# Nominal Exchange Rate Neutrality: The Case of Australia

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**Abstract**
This study uses quarterly macroeconomic data over 1984-2003 period along with a 7-variable structural vector autoregression model to investigate the nominal exchange rate neutrality hypothesis for the case of Australia. Impulse response functions and variance decompositions are generated for four different variations of the model for empirically testing the hypothesis. Empirical evidence presented in this paper support the nominal exchange rate neutrality for the case of Australia. In addition, we find that the neutrality is invariant to the choice of the nominal exchange rate or the measure of monetary aggregates used in the estimation.
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## I. Introduction

Since Australia had adopted free floating market exchange rate system in December 1983, the rate of exchange of the Australian dollar (AUD) into other currencies has been a topic of considerable interest for practitioners and researchers in economics, finance and also for the community at large. Even a slightest movement in the nominal exchange rate headlines the popular business news items as if it really matters for the overall economic performance of the Australian economy. However, well established macroeconomic literature does not warrant such a response to an unanticipated change in a nominal variable. As Lucas ( 1996) pointed out, nominal values such as the nominal exchange rate, interest rates, money supply and price levels do not impact upon real values such as real output or employment in the long run.

This paper uses Structural Vector Autoregression method to find empirical evidence for the nominal exchange rate neutrality concept for the case of Australia. In particular, it examines whether Australian real GDP is neutral to changes in the nominal exchange rate as predicted by the macroeconomic theory.

The paper itself is divided into six main sections. Section II provides a brief synoptic review of the theoretical and empirical literature on neutrality concept. Data definitions, variables employed in the model, and data sources are discussed in Section III. Section IV summarises the methodological basis for the estimation techniques and the assumptions that we make in the estimation, while Section V deals with the interpretation of the estimated results. The paper ends with some brief concluding remarks in Section VI.

## II. Theoretical and Empirical Literature on Neutrality

Neutrality is a condition in which one variable does not change as a result of changes in another variable (Geweke 1986). In general, neutrality is expressed in the context of long-run perspective which, allows for an initial impact in the short-run which dissipates as agents within the economy adjust. Geweke (1986) identifies two distinctive forms of neutrality; structural neutrality and stochastic neutrality. Structural neutrality is one in which one variable has no impact on the value of another variable. Stochastic neutrality, on the other hand is where a change in the mean of the exogenous variable does not result in a change in the mean of an endogenous variable. Geweke also comments on the superneutrality where the growth rate in one variable is structurally neutral with respect to the other variable. According to Fisher and Seater (1993), long run neutrality is a necessary, but not sufficient condition for superneutrality. The advancement of the time series techniques, particularly the availability of unit root tests have made the testing of neutrality and superneutrality much easier in empirical studies.

In macroeconomics, the neutrality concept is mainly associated with the money supply and the level of real output (Leong and McAleer 2000). Since the seminal work of Lucas (1972), many studies have investigated the money neutrality issue. Among others, Fisher and Seater (1993) as well as King and Watson (1997) showed that exogenous and permanent change in the level of money supply would have no effect on the level of output in the long run. However, Haug and Lucas (1997) find that structural breaks in the data can adversely affect the outcome of neutrality tests. As Lucas (1996) points out, the link between changes in the money supply and real output has been largely mixed. The concept of money neutrality has been tested using three main types of econometric techniques. Initially, researchers have used univariate equations and exogenous money supply in the estimation, but most of the times inaccurately rejected the neutrality. Gochoco (1986) as well as Boschen and Grossman (1982) blame the use of seasonally adjusted data for the false rejection of neutrality. The second and the third generations have used vector autoregression (VAR) and structural vector autoregression (SVAR) techniques and generally found some evidence of neutrality (Cogley 1993).

In this study, the neutrality is refereed to a situation, in which real GDP in Australia is neutral with regards to changes in the nominal exchange rate. Although some studies have examined this issue (see: Stockman 1988; Caporale and Pittis 1995), they used the exchange rate neutrality to refer to the effect of the nominal exchange rate determination regime. As Papell (1992) rightly points out, the literature on nominal exchange rate neutrality is dominated by examinations of the neutrality of the exchange rate determination regime. Hence, further opportunities exist for conducting studies on the neutrality of the nominal exchange rate in the true sense.

Since December 1983, Australia has been adopting free floating exchange rate system. Compared to the rest of the world, Australia is a small economy. World prices are generally determined outside of the country, so that a depreciation of its nominal exchange rate increases the cost of imports and decreases the price of exports. Although this should lead to a higher level of real GDP, it would be thwarted by the increase in prices of goods and services within Australia. This leads to neutrality of the nominal exchange rate once price adjustments have occurred.

