APEC and Trade Liberalization

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Abstract: *The paper aims to see the effect of Nominal, Real (External) and Effective Exchange rates (EER) of the U.S dollar on its Terms of Trade with two of its APEC trading partners Australia and New Zealand for the period 1991 to 2010. For analysis, the whole values, percentage changes and relationships between Nominal, Real, EER and Terms of Trade of U.S with the two countries has been taken into consideration. In order to fully access the relationship between the EER and TOT of the U.S with the two trading partners, the Classical Regression analysis is used. It was found that the Real Exchange rate was overvalued as compared to the Nominal Exchange Rate. It was also found that when compared to Nominal exchange rate, Real exchange rate is more effective in explaining the TOT. The Real AUD/USD had both short run and long run impacts on the TOT of U.S.A with Australia but the Real NZD/USD had no impact on the TOT of U.S.A with New Zealand. The EER has been found to be the most effective in determining the TOT balance. The regression analysis showed a regression function of "Terms of Trade= -122.026 + 2.1 Effective Exchange Rate". The relationship is found by coefficient correlation (r) and there is found to be a positive and strong relationship between the two variables. The r^2 value shows that although some values of the TOT are caused by the EER, there are also other variables that might be influencing the EER as well. The t-values show that the values of β0 and β1 are significant. Also the F-test confirms the overall significance of the model and terms the results as authentic.*

I.   Introduction

The APEC (Asian-Pacific Economic Cooperation) was founded initially because of the increasing interdependence of the Asia-Pacific countries and due to the dawn of several trade blocs at that time, particularly the G8. Ever since the Asian-Pacific Economic Cooperation (APEC) was established in 1989, it has succeeded in reducing major trade barriers across the Asia-Pacific region to enhance trade in the area (Baak, 2005). Not only that, the APEC forum has increased to 21 Pacific Rim countries that include many strong emerging economies such as; Canada, Indonesia, Malaysia, China, Japan, Russia, Mexico, U.S, Australia and New Zealand etc (Elek, 1991). Out of these countries, the most interesting trade pattern is the one between the United States, Australia and New Zealand.

These three countries have always had strong ties since 1951, when they signed the ANZUS treaty which specifies the three countries will cooperate on defense matters in the Pacific Ocean (King, 2003). Not only have these countries have had military alliance, the U.S has collaborated with Australia on precise issues such as investment, environment issues, labor, agriculture and intellectual property rights and has worked together with New Zealand on economic, education, labor and scientific issues (US government, 2011 and New Zealand government, 2007). Similarly, U.S's trade ties with Australia and New Zealand have resulted in mutually beneficial trade ever since the APEC free trade area was established in 1989. Recently in 2011, New Zealand became the U.S's 47th largest export market and the 59th largest imports provider. In Contrast, the US trade ties with Australia have been stronger, as Australia became the United State's 14th biggest export market and the 33rd largest supplier in 2011 (U.S government, 2011).

Being a part of APEC, these countries have promoted free trade through reducing tariffs and other trade barriers. However, when ever free trade is concerned, the effects of exchange rate changes on trade patterns should be paid attention to (Baak, 2005). There are three main exchange rates to be considered which are Nominal, Real (External) and Effective Exchange rates. While, the Nominal exchange rate is the rate that is determined by the demand and supply curves of a currency, the Real exchange rate is the measurement of the purchasing power of one currency relative to another currency. On the other hand, the Effective Exchange Rate can be defined as the weighted average of a particular basket of foreign currencies (Aftrai, 2004).

When interpreting different trends behind the pattern of trade, Real and Effective exchange rates are much more useful than the nominal exchange rates. The External Real exchange rate is based on the Purchasing Power Theory (PPP) that compares two countries through their relative prices of their basket of goods produced or consumed ((Hinkle and Nsengiyumva, 1999). When this rate is calculated using GDP deflator as base, it helps in comparing changes in productivity, however when the impact of capital inflows and the international competitiveness of the home country is measured, then using a CPI based index is more appropriate (Aftari, 2004). Since, the Real rate is Nominal rate divided by the ratio of foreign CPI over the local CPI; Real rate depreciation indicates that foreign inflation has lead to a rise in imports prices and as a result the foreign trade balance will suffer a deficit. However this is anticipated to take place only in the short run. In the long run, the

local country's cheap exports can increase exports volume and improve its terms of trade (Kipici and Kesriyeli, 1997).

Usually, the real exchange rate is bilateral and helps compare two countries but when analyzing trade of a country with two countries is concerned, an Effective Exchange rate helps in the analysis. It is not only multilateral but defines the overall competitiveness of a country's nominal currency against a selected number of trading partner's currencies. The weighted average used to calculate the currency helps determine the importance of the currency in international trade. Keeping this is mind; the Effective Exchange Rate helps understand the foreign trade balances of a local country through its nominal exchange rate's competitiveness against its trading partners (Chinn, 2006 and Business Dictionary, 2012). Looking at the formula, it can be interpreted that when the currency of a trading partner that has most share in trade with the country appreciates, the Effective Rate appreciates. This means that the local currency has depreciated against its major trading partner's currency, giving the country a competitive edge. Thus, with its imports falling due to them being expensive and its exports rising due to them being cheaper, it can be safe to say that as Effective Exchange rate appreciates the terms of trade against those partner countries improves along with it.

Keeping all this in mind; for understanding trade between the U.S, Australia and New Zealand, it is important to consider the exchange rate's impact on their trade. Since, the U.S is a more powerful and influential country than the other two and has the most monitored trade market in the world (CIA, 2005), U.S' trade and exchange rate with the two countries has been considered in this report. Thus, to understand trade between the three countries; the Nominal, Real (External) and Effective exchange rate of the U.S dollar against the Australian and New Zealand dollar is used to interpret the trade conditions of the U.S with its APEC partners Australia and New Zealand. Also, regression analysis is used to determine and examine the relationship between a US' Effective Exchange Rate and its Term of Trade against Australia and New Zealand. The layout of the report is as follows: section II contains the Review of Literature. Section III contains the Methodology used. Section IV has relevant Data. Section V contains the Discussion on the findings with respect with the relations between Nominal and Real Exchange rates; Real Exchange rate impacts on Terms of Trade and the Relationship between Effective Exchange rate and the Terms of Trade using the Regression analysis. Section VI contains the Conclusion.

II. Literature Review

Exchange rate impacts on trade across countries have always been the centre of attention for many researchers. Although focus has been made on using Effective Exchange rates to determine the competitiveness, trade and economic conditions in the country; mostly, the focus has been on the Real Effective Exchange rate to understand the price influences as well. Several researchers have sought to compare bilateral trade by using Real exchange rates to see the effects of prices differentials on trade and other economic variables.

Richter and Svavarsson (2006) explored the Effective Exchange Rate calculations, where weights used in calculations and other currencies were examined. The trade and Effective Exchange rate determination of Iceland was focused on and compared with British and U.S' determination of Exchange rates. It was recommended that broader indexes were needed for calculation of Effective Exchange rates. Similarly, methodological issues when calculating real exchange rates were also examined by **Aftari (2004)**, who focused the research on Ghana. It was found that Ghana was more competitive when GDP deflator index was used as compared to the CPI index. It was also found that the nominal exchange rate in Ghana was mostly influenced by changes in imports.

In exploring this relationship, a different approach was taken by **Hyder and Mahboob (2005)**, where they examined the different determinants of Pakistan's Equilibrium Real Effective Exchange Rate from 1978 to 2005. They found them to be trade openness, capital inflows, worker's remittances, productivity differentials and government consumption. However this approach is different from looking at the effects of Effective Exchange Rate on Trade but it does help determine the relationship between trade and the Effective Exchange rate.

On the other hand, **Rose (1991)** analyzed the effect of the Real Effective Exchange rate on the aggregate real trade balances for five OECD countries. The results of this research showed no significant impacts of the exchange rate on the real trade balances. **Marsh and Tokarich (1996)** reached similar conclusions and concluded that to understand trade flows with the help of one variable such as real exchange rate is suboptimal.

Similarly, **Cheung et al (2010)** worked to see the effect of Real Exchange rate on the U.S-China trade balance. They found that Terms of trade of U.S-China do respond to the changes in the real exchange rate of Chinese Renminbi. They concluded that whether multinational or bilateral trade flows are concerned changes in real exchange rates do lead to major effects on the terms of trade.

