (0.07)
Δln(REX)(-3)	-	-1.22 (0.44)		0.65 (0.23)	-	-0.74 (0.45)	-
Δln(TP y)(-3)	-	-2.84 (1.15)		1.61 (0.34)	-	-	-1.95 (0.54)
Δln(NZ y)(-3)	-			-	-	-_	-
Δln(TB)(-4)		0.60 (0.10)					
Δln(REX)(-5)		-0.81 (0.38)					
Δln(TP y)(-6)				1.49 (0.33)	-	-	-
ECM (-1)	-0.17 (0.07)	-0.14 (0.05)	-0.05 (0.08)	-0.30 (0.07)	-0.46 (0.10)	-0.03 (0.01)	-0.09 (0.06)
Constant	0.007 (0.011)	-0.003(0.023)	0.049 (0.029)	0.003 (0.013)	-0.007 (0.028)	0.002 (0.02)	0.009 (0.016)
Adj R2	0.31			0.45	0.33	0.65	0.82
DW	2.16			2.10	2.01	2.09	1.75

Standard errors in brackets.

Examining the short run results for the trend data, the error correction terms in Table 4a are negative except for the zero coefficient for the United States, but only for the United Kingdom is this coefficient significant at a five percent level. The first quarter lnREX coefficient is negative and significant for Japan, but this is the only such case. This raises the question of whether better results would occur using panel data.

Table 4a: Short-Run Estimated Coefficients with Trended Data

Variable	Australia	China	India	Japan	Singapore	US	UK
$\Delta\ln(TB)(-1)$	0,80 (0.09)	Not calculated	0.50 (0.10)	0.86 (0.08)	1.36 (0.10)	0.71 (0.10)	1.45 (0.07)
$\Delta\ln(REX)(-1)$	-0.18 (0.19)		0.63 (0.45)	-0.27 (0.13)		1.53 (0.36)	-0.00 (0.07)
$\Delta\ln(TP\ y)(-1)$				0.85 (0.20)			-0.67 (0.23)
$\Delta\ln(NZ\ y)(-1)$			2.31 (0.99)	-1.16 (0.32)			
$\Delta\ln(TB)(-2)$	-0.50 (0.09)			-0.50 (0.09)	-0.98 (0.13)	-0.68 (0.09)	-1.25 (0.09)
$\Delta\ln(REX)(-2)$				0.47 (0.15)	-0.01 (0.17)	-2.26 (0.52)	
$\Delta\ln(TP\ y)(-2)$					-0.49 (0.16)		
$\Delta\ln(NZ\ y)(-2)$							
$\Delta\ln(TB)(-3)$					0.26 (0.09)	0.24 (0.10)	0.62 (0.07)
$\Delta\ln(REX)(-3)$						1.30 (0.40)	
$\Delta\ln(TP\ y)(-3)$							
$\Delta\ln(NZ\ y)(-3)$							
$\Delta\ln(TB)(-4)$							
$\Delta\ln(REX)(-5)$							
$\Delta\ln(TP\ y)(-6)$							
ECM (-1)	-0.05 (0.03)		-0.05 (0.04)	-0.06 (0.03)	-0.03 (0.18)	0.00 (1.00)	-0.08 (0.02)
Constant	0.003 (0.003)		0.009 (0.013)	0.004 (003)	0.005 (0.005)	0.00 (0.01)	0.00 (0.00)
Adj R2	0.50		0.20	0.65	0.83	0.55	
DW	1.81		1.61	1.81	1.88	1.77	

Standard errors in brackets.

Panel Results

Panel unit root tests showed that ln_REX was I(1). LnTB was sometimes I(0) using the Schwarz test, but I(1) using the modified Hannan-Quinn. The natural log of partner income was sometimes I(0) using the Schwarz test, but usually not using modified Hannan-Quinn. Ln_income was I(1) using modified Hannan-Quinn. Using trend data lnRex was I(1) and so was lnTB, and ln partner income and ln NZ income. Table 5 shows some evidence of cointegration for the original data but when trend data are taken, only the Kao Test shows evidence of cointegration.

Table 5: Panel Cointegration Results

	Initial Data		Trend Data	
Pedroni	Schwarz IC	Modified HQ	Schwarz IC	Modified HQ
Individual intercept	6/11	6/11	0/11	0/11
Individual intercept and trend	5/11	5/11	0/11	0/11
Kao	1/1	1/1	1/1	1/1

Since there is some evidence of cointegration, a long-run cointegrating-equation has been estimated. The results presented in column 1 of Table 6 using the unadjusted data are encouraging since they show a positive and statistically significant coefficient for real exchange rate, a negative and statistically significant error correction term, and negative, but not statistically significant short-run coefficients for the real exchange rate. We re-estimate the model using seasonal dummies and report the results in column 2 of Table 6. Even with dummy variables added for quarterly variations in exports, however, the negative short run coefficient was not statistically significant.