Although there is an extensive literature on neutrality, only a few has studied the nominal exchange rate neutrality in the context of Australia. Brischetto and Voss (1999) used a seven variable SVAR model for Australia and did not find convincing evidence for nominal exchange rate neutrality. To illustrate, their results suggest that 1 percent appreciation of the nominal exchange rate results in 0.24 percent increase in real output. However, they attribute these results to changes in the terms of trade and the simultaneous reduction in the interest rates over the period. They further point out that the neutrality is achieved if interest rates are allowed to respond to the changes in the nominal exchange rate. In our effort to examining the nominal exchange rate neutrality in Australia, we expect to contribute to this growing literature on neutrality in four different ways.

To the best of our knowledge, this is the first study to investigate the nominal exchange rate neutrality for the case of Australia. Although some studies have used nominal exchange rate as an endogenous variable in macroeconomic studies (eg Brischetto and Voss 1999), they do not use it as the focus of the analysis. Secondly, we use SVAR method instead of more popular VAR method to examine the neutrality concept. As indicated in the literature review, most of the work on neutrality has been done in the context of VARs. However, since SVAR allows us to incorporate economics knowledge into the model, it is more appropriate to study exchange rate neutrality hypothesis. Thirdly, we use an updated data sample in the estimation to capture the behaviour of exchange rate in Australia during the first two decades of free floating exchange rate regime. Confinement of the data sample to the post free floating era helps to avoid the possibility of structural break issue in the estimation and allow making use of the full sample in statistical inferences and hypothesis testing. Lastly, unlike a large majority of other studies, this study uses seasonally unadjusted data in the estimation. As Gochoco(1986) pointed out, seasonal adjustment of data could results in false rejection of neutrality in some studies. In supporting this view, Boschen and Grossman (1982) suggest that the use of seasonally adjusted data can conceal information used by agents to make decisions.

**III. Data Sources and Definitions**

This study uses quarterly data over 1984-2003 period encompassing 80 observations to examine the neutrality of real GDP with regards to the change of nominal exchange rate in Australia. The use of quarterly data enables a greater sample size than annual data. The use of a 20-year time horizon is short compared to international studies (Nelson and Plosser 1982), but slightly longer than Australian studies (Lowe 1992; Huh 1999). The scope period begins with the introduction of free floating exchange rate system. The data ends at 2003:Q4 because seasonally unadjusted data are not available for some variables after that point[i]. Since 7-variable SVAR along with two alternative forms of exchange rates are used in the estimation, we need data for 8 variables. The data sources are given in appendix 1. The purpose of this section is to briefly explain the variables that are used in the estimation.

The price of one currency in terms of another is called exchange rate. Trading of the AUD for various currencies occurs continually in currency markets in Australia and overseas. However, Australian Bureau of Statistics data show that more than two-thirds of exports and approximately a half of imports are conducted on contracts specified in USD. Hence, we opt to use USD/AUD bilateral rate (USDAUD) as a proxy for the nominal exchange rate variable. In addition, in order to account for the impact of other currencies, we estimate alternative model utilising nominal effective exchange rate (TWI), which adjusts all the individual bilateral rates for their share of total trade. This approach would also help to compare and contrast the effects of using different form exchange rates in examining nominal exchange rate neutrality. The relationship between nominal exchange rate and Australian real GDP (RGDP) is the focus of this research. Real GDP data are expressed in terms of 2003 dollars.

RGDP has been doubled, from AUD 99.6 billion to AUD 221.8 billion during the sample period.

Following the literature, nominal money supply is included in the model to capture its impacts of monetary policies on other endogenous variables in the model. Money supply has a number of different measures described as M1, M2 and M3. In Australia, M1 is defined as currency plus current deposits with trading banks. M2 is defined as M1 plus the fixed interest bearing and certificates of deposit with trading banks, while M3 is M2 plus deposits with all savings banks. However, M2 has not been used in the recent Australian studies because the Reserve Bank has not recorded M2 data since bank deregulation in 1990 (Foster 1996). Therefore, M1 and M3 will alternatively be used in this study to capture the impacts of money supply on other macroeconomic variables.

