The Effects of Monetary Policy Shocks On Exchange Rates: Evidence from New Zealand and Australia

A thesis presented in partial fulfilment of the requirements
For the degree of Master of Business Studies
In Finance at Massey University

Shirley Young

1998

Abstract

This study investigates the effects of monetary policy shifts in New Zealand and Australia on the New Zealand and Australian exchange rates. The sample period used was from March 1985 to March 1998, a period where both the New Zealand dollar and Australian dollar have been operating under a flexible exchange rate regime. Three VAR models, which differ due to the variables included, were estimated.

The results show that the movements of the New Zealand and Australian exchange rates were not always consistent with theory, but the results were consistent with the results of other studies. In particular the overshooting hypothesis (which suggests that a monetary shock leads to an overreaction of the exchange rate immediately after the shock, but quickly stabilizes again) does not hold. In the majority of the cases, both exchange rates do not always overreact in response to a monetary shock and then return to the long run equilibrium exchange rate. At times the maximal impact of the monetary shock on the exchange rate was delayed and at other times the response of the exchange rate to a monetary shock was quite volatile. However, over time the exchange rate did return to its long run equilibrium rate.

Secondly, the results showed that the exchange rates did not always move in the direction anticipated. A contraction in monetary policy does not always lead to an appreciation of the domestic currency, but may lead to a depreciation of the domestic currency instead.

Finally, the results showed that monetary shocks do contribute to the variability of the New Zealand dollar and Australian dollar, but monetary shocks do not explain the majority of the movements in either the New Zealand or Australian exchange rates.

Acknowledgements

I would like to thank my supervisor Dr. Martin Young, Senior Lecturer in the Department of Finance firstly for making this research possible and then for his generous support and guidance throughout the year.

I would also like to thank my advisor Kate Wilkinson for all the help she has given me with regard to the statistical analysis in this study. I am very grateful that Kate was always available when I needed help.

A special thanks to Andrea Bennett, Lecturer in the Department of Finance for all her time spent proof reading my work. Also I would like to thank everyone in the Department of Finance for their general support and the resources provided to undertake this research project.

Table of Contents

List of Tables

List of Figures

CHAPTER 1

Introduction

Since currencies worldwide have floated, the movements of exchange rates have become more volatile. Under a floating exchange rate regime, the exchange rate is the price of foreign currency determined by the demand for and supply of foreign currency. As a consequence the price of the currency fluctuates. Since the floating of exchange rates, there has been an increase in the number of studies looking at the causes of exchange rate volatility and whether the movements in exchange rates can be forecasted.

A number of studies have shown that movements in exchange rates are impossible to forecast, especially in the short run. However, in the long run, the behaviour of exchange rates is more predictable.

A number of factors are said to cause a change in the exchange rate. Firstly, if inflation differs between two countries, the exchange rate will change in order to offset the inflation differential between the two countries. If inflation in country A is high relative to country B then the currency of country A will depreciate relative to country B's currency.

There are other theories which suggest that monetary policy and interest rates have an impact on the exchange rate. One such theory is Dornbusch's (1976) overshooting hypothesis which suggests that an expansion in monetary policy results in a fall in domestic interest rates and hence an outflow of capital from the country. An outflow of capital means that the domestic currency will depreciate. Dornbusch further argues that the depreciation in the spot exchange rate will exceed that of the long run equilibrium exchange rate. The spot exchange rate is then expected to appreciate back to the long run equilibrium rate so investors can be compensated for the lower interest on domestic assets.

A number of studies have tested to see whether Dornbusch's exchange rate theory holds. Studies such as Lewis (1993), Evans (1994), and Eichenbaum and Evans (1995) examined the impact of US monetary shocks on the US dollar exchange rate using VAR models. These studies found that the overshooting hypothesis did not hold, although a contraction in monetary policy did lead to an appreciation of the US dollar. However, the maximal impact of the monetary shock on the US dollar was always delayed.

Other studies that used VAR models to examine the relationship between monetary shocks and exchange rates for non-US countries include Grilli and Roubini (1995), and Cushman and Zha (1997). The results of these studies were not always consistent with those that examined the effects of US monetary policy on the US dollar. When examining the impact of monetary policy on the exchange rates of non-US countries, an exchange rate puzzle was present where a contraction in monetary policy led to a rise in interest rates but a depreciation in the domestic currency. The studies carried out in non-US countries also found that the overshooting hypothesis does not hold as the maximal impact on the exchange rates were usually delayed.

Based on the study by Eichenbaum and Evans (1995) this study examines the impact of New Zealand monetary policy on the value of the New Zealand dollar, and the impact of Australian monetary policy on the value of the Australian dollar. Like Eichenbaum and Evans, VAR models were estimated. For New Zealand the exchange rates examined were the New Zealand dollar against the Australian dollar, the Japanese Yen, the UK Pound, and the US dollar. For Australia the exchange rates examined were the Australian dollar against the Yen, the New Zealand dollar, the UK Pound, and the US dollar. The sample period for both New Zealand and Australia was March 1985 to March 1998, a period where both the New Zealand dollar and the Australian dollar have a floating exchange rate.

This thesis is presented as follows: a discussion on how monetary policy is implemented in New Zealand and Australia is presented in Chapter 2. Chapter 3 discusses background information regarding the New Zealand dollar and Australian dollar. A detailed literature review is presented in Chapter 4. This discusses the above studies and other studies that have looked at the impact of monetary policy on exchange rates in detail. The data used for this study and where it was obtained is discussed in Chapter 5. Chapter 6 presents the methodology used for this study as well as the preliminary tests carried out before examining the relationship between monetary shocks and exchange rates. Chapter 7 discusses the results found from stationarity tests, tests for cointegration, the impulse response functions of the exchange rates to a monetary shock, and the variance decompositons for each exchange rate. Conclusions are presented in Chapter 8.

CHAPTER 2

Background Information on Monetary Policy

This chapter discusses monetary policy implementation in New Zealand and in Australia. Firstly, there is a discussion on monetary policy implementation in New Zealand. This is divided into two sections: the first section describes how monetary policy was implemented prior to the Reserve Bank Act taking effect in 1989. The second section describes how monetary policy has been implemented in New Zealand since 1989.

The second part of this chapter looks at monetary policy implementation in Australia. In Australia, the cash rate plays an important role in the implementation of monetary policy. There is a discussion on how the Reserve Bank of Australia influences the cash rate. This part of the chapter also focuses on how the Reserve Bank of Australia changes the money supply and also looks at how authorised money market dealers play an important role in the implementation of monetary policy in Australia.

As there are some differences in the way that monetary policy is implemented in New Zealand and Australia, the chapter concludes by highlighting these differences.

2.1 Monetary Policy in New Zealand

Since the deregulation of the New Zealand financial system and the floating of the New Zealand dollar in 1985, monetary policy has become more transparent. This has coincided with the Reserve Bank of New Zealand becoming more accountable for its actions.

First there is a discussion on how the framework for monetary policy implementation developed since the Labour government came in power in July 1984 up until the Reserve Bank Act took effect. Then there is a discussion on how monetary policy is implemented currently.

Monetary Policy Prior to 1989

Since mid 1984, monetary policy has been consistently aimed at lowering inflation. The initial aim of monetary policy was to achieve a rate of inflation below that of New Zealand's main trading partners. As inflation fell, the aim of monetary policy became more specific with price stability becoming the main objective.

In late 1984 the discount window for all government securities over six months to maturity was closed and the concept of primary liquidity (PL) was introduced. "Primary liquidity comprises bankers' cash deposits held at the Reserve Bank and those instruments which financial institutions are readily able to turn into Reserve Bank cash; namely short-term government securities." (Reserve Bank, 1987a, p.105). "The aim was then to fully fund net injections into PL arising from public sector and foreign exchange flows, through the issue of long-term government securities." (Spencer, 1992, p.127). From this market interest rates would be determined.

The Reserve Bank hoped that a stable relationship existed between the quantity of primary liquidity and money and credit aggregates, from monetary policy operating through interest rates. It was found that PL was not a good tool for short-term monetary control.

After the New Zealand dollar was floated in March 1985, it was found that the cash component of PL, that is the quantity of settlement cash balances, was the key instrument for short-term monetary control. Due to the float of the dollar, the Reserve Bank had direct control of the settlement cash and could influence short-term interest rates. After the dollar floated, the Reserve Bank also gained some control over the monetary base of the New Zealand financial system. The Reserve Bank was able to pursue targets for money and/or credit aggregates for the first time.

In the initial period following the floating of the dollar, when implementing monetary policy, the Reserve Bank allowed interest rates to vary considerably and there were large movements in cash balances. By 1985 the Reserve Bank realised that liquidity management was necessary for monetary policy to be efficient. The Reserve Bank's (1987b) definition of liquidity management is " the aspect of monetary policy concerned with short-term conditions in the main wholesale markets." (p.197). Liquidity management is necessary to ensure that short-term and other seasonal factors does not obscure the stance in monetary policy.

In early 1986, a settlement cash target was set and targeted daily. The only other change made prior to the Reserve Bank Act coming into force was that Reserve Bank Bills replaced Treasury Bills as the sole discountable instrument. The reason for the change was because the government wanted to separate monetary policy and government's debt management and banking operations.

Monetary Policy in New Zealand After the Reserve Bank Act 1989

The Reserve Bank Act did not alter the way monetary policy is implemented in New Zealand since 1985. The purpose of the Act was to formalise some of the essential elements of monetary policy. One of the main aims of the Act was to improve transparency.

The Act states that the sole objective of monetary policy is to keep prices stable. The Reserve Bank is given operational independence to achieve the objective of price stability through holding the Governor of the Reserve Bank accountable for the outcome, which is also stated in the Reserve Bank Act.

The Policy Targets Agreement (PTA) is an agreement between the Governor of the Reserve Bank and the Minister of Finance on how the objective of price stability should be achieved. This is then translated into concrete policy goals.

In New Zealand, price stability means maintaining the increase in the annual Consumer Price Index (CPI) between zero and three percent. It should be noted that the range used to be between zero and two percent. The change was made when the National party and New Zealand First formed a coalition government in December 1996. If CPI inflation moves outside the range of zero and three percent, it does not mean that the Reserve Bank has failed to comply with the PTA. Mayes and Riches (1996) states that four types of influences on inflation are excluded:

1. the direct impact of interest cost components of the CPI;
2. the direct impact of significant changes in government charges, indirect taxes, and subsidies;
3. the direct impact of significant price level effects arising from natural disasters;
4. the direct impact of significant changes in import or export prices. (p.6).

The ultimate target of monetary policy is to keep the underlying rate of inflation between zero and three percent. The underlying rate of inflation is the CPI adjusted for the four influences of inflation.

To decide whether monetary policy should be loosened or tightened, formulating monetary policy involves forecasting inflation for at least the next two years as monetary policy has its impact with a lag. The behaviour of the economy is forecasted, as well as the impact of monetary policy on inflation. If the inflation forecast is outside the range of zero to three percent, monetary policy will need to be either tightened or loosened.

For monetary policy to be effective, 'costs' must be taken into account. The first measure of cost is the impact of monetary policy on employment and output. It has been found in some studies that keeping inflation low will not hurt the long run growth rate, in fact long run growth is likely to be enhanced. However, there is a trade off between price stability and the variance in employment and output. Price stability is considered effective if the variances in employment and output are low. A second measure of costs is the fluctuation of the monetary policy instruments. Effective monetary policy is when there are lower fluctuations in interest rates to achieve the objective of price stability.

Monetary policy influences inflation indirectly through a number of channels, the most important being through interest rates and exchange rates. This is where the Reserve Bank is concerned with the impact of the exchange rate on import prices and hence on consumer prices. Through this channel, there is a six to 18 month lag for monetary policy to have an effect on inflation.

Real interest rates also have an effect on wealth, investment, and consumption, and therefore demand and prices. However, through this channel, it takes longer before it has an effect on inflation.

The Reserve Bank, being the banker to the banking system, is able to influence short-term interest rates and therefore able to conduct monetary policy. Each day, banks, the private sector and the government have to settle transactions amongst themselves. This is done through the Reserve Bank, as each bank has a settlement account (deposits) with the Reserve Bank. These settlement accounts cannot go into negative balances on any day.

Databank lets each bank know their net position relative to all the other banks at the end of each banking day as all transactions are processed through Databank. If a bank finds itself in a negative position, then it will have to borrow from banks with a credit balance or sell back some Reserve Bank Bills to the Reserve Bank. Reserve Bank Bills are 63-day instruments that are issued twice a week in tenders of $70 million each. These bills can only be sold back (discounted) to the Reserve Bank if there is 28 days or less until maturity, and they are discounted at a penalty of 0.9%. Banks generally discount bills with only a few days to maturity, as this is an expensive form of one-day loan.

Each day the Reserve Bank conducts open market operations (OMO) and targets the level of aggregate settlement cash to be left in the banking system to be $5 million dollars each day. To see whether settlement cash needs to be injected or withdrew each day, the Reserve Bank prepares daily forecasts of government receipts and payments. If the Reserve Bank is expecting the government to be in surplus for that day, the Reserve Bank will inject settlement cash into the economy by buying government securities from the private sector. However, to cover a government deficit for that day, the Reserve Bank sells Treasury Bills to financial institutions.

Due to government transactions being unpredictable, the target is not achieved precisely. By changing the cash settlement target, the Reserve Bank has an effect on banks obtaining cash through discounting the Reserve Bank Bills. The lower the settlement cash target, the more likely it is that banks will be forced to obtain cash through discounting and vice versa for a higher settlement cash target. The Reserve Bank may also change the discount margin which will also have an effect on banks' discounting.

Changes in either the settlement cash target or the discount margin will have an effect on the interbank interest rate. Expected future short-term interest rates will then have an impact on long term interest rates, as well as an effect on short-term money market rates, which will have an effect on most interest rates and the exchange rate. Increasing the supply of settlement cash, banks will be discounting their Reserve Bank Bills less often, therefore accessing settlement cash is less competitive. This leads to an easing of interest rates and monetary conditions, and banks are more willing to lend. The opposite occurs in the case of reducing the settlement cash target.