We then estimated the long-run cointegration regression using the trended data (we however omit China because a trend variable could not be calculated for the China income data). The results are reported in column 3 of Table 6. For the trend data, the coefficients tend to be smaller. The sign of the short-run coefficients for the real exchange rate varies, and they are again not significant.

Table 6: PMG/ARDL Results

	(1) Unadjusted Data	(2) Unadjusted Data with Seasonal Dummies	(3) Trend Data and Omitting China
Dependent	$\Delta\ln(TB)$	$\Delta\ln(TB)$	$\Delta\ln(TB)$
Long Run			
Ln_NZ_Y	0.59 (0.44)	0.16 (0.45)	0.85 (0.23)
Ln_TP_Y	0.38 (0.28)	0.60 (0.29)	0.26 (0.25)
Ln_Rex	0.67 (0.23)	0.41 (0.20)	0.33 (0.12)
Short Run			
ECM	-0.16 (0.05)	-0.15 (0.03)	-0.06 (0.01)
$\Delta\ln(TB)(-1)$	-0.51 (0.02)	-0.44 (0.06)	0.98 (0.13)
$\Delta\ln(TB)(-2)$	-0.47 (0.09)	-0.32 (0.06)	-0.75 (0.11)
$\Delta\ln(TB)(-3)$	-0.34 (0.08)	-0.20 (0.05)	0.26 (0.07)
$\Delta\ln(REX)$	-0.12 (0.21)	-	-0.21 (0.21)
$\Delta\ln(REX)(-1)$	-0.14 (0.18)	-0.04 (0.18)	0.68 (0.59)
$\Delta\ln(REX)(-2)$	-0.08 (0.27)	-	-0.83 (0.70)
$\Delta\ln(REX)(-3)$	0.31 (0.29)	-	0.60 (0.28)
$\Delta\ln(TP\ y)$	-0.24 (0.46)	-0.45 (0.40)	0.13 (0.96)
$\Delta\ln(TP\ y)(-1)$	0.66 (0.48)	-	-0.11 (2.16)
$\Delta\ln(TP\ y)(-2)$	0.10 (0.48)	-	0.09 (1.99)
$\Delta\ln(TP\ y)(-3)$	0.42 (0.74)	-	-0.23 (0.76)
$\Delta\ln(NZ\ y)$	-0.86 (0.63)	-0.45 (0.40)	-0.85 (0.86)
$\Delta\ln(NZ\ y)(-1)$	-0.62 (0.74)	-	0.45 (0.98)
$\Delta\ln(NZ\ y)(-2)$	-0.48 (0.47)	-	-0.32 (0.56)
$\Delta\ln(NZ\ y)(-3)$	-0.98 (0.34)	-	0.06 (0.28)
Quarter3	-	-0.21 (0.06)	-
Quarter4	-	-0.10 (0.05)	-
Maximum lags	4	4	4

PMG results have also been calculated using Stata, which offers greater flexibility in equation specification. Westerlund's (2007) cointegration tests showed the data was cointegrated, although this was not the case using the trend data. However, the pooled results using trend data were encouraging, with a positive and significant long-run coefficient for the real exchange rate, followed by a negative and significant one lag variable for changes in the real exchange rate, and a significant and negative error correction term. The results for two different specifications are shown in Table 7 and indicate that pooling the data reveals J-curve effects that are not statistically significant using national data. The results are strongest in model one.

Table 7: PMG Results using Stata

	(1) Two-Year Lag Differenced No Lag	(2) Two-Year Lag Not Differenced No Lag
Dependent	$\Delta\ln(TB)$	$\Delta\ln(TB)$
Long Run		
Ln_NZ_Y	1.31 (0.45)	1.11 (0.44)
Ln_TP_Y	0.14 (0.28)	0.40 (0.31)
Ln_Rex	0.91 (0.27)	0.81 (0.25)
Short Run		
ECM	-0.58 (0.02)	-0.06 (0.21)
$\Delta\ln(TB)(-1)$	0.21 (0.33)	0.18 (0.05)
$\Delta\ln(TB)(-2)$	-0.12 (0.09)	0.11 (0.08)
$\Delta\ln(REX)$	0.15 (0.17)	-
$\Delta\ln(REX)(-1)$	-0.73 (0.31)	-0.41 (0.22)
$\Delta\ln(REX)(-2)$	0.68 (0.21)	0.57 (0.18)
$\Delta\ln(TP\ y)$	-0.71 (0.80)	-
$\Delta\ln(TP\ y)(-1)$	2.43 (0.70)	1.45 (0.60)
$\Delta\ln(TP\ y)(-2)$	-1.00 (0.49)	-0.75 (0.47)
$\Delta\ln(NZ\ y)$	-0.61 (0.79)	-
$\Delta\ln(NZ\ y)(-1)$	0.25 (1.03)	-0.81 (0.81)
$\Delta\ln(NZ\ y)(-2)$	-0.83 (0.65)	-0.47 (0.78)
Constant	-0.41 (0.15)	-0.42 (0.16)

The mixed and inconclusive results from the literature review and by our data analysis suggest that further analysis is required especially at a disaggregated level.