Since exchange rate relates to external trade and a significant share of total external trade consists of primary industry products, we incorporate an index of commodity prices (IXCOMPR) in the estimation. It is a Laspeyres index of the prices of 17 major export commodities and 3 categories. The weights used in the calculation if the indexes are revised periodically to reflect the composition of Australian commodities. The current weights specify that agricultural commodities comprise 29.1 percent; base metals 15.7 percent, and all others 55.3 percent (RBA 2003).

Interest rate is another important variable in macroeconomic studies. Interest rate in Australia has a number of different measures. 90-day bank accepted bill rate (BBR90) is a commonly used short-term interest rate indicator. Short-run and long-run yield on government bonds are also regularly used to represent interest rate impacts. Correlation coefficient for these interest rate variables suggest that all three convey basically similar information and the choice between the three is largely discretionary. Accordingly, this paper uses the 90-day Bank Bill rate to represent interest rate impacts.

Australian inflation rate (INFLAT) is used to control for the impacts of price movements in Australia. Again, there are several different measures for the inflation rate, but the most general measure is the consumer price index for all cities.

It is standard practice to incorporate a proxy for the rest of the world economic activities when examining a specified economy via VAR or SVAR techniques. Considering that the USA has been the major trading partner for many years, we use the US real GDP (USRGDP) data to capture the impact of international economic activities on Australian macroeconomic variables. Summary statistics of the variables are given in Table 1.

**Table1: Summary Statistics**

| variable name | USAUD | TWI | RGDP | M1 | M3 | IXCOMPR | BBR90 | INFLAT | USRGDP |
|---|---|---|---|---|---|---|---|---|---|
| mean | 0.70377 | 57.528 | 150290 | 76.314 | 261.99 | 109.11 | 9.0873 | 0.009826 | 1207.3 |
| median | 0.71425 | 56.810 | 0.14388E+06 | 69.754 | 238.65 | 108.20 | 7.1583 | 0.78960E-02 | 1171.0 |
| minimum | 0.5119 | 49.276 | 99565 | 20.728 | 75.751 | 89.339 | 4.2967 | -0.00458 | 906.94 |
| maximum | 0.9306 | 83.646 | 221770 | 166.73 | 554.89 | 131.2 | 18.167 | 0.037242 | 1558.6 |
| Standard deviation | 0.092859 | 7.1695 | 30914 | 44.47 | 132.57 | 11.403 | 4.5783 | 0.008558 | 169.49 |

notes:
1. All data in original form; details on data source available in Appendix 1. All series will be transformed into logs for analysis except for interest rates and inflation.
2. RGDP in AUD million, base period 2003/04; USRGDP in USD billion, base period 1982-4; M1 and M3 in AUD billion

## IV. Structural Vector Autoregression Estimation

Since Sims (1980), VAR approach has become very popular in estimating macroeconomic models. In VAR, all variables are considered endogenous and allowed to impact on the other variables in the system. Hence, our VAR express each of the seven above explained variables as a function of its own lag values, and contemporaneous and lagged values of all other variables. Representations of a VAR can be given in structural form, reduced form or recursive form (Stock and Watson 2001). The structure of the VAR is given as in equation 1.

$$X_t = C(L)X_t + \varepsilon_t \qquad (1)$$

Where X is the vector of variables in the model and C is a lag function which enables each variable to be expressed by lagged vales of its own and of all other variables. Structural Vector Autoregression (SVAR) use economic theory to impose restrictions upon the VAR. The restrictions have the effects of assuming no causal relationship either contemporaneously or through subsequent lags, or both. These restrictions assist in identification of the model (Stock and Watson 2001). To achieve identification, a model with *k* endogenous variables requires at least $(k^2+k)/2$ restrictions. We impose the following assumptions for identifying purposes.

US real GDP, which proxies for the rest of the world economic performance is assumed to not be influenced by Australian events. This is due to the small size of Australia relative to the US economy. Within this model, US real GDP is driven only by its own past values.

The index of commodity prices is the index of world commodity prices and Australia is a small component of international commodity market and unable to influence world prices. Hence, the commodity prices are also assumed to be influence by their own past values.

Australian inflation is assumed to be influenced only by the world economy and the index of commodity prices. This is a quite strong assumption to make. However, the activity of the world economy is the dominant influence on Australian economic activity and therefore is the main influence on inflation. Commodity prices are assumed to contribute to inflation thorough their impacts on domestic prices and thus the consumer price index.

Australian interest rates are nominal rates and assumed to be influenced by the world economy (US real GDP), Australian inflation, and commodity prices. The world economy is assumed to affect the international structure of interest rates and the influences of funds flows.