In the case of increasing the discount margin, this makes it more expensive for banks to discount their Reserve Bank Bills. In this situation banks will bid more aggressively for wholesale deposits, discourage lending, and increase their access to settlement cash in OMO to avoid the cost of discounting. However, if the discount margin is lowered, monetary conditions and interest rates ease, banks would lend more and compete less aggressively for funds as banks can undertake more business for the same expected cost of discounting.

However, changing the cost of discounting will alter the supply of Reserve Bank Bills. For example a decrease in the discount rate leads to a reduction in the supply of discountable Reserve Bank Bills. In this case bills further away from maturity will have to be discounted and, the longer the maturity, the more costly it is to discount. To avoid discounting, demand for settlement cash will increase and bids for Reserve Bank Bills will be more aggressive, pushing interest rates up, and tightening monetary conditions.

The settlement cash target and the discount margin are hardly ever used to adjust money market instrument settings to obtain the desired exchange rate path. In New Zealand, the Reserve Bank makes public announcements on monetary conditions and indicates to the market the direction of movement required in operational targets. Because the conduct of monetary policy is transparent, financial markets are able to analyse the Reserve Bank's forecasts on monetary conditions and react to these forecasts.

The Reserve Bank could also change the interest rate on settlement cash balances held at the bank overnight to influence monetary conditions. If the Reserve Bank wishes to tighten monetary conditions, it could do this by increasing the rate of settlement cash balances, therefore increasing the demand for settlement cash. This would then reduce the cost of holding settlement cash and tighten monetary conditions. This policy tool is not used very often.

In New Zealand, monetary policy is measured using the Monetary Conditions Index (MCI). The MCI is a numerical indicator of the relative 'tightness' or 'looseness' of monetary policy. Research undertaken by the Reserve Bank of New Zealand has shown that a 1% movement in the 90 Day Bank Bill Rate will have approximately the same impact on future inflationary pressures as a movement of about 2% in the Trade Weighted Index (TWI). Based on this information the Reserve Bank constructed the MCI to incorporate changes in the exchange rate and short-term interest rates. The base period is December 1996 which has a value of

1000. A fall in the MCI indicates that monetary conditions have loosened and that either the exchange rate or short-term interest rates or some combination of both have fallen over that period.

2.2 Monetary Policy in Australia

"The framework for the operation of monetary policy is set out in the Reserve Bank Act 1959 which requires the Board to conduct monetary policy in a way that, in the Board's opinion, will best contribute to the objectives of:

a) the stability of the currency of Australia;

b) the maintenance of full employment in Australia; and

c) the economic prosperity and welfare of the people in Australia." (Costello, 1996, p.2).

Both the Reserve Bank and the government agree that it is important to keep inflation low and to keep inflation expectations low. The Reserve Bank is pursuing the goal of medium-term price stability by trying to keep underlying inflation between two and three percent.

"Monetary policy is set in terms of an operating target for the cash rate, which is the interest rate on the overnight loans made between institutions in the money market." (www.rba.gov.au/about/ab_over.html). A new cash rate is specified if the Board decides to change monetary policy. To tighten monetary policy, there will be a higher cash rate. Adjusting the level of the cash rate will have an effect on all other interest rates.

Each morning the Reserve Bank of Australia will announce the cash rate to the public and if there is a change in policy, there will be an explanation. To influence the cash rate, the Reserve Bank uses open market operations (OMO). Open market operations are aimed at moving the cash rate to the new target level.

The cash rate results from the interaction of the demand for and supply of overnight funds. Banks need funds to settle transactions amongst themselves and the Reserve Bank controls the supply of funds as banks settle their transactions through their exchange settlement account with the Reserve Bank. If the Reserve Bank increases the supply of overnight funds, there will be more funds than the banking system want to hold, so banks lend more which lowers the cash rate.

The demand for exchange settlement funds differs for each bank. However, the demand for settlement funds follows quite a predictable pattern. For example, demand will increase if banks expect payment outside their control (tax payments are due), and demand will fall if banks expect an injection of funds (maturity of government bonds).

The volume of exchange settlement funds available to banks is determined by the transactions of the Reserve Bank and its customers. Open market operations are used to maintain the supply of exchange settlement funds at a desired level.

The Reserve Bank uses a wide range of instruments in OMO that are conducted in government securities. Most transactions take form of repurchase agreements (Repos). These "involve the sale or purchase of securities with an undertaking to reverse the transaction at an agreed date in the future and at an agreed price." (http://www.rba.gov.au/ab_monpol.html).

The Reserve Bank can change the money supply due to:

1. International transactions
2. The government's budget outcome
3. Bank lending

International Transactions and Changes in the Money Supply

Since the Australian dollar floated in December 1983, international transactions do not directly influence the domestic money supply. As Hicks and Wheller (1990) said, "The impact of the international sector on the money supply is now under the control of the Reserve Bank" (p.156). However, the international sector may have some influence on the Australian money supply if the Reserve Bank believes that the Australian dollar is under or over valued and intervenes to reverse the trend.

The Government's Budget Outcome

The budget has an effect on the economy daily as the government receives revenue and makes payments to the private sector. The private sector settles their transactions with the government through private banks. These banks have an exchange settlement account with the Reserve Bank and are used to settle transactions with each other or with the Reserve Bank. This exchange settlement account earns no interest and, like the New Zealand case, it must be kept in credit.

On a typical day, some individuals have to make payments to the government (taxes and other charges). Usually the payment is made by cheque drawn on a private bank. The cheque is received by the government department then deposited with the Reserve Bank. The Reserve Bank will credit this amount to the government's account, and on the following day the Reserve Bank will collect the cash from the bank that the cheque was drawn against. This means that deposit levels for private banks are reduced and the ability to lend is reduced. The same effect takes place if the payment by the individual is by cash. The cash is withdrawn from a bank to pay the government. The government will deposit this cash with the Reserve Bank, and again the money is taken out of circulation.

On the same day, other individuals will be receiving payments from the government (payments for work done, welfare payments, interest payments, and repayment of government debt). The government will make the payment in form of a cheque drawn on the Reserve Bank or by crediting the bank account of the recipient. There may be delays in receiving the cheque and it being deposited in a bank, which may have an effect on the volume of money. If the cheque was deposited on the same day that the individual received it, the recipient's bank is credited, and the cash is collected from the Reserve Bank the next day.

At the start of each morning the settlement position (known as the money market cash position) between banks and the Reserve Bank is calculated and published. If there is a net outflow of cash from the Reserve Bank to private banks - that is if Reserve Bank cheques held by private banks total more than cheques of the private banks held by the Reserve Bank - there will be an increase in the amount of cash in the economy. The increase in the supply of cash will mean that it is easier for money market dealers to obtain cash to settle withdrawals, therefore the price of cash on that day will fall. However, if there is a net inflow of cash to the Reserve Bank at the start of the day, the supply of cash will fall. This will result in an increase in the price of cash.

Servicing Public Debt

On any day, the Reserve Bank can calculate the amount of interest that will be paid to holders of government bonds. The amount payable to bond holders who are going to redeem their bonds on that day can also be calculated. These payments will be made to private individuals, financial institutions, or authorised money market dealers.

Payments are made by cheque to individuals and to institutions and will not affect today's cash, as the recipients of the cash will not receive it until the day after the cheque has been deposited.

Payments made to authorised money market dealers are made directly into their accounts held with the Reserve Bank. There is no delay in the clearing process when the government is dealing with authorised money market dealers, so when a payment is made to the authorised money market dealer, there is an increase in the supply of cash on that day. This will cause interest rates to fall.

Institutions can buy Government Bonds and Treasury Notes by bidding to the Reserve Bank. After the closing of each tender, these securities are allocated to the institutions that bid the lowest interest rate. These institutions have seven days to make payment for the securities. Payment by banks or authorised dealers are made by a debit on their settlement account with the Reserve Bank. So the day that payment is made, there will be a reduction in the supply of cash in the economy. Other successful tenderers pay by cheque, and again, today's cash supply will not be affected. This will affect the supply of cash the following day when the cheque has been lodged with the Reserve Bank.

Dealings by the Authorised Dealers

The authorised money market dealers have a close relationship with the Reserve Bank. The Reserve Bank trades short-term government securities with these authorised dealers to influence the level of short-term interest rates. "These dealers are subject to specific Reserve Bank prudential and other requirements that restrict the scope of their assets, but they are granted lender-of-last-resort facilities by the Reserve Bank." (Hunt and Terry, 1994, p.131).

One of the authorised dealers' special role in the financial system is that transactions made between the Reserve Bank and the dealer have an impact on today's cash. For example: if the Reserve Bank sells government securities to an authorised dealer, cash payment by the dealer will affect today's cash. This is also the case if the Reserve Bank buys government securities from a dealer, in this case the Reserve Bank will make payment today. In the case of a lender of last resort loan made by the Reserve Bank to a dealer, it will have an effect on the amount of cash available that day. When a loan is made, cash increases for the day and on a day when repayment is made, the amount of cash available is reduced.

2.3 Conclusion

This chapter concludes by highlighting the differences between New Zealand and Australian monetary policy. In New Zealand, the sole objective of monetary policy is to keep prices stable. Although price stability is important in the case of Australian monetary policy, the objectives of monetary policy include currency stability, maintaining full employment, and the economic prosperity and welfare of the people.

The way monetary policy is implemented differs between New Zealand and Australia in the targeted policy tools. The Reserve Bank of New Zealand focuses on the settlement cash in that the Reserve Bank of New Zealand does not allow each bank's settlement account to go into overdraft. This means that if banks need cash to settle daily transactions, they have to discount (sell back) Reserve Bank Bills to the Reserve Bank but this comes at a cost. However, in Australia, the Reserve Bank targets the overnight cash rate, the interest rate on loans made between institutions and the money market. To influence the cash rate, the Reserve Bank of Australia controls the supply of funds.

The final difference that is worth pointing out is that the Reserve Bank of Australia trades short-term government securities with authorised money market dealers in order to influence the cash rate, hence short-term interest rates. The transactions made between the Reserve Bank and authorised dealers will affect today's cash. In New Zealand no such activity takes place.

CHAPTER 3

Background Information on Exchange Rates

This chapter is divided into three sections. Firstly, there is a discussion on how the exchange rate policy of New Zealand evolved into a floating exchange rate system. There is also a discussion on the Trade Weighted Index which is a measure of how the New Zealand dollar is performing against other countries. The second part of this chapter looks at the Australian exchange rate policy and the Australian Trade Weighted Index. Finally, this chapter looks at what factors determine the exchange rate. This section also looks at what factors influence the movements in the Australian dollar and the New Zealand dollar.

3.1 The Evolution of the Exchange Rate Policy in New Zealand

The New Zealand dollar was floated in March 1985 and has remained a floating exchange rate since. This means that the exchange rate is determined by the demand for and supply of the New Zealand dollar in the foreign exchange market. New Zealand operates under a clean float, that is, the Reserve Bank does not intervene (buy or sell foreign exchange) in the foreign exchange market to influence the value of the dollar as does the Australian Reserve Bank. Prior to the dollar floating, there had been a number of different exchange rate arrangements in New Zealand.

The Reserve Bank of New Zealand was established in 1934. From then, up until 1961, there was a formal link between the New Zealand currency and Sterling. "The essential feature of this standard was the unrestricted convertibility of New Zealand's currency into Sterling." (Reserve Bank, 1985, p.228).

The Bretton Woods agreement took place in 1944 where it was decided that the US dollar would be pegged against gold at a price of $35 per ounce of gold. This was the beginning of the fixed exchange rate regime where central banks were committed to buy and sell foreign exchange to keep the exchange rate fixed if it came under pressure to devalue or revalue.

It was not until 1961, when New Zealand became a member of the International Monetary Fund (IMF), that the New Zealand dollar became fixed against the US dollar or gold.

In the late 1960s, the Bretton Woods system started to break down. There were two main reasons for this. First, the currencies of countries such as Germany that ran massive balance of payments surpluses at the time became undervalued. Also during that time, the US was funding the Vietnam War by printing more money. So the US dollar was under pressure to devalue, except the US dollar being the 'key' currency couldn't be devalued. This led to the floating of the major currencies.

When the US dollar floated in 1973, New Zealand terminated the link with the US dollar and the value of the New Zealand dollar from then onwards was fixed against a basket of currencies. Since then there had been devaluations and revaluations. However, in June 1979 New Zealand switched to the crawling peg approach to determine the exchange rate. Under this approach, the New Zealand dollar was adjusted to offset differences in inflation rates between New Zealand and its trading partners.

Under the crawling peg system in the late 1970s and early 1980s, the New Zealand dollar depreciated by 0.5% per month against a basket of currencies and this led to the wages and prices freeze being introduced in June 1982. So from then on, the Reserve Bank went back to fixing the dollar against a basket of currencies. As the major trading partners' currencies floated, it became impossible to keep the New Zealand dollar fixed against other currencies. This resulted in the dollar floating on 4th March 1985.

The change to a floating regime was to facilitate structural adjustment in the New Zealand economy in response to changing external circumstances. Under a fixed exchange rate system, a downward adjustment of the real exchange rate is more costly in terms of lost output and higher unemployment than in the case of a floating rate system. Under a fixed rate regime, a fall in the real exchange rate will require a reduced rate of domestic credit expansion and higher interest rates. This then leads to a decline in real activity and eventually wages fall and domestic inflation, relative to overseas, declines. The expenditure effects induced by an increase in interest rates will lead to higher unemployment. The final result is a devaluation in the exchange rate.

Under a fixed exchange rate system, monetary policy independence was limited. From 1974 to 1984, a period when the value of the New Zealand dollar was fixed to a basket of currencies, and when exchange controls were imposed, outward capital flows were restricted but inward capital flows were unrestricted. The government was not able to achieve the same degree of independence when its monetary policy was intended to be tighter than the external sector allowed it to be.