The trade and real exchange rate relationship has also been analyzed through a regression analysis. **Chinn (2006)** examined the Effective and Real Effective Exchange Rate in U.S, euro region and East Asian

countries. When they analyzed the relationship between exports and real exchange rates, they found exports to be sensitive to real exchange rate of the U.S. **Hooper and Richardson (1998)** also found a significant relationship between exports and real exchange rate of U.S but they reported an export sensitivity lower than that found by Chinn (2006).

Similarly, a lot of studies have worked on finding a relationship between exchange rates and exports of a country. Both **De Grauwe (1988) and Secru and Uppal (2000)** have shown an ambiguous relationship between the two variables. On the other hand, **Baccheta and Wincoop (2000)** found there to be no existence of a relationship. The empirical research **of Chowdhurry (1993), Kim and Lee (1996), Baak et al. (2003), Peree and Steinherr (1989)** and **Arize, Osang and Slottje (2000)** report a negative relationship. These results reflect that the impact of exchange rate volatility varies across regions and periods.

With respect to the U.S, **Rose and Yellen (1989)** and **Bahmani-Oskooee and Brooks (1999)** analyzed bilateral disaggregated U.S trade data and compared it with exchange rate, with respect to six major trading partners using the ARDL approach and both studies did not find any evidence of a J-curve effect. Researches have reported mixed results on the effects of exchange rate changes on the trade flows of the U.S. On the other hand, **Marwah and Klein (1996)** found evidence for an S-curve. Using OLS regression for the period 1977 to 1992, they found that trade balance initially declines after depreciation of currency, and then later experiences trade balance improvement (the typical J-curve effect).However, after a time period (long run), there is a tendency for the trade balance to deteriorate. As a result the S-curve shape exists.

Finally, in terms of APEC Countries, not much work has been done on exploring the Exchange rate volatility effect on Trade balances but studies like **Baak (2005)** there to be a positive effect on exports of a member country of APEC due to a depreciation of the country's currency. He also concluded there to be a positive impact of membership to APEC and adverse effects on trade when there are distances between the countries.

Keeping all of this in mind, this study focuses on exploring the effects of Real and Effective exchange rates of the U.S dollar on the Trade of the U.S against its two APEC trading partners Australia and New Zealand. As per econometric analysis is concerned "Method of Least Ordinary Squares", classic regression is used to explore the relationship between the Effective Exchange Rate and Trade Balances of the U.S from a period ranging from 1991 to 2010.

III.   Methodology

Real Exchange rates are calculated from Nominal Exchange Rates and CPI's of U.S, Australia and New Zealand.

Nominal Exchange Rate of Australian Dollar per U.S dollar = **Sa**

Formula applied is:

   Real Sa = Sa/ (CPI AUS / CPI US)

Nominal Exchange Rate of New Zealand Dollar per U.S dollar = **Snz**

Formula applied is:

   Real Snz = Snz / (CPI NZ / CPI US)

Effective Exchange Rates are calculated from Relative exchange rates (that were manually calculated from nominal rates and base year rate).

Formula applied is:

Firstly, Bilateral Weights were calculated:

W_{aus}^{b} **(Bilateral Weight of U.S trade with Australia):**

U.S total trade with Australia was divided with the sum of the total trade with both Australia and New Zealand.

W aus = (X aus + M aus) / [(X aus + M aus) + (X nz + M nz)]

W_{nz}^{b} **(Bilateral Weight of U.S trade with Australia):**

U.S total trade with New Zealand was divided with the sum of the total trade with both Australia and New Zealand.

W nz = (X nz + M nz) / [(X aus + M aus) + (X nz + M nz)]

X= Exports   M= Imports

Then Relative Exchange Rate was calculated:

The Nominal exchange rate of Australia and New Zealand each year is divided by the Base Year's exchange rate value of that currency. The base year taken here is of 1991.

EER formula:

EER t = [(Weight aus) (Relative Exchange Rate AUD/USD) + (Weight nz) (Relative Exchange Rate NZD/USD)] x 100

The Effective Exchange Rate of the U.S dollar has been calculated from Relative Exchange rates of Australia and New Zealand and the total trade of U.S with Australia and New Zealand.

Formulas taken from Daniels and VanHoose (2002)

Base Year Choice:

The base year chosen should be normal that is it should be a stable year in terms of trade, production and their prices. Its data prices data should be reliable. Also, the base year should be as recent as possible so that by the time revised series of items and their prices are released, it should not have outlived its utility (Eaindustry, 2006). The Base Year selected is 1991 for its stable prices and for its recent reliable data. For this reason, 1991 has been selected as a base year for further analysis of the data of Nominal, Real and Effective Exchange rates (Georges, 2000; Eaindustry, 2006 and Daniels and VanHoose, 2002).

IV. Economic Analysis:

Referring from past researches and the theory present, The Classical Linear Regression Model has been formed. The model consists of two parameters. The model constructed is:

Terms of Trade= β0 + β1 Effective Exchange Rate + ui

(with the help from Gujarati and Sangeetha, 2007)

Here in a regression model equation of; Y= β0 + β1 X + ui. Y is the Terms of Trade of U.S with Australia and New Zealand, which is a dependent or endogenous variable. X is the Effective Exchange Rate of U.S dollar that is the independent or exogenous variable.

β0 is the intercept which is present in theory and Literature Review, which shows that even at zero Effective Exchange Rate some value of Terms of Trade exists in the U.S.

β1 is the slope of the regression model and shows the elasticity of the slope.

β1 is to be calculated by the formula:

$$\hat{\beta}1 = \frac{\sum XY - n\bar{X}\bar{Y}}{\sum X^2 - n\bar{X}^2}$$

β0 is to be calculated by the formula:

$$\hat{\beta}0 = \bar{Y} - \hat{\beta}1\bar{X}$$

Method of Ordinary Least Squares (OLS) is used to estimate the parameters of the two-variable regression model. The t-test and F-test have been used to interpret the results.

The Alternative hypothesis (H1) is that there is a relationship between Terms of Trade and Effective Exchange Rate, while the Null hypothesis (H0) states that no relationship exists. If 't' calculated is more than 't' tabulated, then Alternative Hypnosis will be accepted. However if 't' calculated is less than 't' tabulated, then the Null Hypothesis will be accepted.

T-test helps in interpreting the authenticity of the results of the parameters calculated and F-test portrays the overall significance of the results. The more the probability or p-value is away from 0.1, the more significant are the results.

T-test

β̂0

$$t = \frac{\hat{\beta}0 - \beta0}{SE\ (\beta0)}$$

β̂1

$$t = \frac{\hat{\beta}1 - \beta1}{SE\ (\beta1)}$$

F-test

$$\mathbf{F} = \frac{\hat{\beta}1^2 \sum xi^2}{\hat{\delta}^2}$$

The value of r- correlation coefficient and r^2 value has been calculated to understand the relationship between Trade balances of U.S with Australia and New Zealand and the Effective Exchange Rate of U.S dollar.

The r value, that is the correlation value found through the Pearson r correlation:

$$r = \frac{\sum xi\ yi}{\sqrt{(\sum xi^2)\ (\sum yi^2)}}$$

The correlation value if positive shows that variables move in the same direction and if negative means that they more in the opposite direction. The closer the value comes towards 1, the stronger the relationship and the closer it is to 0 the weaker the relationship is.

The r^2 value has been calculated though the formula:

$$r^2 = \hat{\beta}1^2\ \frac{\sum x^2}{\sum y^2}$$

R^2 is used in analyzing the goodness of fit of the regression line, that how effective is the regression line in defining the data. The closer the value is to 1, the better the regression line fits the data while the further away the value is 0 the less the regression line defines the data (Gujarati and Sangeetha, 2007).

Data
Nominal, Real and Effective Exchange rates:
The Data has been taken in relation to the U.S dollar and trade from 1991 to 2010. The Nominal and Real Exchange rates have been manually calculated and are bilateral. While the Effective Exchange Rate (also manually calculated), is multilateral and uses the data of U.S' trade with Australia and New Zealand.

Table 1:
Nominal and Real Australian and New Zealand Dollars Rate per U.S.A Dollars, and U.S Effective Exchange Rate with Australia and New Zealand.