Nominal interest rates are determined by inflation thorough the need for nominal interest rates to maintain real returns and also through monetary policies. The RBA uses inflation targeting to determine monetary policy so it is reasonable to assume that the inflation influences monetary policy.

Australian money supply (M1 or M3) is related to the world economy, the commodity prices, inflation, and interest rates. This is assumed to be the case because of the RBA's inflation targeting approach to monetary policy which affects interest rates and bank deposits and lending and thereby the money supply.

In this analysis the exchange rate is assumed to be influenced by all variables except for real Australian GDP, but Australian real GDP is assumed to be influenced by all variables. These assumptions are summarised in Table 2.

**Table 2: Contemporaneous Relationships among Variables**

| | independent variables | | | | | | |
|---|---|---|---|---|---|---|---|
| dependent variable | USRGDP | IXCOMPR | INFLAT | BBR90 | M1 or M3 | USDAUD or TWI | RGDP |
| USRGDP | | | | | | | |
| IXCOMPR | * | | | | | | |
| INFLAT | * | * | | | | | |
| BBR90 | * | * | * | | | | |
| M1 or M3 | * | * | * | * | | | |
| USDAUD or TWI | * | * | * | * | * | | |
| RGDP | * | * | * | * | * | * | |

## V. Interpretation of Results

When conducting a VAR analysis, it is standard practise to conduct unit root tests to verify the stability properties of the system. There are a number of different tests for stationarity each with different approaches and hypothesis. For example, Dickey-Fuller as well as Phillips-Perron test (Phillips and Perron 1988) starts with a null hypothesis of a unit root while the KPSS test (Kwiatkowski at. el. 1992) tests stationarity rather than its absence. In this paper, all three tests are performed and overall summary of the testings is reported in Table 3.

As is common with the literature, the tests give mixed results regarding stationarity. Hence, some judgment as to the nature of the series and the transformation required to make it stationary is required in the estimation. The summary of the conclusions and the method of transformation are given in Table 4. All variables except TWI and INFLAT contains a unit root and hence transformed to make them stationary before estimating the system. Although this is the most widely used method in estimating VAR, some studies (Sims 1980; Stock and Watson 2001) have shown that in doing so, vital long run information can be lost.

Another important step of the VAR/SVAR estimation is to determine the appropriate lag length. Conventional method of selecting the lag length is via the Akaike information criterion or Schwartz criterion. Since these two tests have produced conflicting results regarding the optimum lag length, in line with Schwartz criterion, we opt to use more parsimonious first order SVAR in our estimation. In fact, it has shown that Schwartz criterion generally results in a more parsimonious model (Enders 2004).

**Table 3: Summary of Unit Root Test Results**

| Variable | Augmented Dickey-Fuller | Phillips Perron | KPSS | conclusion |
|---|---|---|---|---|
| USDAUD | I(1) | I(1) | 10%: I(1)<br>5%: Trend stationary | I(1) |
| TWI | stationary | stationary | 5%: Trend stationary<br>1%: stationary | stationary |
| RGDP | I(1,4) | stationary | I(1) or I(1,4) | I(1,4) |
| M1 | I(1) | I(1) | I(1) | I(1) |
| M3 | trend stationary with drift | trend stationary with drift | I(1) | trend stationary |
| IXCOMPR | I(1) | I(1) | stationary | I(1) |
| BBR90 | I(1) | I(1) | I(1) | I(1) |
| INFLAT | stationary with trended section | stationary with trended section | stationary | stationary with trended section |
| USRGDP | I(1,4) | stationary | I(1) or I(1,4) | I(1,4) |
| Interest Rate | I(1) | I(1) | I(1) | I(1) |

**Table 4: Summary of conclusions regarding stationarity and transformation**

| Test, variable | test statistic | transformation required |
|---|---|---|
| USDAUD | I(1) | differencing once |
| TWI | stationary | none |
| RGDP | I(1,4) | seasonal differencing once, differencing once |
| M1 | I(1) | differencing once |
| M3 | trend stationary | detrending |
| IXCOMPR | I(1) | differencing once |
| BBR90 | I(1) | differencing once |
| INFLAT | stationary with trended section | none |
| USRGDP | I(1,4) | seasonal differencing once, differencing once |

The responses of Australian real GDP to changes in nominal exchange rates and the interrelationships of the selected macroeconomic variables are analysed using techniques of innovation accounting, namely the impulse response functions (IRF) and variance decompositions (VDC).