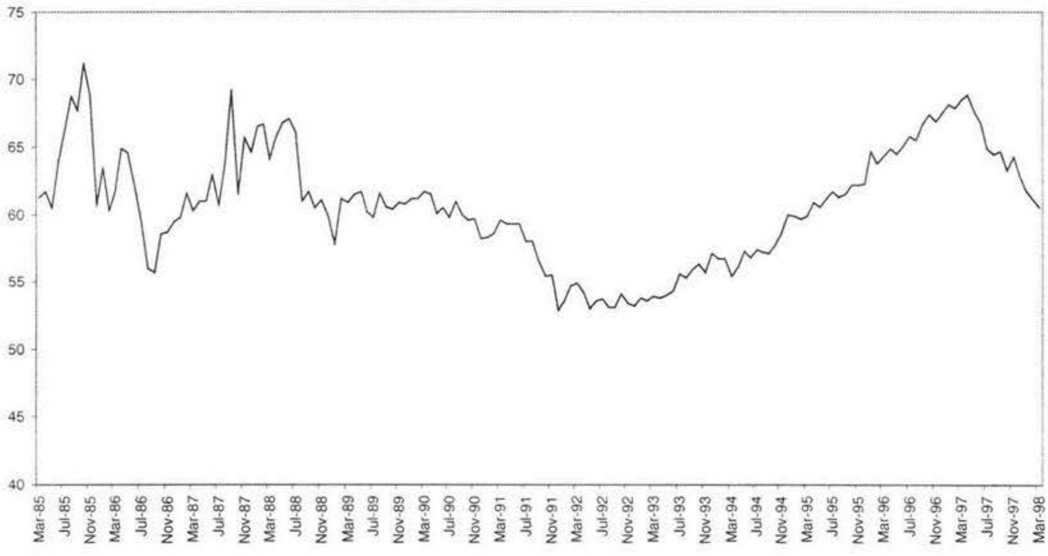
In December 1984 when exchange controls were removed, monetary policy became less independent. A tighter monetary policy means that the Reserve Bank has to sell government securities reducing the domestic money supply. This leads to an increase in interest rates, which means there will be capital inflows. With capital inflows, the demand for New Zealand dollars increases and is under pressure to appreciate. If the Reserve Bank wants to keep the exchange rate fixed, it must intervene by buying foreign currency and selling the New Zealand dollar. This results in an increase in the domestic money supply. Under a fixed exchange rate system, monetary policy is not very effective.

In the case of a floating exchange rate system, there is greater scope for an independent monetary policy at the expense of greater real exchange rate volatility. A tightening of monetary policy will lead to an appreciation of the New Zealand dollar, due to higher interest rates leading to capital inflows. Unlike the fixed rate regime, the Reserve Bank does not have to intervene.

To see how the New Zealand dollar is doing overall compared to its trading partner, instead of looking at each exchange rate individually, the Trade Weighted Index (TWI) has been constructed for this purpose. The TWI looks at the overall trade implications for New Zealand. The TWI weights the currencies of its five main trading partners according to their trade value associated with these countries. The base period is June 1979, which had a value of 100. A rise in the TWI means that the New Zealand dollar has appreciated while a fall means that the New Zealand dollar has depreciated.

Figure 3.1 shows the end of the month values of the New Zealand TWI. The TWI values range from 52.9 in December 1991 to 71.2 in October 1985 for the sample period. After the New Zealand dollar floated, the movements in the TWI were rather volatile. From the end of 1991, the TWI began to steadily increase until the end of 1997 when it started to fall again.

Figure 3.1: New Zealand TWI for the Period March 1985 to March 1998, Monthly Data Used



3.2 The Evolution of the Exchange Rate Policy in Australia

The evolution of the exchange rate policy in Australia is similar to that of New Zealand. The Australian dollar floated in December 1983 and is still operating under a floating exchange rate system. Up until 1971, the Australian dollar was pegged to the UK Pound as Britain was Australia's most important trading partner. Then the Australian dollar was fixed against the US dollar until 1976.

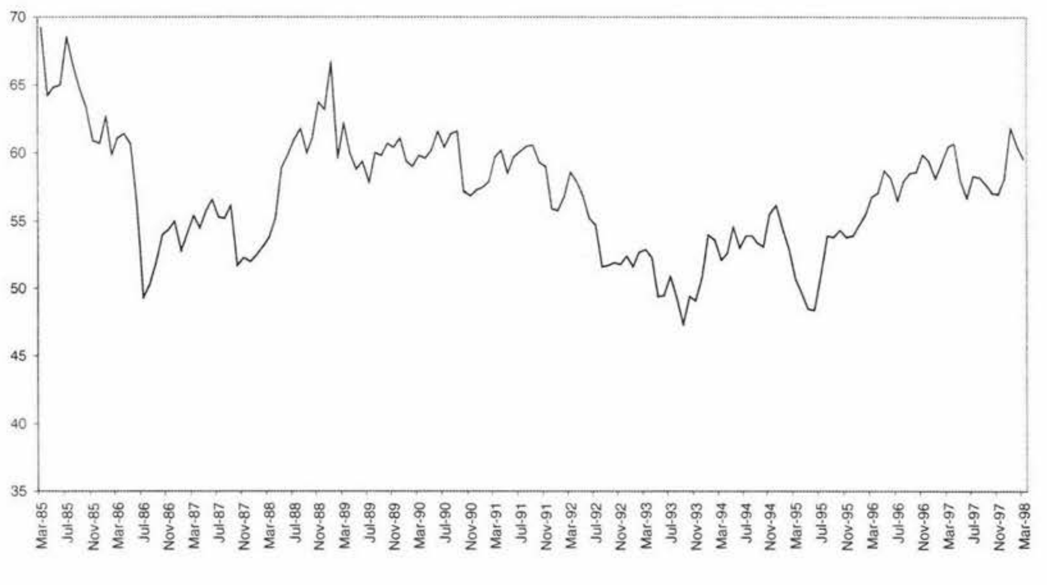
Between 1973 and September 1974, the Australian dollar operated under a system where it was pegged but adjustable to the US dollar. Then after that, until November 1976, the Australian dollar was pegged to a basket of currencies. Then from November 1976 until the dollar floated in December 1983, Australia operated under a crawling peg regime.

Since the floating of the dollar, the nature and the size of the foreign exchange market changed dramatically as exchange controls which limited investment abroad for Australian residents and prevented Australian based firms from borrowing offshore, were also abolished. With foreign banks entering the Australian financial markets there has been increased access to international financial capital. The Australian dollar is now one of the ten most traded currencies in the world.

Australia also uses a trade-weighted index for its nominal effective exchange rate. The currencies that make up the TWI account for over 90% of Australia's trade. The currencies of 24 countries that trade with Australia have individual weights reflecting the importance of trade each way.

Figure 3.2 below shows the monthly Australian TWI values for the period March 1985 to March 1998. The values range from 47.3 in September 1993 to 69.2 in March 1985. The movements in the TWI are very volatile. There are no periods where the TWI is steadily increasing or steadily decreasing as was the case with the New Zealand TWI. When comparing the New Zealand dollar and the Australian dollar, based on the trade weighted index of both countries, it can be concluded that the Australian dollar is more volatile than the New Zealand dollar. The values for the period March 1985 to March 1998 range from about 50 to 70 for both series but the movements are much more volatile for Australia.

Figure 3.2: Australian TWI for the Period March 1985 to March 1998, Monthly Data Used



3.3 Determination of Exchange Rates

The nominal exchange rate is the price of one currency in terms of another. It is generally accepted that changes in the nominal exchange rate may occur when the rate of inflation differs between two countries. For example, if the inflation rate in the UK is persistently above that of its trading partners, the Pound will depreciate. If inflation is persistently below that of its trading partners, like in the case of Germany, the currency will appreciate.

The inflation rate for a country is the rate at which it produces money relative to the rate at which it produces goods and services. If the money supply persistently grows faster than the demand for money arising from growth of real output, this results in inflation.

The real exchange rate is defined as the ratio of foreign to domestic prices, measured in the same currency. It measures a country's competitiveness in international trade.

$$R = eP_f / P \tag{3.1}$$

Where: R = The real exchange rate

e = The price of foreign exchange, domestic price of one unit of foreign currency

P = Domestic price levels

P_f = Foreign prices

Changes in the real exchange rate cannot be attributed to inflation differentials between two countries but reflect structural differences in real economic performance between these countries. The sources of real exchange rate changes according to Korteweg (1980) are:

1. Unstable monetary policy.
2. Change in the growth rate of a country's productivity in manufactured goods.
3. Shifts in international demand.
4. A rise in a country's labour costs.
5. Discovery and exploitation of new natural resources.

Firstly, a sudden change in monetary policy will affect the exchange rate immediately, but the inflation rate will not respond until later because of sticky wages and prices. A monetary expansion will raise the spot exchange rate faster than its inflation rate and result in a temporary rise in the real exchange rate (a real currency depreciation).

Secondly, if the growth rate of a country's productivity in manufactured tradable goods rise relative to productivity in non-tradables, the result is that total output starts rising faster leading to growth in demand for money. Output will grow faster than the demand for it if the rate of monetary expansion does not change. This would lead to a fall in inflation and to an appreciation in the domestic currency relative to other currencies.

An increase in international demand for a country's traded goods away from its competitors would lead to a current account surplus for that country. Overall, the result is a real appreciation of the exchange rate for that country.

If there is a rise in a country's labour costs relative to those of its competitors, this would lead to lower output and lower profits. Lower output growth will lead to more inflation if the rate of monetary expansion remains unchanged. The country's currency will depreciate because competition ensures that the price of traded goods is the same everywhere when expressed in a common currency. If these costs affect both traded and non-traded goods equally, the real exchange rate does not change. However, if costs have more impact on tradables then non-tradables, there will be an appreciation of the real exchange rate.

Finally, in the case of a new resource being discovered and extracted, the country's output growth would increase leading to a lower inflation rate. The balance of trade is improved because of increased exports and a reduction in imports. As a result, there is a real appreciation in the country's currency.

A study done by Makin (1997) looked at the main determinants of the Australian dollar exchange rate. Inflation was found to have an influence on the Australian dollar exchange rate in the long run. During the period of 1970 to 1990 when Australia's price level rose by 35 percent more than the average of its trading partners, the TWI also fell to the same extent during that time. Although the relative inflation performance will have an effect on the Australian dollar in the long run, it does not explain short run fluctuations in the exchange rate. In the short run, movements in the terms of trade will have an impact on the Australian dollar. If international commodity prices rise (fall) the exchange rate depreciates (appreciates).

New information regarding the Australian economy will impact on the nominal exchange rate through short-term international capital flows. If the news is good, foreign funds would move into Australia and the exchange rate will appreciate. However, if the news is bad there will be an outflow of capital causing the Australian dollar to depreciate.

For New Zealand there is no specific study that looks at the determinants of the New Zealand dollar. However, past experiences show that the inflation differential between New Zealand and overseas, capital flows and interest rate have an effect on the movement of the New

Zealand dollar. Since the rate of inflation decreased in the early 1990s, interest rates fell as well. Accompanying these low interest rates was an appreciation of the New Zealand dollar. The appreciation of the New Zealand dollar was due to the inflation differential between New Zealand and overseas shifting in New Zealand's favour. While interest rates reduced in nominal terms, increases in borrowing by individuals and businesses pushed up the real interest rates and this led to further appreciations in the New Zealand dollar.

In the mid 1990s, the New Zealand dollar continued to appreciate but this was due to continuing high real interest rates as inflationary pressures increased. To maintain price stability, the Reserve Bank of New Zealand had to keep monetary conditions tight. As a result, short-term New Zealand interest rates increased at a time when overseas central banks were lowering their interest rates. Because New Zealand's real interest rates were above those of its trading partners, there was an increase in demand for New Zealand dollars so that overseas investors could invest in New Zealand dollar securities. This increase in demand for New Zealand dollars led to a further appreciation of the exchange rate.

Past experiences in New Zealand also show that a fall in interest rates does not always lead to a depreciation of the New Zealand dollar. An example would be October 1996 where both interest rates and the dollar fell briefly, but within a week the TWI was up again although interest rates fell even further. Also when there is an increase in interest rates, the dollar does not necessarily appreciate either.

3.4 Conclusion

Both the New Zealand dollar and Australian dollar have floated for over ten years and both remain floating today. That is the demand for and supply of foreign currency determines the exchange rate. Before both countries floated their currency, both countries had experienced a number of different exchange rate regimes.

Firstly, there was a period where both countries, as well as other countries, operated under a fixed exchange rate regime where the currency was set at a certain level against the US dollar. There were also times when both the New Zealand dollar and Australian dollar was fixed to a basket of currencies. The central banks of these countries were committed to buy and sell foreign currency if the exchange rate came under pressure to devalue or revalue during this period.

One of the reasons why currencies remain floating is that under a fixed exchange rate system, monetary policy is less effective. This is illustrated with the following example. To tighten monetary policy, the government would sell government securities, which would reduce the domestic money supply and push up interest rates. An increase in interest rates would lead to an inflow of capital and the domestic currency is under pressure to appreciate. To prevent this from happening, central banks have to sell domestic currency (buy foreign currency) which in effect is an increase in the domestic currency. Under a floating exchange rate regime, the domestic currency would be allowed to appreciate and central banks do not have to intervene.

When looking at the determinants of an exchange rate, a number of studies found that the inflation differential between two countries is the main determinant of the real exchange rate. Real exchange rate changes are associated with changes in monetary policy, changes in a country's productivity growth rate, changes in international demand, increases in a country's labour costs, and new natural resources becoming available.

CHAPTER 4

Literature Review

This chapter reviews the literature regarding the effects of monetary policy shocks on exchange rates. The first part of this chapter discusses the theories of exchange rate movements due to changes in monetary policy. There are a number of different theories that attempt to explain the effects of a change in monetary policy on exchange rates. These include Dornbusch's (1976) theory of exchange rate movements, the anticipated liquidity effect, and the inflationary expectations effect. The main focus of this section is Dornbusch's exchange rate theory.