(1)   Some industries benefit more from a devaluation than others. A country then needs to analyse the impact of each industry and then combine the impact for an overall result of devaluation. If the overall impact is positive and significant only then the country may take measures for devaluation, else it will deteriorate and may occur as a final blow to some companies or industries.

(2)   The benefit of devaluation can only be enjoyed by an industry or a country if it keeps the competitive and dynamic comparative advantage over the long run, that is, continuous improvement in processes, efficiencies and technology in order to keep a steady flow of goods. If the competitive advantage is lost then the trade will be lost to another country and hence negative impact of devaluation instead of positive. An example in the telecommunication industry is Nokia who lost its share to other countries.

(3)   This also supports the case of Innovation hubs and industrial clusters in order to keep the competitive and dynamic comparative advantage and benefit from currency devaluations. One such example is Foxconn city in Taiwan where manufacturing of the X-Box and Playstation (along with many other electronic products) takes place. Both products compete with each other and belong to different countries but the manufacturing efficiencies that are available at Foxconn cannot be matched anywhere else. Hence a sustained competitive advantage.

(4)   The mixed results of J-curve analysis also indicate that the dynamics of trade are changing. A lag that could be explained due to price contracts (Magee 1973) may not exist today especially for advanced economies for reasons such as:

(a) Dynamic and fast reacting commodity and currency hedging instruments that are utilised by multinational companies (MNC) hence acting against the measures of artificial currency adjustments. Hedging overlaps the actual commodity transaction and while the commodity transaction takes place under new currency rates, the gains or losses due hedging the commodity prices are absorbed by the financial markets.

(b) Shifting and sourcing of stock between the geographic locations of big MNCs

(5)   Recording and maintaining data for service industries remains an unsolved issue on a global level however the importance is ever increasing and not only due to increase in import and export of services but also because of its increasing linkage with the commodities. Example of this is machinery that used to be traded when a newer and efficient machine came out in industry however in many cases these days the machinery stays the same and it is the software that gets updated which unlocks new features in the machine or improves its performance. This phenomenon, which is easily understood from the operating system upgrades to mobiles and computers, is happening in the industry replacing some physical trade with intangible trade.

5. Summary and Conclusions

This study has investigated the existence of J-curve patterns between New Zealand and selected trading partners (including Australia, USA, Japan, China, India and Singapore). The results show some evidence of J-curve effects in the case of New Zealand and China and New Zealand and Japan. There is no evidence to support J-curve effects between New Zealand and the other trading partners. Diagnostic tests, however, suggest that there are some omitted variables implying that the bilateral exchange rate is not a key determinant in explaining variations in New Zealand's trade balance with trading partners.

Further research could consider disaggregating data by industry or by firm for each country pair. This country-specific and industry-specific disaggregated data may provide further insights on whether the impact of currency depreciation on trade balances is significant. In addition, this disaggregated analysis may also provide evidence of the impact of the changing business environment from software developments, commodity and currency hedging, time lags and geographic sourcing changes by firms.

Appendix
Data Sources

Quarterly data between 1990:1 and 2014:4 are used in the estimations. In the case of China, quarterly data covers the periods between 1999:1 and 2014:4 due to data availability. Data obtained from the following sources:

a. IMF *International Financial Statistics,* 2016.
b. OECD, 2016.
c. Statistics New Zealand, 2016.

REX Real bilateral exchange rate between New Zealand dollar and each trading partner's currency. It is calculated as (NZD/USD)/(Trading partner's Currency/USD) times partner country prices/domestic country prices. Therefore, an increase in REX is the depreciation of the New Zealand dollar. All data come from source a. (International Financial Statistics of IMF, 2016).

Y New Zealand's and its trading partners' industrial production index.

Y_NZ For New Zealand and *Y_TP* for its trading partners, for example, *Y_AUS* is the industrial production index of Australia. All data from source *b*.

TB New Zealand's trade balance with its selected trading partners. It is defined as the ratio of New Zealand's exports to its partners' imports. All data are from sources, a, b and c.

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