The responses of each of the variables to a one unit increase in the current value of one of the VAR errors are traced out by the IRF (Stock and Watson 2001). This is possible because the VAR can also be expressed as vector moving average (VMA) representation. In VMA representation, each equation in the VAR is expressed in terms of the current and past values of the innovations. This enables us to trace the time path of the innovations to each of the endogenous variables. The general form of VMA and the impulse responses are given in equation (2) and (3) respectively (Enders 2004).

$$X_t = \mu + \sum_{i=0}^{\infty} \delta_i \varepsilon_{t-i} \quad (2)$$

$$\frac{\partial X_{i,t+s}}{\partial \varepsilon_t} = \delta_s \quad (3)$$

We estimate four different specifications of the model, representing variations in the choice of nominal exchange rate (bilateral or trade weighted) and the nominal money supply (M1 or M3). The model specifications are shown in Table 5.

**Table 5: Variations of the Model**

| variable | A | B | C | D |
|---|---|---|---|---|
| Real Australian GDP (RGDP) | | | | |
| Bilateral nominal USD-AUD exchange rate (UDSAUD) | | | | |
| Nominal effective exchange rate for Australia (TWI) | | | | |
| Nominal Monetary Aggregate M1(M1) | | | | |
| Nominal Monetary Aggregate M3 (M3) | | | | |
| Index of all commodity prices, US Dollar series (IXCOMPR) | | | | |
| Australian interest rates (BBR90) | | | | |
| Australian inflation (INFLAT) | | | | |
| US Real GDP (USRGDP) | | | | |

For the sake of brevity, we report only the responses of Australian real GDP to a shock in the nominal exchange rate. The IRFs for other variables are available upon request. In this exercise, one standard deviation shock is used to generate impulse response functions[ii]. IRFs are given for a shock to the bilateral exchange rate (Model A and B) and to a shock to the effective exchange rate (Model C and D). The results are shown in figure 1-4.