Secondly, there is a discussion on the empirical evidence found regarding the impact of monetary policy on exchange rates. These studies test to see which of these exchange rate theories holds. There is a discussion on the empirical studies regarding the impact of monetary shocks on exchange rates, and this is followed by a discussion on the study by Eichenbaum and Evans (1995), on which this study is based.

To conclude, there is a summary of what the empirical studies have found and whether this is consistent with theory.

4.1 Theory of Exchange Rate Movements

"Theories of the determination of the exchange rate suggest that the effect of interest rates on exchange rates depends on the disturbance that leads to the change in interest rates." (Grilli and Roubini, 1995, p.1). A number of different exchange rate models and theories suggest that an expansion in monetary policy reduces interest rates for a given expected inflation rate and will lead to a depreciation in the domestic currency. Conversely, an increase in interest rates leads to a appreciation of the currency. This includes Dornbusch's (1976) theory of exchange rate movements.

Dornbusch (1976) developed a theory of exchange rate movements with the assumptions of perfect capital mobility, a slow adjustment of goods markets relative to asset markets, and consistent expectations. Part of Dornbusch's study looked at the adjustment process of the exchange rate to a monetary expansion.

If the economy is in equilibrium initially, an increase in the quantity of money will cause disequilibrium in both the goods and assets markets. To maintain asset market equilibrium, the increased quantity of money will have to be matched by a higher price level and/or a depreciation in the exchange rate.

Firstly, assuming that output is fixed at the full employment level in the short run, a monetary expansion will cause interest rates to fall and the exchange rate is expected to depreciate. Both these factors reduce the attractiveness of domestic assets so there will be an outflow of capital and as a result the spot rate depreciates. According to Dornbusch, this immediate depreciation of the spot exchange rate will exceed that of the long run equilibrium exchange rate and only in these circumstances will the public anticipate an appreciating exchange rate and be compensated for the lower interest on domestic assets.

The interest response of money demand will have an effect on how much the exchange rate will overshoot by. Overshooting would be less if there is a high interest response of money demand. In the case of a monetary expansion, there will only be a small reduction in the interest rate. To offset this, only a small appreciation in the exchange rate is required. The overall effect is that there will only be a small depreciation of the exchange rate.

Based on this theory, Dornbusch concluded that the effects of monetary expansions are entirely dominated by asset markets, more specifically by capital mobility and expectations.

Dornbusch's theory of exchange rate movements was extended so that output can be adjusted in the short run. A monetary expansion has the effect of increasing output in the short run and induces inflation (the price level increases). Since output now adjusts in the short run, the effects of a monetary expansion on the exchange rate now differs from when output was fixed. This is because increased output leads to income expansion, which raises money demand. If output expansion is strong, this increase in money demand could raise the interest rate. However, when output is fixed, interest rates fall when there is a monetary expansion. In the case of output being variable, the effect on the exchange rate will be dampened.

Although the exchange rate will depreciate, it will not exceed the long run equilibrium exchange rate as much as in the case when output is fixed.

Naturally, the question one would ask is which assumption is more relevant. Dornbusch argued that keeping output fixed rather than variable was more relevant in the very short run as output does not adjust instantaneously to meet an increase in aggregate demand. However, in the intermediate run, output being variable is more relevant since both output and prices are expected to respond to increased aggregate demand.

Other theories on the impact of monetary policy on exchange rates include the anticipated liquidity effect, and the inflationary expectations effect. Firstly, the anticipated liquidity effect says that an expansion in monetary policy leads to an appreciation of the domestic currency. This is because an unanticipated increase in the money supply is an indicator to the market that monetary authorities will slow money growth in the near future. Because the market believes that slower money growth will raise domestic interest rates via the usual liquidity effect, it anticipates an increase in the domestic currency due to the widening of the spread between domestic and foreign real interest rates. As a result the domestic currency will appreciate immediately.

However, the result is the opposite for the inflationary expectations effect. The inflationary expectations hypothesis suggests that an unanticipated increase in the money supply gives rise to expectations of further easing and higher future inflation. The domestic currency will depreciate immediately as the market expects the domestic currency to decline with higher inflation.

4.2 Empirical Evidence

Batten and Thornton (1985) found that explanations of exchange rate movements focused on two factors: changes in credit market conditions reflected by changes in interest rate differentials across countries, and changes in the monetary policy stance of central banks especially those of the Federal Reserve.

Batten and Thornton tested the validity of these explanations. More specifically, their study looked at the impact of changes in short-term interest rate differentials between the US and the following countries: Canada, France, German, Japan, and UK, and how this impacted on the US dollar exchange rate against each of these countries. Batten and Thornton also investigated the impact of unexpected changes in monetary policy on exchange rates, where the discount rate was used as a measure of a change in monetary policy.

Batten and Thornton used daily data for their study from January 2, 1975 to October 31, 1984. To test whether changes in monetary policy and interest rates had any impact on the exchange rates, a regression equation was estimated. This model looked at changes in the exchange rate where the exchange rate was expressed as the US dollar price of a unit of foreign currency and tested whether the exchange rate was affected by past exchange rate values, the discount rate, and an interest rate differential between the US 90 day CD rate and a comparable foreign short-term interest rate.

During the sample period, there were 37 changes in the discount rate. Sixteen of these were made for technical reasons, 14 of these included domestic monetary policy considerations, and seven included international policy considerations.

Firstly, the results showed that all estimations had low adjusted R^2s. This means that most of the variance of the exchange rate movements is attributable to unexpected events. This result is consistent with the asset market approach to exchange rate determination.

Secondly, the results showed that when the US discount rate is increased (decreased), the US dollar appreciated (depreciated) against each of these currencies. Other things being equal, a one percentage point change in the discount rate led to a change in the exchange rate that ranged from a low of 0.11 percentage points (Canada) to a high of 0.73 percentage points (Germany).

When the discount rate changes were separated into categories based on the reasons for the change, the results differed across countries. When changes to the discount rate were made for technical reasons, this had no effect on the exchange rate since these changes did not represent Fed policy. When the discount rate changes were made for domestic reasons, the results showed that it was statistically significant for Canada, France, and Germany. When changes were made for international reasons, this was significant for all countries except for Canada.

Finally, changes in the interest rate differential were found to have a statistically significant impact on daily exchange rate movements for every country. More specifically, an increase (decrease) in the interest differential resulted in an appreciation (depreciation) of the US dollar exchange rate. However, the magnitude of the exchange rate movements differed across countries. A one-percentage point change in the interest differential resulted in a 0.72 percentage point change in the dollar/Deutsche Mark exchange rate, and 0.08 percent for the dollar/Canadian dollar exchange rate.

Batten and Thornton did further tests for the dates November 1, 1978 and October 6, 1979. Further testing was done for November 1, 1978 because it was expected that a change in the discount rate would have a larger impact on the foreign exchange value of the dollar since the Fed wanted to strengthen the dollar during that time. For October 6, 1979 further testing was done because on that day, the Fed had changed the way domestic monetary policy was implemented.

The discount rate change made on November 1, 1978 was found to be an important discount rate change. The results were found to be significant for all countries except for Canada.

When discount rate changes were partitioned into before and after October 6, 1979, the results showed that changes in the interest differential were not statistically significant before October 6, but highly significant afterward. This may be because inflation was rising rapidly in the US relative to the rest of the world for the period January 1, 1975 to October 6, 1979. Any changes in the nominal interest rate differential reflected changes in inflationary expectations and therefore had no impact on the foreign exchange value of the dollar. After October 6, 1979 inflation declined dramatically due to changes in the way monetary policy was implemented. Any changes in the nominal interest rate differential were due to real interest differential changes and this had a positive effect on the foreign exchange value of the dollar.

Batten and Thornton found that when the US discount rate was increased (decreased), the US dollar appreciated (depreciated) against each of these currencies. They interpreted the increase in the discount rate as a contraction in monetary policy and this led to an appreciation of the US dollar. A contraction in US monetary policy also led to a rise in US short-term interest rates, hence the interest differential between US and foreign interest rates, increased. Batten and Thornton also found that an increase in the interest differential led to an appreciation of the US dollar.

A further study carried out by Thornton (1989), investigated the response of the US money market and foreign exchange market using six bilateral exchange rates where the market's responses to unanticipated changes in the money stock were measured over narrow time intervals. The purpose of this study was to test whether the anticipated liquidity effect or the inflationary expectations effect held.

For this study, Thornton used weekly data for the period January 5, 1978 to January 26, 1984. The data was divided into three sub-periods: January 5, 1978 to October 5, 1979; October 9, 1979 to October 6, 1982; and October 8, 1982 to January 26, 1984. The exchange rates considered were the bilateral US exchange rates for six countries: UK, Canada, Germany, France, Japan, and Switzerland.

Firstly, the results showed that there was a strong positive relationship between the foreign exchange value of the dollar and unanticipated money for all six countries post 1979. That is a fall in the stock of money led to an increase in interest rates and as a result the dollar appreciated. The results are consistent with the anticipated liquidity effect. However, pre 1979, the results were statistically insignificant for all currencies.

For the period October 1979 to October 1982, the foreign exchange market did not respond frequently to unanticipated changes in money. There was also times when the dollar decreased in response to an unanticipated rise in the money stock.

The results for the post October 1982 period showed that unanticipated changes in the money stock during that period led to a positive response of the dollar. There were very few negative responses during that period.

Finally, the results showed very little support for either the anticipated liquidity effect or the inflationary expectations effect. For the period October 1979 to October 1982, only 15% of the unanticipated changes in the money stock were consistent with the anticipated liquidity effect. For the period post October 1982, only 19% of unanticipated changes in the money stock were consistent with the anticipated liquidity effect. Although there was weak support for the anticipated liquidity hypothesis, there was more support for it than for the inflationary expectations hypothesis. During the post October 1979 period, there was no evidence to support the inflationary expectations hypothesis.

As part of Lewis' (1993) study looking at foreign exchange intervention and monetary policy, Lewis examined the impulse response functions of the US dollar against the Deutsche Mark and the Yen to shocks on various monetary variables. Three different measures of monetary policy were used. The first variable used was M1, which is frequently used as a measure of money supply. The second monetary aggregate used was non-borrowed reserves. The third monetary variable used was the Federal funds rate as Bernanke and Blinder (1992) found that the Federal funds rate is a strong predictor of real economic activity relative to other monetary variables.

The exchange rates examined were the US dollar against the Deutsche Mark, and the Yen. The sample period was from 1985 to 1990 and weekly data was used. It should be noted that the innovations in monetary variables did not control for real economic activity. Changes in monetary conditions are usually due to changes in the inflation rate and income growth, but these measures are only available monthly or quarterly.

Firstly, Lewis examined whether exchange rates are dependent on US monetary variables, using a bi-variate vector autoregression (VAR) model of the US monetary variables together with the exchange rates and examined the impulse response functions of the exchange rates to a shock on each of the monetary variables.

The results to the DM/US dollar exchange rate were as follows. A one percent shock on M1 led to an immediate depreciation of the US dollar against the Deutsche Mark and the US dollar continued to decline. The second variable shocked was non-borrowed reserves and this had no immediate effect on the DM/US dollar exchange rate. However, the US dollar depreciated against the Mark, even 20 weeks after the shock on non-borrowed reserves. The third variable shocked was the Federal funds rate. Again there was no immediate effect on the exchange rate. Two weeks after the shock on the Federal funds rate, an appreciation of the dollar occurred.

On examining the shock of the monetary variables on the Yen/dollar exchange rate, Lewis found a shock on M1 led to very little variation in the exchange rate and the confidence intervals were very large. The point estimates of the impulse responses to non-borrowed reserves shocks and Federal funds rate shocks generally imply movements in the exchange rate in the direction suggested by a monetary model with liquidity effects.

Lewis then investigated further to see whether the exchange rate was dependent on relative monetary policies. A foreign monetary variable was introduced into the model, this being the German and Japanese call rates. A tri-variate VAR model was estimated for the US dollar against the Deutsche Mark or the Yen with a monetary variable included in each model plus either the German or Japanese call rate.

The impulse responses for the US dollar against the Deutsche Mark from the shock on each monetary variable on controlling for German interest rates was found to be very similar to the impulse responses when the German call rate was not included in the VAR model. This was also the case for the Yen.

Evans (1994) examined the relationship between short-term interest rates in the US, Germany, and Japan, and the movements in the Mark/dollar and Yen/dollar exchange rates. Although this study by Evans did not directly look at the effects of monetary policy on the Mark/dollar and Yen/dollar exchange rates, it is relevant because changes in monetary policy affects interest rates and these changes in interest rates may have an effect on exchange rates. A positive shock to the Federal funds rate is defined as an unforecast increase in the Federal funds rate that results in movements in the foreign interest rate and the exchange rate. A shock such as this may be a result of a contraction in monetary policy.

Evans used weekly data for his study for the period 1979 to 1994. To investigate the relationship between interest rates and exchange rates, a three variable VAR was estimated for each country. The three variables in the VAR are the Federal funds rate, the difference between the foreign interest rate and the Federal funds rate, and the logarithm of the exchange rate (Mark/dollar or Yen/dollar).

The results showed that a positive shock to the Federal funds rate led to a persistent appreciation of the dollar against both the Mark and the Yen. The effect of the Federal funds shock on the Mark and the Yen were delayed and in both cases the maximal effect does not occur until at least two years after the shock.

Secondly, Evans found that a shock to the interest differential did not have such a strong effect on the exchange rate as in the case of a shock to the Federal funds rate. A shock to the spread of the foreign interest rate and the Federal funds rate represented a shock to the foreign interest rate (German/Japanese interest rate). A positive shock to the foreign interest rate caused the Federal funds rate to fall slightly. The result was that the dollar is expected to depreciate against both the Mark and the Yen.