Year	Nominal Exchange Rate		Real Exchange Rate		Effective Exchange Rate
	AUD/USD	NZD/USD	AUD/USD	NZD/USD	Of the US Dollar
1991	0.78	1.73	0.99	3.11	100
1992	0.74	1.86	0.97	3.41	96.99
1993	0.68	1.85	0.90	3.45	90.64
1994	0.73	1.69	0.97	3.18	94.34
1995	0.74	1.52	0.97	2.84	93.60
1996	0.78	1.45	1.02	2.72	97.30
1997	0.74	1.51	0.99	2.87	93.54
1998	0.63	1.87	0.85	3.56	85.40
1999	0.65	1.89	0.88	3.67	87.91
2000	0.58	2.20	0.78	4.28	83.67
2001	0.52	2.38	0.69	4.65	80.74
2002	0.54	2.16	0.70	4.18	78.86
2003	0.65	1.72	0.84	3.35	86.21
2004	0.74	1.51	0.96	2.94	93.43
2005	0.76	1.42	0.99	2.77	94.36
2006	0.75	1.54	0.98	3.01	94.82
2007	0.84	1.36	1.10	2.66	102.65
2008	0.85	1.42	1.11	2.78	104.99
2009	0.79	1.60	1.01	3.06	99.99
2010	0.92	1.39	1.20	2.71	112.11
Avg	**0.72**	**1.70**	**0.95**	**3.26**	**93.58**

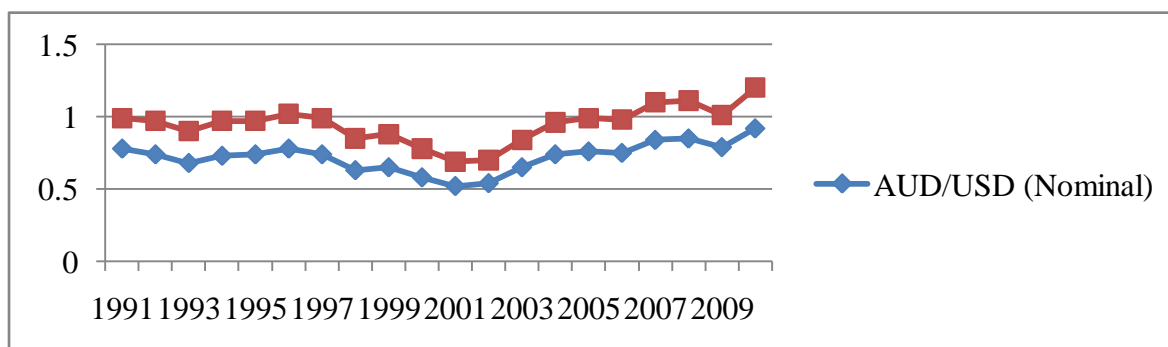**(Own Contribution)**

Source: **Nominal Exchange Rates: U.S Federal Reserve (2012).**
**The data has been taken up to 2 decimal places.**

Real and Effective Exchange Rates have been manually calculated.
The CPI values used to calculate Real Exchange rate are given on page 17. Trade values used to calculate Real and Effective Exchange Rate are given in Appendix A. The calculated Bilateral trade weights and Relative Exchange rates are also present in Appendix A.
Graph1:
The Australian Dollar per U.S Dollar: Nominal v.s Real exchange rates

The New Zealand Dollar per U.S Dollar: Nominal v.s Real Exchange rates
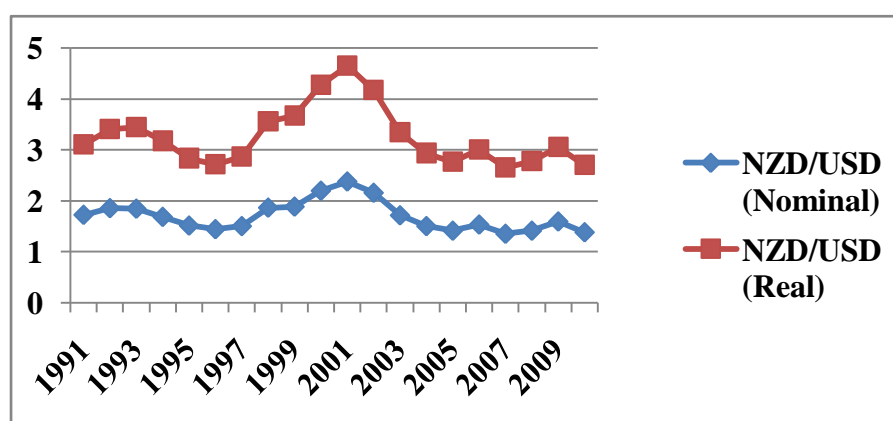
(Own Contribution)
Source: Nominal Exchange Rates: U.S Federal Reserve (2012).

V.   Real Exchange rate has been manually calculated.

From the data and graphs, it can be deducted that the trends in Nominal, Real and Effective Exchange rate have been varying over the 19 years. However, the changes in these values have been seen to quite small and major volatility is not seen. Evident from the table is that the Real Exchange rate's value has been more than that of the Nominal Exchange rate.

The Effective Exchange rate has been shown to be lower than the base year 1991's value of 100. This trend is seen from 1992 to 2006. However after 2006 to 2010, the Effective Exchange rate has become more that the base rate of 100, with the exception of the year 2009.

Table 2:
The table shows the Appreciation and Depreciation rates of Nominal, Real and Effective Exchange rates.

Year	Nominal Exchange Rate Appreciation/Depreciation		Real Exchange Rate Appreciation/Depreciation		Effective Exchange Rate App/Dep
	AUD/USD	**NZD/USD**	**AUD/USD**	**NZD/USD**	**Of the US Dollar**
1991	-	-	-	-	-
1992	-5.13 %	7.51%	-3.23%	9.65%	-3.01%
1993	-8.11%	-0.54%	-7.04%	1.13%	-6.55%
1994	7.35%	-8.65%	8.05%	-7.81%	4.09%
1995	1.37%	-10.06%	-0.38%	-10.86%	-0.79%
1996	5.41%	-4.60%	5.76%	-3.97%	3.95%
1997	-5.13%	4.14%	-3.19%	5.28%	-3.85%
1998	-14.87%	23.84%	-14.27%	24.21%	-8.70%
1999	3.17%	1.07%	-3.93%	3.02%	2.94%
2000	-10.77%	16.40%	-11.72%	16.79%	-4.83%
2001	-10.34%	8.18%	-11.66%	8.55%	-3.51%
2002	3.85%	-9.24%	2.41%	-10.21%	-2.33%
2003	20.37%	20.37%	19.79%	-19.77%	9.32%
2004	13.85%	-12.21%	14.20%	-12.15%	8.37%
2005	2.70%	-5.96%	3.42%	-5.76%	0.99%
2006	-1.32%	8.45%	-1.61%	8.51%	0.49%
2007	12%	-11.69%	12.54%	-11.48%	8.26%
2008	1.19%	4.41%	0.71%	4.42%	2.28%
2009	-7.06%	12.67%	-9.06%	10.18%	-4.75%
2010	16.46%	-13.13%	18.72%	-11.49%	12.11%

(Own Contribution)

The values have been manually calculated from the each year's exchange rates taken from U.S Federal Reserve (2012) and the manually calculated Real and Effective Exchange rates.
The Nominal, Real and Effective Exchange rates have shown volatile changes over the passage of 19 years.

The Nominal value of the U.S dollar against the Australian Dollar appreciated between 1991 and 1993 at an average rate of 6.52%. After an average depreciation of 4.71% between 1994 and 1996; there has been an up down trend between 1997 and 2001, with the currency mostly appreciating against the Australian Dollar. After 2002 to 2010, there has been a continuous depreciation in the U.S Dollar, with the exception of 2006 and 2009.The Nominal value of the U.S dollar against the New Zealand Dollar has shown almost similar trends. There has been a huge depreciation in 1992 of 7.51%, however later on, the U.S dollar appreciated between 1993 and 1996. Between 1997 and 2001 there has been a continuous depreciation in its value with a high depreciation in 1998 of 23.84%. 2002 to 2010 has shown variations, in the recent time there has been a major appreciation in the U.S dollar against the New Zealand Dollar by 13.13%.