**Figure 1: Impulse Response Functions- Model A- impact on Real GDP**

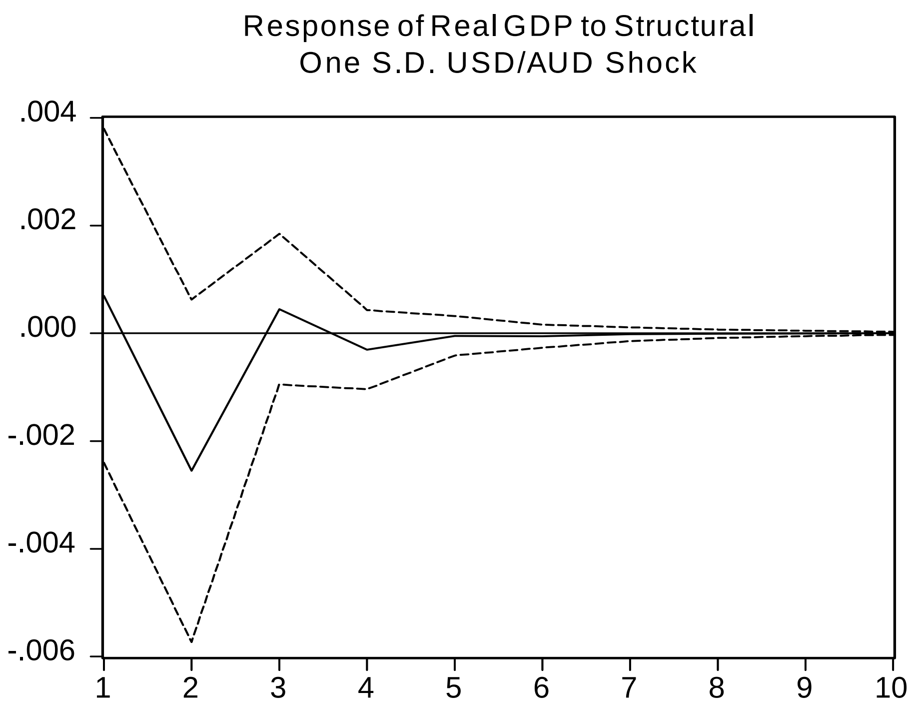


**Figure 2: Impulse Response Functions- Model B- impact on Real GDP**

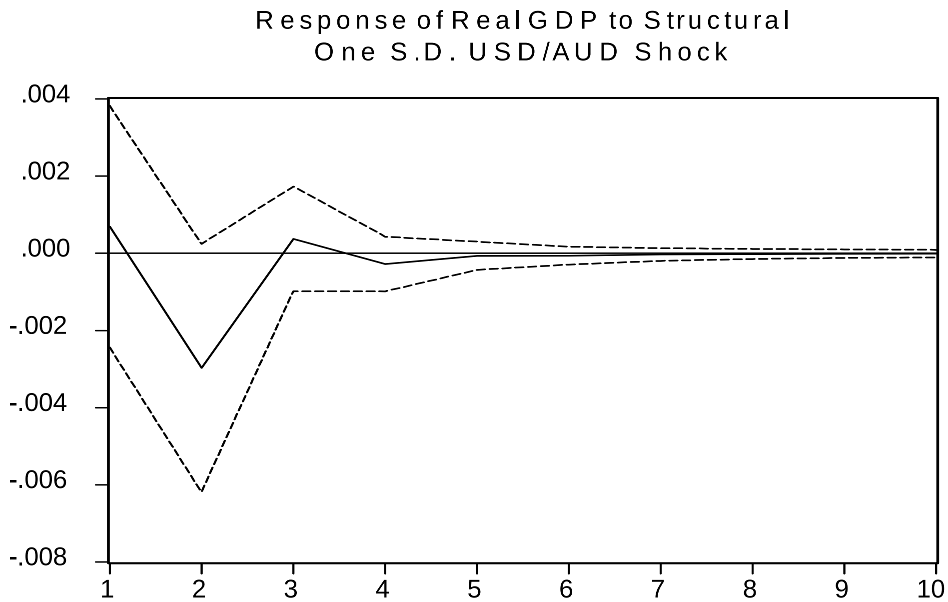



**Figure 3: Impulse Response Functions- Model C- impact on Real GDP**

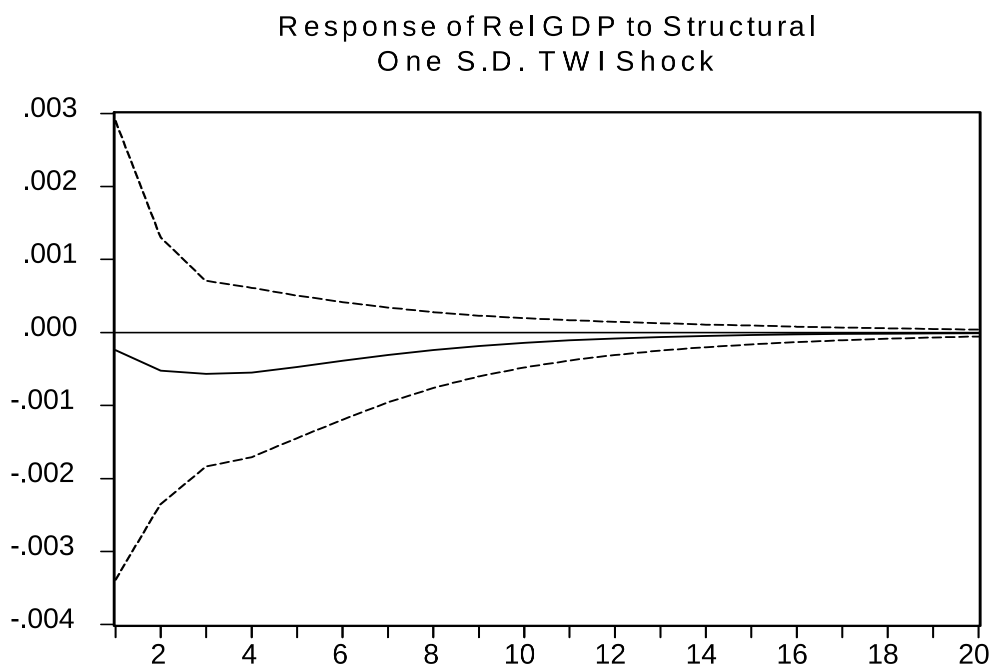
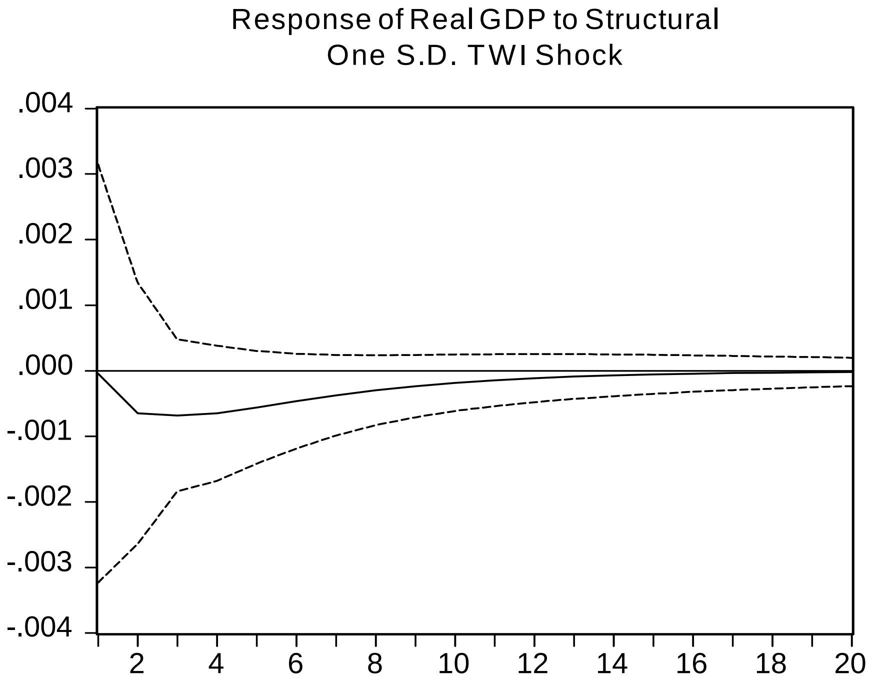