When there was a positive exchange rate shock, Evans found that the dollar appreciated against the Mark and Yen and this appreciation lasted for about three years. Exchange rate shocks were found to have a large, persistent, and significant effect on the Mark/dollar and Yen/dollar exchange rates.

Finally, Evans found that it was hard to forecast exchange rate movements in the short run (less than one year). This is consistent with other studies that looked at forecasting exchange rate movements. Also, in the longer run, shocks to the Federal funds rate may explain movements in exchange rates.

Grilli and Roubini (1995) looked at the effects of monetary policy shocks on exchange rates in the G-7 countries based on the study by Eichenbaum and Evans (1995) which is discussed later in Section 4.3.

It was found that for a given expected inflation rate, an expansion in monetary policy led to a fall in the domestic interest rate and then led to a depreciation of the nominal exchange rate. In the case of a contraction in monetary policy, interest rates would rise and the nominal exchange rate would appreciate. However, if changes in monetary policy are associated with a change in expected inflation, then a contraction in monetary policy will lead to an increase in interest rates but the exchange rate will depreciate. It may be likely that monetary shocks are a combination of a liquidity effect (a decrease in interest rates and currency depreciation) and a Fisherian inflationary effect (an increase in interest rates and a currency depreciation).

Grilli and Roubini investigated exchange rate movements to see whether the liquidity effect or the Fisherian inflationary effect held, based on changes in monetary policy. The liquidity effect should dominate in the short run in response to a change in monetary policy, while the Fisherian effect should be more important in the medium-long run. An unrestricted VAR model was used to identify monetary policy shocks. Innovations in short-term interest rates were used as the measure of monetary policy rather than innovations in a monetary aggregate. The first reason was because interest rates are the instrument used by central banks of these countries rather than monetary aggregates. Secondly, non-borrowed reserves to total reserves are not policy instruments in the non-US countries and this data is also not available. Finally, other studies have found that using monetary aggregates leads to the liquidity puzzle found for the US.

The countries looked at in the study were the six non-US G-7 countries: Japan, Germany, France, UK, Canada, and Italy. The impulse response functions to interest rate innovations in each of the non-US G-7 countries were estimated using a seven variable VAR. The ordering of the variables was as follows: domestic industrial production, domestic consumer price level, US industrial production, US short-term interest rates, domestic short-term interest rates, domestic monetary aggregate, and the nominal exchange rate of the country considered relative to the US dollar. Note that the exchange rate is expressed as units of domestic currency per one US dollar. Like Eichenbaum and Evans, Grilli and Roubini uses monthly data for the period January 1974 to December 1991.

Unlike Eichenbaum and Evans, who consistently found that US monetary contractions led to an appreciation of the US dollar, Grilli and Roubini found that the Deutsche Mark, French Franc, Italian Lira and the Canadian dollar depreciated against the US dollar when there was a positive shock to the domestic interest rate due to the contraction in monetary policy. However, in the case of Japan and UK, an increase in the domestic interest rate led to an appreciation of these exchange rates relative to the US dollar. When considering the shocks of foreign interest rates (the US interest rate) to these countries, Grilli and Roubini found that all six countries' currency depreciated against the US dollar.

There are several explanations for a Fisherian effect (a positive shock to the domestic interest rate being associated with a depreciation of that country's currency). Firstly, there is the leader-follower hypothesis where the US has a leader role and sets monetary policy independently from the behaviour of the other G-7 countries. Then there are the followers, which are the other G-7 countries. They are followers in that their interest rate policy is affected by US monetary actions. In this situation, an increase in the US interest rate would lead to the dollar appreciating. If the follower countries respond to the appreciation of the US dollar by increasing their interest rates, the dollar might still appreciate but not by as much.

The second explanation to the Fisherian effect is that interest rate innovations are an endogenous response to inflationary pressure. If inflationary expectations increase, then an increase in interest rates would result in a depreciation rather than an appreciation of the currency. An appreciation is observed if expected inflation is controlled for.

Grilli and Roubini carried out further tests. The VAR system was then modified as follows:

- The effects of interest rate innovations on the cross exchange rates between Japan, Germany, UK, France, and Italy were used.
- A two country seven variable VAR system was used. The variables were ordered as follows: domestic output, the domestic inflation rate, foreign output, the foreign inflation rate, the foreign nominal interest rate, the domestic nominal interest rate, and the nominal exchange rate (units of domestic currency per one unit of foreign currency).
- The monetary aggregate measures were dropped.

From the modified VARs, the results were as follows. When examining the effects of US interest rates on the US dollar exchange rates, the results Grilli and Roubini found are consistent to those found by Eichenbaum and Evans, that is an increase in US interest rates resulted in an appreciation of the US dollar. For the other six countries the results were mixed. An increase in the domestic interest rate in Germany, France, and Italy resulted in a depreciation of the currency. In the case of Japan, UK, and Canada, an appreciation of the exchange rate resulted. When Grilli and Roubini investigated the effects of monetary policy shocks on cross exchange rates, there was less evidence of an 'exchange rate puzzle'.

Finally, Grilli and Roubini found that uncovered interest rate parity does not hold. Under certainty, uncovered interest parity would imply that the exchange rate depreciation would equal the interest rate differential and that the risk premium (differential between domestic and foreign interest rates minus the percentage of exchange rate depreciation) would equal zero. With uncertainty the interest differential does not always equal the depreciation, but the risk premium should on average be equal to zero. The results from this study clearly showed that the risk premium is persistently positive when there is a positive interest rate innovation.

Grilli and Roubini concluded that the impact of US monetary shocks on the US dollar exchange rate was consistent with other studies, that is an increase in interest rates led to an appreciation of the US dollar. However, for the other G-7 countries the results were mixed. If US monetary policy and inflation were controlled for, an increase in interest rates led to persistent currency appreciations in the G-7 countries. Also the results found failed to explain interest rate parity conditions.

Floyd (1996) examined the effects of unanticipated shocks to the money supply on real exchange rates. The real exchange rates of nine major industrialized countries (Canada, Australia, Austria, Germany, US, UK, Japan, Italy, and France) were examined. The sample period was from January 1974 to March 1991. To test the effect of unanticipated monetary shocks on the real exchange rates, Floyd estimated the ordinary least squares (OLS) regressions for the real exchange rates. A number of variables were included in the model including real income, government consumption, government budget surplus, oil prices, the terms of trade, net capital outflow, unanticipated M1, and unanticipated M2.

Floyd's results showed that unanticipated money shocks did not have a significant effect on the real exchange rates. The results showed that the real exchange rate series tended to be low frequency series and that unanticipated monetary shocks tended to be high frequency white noise series. Unanticipated money shocks being a high frequency series could explain very little of the major movements in real exchange rates. Floyd concluded that shocks related to technological change, real income cycles, commodity market developments, and government fiscal policy virtually explained all the variability of real exchange rates. Also there was no evidence that money shocks had any effect on the real exchange rates.

Cushman and Zha (1997) examined the effects of monetary shocks on a small open economy under flexible exchange rates. More specifically they investigated the effects of monetary shocks on the Canadian economy using a structural VAR approach. For this study monthly data was used for the sample period 1974 to 1993. Although the Canadian dollar floated in 1970, the sample period avoided the oil price shock of 1973 and the unsettled period for the US dollar that preceded generalized floating.

Firstly, Cushman and Zha examined the impact of monetary policy (interest rates) on the Canadian dollar against the US dollar by using methods previous studies used. A VAR was estimated with the variables ordered as follows: US industrial production, the US consumer price index, the US Federal funds rate, the world total exports commodity price index in US dollars, Canadian exports to the US, Canadian imports from the US, Canadian industrial production, the Canadian consumer price index, the Canadian three month Treasury Bill rate, Canadian M1, and the Canadian/US dollar exchange rate.

The results showed that a contraction in US monetary policy resulted in a positive shock to US interest rates, which led to the Canadian Dollar depreciating against the US dollar. These results are consistent with other studies looking at the impact of US monetary policy on exchange rates. However, when there is a contraction in Canadian monetary policy the result differs. Canadian interest rates rise when there is a contraction in monetary policy, but the Canadian dollar depreciates against the US dollar. The exchange rate puzzle is present in the data when an unrestricted VAR was estimated.

Using the structural VAR approach, Cushman and Zha found that a contraction in Canadian monetary policy was followed by an immediate and significant appreciation in the Canadian dollar, which lasted for about 12 months. The exchange rate puzzle is not present using the structural VAR approach. Also movements in the real exchange rate were found to be similar to nominal exchange rate movements. These findings are consistent with theory and other studies.

Bonser-Neal et al (1998) reexamined the relationships among Federal Reserve monetary policy actions, US interventions in currency markets and exchange rates using event study methodology unlike previous studies, which used vector autoregressions (VARs). This study also differs from previous studies as Bonser-Neal et al measured monetary policy by the Federal funds rate target, which was actually used by the Federal Reserve to implement monetary policy. Previous studies looked at the effects of changes in the actual Federal funds rate rather than the target Federal funds rate which means these studies failed to control for differences in monetary policy regimes. There were two sub-periods when the Federal Reserve implemented monetary policy using a Federal funds rate target. Firstly, from September 1974 to September 1979, then from October 1987 to 1994. From September 1979 to October 1987, the Fed used a reserves targeting procedure and then an interest rate targeting procedure. During this period Bonser-Neal et al used the Federal funds rate target series developed by Rudebusch (1995a, 1995b).

The responses of four currencies against the US dollar were examined: the Deutsche Mark, the Yen, the British Pound, and the Canadian dollar. The exchange rates were expressed in terms of units of foreign exchange per one US dollar.
The responses of the spot exchange rates, forward exchange rates, forward premia to a change in the Federal funds rate target were examined. A two-day event window for the exchange rate response was used to maximize the change of measuring the market's complete response while at the same time minimizing the possible effects from other economic factors.

In the 1974-79 period, three out of the four spot exchange rate responses were significantly different from zero at the 5 % level and they were of the expected sign. For example a one percent increase in the Federal funds rate resulted in a 1.22 percent rise in the value of the US dollar against the Deutsche Mark. In the post 1987 period, three out of the four spot exchange rate responses were positive and significant at the 10% level. These results suggest that the immediate response of exchange rates to US monetary policy actions are statistically and economically significant in majority of the cases.

The results Bonser-Neal et al found differ to those of previous studies. Previous studies using VARs, resulted in exchange rate response patterns that were inconsistent with the overshooting hypothesis. However, Bonser-Neal et al found that only one of the eight cases rejected the overshooting hypothesis.

4.3 Study by Eichenbaum and Evans

This study is based on the work of Eichenbaum and Evans (1995) who looked at the effects of US monetary policy shocks on exchange rates. To test the robustness of their results, three different measures of monetary policy shocks were used: the orthogonalized components of the innovation to the ratio of non-borrowed to total reserves, the orthogonalized components of the innovation to the Federal funds rate, and the Romer and Romer index of monetary contractions.

Firstly, a non-borrowed reserves based measure was used rather than a broad monetary aggregate because non-borrowed reserves reflect exogenous shocks to monetary policy while broader monetary aggregates reflect shocks to money demand. Other studies have also used non-borrowed to total reserves as a measure of monetary policy and have found it to be a good measure of shocks to the money supply. Secondly, orthogonalized shocks to the Federal funds rate was used in this study because it is a better measure of monetary shocks than orthogonalized shocks to the stock of money. Finally, the Romer and Romer index was used as a measure of monetary shocks because Romer and Romer were able to identify specific periods when a contraction in monetary policy was initiated by the Federal Open Market Committee.

This study used monthly data for the sample period January 1974 to May 1990. Five nominal spot exchange rates were considered: the Yen, Deutsche Mark, Lira, French Franc, and UK Pound. In this study the exchange rate was defined as the number of US dollars per one unit of foreign currency. This means that an increase in the exchange rate corresponds to a depreciation of the US dollar. Again, vector autoregression (VAR) methodology was used. All VARs were estimated using six lags for each variable. Eichenbaum and Evans did a number of tests for each of the exchange rates. The testing of each exchange rate was carried out using a benchmark specification, and then each of the three measures of monetary policy shocks were used.

Firstly, a five variable benchmark was used to look at the impact of monetary shocks on each of the exchange rates. The variables included US industrial production, the US consumer price level, ratio of non-borrowed to total reserves, a measure of the difference between short-term US and foreign interest rates, and the real exchange rate.

The results showed that a contraction in US monetary policy led to a persistent decrease in the spread between foreign and US interest rates. Secondly, movements in the nominal and real exchange rates were highly correlated. The third important result found was that a contraction in US monetary policy lead to persistent appreciations in the US dollar exchange rates (both nominal and real). The monetary shocks on the nominal and real exchange rates do not occur contemporaneously. This is not consistent with the simple overshooting models where a contraction in monetary policy leads to a large appreciation of the exchange rate followed by subsequent depreciations.

The movement of the exchange rate was found to be inconsistent with uncovered interest rate parity. In theory, a contraction in US monetary policy leads to US interest rates rising and hence a fall in the interest differential between foreign and US interest rates. This fall in the interest differential is offset by an expected depreciation of the dollar. However, the results showed that a contraction in monetary policy led to a fall in the expected return from investing in foreign bonds relative to the returns from investing in short-term US Treasury Bills.

When looking at non-borrowed to total reserves as a measure of monetary policy, a seven variable VAR was estimated. The variables included US industrial production, the US consumer price level, foreign output, the foreign interest rate, the ratio of non-borrowed to total reserves, the three month Treasury Bill rate, and the real exchange rate.

The results showed that a contraction in monetary policy leads to a sharp and persistent increase in the US interest rate as well as a rise in foreign interest rates. However, the increases in US interest rates exceeded the increases in foreign interest rates. Like in the case of using the benchmark specification, a contraction in monetary policy led to persistent appreciations in the US dollar. However, due to the large number of variables in the VAR, the impulse response functions were less precisely estimated than in the benchmark specification. Again the overshooting hypothesis did not hold.