Comparing Real Exchange rate changes with Nominal changes there has been similar trends, as when Nominal Exchange rate appreciated so did the Real exchange rate and when it depreciated so did the Real Exchange rate. There have been exceptions such as 1995 and 1999 showed Nominal depreciation of the U.S dollar against the Australian Dollar but in Real terms the U.S dollar has appreciated. Similarly, in nominal terms the U.S dollar appreciated in 1993 but in real terms it depreciated. In 2003, in nominal terms there was depreciation in currency but the real rate shown an appreciation.

The Effective Exchange rate has mostly depreciated between 1992 and 2002 with the exception of 1994, 1996 and 1999. From 2003 to 2010 there has been a continuous appreciation in the Effective Exchange rate with an exception of depreciation in 2009 of 4.75%.

Table 3:
Changes in U.S Terms of Trade with Australia and New Zealand and Real Exchange Rate of AUD/USD and NZD/USD:

Year	U.S' trade with Australia		U.S' trade with New Zealand	
	Change (%) in Terms of Trade with Australia	Change (%) in Real Exchange Rate AUD/USD	Change (%) in Terms of Trade with New Zealand	Change (%) in Real Exchange Rate NZD/USD
1991	-	-	-	-
1992	17.50%	-3.23%	-143.90%	9.65%
1993	-4.03%	-7.04%	-53.54%	1.13%
1994	32.11%	8.05%	109.44%	-7.81%
1995	13.49%	-0.38%	176.88%	-10.86%
1996	9.02%	5.76%	10.77%	-3.97%
1997	-8.34%	-3.19%	44.33%	5.28%
1998	-12.47%	-14.27%	-36.85%	24.21%
1999	0.12%	-3.93%	-27.50%	3.02%
2000	-7.56%	-11.72%	-162.75%	16.79%
2001	-26.33%	-11.66%	-19.36%	8.55%
2002	48.36%	2.41%	428.07%	-10.21%
2003	1.03%	19.79%	18.57%	-19.77%
2004	-3.92%	14.20%	61.15%	-12.15%
2005	28.60%	3.42%	-37.08%	-5.76%
2006	13.28%	-1.61%	-44.91%	8.51%
2007	13.08%	12.54%	27.60%	-11.48%
2008	10.10%	0.71%	60.91%	4.42%
2009	-0.36%	-9.06%	-37.32%	10.18%
2010	14.04%	18.72%	-114.23%	-11.49%

(Own Contribution)

These changes have been manually calculated from the data of Terms of Trade present in Appendix A and Real Exchange rate changes are taken from calculated values present on page 12.
The table shows that Real Exchange rate of AUD/USD does influence the patterns of the Terms of Trade to a certain extent but In case of New Zealand, the pattern of changes of Terms of Trade and Real Exchange rate of NZD/USD do not show much of a relationship.

Table 4:
Changes in the Terms of Trade and Effective Exchange Rates:

Year	Terms of Trade Percentage Changes	Effective Exchange Rate App/Dep
	In Millions of Dollars	Of the US Dollar
1991	-	-
1992	25.25%	-3.01%
1993	-4.86%	-6.55%
1994	32.75%	4.09%
1995	15.61%	-0.79%
1996	9.07%	3.95%
1997	-6.68%	-3.85%
1998	-13.66%	-8.70%
1999	-0.87%	2.94%
2000	-11.60%	-4.83%
2001	-26.46%	-3.51%
2002	40.64%	-2.33%
2003	-0.31%	9.32%
2004	-9.82%	8.37%
2005	39.25%	0.99%
2006	17.55%	0.49%
2007	12.58%	8.26%
2008	8.12%	2.28%
2009	1.78%	-4.75%
2010	18.62%	12.11%

(Own Contribution)

VI.   Values have been manually calculated

At most parts there have been movements in the same direction between the Terms of Trade and Effective Exchange Rates. The years 1993, 1997, 1998, 2000 and 2001 show that when Effective Exchange rate depreciates the Term of Trade shows decline. While, years 1994, 1996, 2005, 2006, 2007, 2008 and 2010 show that an appreciation in Effective Exchange rate leads to a positive change in the Terms of Trade. However, 1992, 1995, 1999, 2002, 2003, 2004 and 2009 show an inverse relationship between the two variables, that when the Effective Exchange rate depreciates the Terms of Trade improve and when it appreciates then the Terms of Trade deteriorate. However, deducted from the graph the movements have mostly been similar.

Table 5:
CPI data used to in calculating Real Exchange Rate

Year	CPI of USA	CPI of Australia	CPI of New Zealand
1991	136.2	106.5	75.74
1992	140.3	107.55	76.50
1993	144.5	109.5	77.49
1994	148.2	111.575	78.75
1995	152.4	116.75	81.71
1996	156.9	119.8	83.57
1997	160.5	120.1	84.56
1998	163.0	121.125	85.62
1999	166.6	122.9	85.85
2000	172.2	128.4	88.44
2001	177.1	134.025	90.65
2002	179.9	138.05	93.07
2003	184.0	141.875	94.48
2004	188.9	145.2	96.93
2005	195.3	149.075	100.00
2006	201.6	154.35	103.17
2007	207.3	157.95	105.84
2008	215.3	164.825	109.92
2009	214.5	167.825	111.99
2010	224.9	172.6	115.25

(Own Contribution)

Graph 5: The CPI comparison of U.S.A, Australia and New Zealand:

Own Contribution)
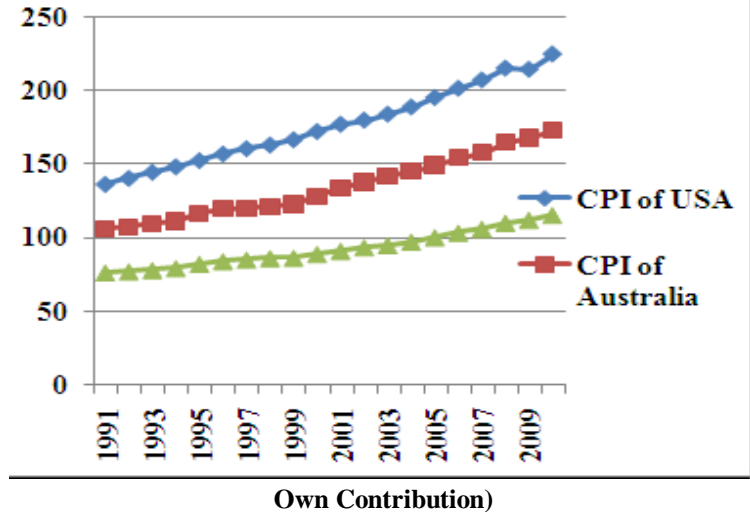
The CPI inflation rate can help in understanding the Real Exchange rate trend over the years. There has been a continuous increase in CPI inflation in all three countries over the 19 years. The U.S CPI has been a lot more than Australia and New Zealand, with New Zealand having the least CPI inflation.

Table 6:
Calculated Weights for Trade with Australia and New Zealand

Year	W_{aus}^b	W_{nz}^b
1991	0.85	0.15
1992	0.83	0.17
1993	0.82	0.18
1994	0.82	0.18
1995	0.82	0.18
1996	0.83	0.17
1997	0.83	0.18
1998	0.83	0.17
1999	0.82	0.18
2000	0.82	0.18
2001	0.80	0.20
2002	0.83	0.17
2003	0.82	0.18
2004	0.81	0.19
2005	0.79	0.20
2006	0.81	0.19
2007	0.83	0.17
2008	0.85	0.15
2009	0.85	0.15
2010	0.85	0.16
Avg	**0.83**	**0.17**

(Own Contribution)

(Own Contribution)
Manually calculated values have been taken up to 2 decimal places.
The Graph shows the Average share of Australia and New Zealand in U.S trade over the 19 years:

(Own Contribution)

The Average weights of trade with the U.S (Manually calculated)

These weights show that throughout the period of 1991 to 2010, the trade of the U.S with Australia has been significantly more than the trade with New Zealand. In the recent years, the trade weights with Australia has been increasing during the recent period of 2006 to 2010 and falling with respect to New Zealand.