**Figure 4: Impulse Response Functions- Model D- impact on Real GDP**




As the figure 1 shows, For a 1 standard deviation shock to the nominal bilateral exchange rate, Australian real GDP responds negatively in the first quarter followed by a positive response in the second quarter and negative response in the next two successive quarters before the impacts are dissipated in the fifth quarter. This suggests that the effects last only for one year. The effects are almost identical to Model B impulse responses. Models C and D use trade weighted index as the nominal exchange rate. Results from these models indicate that Australian real GDP responds negatively in the fist three quarters and then dissipates slowly.

Findings from all four models clearly support nominal exchange rate neutrality for the case of Australia. As expected, some responses are found in the short-run, but they dissipate quite quickly and revert back to the base line level implying no impact on the long run equilibrium real GDP. Nevertheless, the results show that the magnitude of the responses and the time it takes to return to the base line level depend on the type of nominal exchange rate that is used in the estimation. For instance, we observe rather fluctuating responses of GDP to a shock in the bilateral exchange rate compared to those of trade weighted exchange rate. In other words, although we find that the nominal exchange rate neutrality is invariant to the type of nominal exchange rate, the duration of the short run impacts and the features of neutrality process vary with the choice of the impulse variable.

We also find that the choice of the monetary aggregates does not alter the relationship between nominal exchange rate and Australian real GDP. For instance, both model A and B produce almost similar responses in real GDP regardless of the fact that the former uses M1 as money supply measure and the latter uses M3 to capture money supply effects. The similar observation is made in relation to Model C and D impulse response functions.

The second most popular tool of analysing a VAR is the use of variance decompositions (VDC). This method allows us to decompose the forecast error of a variable into the component causes of that error. VDS are useful because it explains the interactions among the series and the extent of a variable that is influenced by others. Therefore, the relative importance of each random innovation in affecting the variables in the VAR can be found using VDC[iii]. Table 6 depicts the results for all four models[iv].

The VDC results show that the variation in Australian real GDP is not significantly affected by the changes in nominal exchange rates in either bilateral or trade weighted form. According to Model A results, bilateral nominal exchange rate is responsible for only 3 percent of total forecast error of real GDP even at the end of 10-quarter horizon. The real GDP itself is responsible for about 81 percent and the rest of the endogenous variables contribute for about 16 percent of the variation of the real GDP. The relationship is further weakened once the bilateral rate is replaced with the trade weighted exchange rate. For example, according to Model C and D results, nominal exchange rate innovations are contributed to less than 1 percent of forecast error variance in Australian real GDP. These findings further validate the evidence for the nominal exchange rate neutrality that is provided by impulse response analysis. VDC results reconfirm that the choice of the money supply measure is irrelevant in testing the nominal exchange rate neutrality in Australia.