When monetary shocks were measured as an orthogonalized component of the innovation to the Federal funds rate, a seven variable VAR was estimated. These seven variables being US industrial production, the US consumer price level, foreign output, the foreign interest rate, the Federal funds rate, the ratio of non-borrowed to total reserves, and the real exchange rate. The results found are similar to those when non-borrowed to total reserves was used as a measure of monetary policy.

Consistent with the liquidity effect, an increase in the Federal funds rate led to a sharp and persistent decline in the ratio of non-borrowed to total reserves. Again a contraction in monetary policy led to persistent appreciations in the US dollar exchange rates. The maximal impact of the monetary shocks on the nominal and real exchange rates did not occur contemporaneously. Again the nominal and real exchange rates were highly correlated as the dynamic response functions of the nominal and real exchange rates were quite similar.

There were persistent increased returns when investing in short-term US bills relative to foreign bills when there was a contraction in monetary policy. Also, there is substantial evidence that monetary policy shocks have a large impact on the variability of the exchange rates when the Federal funds rate is used as a measure of monetary shocks.
Finally, Eichenbaum and Evans tested monetary shocks on exchange rates using the Romer and Romer index of monetary policy. The variables included in the VAR were US industrial production, the US consumer price level, foreign output, the foreign interest rate, the ratio of non-borrowed to total reserves, the real exchange rate, the Federal funds rate and the Romer and Romer index of monetary policy.

An increase in the Romer and Romer index (contractionary monetary policy) is associated with an increase in the Federal funds rate and a decrease in non-borrowed to total reserves. The results showed that the maximal increase in the Federal funds rate and a decrease in non-borrowed to total reserves did not occur at the same time as the index but occurred six months later. The dynamic response functions of the nominal and real exchange rates were initially zero or slightly negative but after six months the US dollar appreciated. Finally, the results showed that uncovered interest rate parity does not hold, that is a contraction in US monetary policy leads to excess returns when holding US Treasury Bills relative to short-term foreign bonds.

This section is concluded by summarizing the results found in the study by Eichenbaum and Evans (1995). When Eichenbaum and Evans investigated the effects of monetary shocks on the US dollar exchange rates (both nominal and real), three measures of monetary shocks were used: the ratio of non-borrowed to total reserves, the Federal funds rate, and the Romer and Romer index of monetary policy. There was strong evidence that a contraction in US monetary policy led to persistent appreciations in the US dollar, which were found to be significant. Secondly, uncovered interest rate parity does not hold. Uncovered interest rate parity implies that a contraction in monetary policy will result in a depreciation of the US dollar. Instead the results showed that the dollar appreciated and there were excess returns associated with investing in short-term US Treasury Bills relative to foreign bonds. Finally, Eichenbaum and Evans concluded that monetary policy was important in explaining exchange rate movements but does not explain the majority of the movements in the exchange rate.

4.4 Conclusion

The empirical studies have found mixed results regarding the impact of monetary policy shocks on exchange rates. Firstly, US studies that looked at the effect of monetary policy on the US exchange rate were consistent. That is, the liquidity effect was present. In another words a contraction in US monetary policy led to US interest rates rising and as a result the US dollar appreciated.

However, studies investigating the effects of monetary policy on exchange rates for non-US countries tended to show mixed results. The results found was that a contraction in monetary policy in the non-US countries resulted in interest rates rising, but the domestic currency would depreciate instead of appreciate, so the exchange rate puzzle is present. Other studies carried out for non-US countries found results similar to that of the US.

All studies that estimated VAR models found that Dornbusch's overshooting hypothesis does not hold. The overshooting theory suggests that when there is an expansion in monetary policy, a depreciation of the domestic currency is expected and the maximal impact of the shock occurs contemporaneously. The domestic currency is then expected to appreciate again back to its long run equilibrium level. Although some studies found that the domestic currency appreciated in response to a contraction in monetary policy, the maximal impact of the shock was usually delayed. Only one study showed that the overshooting theory held, the study done by Bonser-Neal et al (1998) where event study methodology was used.

CHAPTER 5

Data Sources

The data used for this study was monthly data for the period March 1985 to March 1998. This period was chosen because the New Zealand dollar floated in March 1985. Although the Australian dollar floated in December 1983, the sample period considered when looking at the impact of Australian monetary shocks on the exchange rate is the same as that for New Zealand for time frame consistency.

Exchange Rates

The exchange rates used in this study when testing the effects of New Zealand monetary policy on the exchange rate were the New Zealand dollar against the Australian dollar, the Japanese Yen, the UK Pound, and US dollar. When looking at the impact of Australian monetary policy on the exchange rate, the exchange rates considered were the Japanese Yen, the New Zealand dollar, the UK Pound, and the US dollar,

The New Zealand dollar exchange rates and the New Zealand Trade Weighed Index values were obtained from the Reserve Bank of New Zealand. The Australian dollar exchange rates, excluding the New Zealand – Australian dollar exchange rate were obtained from Datastream International. The Australian Trade Weighted Index was also obtained through Datastream International.

Real exchange rates were required for this study. Since this information was not available, it was calculated as follows:

$$R = e\, P_f / P \qquad (5.1)$$

Where P and P_f are the domestic price levels and price levels abroad respectively, and e is the exchange rate expressed as the domestic price of a unit of foreign currency.

Consumer Price Indices

The consumer price indexes for New Zealand, Australia, Japan, UK, and US were obtained through Datastream International. The CPI values were monthly for Japan, UK, and US but were only available quarterly for New Zealand and Australia. For Australia and New Zealand where only quarterly data was available, it was averaged out and converted into monthly data.

Proxy for the Ratio of Non-borrowed to Total Reserves

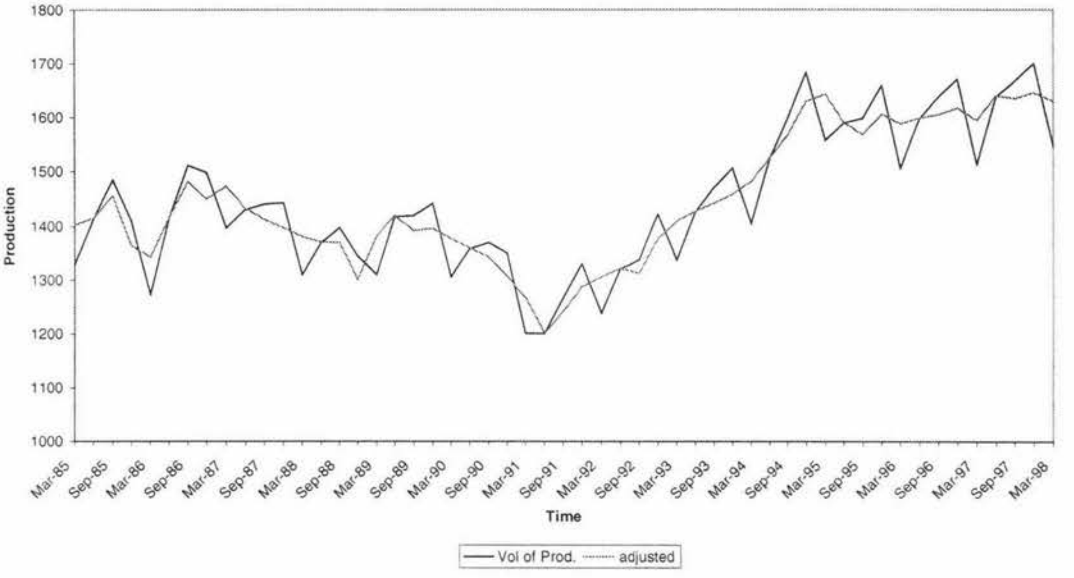
This information is not available in New Zealand or Australia, so M1 was used as a proxy for both New Zealand and Australia. For New Zealand, M1 was obtained from the Reserve Bank of New Zealand Bulletins and for Australia, M1 was obtained from the Reserve Bank of Australia.

Industrial Production

The Volume of Production Index was used as a measure of New Zealand production. This was obtained through the Reserve Bank of New Zealand. The data was only available quarterly so this had to be converted to monthly data. When the Volume of Production Index was graphed against time, there was a definite seasonal component in the data. The data showed that production was always on a high in September and on a low in March. Figure 5.1 shows the graph of New Zealand production. After seasonally adjusting the data, the seasonal component is not so obvious.

To seasonally adjust the New Zealand Volume of Production Index the process outlined by Sanders et al (1980) was used. However, Sanders et al adjusted monthly data, but the process is the same for adjusting quarterly data.

Figure 5.1: New Zealand Volume of Production - Actual and Seasonally Adjusted For the Period March 1985 to March 1998, Monthly Data Used



Quarterly data for Q1 1985 to Q1 1998 was used. Firstly, a four-quarter moving total of the data is computed. The first four-quarter moving total of the data is the sum of the Volume of Production Index values for Q1 1985 through Q4 1985. The next moving total is found by dropping the value of Q1 1985 and adding the value of Q1 1986 to the previous total. The next step is to find the four-quarter moving average. This is done by dividing each moving total by four.

The specific seasonals are computed by dividing the volume of production index data by the moving average, and then this is multiplied by 1000. The specific seasonals are then arranged in a table in one of the four quarters for each year. From this information, the seasonal index values are computed. For each quarter, the highest and lowest value is dropped and the mean of the remaining values is found – this is called the modified mean.

The sum of the modified means is found. Theoretically, a four-quarter seasonal index should add up to 4000 theoretically. However, this was not the case so a correction factor is found by dividing the sum of the modified means into 4000. For each quarter, the modified mean is multiplied by the correction factor. This is the seasonal index for each quarter.

To remove the seasonal component from the original volume of production index data, the original data is divided by seasonal index for that quarter. The seasonally adjusted, quarterly production data was then averaged out and converted into monthly data.

To measure Australian production, the Melbourne Institute Index of Production was used. The Melbourne Institute Index was obtained from Melbourne University. This data was available monthly.

Interest Rates

Short-term interest rates were required to calculate the interest rate differential between foreign and domestic interest rates (New Zealand or Australia). The interest rates used for this study were the New Zealand 90 Day Bank Bill Rate, Australian Three Month Treasury Bill Rate, the Japanese Three Month Treasury Bill Rate, the US Three Month Treasury Bill Rate, and the UK Discount Three Month Treasury Bill Rate. The interest rates were all obtained through Datastream International.

Proxy for the Federal Funds Rate

For New Zealand the end of the month values for the Weighted Average Successful Bids from Open Market Operations were used as a proxy for the federal funds rate. This information came from the Reserve Bank of New Zealand Bulletins on the tables showing Open Market Operations for that quarter. However, this information was not available from March 1985 to October 1986 so the Weighted Average Successful Bids from Open Market Operations were obtained from the Reserve Bank of New Zealand Bulletins on the tables showing New Zealand Government Treasury Bill Sales by Tender.

For Australia the 11am Call Rate was used as a proxy for the Federal funds rate. This was obtained through the Reserve Bank of Australia.

CHAPTER 6

Methodology

This chapter is divided into four sections. The first two sections discuss the preliminary tests for stationarity and cointegration. There are a number of tests that can be used to test for stationarity but the one used for this study is the Augmented Dickey Fuller (ADF) test. The cointegration tests are carried out to see whether there are long run relationships between variables. Johansen's maximum likelihood test for cointegration is applied in this case. The third section of this chapter is on VAR methodology, which is the test used to examine the impact of monetary shocks on the exchange rate. Finally cointegrating VAR methodology is discussed.

6.1 Testing for Stationarity

Empirical studies based on time series data assume that the underlying time series is stationary. "A stochastic process is said to be stationary if its mean and variance are constant over time and the covariance between two time periods depends only on the distance or lag between the two time period and not on the actual time at which the covariance is computed." (Gujarati, 1995, p.713). This means that the series exhibits mean reversion in that it fluctuates around a constant long run mean, and the variance of the series is time invariant.

A non-stationary time series has a mean and/or variance, which is time dependent. This means that there is no long run mean that the series reverts to, and the variance increases as time approaches infinity.

There are a number of ways to test to see if a series is stationary, one way of testing for stationarity is to test for a unit root using the Dickey Fuller test. The following regression is estimated:

$$\Delta Y_t = (\rho-1)Y_{t-1} + u_t$$

$$\Delta Y_t = \delta Y_{t-1} + u_t \tag{6.1}$$

where Y is the series being tested and u_t is a white noise error term that has zero mean, constant variance, and is non-autocorrelated. To check whether Y_t is stationary, a test is carried out to see whether $\rho=1$ or $\delta=0$ as $\delta=\rho-1$. If $\rho=1$ or $\delta=0$ it means that the series is not stationary.

The Dickey Fuller test comes in three forms:

$$\Delta Y_t = \delta Y_{t-1} + u_t \tag{6.2a}$$

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t \tag{6.2b}$$

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + u_t \tag{6.2c}$$

where β_1 is an intercept term or constant, and t is the time trend variable. To test for stationarity, the null hypothesis is still to test whether $\delta=0$. The first equation is a pure random walk model, the second adds an intercept or drift term and the third equation includes both a drift and linear time trend.

However, the error term u_t may be autocorrelated so the regression is modified to include lags in the model. Including lags into the model should remove error autocorrelation. This is called the Augmented Dickey Fuller (ADF) test and the test is based on the following regression:

$$\Delta Y_t = \beta_1 + \beta_2 t + (\rho - 1)Y_{t-1} + \alpha_i \sum_{i=1}^{m} Y_{t-i} + \varepsilon_t$$

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} Y_{t-i} + \varepsilon_t \tag{6.3}$$

where m is the number of lags required in the model so that error autocorrelation is not present.

Before testing for stationarity, a test is carried out to see whether the time trend, t should be included in the regression. The significance of the coefficient of the time trend, β_2 is tested.

The t-value of β_2 is found. If the t-value is greater than 1.96 in absolute value terms, then the time trend is found to be significant at the 5% level and the time trend should be included into the ADF regression. However, if the t-value is less than 1.96 in absolute value terms then the trend is statistically insignificant and will not be included in the ADF regression.