Econometric Analysis:

Table 7:
Terms of Trade and Effective Exchange Rate

Year	Terms of Trade in terms of trade with AUS and NZ	Scaled value of TOT (divided by 100)	Effective Exchange Rate
1991	4,213.30	42.133	100
1992	5,277.20	52.772	96.99
1993	5,020.70	50.207	90.64
1994	6,665.00	66.65	94.34
1995	7,705.60	77.056	93.60
1996	8,404.80	84.048	97.30
1997	7,843.50	78.435	93.54
1998	6,772.30	67.723	85.40
1999	6,713.50	67.135	87.91
2000	5,934.40	59.344	83.67
2001	4,364.00	43.64	80.74
2002	6,137.70	61.377	78.86
2003	6,118.50	61.185	86.21
2004	5,517.40	55.174	93.43
2005	7,683.20	76.832	94.36
2006	9,031.50	90.315	94.82
2007	10,167.40	101.674	102.65
2008	10,992.90	109.929	104.99
2009	11,188.60	111.886	99.99
2010	13,271.50	132.715	112.11

(Own Contribution)

Source:
U.S Total trade with Australia and New Zealand has been manually calculated from the data of U.S Imports and Exports to Australia and New Zealand taken from **U.S. Census Bureau, Foreign Trade**.

The foreign trade values have been scaled by dividing the values by 100, in order to obtain authentic econometric results.

VII. Discussion

As discussed before, in order to examine the free trade of the U.S with Australia and New Zealand; nominal, real and effective exchange rates analysis shows variation in trade between the countries.

- **Relationship between the Nominal and Real Exchange rates of AUD/USD and NZD/USD over 1991 to 2010:**

When examining the nominal and real exchange rate patterns of the Australian and New Zealand Dollar per U.S dollar, it can be seen that the Real exchange rate is more than the Nominal Exchange rate. This means that in real terms it took more Australian and New Zealand dollars to exchange in order to receive one U.S dollar. In real terms the U.S dollar has been over valued throughout the period of 19 years. This can be due to the U.S inflation (CPI) being more than the inflation in Australia and New Zealand throughout the period 1991 to 2010. When inflation in U.S is higher than that of Australia and New Zealand; then more Australian and New Zealand dollars are required to buy a U.S dollar in real terms (Brahmbhatt et al, 2010).

This overvaluation of Real Exchange rate is usually not beneficial to a country. Real Exchange rate overvaluation usually leads to a negative growth of an economy (Aguirre and Calderón, 2005). However, this overvaluation's negative impact on growth is not evident when viewing the economic trends in the U.S, as financial crisis are more likely to decrease growth in the U.S economy than changes in the Real Exchange Rate (Simpson, 2009). Also, even though the Real Exchange rate is overvalued against the Australian and New Zealand Dollar, it does not mean that is also over valued against other currencies as well.

In terms of movements, the Real and Nominal Exchange rate of the U.S dollar against the Australian and New Zealand has mostly been in the same direction that when the Nominal value appreciates so does the Real value appreciates.

The Percentage changes in Nominal and Real AUD/USD Exchange rates:
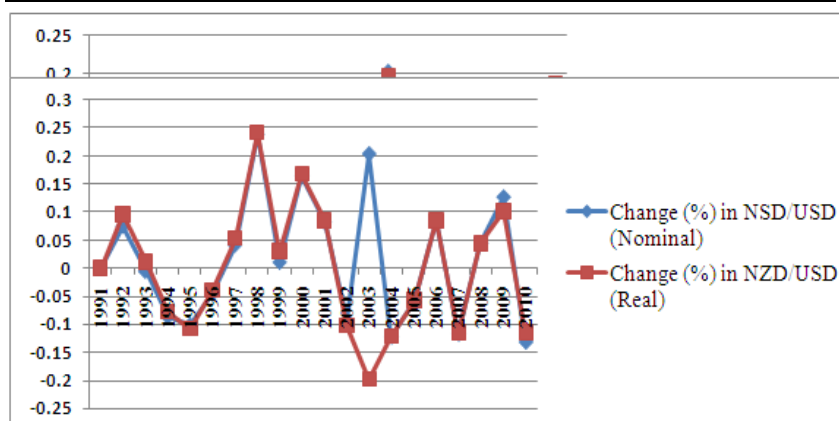
The Percentage change in Nominal and Real NZD/USD Exchange rates:
(Own Contribution)

The values have been taken from manually calculated values present in table 2 on pg 12.

As there can be seen from the graph, the Real and Nominal Exchange rates of the AUD/USD and NZD/USD moved in the same direction over the 19 years. There has been only one exception in the NZD/USD exchange rate values in 2003 that when the nominal exchange rate depreciated by 20.37% the real exchange rate appreciated by 19.77%. This trend is due to the fact that the Inflation in U.S rose by 0.78% more than the inflation rise in the New Zealand and as a result the real values of the U.S dollar rose while the nominal value fell.

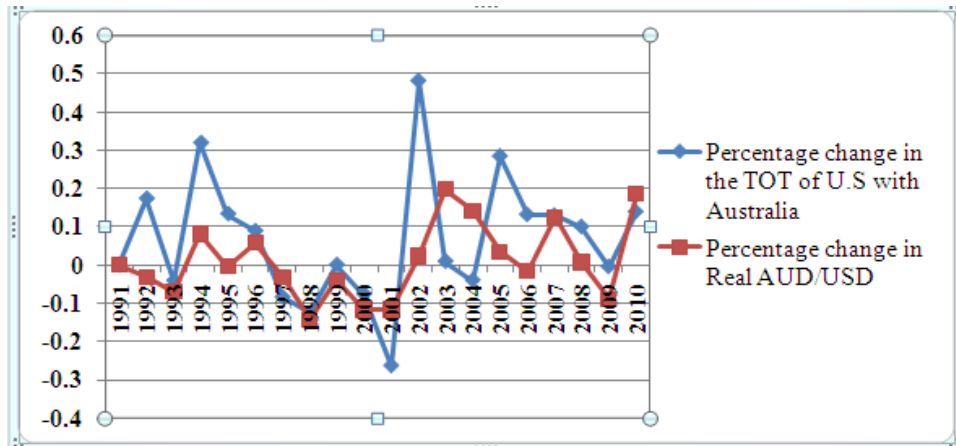- **Real Exchange Rate impacts on the Terms of Trade:**

One impact that Real Exchange rate does have is on the terms of trade. As discussed before, Real rate depreciation indicates that foreign inflation has lead to a rise in imports prices and as a result the foreign trade balance will suffer a deficit. Similarly, Real Exchange rate appreciates in the short run the terms of trade improves and in the long run it deteriorates (Kipici and Kesriyeli, 1997).

Looking at the Real Exchange rate of Australian Dollar per U.S dollar and Terms of trade of the U.S with Australia, there can be seen a relationship between the two.

The graph shows the relationship between the percentage changes in Terms of Trade of Australia and Real Exchange rate (AUD/USD):

(Own Contribution)

The values have been taken from manually calculated values present in table 3 on pg 14.

As evident from the graph above, the changes in the terms of trade and the real exchange rate of the U.S with

Australia show that small changes in the real exchange rate has led to huge changes in the terms of trade. The hypothesized trend of an appreciation in Real Exchange rate leads to an improvement in the Terms of Trade is clearly seen in the trade pattern of the U.S with Australia. When the AUD/USD depreciates the TOT deteriorates as well. However in terms of the U.S Dollar there is an opposite trend seen, that when the U.S Dollar appreciates the TOT deteriorates and when it depreciates the TOT improves. The depreciation of currency leads a competitive advantage to the country and leads to the quantity of exports to increase and imports to fall and thus the TOT improved. While the appreciation leads to imports to rise and exports to fall and leads to the deterioration of the TOT.

Each year's change in the Real exchange rate alone does not impact the TOT in that period, the impact of the Real exchange rate change in the previous year also impacts the changes as it can be seen the periods 2001 to 2010. It is most evident between 2003 and 2004; even though the real exchange rate of the U.S depreciates there is deterioration in the TOT. This can be due to the long run impacts of a previous appreciation in the Real Exchange rate that can cause the TOT to deteriorate in 2003 and 2004 despite Real Exchange rate depreciation in the period. Similarly, between 1991 and 1993, the U.S dollar real rate appreciated by 5.1% but the TOT improved as well by 6.7%. This can be due to the long run impacts of a previous depreciation in the Real Exchange rate that can cause the TOT to improve between 1991 and 1993 despite Real Exchange rate appreciation in the period.