**Table 6: Variance Decomposition Results**

| | Model A | | Model B | | Model C | | Model D | |
|---|---|---|---|---|---|---|---|---|
| Period | USD/AUD | Real GDP | USD/AUD | Real GDP | TWI | Real GDP | TWI | Real GDP |
| 1 | 0.203490 | 93.47403 | 0.184075 | 91.77923 | 0.067067 | 93.17156 | 0.016881 | 91.52913 |
| 2 | 3.130468 | 83.00999 | 4.226087 | 84.21890 | 0.140727 | 85.83255 | 0.135839 | 88.51578 |
| 3 | 3.150060 | 81.91706 | 4.217804 | 83.28289 | 0.309367 | 85.28574 | 0.346457 | 88.14875 |
| 4 | 3.168365 | 81.60749 | 4.227470 | 82.99303 | 0.463588 | 84.97206 | 0.534020 | 87.83004 |
| 5 | 3.166248 | 81.51683 | 4.225464 | 82.90806 | 0.589187 | 84.72618 | 0.687647 | 87.55958 |
| 6 | 3.166486 | 81.49079 | 4.225568 | 82.88222 | 0.676714 | 84.55531 | 0.799370 | 87.34791 |
| 7 | 3.166463 | 81.48366 | 4.225629 | 82.87437 | 0.733646 | 84.44053 | 0.875516 | 87.19520 |
| 8 | 3.166454 | 81.48179 | 4.225662 | 82.87175 | 0.768963 | 84.36831 | 0.925131 | 87.09169 |
| 9 | 3.166446 | 81.48131 | 4.225670 | 82.87070 | 0.790298 | 84.32424 | 0.956550 | 87.02431 |
| 10 | 3.166443 | 81.48119 | 4.225669 | 82.87016 | 0.802974 | 84.29795 | 0.976071 | 86.98165 |
| Factorization: Structural | | | | | | | | |

**VI. Conclusions**

Nominal exchange rate neutrality is the situation where variations in the nominal exchange rate have no impact upon real GDP. It is generally defined for the long-run allowing some short-run variations during the period of adjustment.

In this paper we have utilised 7-variable SVAR model along with quarterly data for the 1984-2003 period to empirically examine this concept for the case of Australia. Two popular techniques; impulse responses and variance decompositions are used to test the hypotheses. We estimated four different variations of the 7-variable SVAR representing variations in the choice of nominal exchange rate (bilateral or trade weighted) and the nominal money supply (M1 or M3).

Empirical results presented in this paper support the nominal exchange rate neutrality for the case of Australia. However, the duration of the adjustment process varies with the choice of exchange rate; with the nominal bilateral exchange rate having a greater short run effect, which dissipates faster than that of the effective exchange rate. Even though we find strong empirical support for the nominal exchange rate neutrality for Australia, we are reluctant to generalise these findings into other economies because of the possible country specific effects.

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**Appendix**

***Table A1.1: Data sources and definitions***

| *section* | *item* | *source* | *frequency in source* |
|---|---|---|---|
| 3.3.1 | nominal exchange rate- USD/AUD | IFS | quarterly |
| 3.3.1 | nominal exchange rate- TWI | IFS | quarterly |
| 3.3.2 | Australian Real GDP | ABS 5206.0 Table 50 | quarterly |
| 3.3.3 | money supply- M1 | RBA- D03 | monthly |
| 3.3.3 | money supply- M3 | RBA- D03 | monthly |
| 3.3.4 | RBA Index of commodity prices (USD series) | RBA-G05 | monthly |
| 3.3.5 | interest rates – 90 day bank accepted bill rate | RBA-F01 | monthly |
| 3.3.5 | interest rates –Government bond yields- short term | IFS series 61a | quarterly |
| 3.3.5 | interest rates –Government bond yields- long term | IFS series 61 | quarterly |
| 3.3.6 | inflation (quarterly proportional change in consumer price index) | RBA-G02 | quarterly |
| 3.3.7 | US Real GDP | Econstats*, | quarterly |

Legend
ABS- Australian Bureau of Statistics. The number quoted is the catalogue number
IFS- International Financial Statistics published by the International Monetary Fund
NIPA- National Income and production Accounts
RBA- Reserve Bank of Australia. Reference is the Table number.
n/a not applicable
*http://www.econstats.com/nipa/NIPA8_8_1__4.csv NIPA Table 8.1 item A191RU1

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[i] We could not find seasonally unadjusted data for USA real GDP after 2003 Q IV.
[ii] If the correlations among the various innovations are large, ordering of the variables can substantially change the results of IRF and VDS. However, our estimations suggest that correlations among innovations are small and do not alter the results.
[iii] An excellent treatment of the technical details of VDC is given in Enders (2004) as well as in Hamilton (1994).

[iv] VDC results are provided only for Australian real GDP and a form of nominal exchange rates. Results of other variables are available upon request.