The next step is to find the number of lags to include in the regression model. By adding more lags the residual sum of squares (the unexplained variation of the response variable) is reduced but at the same time there is a loss of degrees of freedom. There are a number of different models to select the appropriate lag length for the ADF test, but for this study, the Schwartz Bayesian Criterion (SBC) is used. The SBC statistic is calculated as follows:

$$SBC = T \ln(\text{residual sum of squares}) + 2n \qquad (6.4)$$

where T is the number of usable observations and n is the number of parameters estimated. The best model is the one with the lowest SBC value. However, Microfit[1] uses a different method to calculate the SBC value so the model selected is the one with the highest SBC value.

After deciding on the number of lags to include in the model and after finding out whether the time trend should be included in the model, the ADF test for stationarity is carried out. Using the ADF test to test for stationarity is like testing for stationarity using the Dickey Fuller test, that is, to see whether $\rho=1$ or $\delta=0$. If $\rho = 1$ or $\delta = 0$, then the time series has a unit root, that is, the series is non-stationary. To find out whether the series has a unit root or not, the t-value of ρ is calculated as follows:

$$t_\rho = \rho / SE(\rho) \qquad (6.5)$$

where ρ is the coefficient of Y_{t-1} and $SE(\rho)$ is the standard error of ρ. The t-statistic, t_ρ is then compared with the critical values found in the t tables. If the absolute value of t_ρ is greater than the critical values, then the series is stationary. However, if the absolute value of t_ρ is less than the critical values, then the series is non-stationary.

[1] Microfit is an interactive econometric software package designed for econometric modelling of time series data.

If the series is found to be stationary, then it is said to be a series integrated of order zero, denoted by I(0). If the time series is found to be non-stationary, then the first difference is found by subtracting Y_{t-1} by Y_t ($Y_t - Y_{t-1}$). The ADF test is performed on the first differenced series. If this series is stationary, then the original time series is integrated of order one, denoted by I(1). A time series is differenced d times until it is stationary and the original time series is integrated of order d or I(d).

6.2 Testing for Cointegration

Cointegration describes the long run relationship between a group of variables that exhibit an equilibrium relationship with each other although each series may possess differing short run dynamics. The variables may all be non-stationary but move together over time and the difference between them will be stable i.e. stationary. If an equilibrium relationship exists among a group of non-stationary variables, it implies that their stochastic trends are linked and the variables cannot move independently of each other.

When two series are integrated of order d, I(d) then the series must be differenced d times before it is stationary. In general, any linear combination of the two series will also be I(d). However, there may exist a vector β, such that the disturbance term from the regression ($u_t = y_t - \beta x_t$) is of a lower order of integration, I(d-b) where b>0. If y_t and x_t are both I(1) and $u_t \sim I(0)$ then the two series are cointegrated of order CI(1,1).

Cointegration tests are used to see whether there is a long run relationship between variables. When testing for cointegration, all variables must be integrated of the same order. If variables differ in the order of integration, then they cannot be cointegrated. Although variables must have the same order of integration, it does not mean that all similarly integrated variables are cointegrated. If the variables are not cointegrated, then there is no long run relationship among the variables. If there are n variables with the same order of integration, then there may be up to n – 1 linearly independent cointegrating vectors (the number of cointegrating relationships that exist in that model). Only when n = 2 is it possible to show that the cointegration vector is unique.

There are univariate tests of cointegration which test to see whether two variables are cointegrated. There are also the multivariate tests of cointegration. Firstly, looking at the univariate tests of cointegration, a commonly used test is the Engle and Granger approach which is a residual based test. This approach tests to see whether there is a long run relationship between y_t and x_t and is based on the following regression:

$$y_t = \beta x_t + \varepsilon_t \qquad (6.6)$$

The null hypothesis is that x_t and y_t are not cointegrated, that is $\varepsilon_t \sim I(1)$. The alternative hypothesis is that x_t and y_t are cointegrated and that $\varepsilon_t \sim I(0)$. The following ADF test is performed:

$$\Delta\varepsilon_t = \psi\varepsilon_{t-1} + \sum_{i=1}^{p-1} \psi\Delta\varepsilon_{t-i} + \mu + \delta t + \omega_t \qquad (6.7)$$

A trend and/or intercept terms may be added to the regression equation but this depends on whether these were included in equation (6.6). The deterministic component can be added to either equation (6.6) or (6.7) but not to both. The null hypothesis is $\psi = 0$, that is a unit root exists and hence no cointegration. The t-statistic found by testing $\psi = 0$ is compared with the critical values found by MacKinnon (1991). If the t-statistic associated with ψ is less than the critical value then the null hypothesis of no cointegration is rejected.

Models will often have more than two variables, so a multivariate cointegration test has to be carried out to test whether there are long run relationships between variables in the model. The reason for using multivariate tests is because when there are more than two I(1) variables under consideration, univariate cointegration tests such as the residual based test are inefficient and can lead to contradictory results.

The main multivariate cointegration test used is Johansen's maximum likelihood approach. This approach is outlined in Pesaran and Pesaran (1997) and is based on the vector error correction model (VECM) as follows:

$$\Delta y_t = a_{0y} + a_{1y}t - \Pi_y z_{t-1} + \sum_{i=1}^{p-1} \Gamma_{iy}\Delta z_{t-i} + \Psi_y w_t + \varepsilon_t, t = 1,2,\ldots,n \qquad (6.8)$$

where:

- $z_t = (y_t', x_t')'$
- y_t is an $m_y \times 1$ vector of jointly determined endogenous I(1) variables
- x_t is an $m_x \times 1$ vector of exogenous I(1) variables

$$\Delta x_t = a_{0x} + \sum_{i=1}^{p-1} \Gamma_{ix} \Delta z_{t-i} + \Psi_x w_t + v_t \qquad (6.9)$$

- w_t is a $q \times 1$ vector of exogenous/deterministic I(0) variables, excluding the intercepts and/or tends
- ε_t and v_t are disturbance vectors
- The intercept and the trend coefficients, a_{0y} and a_{1y} are $m_y \times 1$ vectors
- Π_y is the long run multiplier matrix of order $m_y \times m$, where $m = m_x + m_y$
- $\Gamma_{1y}, \Gamma_{2y}, \ldots, \Gamma_{p-1,y}$ are $m_y \times m$ coefficient matrices capturing the short run dynamic effects
- ψ_y is the $m_y \times q$ matrix of coefficients on the I(0) exogenous variables.

When testing for cointegration, the rank of the long run multiplier matrix, Π, could be equal to m_y. Therefore, rank deficiency of Π can be represented as :

$$H_r\text{: } \operatorname{Rank}(\Pi_y) = r < m_y$$

There are a number of ways to find the number of cointegrating relationships in the VECM. The tests most often used are the maximum eigenvalue statistic and the trace statistic which will be discussed.

Firstly, using the maximum eigenvalue statistic, the null hypothesis is that there are r cointegrating relationships:

$$H_r\text{: } \operatorname{Rank}(\Pi_y) = r \qquad (6.10)$$

against the alternative hypothesis:

$$H_{r+1}\text{: } \operatorname{Rank}(\Pi_y) = r + 1 \qquad (6.11)$$

where $r = 0,1,2,\ldots, m_y - 1$ in the VECM. The test statistic used for this test is the log-likelihood ratio statistic, which is:

$$LR(H_r|H_{r+1}) = -n\ \log(1-\lambda_{r+1}) \tag{6.12}$$

where λ_r is the rth largest eigenvalue of $S_{00}^{-1}S_{01}S_{11}^{-1}S_{10}$, and the matrices S_{00}, S_{01}, and S_{11} are defined by:

$$S_{ij} = n^{-1}\sum_{t=1}^{n} r_{it}r_{jt}^{'},\ i,j = 0,1 \tag{6.13}$$

where r_{0t} and r_{1t} for t = 1,2, …, n are residual vectors.

When using the trace statistic to find the number of cointegrating relationships in the model, the null hypothesis H_r is defined in (6.10) where there are r cointegrating relationships. The alternative hypothesis is that trend stationarity exists, that is:

$$H_{my}:\ \text{Rank}(\Pi_y) = m_y \tag{6.14}$$

for r = 0,1,2, …, $m_y - 1$. The log-likelihood ratio statistic for this test is given by:

$$LR(H_r \mid H_{my}) = -n\sum_{i=r+1}^{my}\log(1-\lambda_{r+1}) \tag{6.15}$$

where λ_{r+1}, $\lambda_{r+1,\ \ldots,}$ λ_{my} are the largest eigenvalues of $S_{00}^{-1}S_{01}S_{11}^{-1}S_{10}$, and the matrices S_{00}, S_{01}, and S_{11} are defined by (6.13).

The critical values for the maximum eigenvalue and trace statistics depend on $m_y - r$, m_x, and whether the VECM (6.8) contains intercepts and/or trends.

All the VAR models used in this study contains at least five variables so only multivariate cointegration tests are carried out. Before actually testing for cointegration, the number of lags to include in the model is found. The significance of intercepts and trends is tested and is included/excluded in the VECM (6.8) depending on how significant they are.

6.3 VAR Methodology

In this study VAR models are used to examine the impact of monetary shocks on the New Zealand and Australian exchange rates. "VAR methodology superficially resembles simultaneous equation modeling in that we consider several endogenous variables together. But each endogenous variable is explained by its lagged or past values and the lagged values of all other endogenous variables in the model; usually there are no exogenous variables." (Gujarati, 1995).

A number of issues are discussed in this section. Firstly, there is a discussion on formulating a VAR model. Once a VAR model is formulated, we can then look at the impulse response functions which "measures the time profile of the effect on the future states of a dynamical system" according to Pesaran and Pesaran (1997). Finally there is a discussion on the forecast error variance decomposition, which is "a decomposition of the variance of the forecast errors of the variables in the VAR at different horizons." (Pesaran and Pesaran, 1997).

6.3.1 Formulation of a VAR Model

A multivariate VAR model as defined in Pesaran and Pesaran (1997) is as follows:

$$z_t = a_0 + a_1 t + \sum_{i=1}^{p} \phi_i z_{t-i} + \psi w_t + u_t \quad t=1,2,\ldots n \tag{6.16}$$

where z_t is an m × 1 vector of jointly determined endogenous variables; w_t is a q × 1 vector of deterministic or exogenous variables; and u_t is an m × 1 vector of disturbances.

It is important to determine the appropriate lag length, p. One possible procedure is to allow for different lag lengths for each variable. However, to preserve symmetry of the system, it is common to use the same lag length for all variables (or equations). It is important to determine the optimal lag length. If the lag length is p and there are m variables in the VAR model, then there are m × p coefficients plus the intercept term for each equation. If p is too small, then the model is mis-specified. If p is too large, then degrees of freedom are lost. Two commonly used criteria to find the appropriate lag lengths for a VAR model are the

Akaike Information Criterion (AIC) and the Schwartz Bayesian Criterion (SBC). These are calculated as follows:

$$AIC_p = \frac{-nm}{2}(1+\log 2\pi) - \frac{n}{2}\log\left|\tilde{\Sigma}_p\right| - ms \tag{6.17}$$

$$SBC_p = \frac{-nm}{2}(1+\log 2\pi) - \frac{n}{2}\log\left|\tilde{\Sigma}_p\right| - \frac{ms}{2}\log(n) \tag{6.18}$$

where $s = mp + q + 2$ and $\tilde{\Sigma}_p$ is the estimated covariance matrix of the coefficients of each equation in the VAR model. Microfit reports AIC_P and SBC_p for values of p = 0,1,2,…,P, where P is the maximum order of the VAR model as chosen by the user.

6.3.2 Impulse Response Functions

The discussion on impulse response functions is based on the work of Pesaran and Pesaran (1997). The impulse response function measures the time profile of the effect of shocks on the future states of a dynamical system. There are two types of impulse response functions:

1. The orthogonalized impulse response function developed by Sims (1980, 1981), and
2. The generalized impulse response function proposed by Koop et al (1996) and Pesaran and Shin (1997).

Both impulse response functions work with the $m \times m$ coefficient matrices, A_i, in the infinite moving average representation of the VAR model (6.16)

$$z_t = \sum_{j=0}^{\infty} A_j u_{t-j} + \sum_{j=0}^{\infty} B_j w_{t-j} \tag{6.19}$$

where the matrices, A_j , are computed using recursive relations

$$A_j = \Phi_1 A_{j-1} + \Phi_2 A_{j-2} + \ldots + \Phi_p A_{j-p} \quad j=1,2,\ldots \tag{6.20}$$

with $A_0 = I_m$, and $A_j = 0$ for $j < 0$, and $B_j = A_j\psi$, for j = 1,2,…

Both the orthogonalized impulse responses and the generalized impulse responses are discussed in more detail. Firstly, orthogonalized impulse responses are discussed. Sims' work on orthogonalized impulse responses was based on the Cholesky decomposition of Σ, the covariance matrix of the shocks, u_t, which is as follows:

$$\Sigma = TT' \tag{6.21}$$

where T is the lower triangular matrix. Sims then rewrite the moving average representation (6.19) as:

$$\begin{aligned} z_t &= \sum_{j=0}^{\infty}(A_j T)(T^{-1}u_{t-j}) + \sum_{j=0}^{\infty} B_j w_{t-j} \\ &= \sum_{j=0}^{\infty} A_j^* \varepsilon_{t-j} + \sum_{j=0}^{\infty} B_j w_{t-j} \end{aligned} \tag{6.22}$$

where: $A_j^* = A_j T$ and $\varepsilon_t = T^{-1}u_t$

From there it can be seen that:

$$E(\varepsilon_t \varepsilon_t') = T^{-1}E(u_t u_t')T'^{-1} = T^{-1}\Sigma T'^{-1} = I_m$$

where ε_t, the new errors obtained using the transformation matrix T are orthogonal to each others. That is ε_t are now contemporaneously uncorrelated and have unit standard errors. This means that the shocks $\varepsilon_t=(\varepsilon_{1t}, \varepsilon_{2t}, \dots \varepsilon_{mt})'$ are orthogonal to each other.