How ever, when the relationship between the U.S Real Exchange rate against the New Zealand Dollar and its TOT with New Zealand is concerned, there is not any evidence at all of a relationship.

The graph shows the relationship between the percentage changes in Terms of Trade of New Zealand and Real Exchange rate (NZD/USD):

(Own Contribution)

The values have been taken from manually calculated values present in table 3 on pg 14.
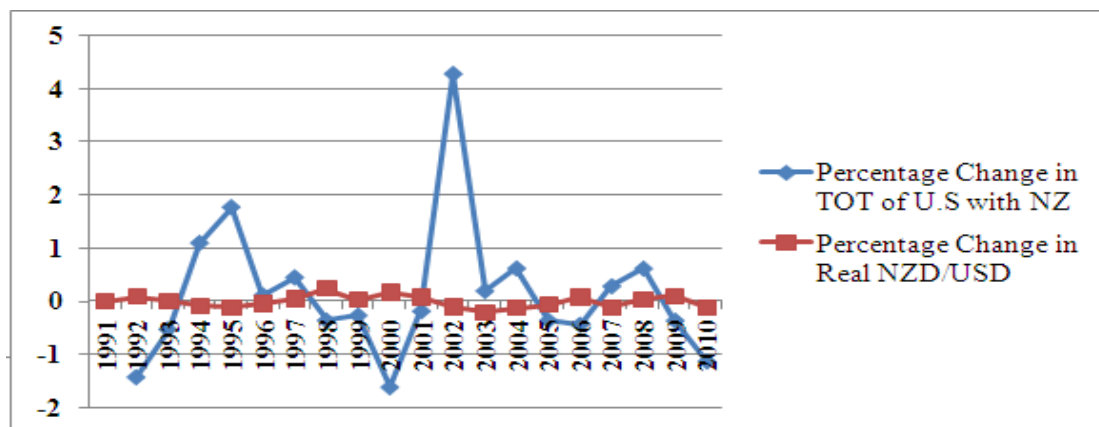
As evident from the graph above, the Real exchange rate of NZD/USD has had very little or no impact on the TOT of U.S' trade with New Zealand. The deficits and surpluses of the TOT are more likely to be because of economic conditions in the two countries. The New Zealand economy has been mostly dependent on Australia, European countries and the U.S, so small shock in the U.S economy can also impact the New Zealand economy (McCarten, 2007).

The trade patterns have mostly been favoring New Zealand as the U.S is the New Zealand's second largest market for agricultural products, while New Zealand is the U.S' 47th largest export market and this can explain the fact that mostly the U.S imported more from the NZ then exported to it (New Zealand government, 2012 and U.S government, 2011). The 2000 to 2002 rise in the exports of the U.S to the New Zealand has more to do with the nominal exchange rate then with the real exchange rate, as the U.S strong currency slowly depreciated against the New Zealand Dollar up to 2001. Overall, the U.S dollar depreciated against the NZ dollar by 5.06% during 2000 to 2002, giving U.S a competitive advantage (NZ Parliamentary Library, 2004). From 2000 to 2007, the up and down trend in the TOT of the U.S with New Zealand can be due to the long term effects of appreciation and depreciation of the Nominal Exchange rate. While the decline in TOT between 2008 and 2010 are evidences of the U.S recession in that period (Simpson, 2009).

As New Zealand relies mostly on the U.S so, a U.S recession can hurt the New Zealand economy as well. This is evident in the Trade deficits of U.S' with New Zealand between the years 2008 to 2010. This could have occurred because of the loss in the GDP of New Zealand because of the U.S recessionary effects on the NZ economy.

Even though, U.S.A's trade with New Zealand is important, it is the trade with Australia that gains more importance. The Australian trade has more of a share of 83% with the U.S compared to the 17% share of New Zealand over the 19 years. Even though Australia is important for the U.S; U.S is no longer important to Australia due to the decoupling from the U.S in terms of trading from 2000 onwards. Australia is now impacted by changes in the Asian Economy. Between the periods of 1991 to 2000, when the U.S economy witnessed a recession it impacted the Australian economy, however in the recent recession of 2008 to 2010 in the U.S, the Australian Economy is still booming (Dobell, 2011). This Australian economy boom, can benefit the U.S' terms of trade and its exports and are evident in the recent improvement of TOT of the U.S' with Australia of 9.2% between 2007 and 2010. This improvement in the trade balance was made despite U.S.A suffering from a recession and financial crisis in this period.

The Relationship between the Effective Exchange Rate and Terms of Trade of the U.S with Australia and New Zealand:

It was theorized that as Effective Exchange rate appreciates the terms of trade against those partner countries improves along with it. This was hypothesized because Effective Exchange rate appreciation means the depreciation of the U.S currency against its trading partners Australia and New Zealand that gives it a competitive advantage and as a result its TOT against those countries improves.

As it is evident from the data (given on page 9 and 10), the Effective Exchange rate has shown trends of appreciation and depreciation over the 19 years and it has impacted the Trade Balance as well. To understand this relationship even better, a simple regression analysis was conducted.

VIII.   Regression Analysis

With the literature kept in mind, a regression line formed is used to find help in the regression analysis of the data.

Terms of Trade= β0 + β1 Effective Exchange Rate + ui

The table shows the calculated Regression values in order to interpret the relationship between Terms of Trade and Effective Exchange Rate:

$\hat{\beta}0$	-122.026
$\hat{\beta}1$	2.1
R	0.71
r^2	0.51
t-test ($\hat{\beta}0$)	-2.67
t-test ($\hat{\beta}1$)	4.312
F-test	18.62

For calculations refer to Appendix B.

From the results, the Regression function found is:

Terms of Trade = -122.026 + 2.1Effective Exchange Rate.

T-test:

$$\hat{\beta}0 \qquad \hat{\beta}1$$
$$\text{t-test} = \quad (-2.67) \quad (4.312)$$

The t-test results for $\hat{\beta}0$ and $\hat{\beta}1$ are significant at p = 0.025.

F-Test:

$$\text{F-test} = 18.62$$

F-test is also significant at p = 0.01.

From this model, it is evident that the Terms of Trade Balance of -122.026 is the intercept and 2.1 is the slope. The positive sign shows the positive relationship between the Terms of Trade and Effective Exchange Rate. The slope of 2.1 shows an elastic regression line.

The Regression Line showing the relationship between Terms of Trade and the Effective Exchange Rate:
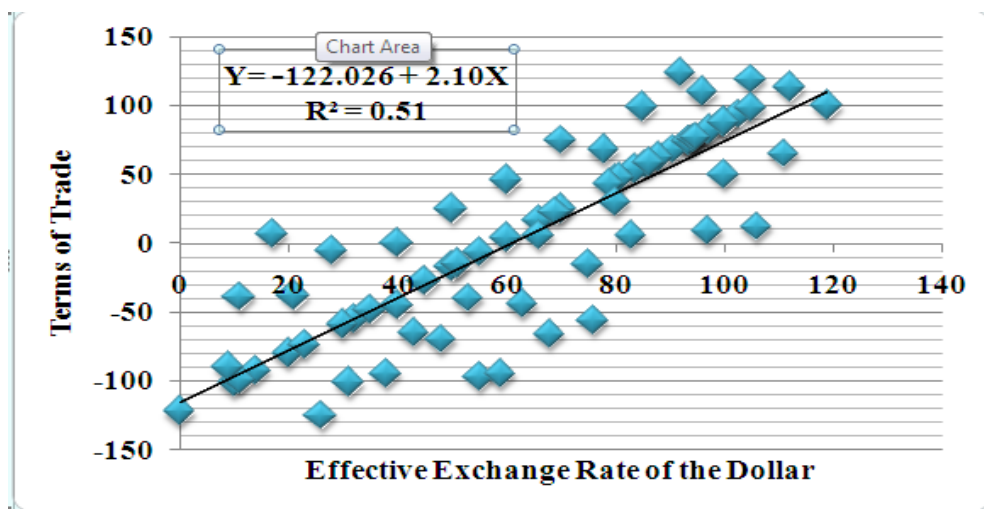

The Regression line is derived from the values that were manually calculated.
(For values of X and Y refer to Appendix B)

The t value of $\hat{\beta}1$ of 4.312 and of $\hat{\beta}0$ of -2.67, shows that the results are significant at p=0.025. This means that the values are mostly authentic. The t negative values can be ignored. The t-values show that the calculated t-values of both $\hat{\beta}1$ and $\hat{\beta}0$ are more than the tabulated value of 2.093and this means that the Null Hypothesis is rejected and the Alternative Hypothesis is accepted. This means that there is a relationship between EER and TOT of the U.S with Australia and New Zealand. The overall testing parameter, F-test shows the value of 18.62 which is significant at p= 0.01, which shows that the overall results are authentic and significant. Also the F-test calculated value is more than the tabulated value of 3.00, thus it is further proved that there does exist and overall relationship between EER and TOT of the U.S with Australia and New Zealand. It also means that the overall model is significant.

The relationship between the two variables has been found to positive as the value of $\hat{\beta}1$ is 2.10, which shows a positive slope. Since the slope is elastic, it means that a little change in Effective Exchange Rate causes a lot of change in the Terms of Trade of the U.S with Australia and New Zealand. The $\hat{\beta}0$ value shows that even when the Effective Exchange Rate of the U.S is zero, there will be a TOT balance of -122.026. It also indicates that when the EER is zero, there is bound to be a Trade Deficit.

Although this does explain the relationship, but the value of r^2 of 0.51 shows that the regression line does not fully explain the entire data. It explains 51% of the data and fails to explain the remaining 49%. This means that 49% of the trends in the Term of Trade of U.S.A with Australia and New Zealand can be caused by other variables such as financial crises, economic trends in all three countries, government's exports promoting policies, restrictions on imports, transportation costs and the distance between the countries (Baak, 2005).

When examining that how strong is the relationship, coefficient of correlation (r) is used. The 'r' value of 0.71 shows that there is a positive and somewhat strong relationship between the two variables. This strong relationship is evident in the movements of the two variables from 1991 to 2010.

The Changes of Effective Exchange Rate and TOT:
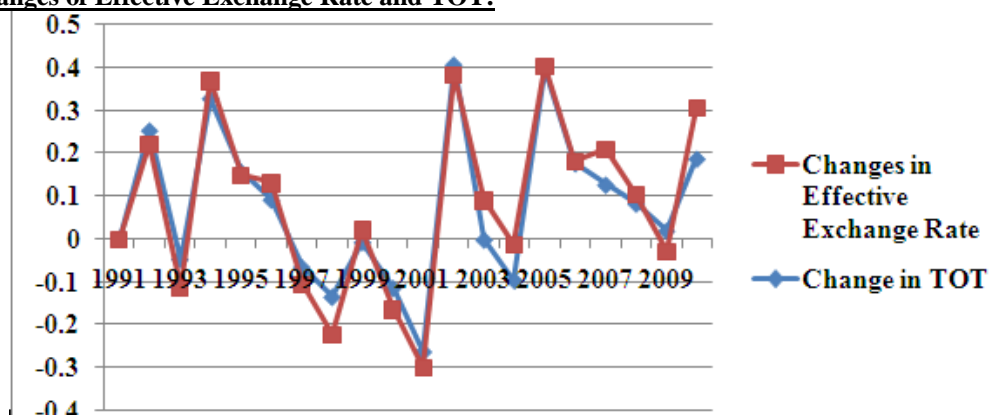
Taken from Manually calculated values in table 7 on page 19.

As it can be seen from the graph values, the changes in EER and TOT moved in the same direction over the period of 19 years. When the EER depreciated, the TOT deteriorated as well and when the EER appreciated, the TOT improved as well. Between the time periods of 2003 to 2005 the TOT deteriorated more than the EER value shows a strong impact of the EER on the TOT value. Other than that changes have mostly been uniform.   (Analysis made with the help of Gujarati and Sangeetha, 2007).

IX.   Conclusion

It can be concluded that in order to deduct the patterns in the Term of Trade of a country Nominal, Real and Effective Exchange rates all come in handy. However, out of these three Effective Exchange rate is the most effective while Nominal is the least.

When comparing the Nominal and Real Exchange rates of AUD/USD and NZD/USD, it was found that Real Exchange was overvalued compared to the Nominal Exchange rate throughout the 19 years. It had to be because the CPI of U.S.A was more than the other two countries, resulting in there being more requirements of New Zealand and Australian Dollars to buy one U.S Dollar. The appreciation and depreciation of Nominal and Real AUD/USD and NZD/USD have mostly shown to be moving in the same direction. When the Nominal value appreciated so did the Real value and when the Nominal value depreciated so did the Real value. There was an exception in the NZD/USD trend in 2003 where Nominal value depreciated while the Real value appreciated and it was due to the higher percentage rise in prices of the U.S compared to New Zealand's.

The Real Exchange rate has been found to impact the U.S' TOT with Australia a lot more than that with New Zealand. The changes in Real Exchange rate patterns of AUD/USD has shown both short term effects and the long term effects on the TOT. Short term effects were e.g., deprecation in currency leads to deterioration in TOT immediately; while Long term effects were e.g., depreciation in currency leads to an improvement in TOT later on. How ever, in case of New Zealand, the Real Exchange rate didn't seem to have any impact on the TOT of the U.S with the New Zealand.

In case of determining the relationship between the Effective Exchange Rate of the U.S dollar and the Terms of Trade with Australia and New Zealand, the regression analysis determined that there is a strong relationship between the two. The correlation coefficient 'r' showed a value 0.71, which confirms a positive and strong relationship between the two variables. It is also evident from the changes in EER and TOT, as they moved in the same direction over the period of 19 years. That is; when the EER depreciated, the TOT deteriorated as well and when the EER appreciated, the TOT improved as well.

However when it comes to how the Effective Exchange Rate affects the Terms of Trade, a regression line with a positive slope of $\hat{\beta}1= 2.10$ and the intercept of $\hat{\beta}0= -122.026$ was found. Thus, it is found that the relationship is positive and elastic which means that a small change in EER will bring about a huge positive change in the TOT of the U.S with Australia and New Zealand. The t-tests and F-test confirm that the overall model is significant and the values are authentic. However, the value of $r^2 = 0.51$, shows only 51% of the data values are explained by the regression line. Thus, Variables such as financial crises, economic trends in all three countries, government's exports promoting policies, restrictions on imports, transportation costs and the distance between the countries can also impact of 49% on the TOT values.

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Appendix A   (Data)
U.S trade data used to calculate Effective Exchange Rate

Year	U.S. Trade with Australia			U.S. Trade with New Zealand		
	Exports	Imports	Total Trade	Exports	Imports	Total Trade
1991	8,403.8	3,988.0	12,391.80	1,006.6	1,209.1	2,215.70
1992	8,875.9	3,687.6	12,563.50	1,307.0	1,218.1	2,525.10
1993	8,276.7	3,297.3	11,574.00	1,248.8	1,207.5	2,456.30
1994	9,780.6	3,202.1	12,982.70	1,507.7	1,421.2	2,928.90
1995	10,789.1	3,323.0	14,112.10	1,691.3	1,451.8	3,143.10
1996	12,008.4	3,868.9	15,877.30	1,728.4	1,463.1	3,191.50
1997	12,062.9	4,602.3	16,665.20	1,962.1	1,579.2	3,541.30
1998	11,917.5	5,387.0	17,304.50	1,886.6	1,644.8	3,531.40
1999	11,818.3	5,280.1	17,098.40	1,923.6	1,748.3	3,671.90
2000	12,482.4	6,438.0	18,920.40	1,970.2	2,080.2	4,050.40
2001	10,930.5	6,477.8	17,408.30	2,110.5	2,199.2	4309.70
2002	13,084.9	6,478.8	19,563.70	1,813.2	2,281.6	4,094.80
2003	13,087.6	6,413.7	19,501.30	1,847.7	2,403.1	4,250.80
2004	13,957.9	7,545.5	21,503.40	2,072.9	2,967.9	5,040.80
2005	15,588.5	7,342.2	22,930.70	2,592.1	3,155.2	5,747.30
2006	17,545.7	8,204.0	25,749.70	2,806.2	3,116.4	5,922.60
2007	19,178.2	8,615.0	27,793.20	2,717.6	3,113.4	5,831.00
2008	22,218.6	10,588.8	32,807.40	2,533.9	3,170.8	5,704.70
2009	19,599.3	8,011.5	27,610.80	2,158.5	2,557.7	4,716.20
2010	21,797.6	8,582.9	30,380.50	2,819.1	2,762.3	5,581.40

Source:
U.S Imports and Exports to Australia and New Zealand: U.S. Census Bureau, Foreign Trade.
Total Trade Values have been manually calculated.
The Terms of Trade of the U.S with Australia and New Zealand

Year	Terms of Trade with Australia	Terms of Trade with New Zealand
1991	4,415.80	-202.50
1992	5,188.30	88.90
1993	4,979.40	41.30
1994	6,578.50	86.50
1995	7,466.10	239.50
1996	8,139.50	265.30
1997	7,460.60	382.90
1998	6,530.50	241.80
1999	6,538.20	175.30
2000	6,044.40	-110.00
2001	4,452.70	-88.70
2002	6,606.10	-468.40
2003	6,673.90	-555.40
2004	6,412.40	-895.00
2005	8,246.30	-563.10
2006	9,341.70	-310.20
2007	10,563.20	-395.80
2008	11,629.80	-636.90
2009	11,587.80	-399.20
2010	13,214.70	56.80

These values have been manually calculated from the trade data given above.

Calculated Weights for Trade with Australia and New Zealand and Relative Exchange rates for calculation of Effective Exchange Rates:

Year	W_{aus}^b	W_{nz}^b	Relative Exchange Rate (AUD)	Relative Exchange Rate (NZD)
1991	0.85	0.15	1	1
1992	0.83	0.17	0.95	1.08
1993	0.82	0.18	0.87	1.07
1994	0.82	0.18	0.94	0.98
1995	0.82	0.18	0.95	0.88
1996	0.83	0.17	1	0.84
1997	0.83	0.18	0.95	0.87
1998	0.83	0.17	0.81	1.08
1999	0.82	0.18	0.83	1.09
2000	0.82	0.18	0.74	1.27
2001	0.80	0.20	0.67	0.38
2002	0.83	0.17	0.69	1.25
2003	0.82	0.18	0.83	0.99

2004	0.81	0.19	0.95	0.87
2005	0.79	0.20	0.97	0.82
2006	0.81	0.19	1.96	0.89
2007	0.83	0.17	1.08	0.79
2008	0.85	0.15	1.09	0.82
2009	0.85	0.15	1.01	0.92
2010	0.85	0.16	1.18	0.80

The values have been taken to the 2nd decimal place

Appendix B
Calculations
Values calculated in calculating values of the Regression Line:

S. No.	Fiscal Year	X	Y	X^2
1	1991	100	42.133	10000
2	1992	96.99	52.772	9407.0601
3	1993	90.64	50.207	8215.6096
4	1994	94.34	66.65	8900.0356
5	1995	93.6	77.056	8760.96
6	1996	97.3	84.048	9467.29
7	1997	93.54	78.435	8749.7316
8	1998	85.4	67.723	7293.16
9	1999	87.91	67.135	7728.1681
10	2000	83.67	59.344	7000.6689
11	2001	80.74	43.64	6518.9476
12	2002	78.86	61.377	6218.8996
13	2003	86.21	61.185	7432.1641
14	2004	93.43	55.174	8729.1649
15	2005	94.36	76.832	8903.8096
16	2006	94.82	90.315	8990.8324
17	2007	102.65	101.674	10537.0225
18	2008	104.99	109.929	11022.9001
19	2009	99.99	111.886	9998.0001
20	2010	112.11	132.715	12568.6521
		$\sum X=$ 1871.55	$\sum Y=$ 1490.23	$\sum X^2=$ 176443.077

$\bar{X}$= 93.58
$\bar{Y}$ =74.51

S. No.	Fiscal Year	x (X-X bar)	y (Y-Y bar)	xy	x^2	y^2	e_i $(e_i=y-\beta_{1x})$	e_i^2
1	1991	6.42	-33.377	-214.28	41.2164	1114.024	-46.859	2195.77
2	1992	3.41	-22.738	-77.5366	11.6281	517.0166	-29.899	893.95
3	1993	-2.94	-25.303	74.39082	8.6436	640.2418	-19.129	365.919
4	1994	0.76	-8.86	-6.7336	0.5776	78.4996	-10.456	109.328
5	1995	0.02	1.546	0.03092	0.0004	2.390116	1.504	2.26202
6	1996	3.72	8.538	31.76136	13.8384	72.89744	0.726	0.52708
7	1997	-0.04	2.925	-0.117	0.0016	8.555625	3.009	9.05408
8	1998	-8.18	-7.787	63.69766	66.9124	60.63737	9.391	88.1909
9	1999	-5.67	-8.375	47.48625	32.1489	70.14063	3.532	12.475
10	2000	-9.91	-16.166	160.2051	98.2081	261.3396	4.645	21.576
11	2001	-12.84	-31.87	409.2108	164.8656	1015.697	-4.906	24.0688
12	2002	-14.72	-14.133	208.0378	216.6784	199.7417	16.779	281.535
13	2003	-7.37	-14.325	105.5753	54.3169	205.2056	1.152	1.3271
14	2004	-0.15	-20.336	3.0504	0.0225	413.5529	-20.021	400.84
15	2005	0.78	1.322	1.03116	0.6084	1.747684	-0.316	0.09986
16	2006	1.24	14.805	18.3582	1.5376	219.188	12.201	148.864
17	2007	9.07	26.164	237.3075	82.2649	684.5549	7.117	50.6517
18	2008	11.41	34.419	392.7208	130.1881	1184.668	10.458	109.37
19	2009	6.41	36.376	233.1702	41.0881	1323.213	22.915	525.097
20	2010	18.53	57.205	1060.009	343.3609	3272.412	18.292	334.597
		$\sum x=$ -0.05	$\sum y=$ -19.97	$\sum xy=$ 2747.38	$\sum x^2=$ 1308.107	$\sum y^2=$ 11345.72		$\sum e_i^2=$ 5575.499

$\hat{\beta}1$

$$\hat{\beta}1 = \frac{\sum xiyi}{\sum xi^2}$$

$$\hat{\beta}1 = \frac{2747.38}{1308.107}$$

$$\boxed{\hat{\beta}_1 = 2.1}$$

β̂0

$\hat{\beta}0 = \bar{Y} - \hat{\beta}1\bar{X}$

$\hat{\beta}0 = 74.51 - (2.1)\ (93.58)$

$= 74.51 - (206.81)$

$=$

$$\boxed{\hat{\beta}0 = -122.026}$$

r

$r = \dfrac{\sum xi\ yi}{\sqrt{(\sum xi^2)\ (\sum yi^2)}}$

$= \dfrac{2747.38}{\sqrt{(1308.107)\ (11345.72)}}$

$= \dfrac{-185.12747.385}{3852.45}$

$$\boxed{r = -0.71}$$

$$r^2$$

$r^2 = \hat{\beta}1^{\ 2}\ \dfrac{\sum x^2}{\sum y^2}$

$= (2.1)^2 \cdot \dfrac{1308.107}{11345.72}$

$= 4.41 \times (0.115)$

$$\boxed{r^2 = 0.51}$$

T-test

β̂0

$t = \dfrac{\hat{\beta}0 - \beta0}{\mathbf{SE}\ (\beta0)}$

Taking β0 as 0:

$= \dfrac{-122.026}{45.71}$

$$\boxed{t = -2.67}$$

β̂1

$t = \dfrac{\hat{\beta}1 - \beta1}{\mathbf{SE}\ (\beta1)}$

Taking β1 as 0:

$= \dfrac{2.1}{0.487}$

$$\boxed{t = 4.312}$$

F-test

$F = \dfrac{\hat{\beta}1^2\ \sum xi^2}{\hat{\delta}^2}$

$= \dfrac{(2.21)^2 \cdot\ 1308.11}{309.75}$

$= \dfrac{4.41 \times 1308.11}{309.75}$

$$\boxed{\text{F- test} = 18.62}$$