The orthogonalized impulse response function of a unit shock (one standard error) at time t to the ith orthogonalized error, ε_{it}, on the jth variable at time t + N is given by the jth element of:

$$\text{Orthogonalised IR function to the ith variable (equation)} = A_N^* e_i = A_N T e_i \tag{6.23}$$

where e_i is the m × 1 selection vector,

$$e_i = (0, 0, \ldots 0, 1, 0, \ldots 0)' \qquad (6.24)$$
$$\uparrow$$
$$\text{ith element}$$

The orthogonalized impulse response function can also be written as:

$$OI_{ij,N} = e_j' A_N T e_i \quad i,j,=1,2,\ldots,m \qquad (6.25)$$

The orthogonalized impulse responses are not unique and in general the ordering of the variables in the VAR is important. However, if the covariance matrix of shocks, Σ, is diagonal or almost diagonal, then the orthogonalized responses are invariant to the ordering of the variables. This non-uniqueness of orthogonalized impulse responses is related to the non-uniqueness of the matrix T in the Cholesky decomposition of Σ in equation (6.21).

The second type of impulse responses are the generalized impulse responses. With the generalized impulse responses, the ordering of the variables is not important unlike the orthogonalized impulse responses. The three main issues that generalized impulse responses deal with are:

1. Was the shock variable specific or system wide?
2. What was the state of the system prior to the shock? Was the system in an upward or in a downward phase?
3. How would one expect the system to be shocked in the future from period t + 1 to t + N?

The discussion on generalized impulse responses is divided into two parts. The first part is a discussion on generalized impulse responses for a system wide shock. Then follows a discussion on generalized impulse responses for a variable specific shock.

The generalized impulse response for a system wide shock u_t^0, is defined by:

$$GI_z(N, u_t^0, \Omega_{t-1}^0) = E(Z_{t+N} | u_t = u_t^0 \Omega_{t-1}^0) - E(Z_{t+N} | \Omega_{t-1}^0) \qquad (6.26)$$

where $E(\cdot \mid \cdot)$ is the conditional mathematical expectation taken with respect to the VAR model

(6.16); and Ω^0_{t-1} is a particular historical realization of the process at time t – 1. The infinite moving average representation of the VAR model is as follows:

$$GI_z(N, u_t^0, \Omega^0_{t-1}) = A_N u_t^0 \quad (6.27)$$

which is independent of the history of the process.

In practice, the choice of the vector shock, u_t^0, is arbitrary. One possibility would be to consider a large number of likely shocks and then examine the empirical distribution function of $A_N u_t^0$ for all these shocks. In the case where u_t^0 is drawn from the same distribution as u_t, a multivariate normal with zero means and a constant variance matrix Σ, the result is:

$$GI_z(N, u_t^0, \Omega^0_{t-1}) \sim N(0, A_N \Sigma A_N') \quad (6.28)$$

The diagonal elements of $A_N \Sigma A_N'$ when appropriately scaled are the persistence profiles. Note that when the underlying VAR model is stable, the limit of the persistence profile as N→ ∞ tends to the spectral density function of z_t at zero frequency.

The generalized impulse responses for a variable specific shock is now discussed. Consider the effect of a variable specific shock on the evolution of z_{t+1}, z_{t+2}, …,z_{t+N} and suppose that for a given w_t, the VAR model is perturbed by a shock of size $\delta_i = \sqrt{\sigma_{ii}}$ to its ith equation at time t. The generalized impulse response function is defined as:

$$GI_z(N, \delta_i, \Omega^0_{t-1}) = E(z_t | u_{it} = \delta_i, \Omega^0_{t-1}) - E(z_t | \Omega^0_{t-1}) \quad (6.29)$$

Using the infinite moving average representation (6.19), the following is obtained:

$$GI_z(N, \delta_i, \Omega^0_{t-1}) \sim A_N E(u_t | u_{it} = \delta_i) \quad (6.30)$$

which is history invariant (ie. does not depend on Ω^0_{t-1}). The conditional expectations depends on the nature of the multivariate distribution assumed for the disturbances, u_t. When $u_t \sim N(0,\Sigma)$, the following results:

$$E(u_t | u_{it} = \delta_i) = \begin{pmatrix} \sigma_{1i}/\sigma_{ii} \\ \sigma_{2i}/\sigma_{ii} \\ \vdots \\ \sigma_{mi}/\sigma_{ii} \end{pmatrix} \delta_i \tag{6.31}$$

where $\Sigma=\sigma_{ij}$. A unit shock defined by $\delta_i = \sqrt{\sigma_{ii}}$ results in the following:

$$GI_z(N, \delta_i = \sqrt{\sigma_{ii}}, \Omega_{t-1}^0) = \frac{A_N \Sigma e_i}{\sqrt{\sigma_{ii}}} \quad i,j,=1,2,\ldots,m \tag{6.32}$$

where e_i is a selection vector given by (6.24). The generalized impulse response function of a unit shock to the ith equation in the VAR model (6.16) on the jth variable at horizon N is given by the jth element of (6.32). This can also be expressed as follows:

$$GI_{ij,N} = \frac{e_j' A_N \Sigma e_i}{\sqrt{\sigma_{ii}}} \quad i,j,=1,2,\ldots,m \tag{6.33}$$

The generalized impulse responses in (6.33) differ from the orthogonalized impulse responses in (6.23) as the generalized impulse responses are invariant to the ordering of the variables in the VAR. The two impulse responses give the same result for the first variable in the VAR, or when the covariance matrix, Σ, is diagonal.

6.3.3 Forecast Error Variance Decompositions

A decomposition of the variance of the forecast errors of the variables in the VAR at different horizons is provided by the forecast error variance decomposition. There are two types of forecast error variance decompositions – the orthogonalized and the generalized. There is a discussion on both the orthogonalized forecast error variance decomposition and the generalized forecast error variance decomposition.

In relation to the orthogonalized moving average representation of the VAR model given by

(6.22), the orthogonalized forecast error variance decomposition for the ith variable in the VAR is given by:

$$\theta_{ij,N} = \frac{\sum_{i=0}^{N}(e_i' A_l T e_j)^2}{\sum_{i=0}^{N} e_i' A_l \Sigma A_l' e_i} \quad i,j,=1,2,\ldots,m \tag{6.34}$$

where T is defined by the Cholesky decomposition of Σ, (6.21); e_i is the selection vector defined by (6.24); and A_l, l = 1, 2, ... are the coefficient matrices in the moving average representation, (6.19).

The proportion of the N-step ahead forecast error variance of variable i, which is accounted for by the orthogonalized innovations in variable j, is measured by $\theta_{ij,N}$. Like the orthogonalized impulse response function, the orthogonalized forecast error variance decomposition is not invariant to the ordering of the variables in the VAR.

An alternative to the orthogonalized forecast error variance decomposition would be to consider the proportion of the variance of the N-step forecast errors of z_t which is explained by conditioning on orthogonalized shocks, u_{it}, $u_{i,t+1}$, ... , $u_{i,t+N}$ but explicitly to allow for the contemporaneous conditions between these shocks and shocks to the other variables in the VAR.

The generalized forecast error variance decomposition is defined as follows:

$$\psi_{ij,N} = \frac{\sigma_{ii}^{-1}\sum_{l=0}^{N}(e_j' A_l \Sigma e_i)^2}{\sum_{l=0}^{N} e_i' A_l \Sigma A_l' e_i} \tag{6.35}$$

The definitions of the variables in equation (6.35) are the same as those for the orthogonalized forecast error variance (6.34). Note that the denominator of the generalized forecast error variance decomposition and the orthogonalized forecast error variance decomposition are the same. Also $\theta_{ij,N} = \psi_{ij,N}$ when z_{it} is the first variable in the VAR and/or when the covariance matrix, Σ is diagonal. However, in general the two decompositions differ. The numerator of the generalized forecast error variance decomposition equation (6.35) can be written as the sum of squares of the generalized responses of the shocks to the ith equation on the jth variable in the model, namely $\sum_{l=0}^{N}(GI_{ij,l})^2$, where $GI_{ij,l}$ is given by (6.33).

To see how the equation for the generalized forecast error variance decomposition was derived refer to Chapter 19 of Pesaran and Pesaran (1997).

6.4 Cointegrating VARs

If cointegration exists between non-stationary series, it would be natural to add a cointegrating vector into the VAR model to adjust for this. The computation of the impulse response function for the cointegrating VAR model is based on the following vector error correction model (VECM):

$$z_t = a_0 + a_1 t - \Pi z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta z_{t-i} + \psi w_t + u_t \tag{6.36}$$

which combines the equation systems for y_t and x_t given by equations (6.8) and (6.9). Where Π is deficient, the solution to equation (6.36) is given by:

$$z_t = z_0 + b_0 t + b_1 \left\{ \frac{t(t+1)}{2} \right\} + C(1)S_t + C^*(L)(h_t - h_0) \tag{6.37}$$

where:

$$h_t = \psi w_t + u_t \tag{6.38}$$

$$S_t = \sum_{i=1}^{t} u_i \text{ , } t = 1, 2, \ldots \tag{6.39}$$

$$b_0 = C(1)a_0 + C^*(1)a_1 \tag{6.40}$$

$$b_1 = C(1)a_1 \tag{6.41}$$

$$C(L) = C(1) + (1-L)C^*(L)$$

$$C^*(L) = \sum_{i=0}^{\infty} C_i^* L^i \tag{6.42}$$

where L is the one period lag operator and the m × m matrices, C_i^*, are obtained recursively from:

$$C_i^* = C_{i-1}^*\Phi_1 + ... + C_{i-p}^*\Phi_p \tag{6.43}$$

i = 1, 2, ..., with $C_0^* = I_m - C(1)$, $C_i^* = 0, i < 1$ and

$$\Pi C(1) = 0 = C(1)\Pi \tag{6.44}$$

The matrices, Φ_1, Φ_2, ..., Φ_p are the coefficient matrices in the VAR form of equation (6.36), in terms of Π, Γ_1, Γ_2, ..., and Γ_{p-1} are given by:

$$\Phi_1 = I_m - \Pi + \Gamma_1$$

$$\Phi_i = \Gamma_i - \Gamma_{i-1}, \qquad i = 2, 3, ..., p-1$$

$$\Phi_p = -\Gamma_{p-1}$$

The orthogonalized impulse response function of a shock to the ith variable at time t in (6.36) on the jth variable at time t + N is given by:

$$OI_{ijN} = e_j'(C(1) + C_N^*)Te_i \tag{6.45}$$

where T is a lower triangular matrix such that $\Sigma = TT'$, e_i is the selection vector defined in (6.24), and $C(1)$ and C_N^* are defined by equations (6.42) to (6.44). If

$$A_i = C(1) + C_i^* \tag{6.46}$$

Then substituting $C_i^* = A_i - C(1)$ into (6.43) and using (6.44) the following is expected:

$$A_i = A_{i-1}\Phi_i + ... + A_{i-p}\Phi_p, \quad i = 1, 2, ... \tag{6.47}$$

where $A_0 = I_m$, and $A_i = 0$, for i < 0. However, from (6.46) it can be seen that:

$$\lim_{i \to \infty} A_i = C(1) \tag{6.48}$$

which is a non-zero matrix with rank $m - r$. The orthogonalized impulse responses for the cointegrating VAR model is computed the same way as a stationary VAR model. The difference is that the moving average representation of the z-process tends to zero when the underlying VAR model is trend stationary, and tends to a non-zero rank deficient matrix C(1) when the underlying VAR model is first difference stationary.

The generalized impulse response function and the forecast error variances, both orthogonalized and generalized can also be computed in the same way as for a stationary VAR model.

Although there are long run advantages in using a constrained vector error correction model to take into account the cointegrating relations that exist in non-stationary series, there are reasons why practitioners still want to estimate the unrestricted vector autoregression. These reasons were outlined in Naka and Tufte (1997). The first reason is that a vector error correction model or cointegrating VAR is much more complex to estimate than an unrestricted VAR. Secondly, due to their unrestricted nature, recent entries into literature increasingly advocated vector autoregression techniques. Third, obtaining the impulse response functions and variance decompositions from a vector error correction model is not always straightforward for most computer packages. The fourth reason is that it is not clear whether a cointegrating VAR improves performance of the impulse responses and the variance decomposition at all horizons. There is evidence that an unrestricted VAR is superior to a restricted vector error correction model at short horizons in terms of the forecast variances. This was found by Engle and Yoo (1987), Clements and Hendry (1995), and Hoffman and Rasche (1996). Finally, it may not be wise to add a cointegrating vector into the model since cointegration is a point hypothesis that may have low power against close alternatives.

Cointegration may exist between variables but in this study only the unrestricted VARs are estimated due to the reasons outlined above.

CHAPTER 7

Results

The stationarity and cointegration results are presented in the first two sections of this chapter. Section 7.1 gives the results to the Augmented Dickey Fuller (ADF) test for stationarity. Section 7.2 gives the results to the cointegration tests to determine the existence of long run relationships between variables in the model.

Finally Section 7.3 presents a detailed discussion on the impact of monetary shocks on New Zealand and Australian exchange rates. The first two parts of Section 7.3 discuss the impulse response functions of the New Zealand dollar and Australian dollar exchange rates to a one standard deviation monetary shock. The impulse response functions show how the exchange rates react to these shocks. The last two parts of Section 7.3 discuss the variance decompositions of the New Zealand dollar and Australian dollar exchange rates. The variance decompositions show how much of the exchange rate variability is explained by the monetary variables as the forecast horizon increases.

7.1 Results of Stationarity Tests

The results of the Augmented Dickey Fuller (ADF) tests show that most series are not stationary in their levels. However, the first differences are stationary, meaning that these series are integrated of order one or I(1) stationary. There are some exceptions where the series are stationary in their levels or I(0) stationary. The series that are found to be I(0) includes: the Australian – Japanese exchange rate, the Australian – UK exchange rate, the Australian TWI, the New Zealand – US real exchange rate, the Australian – New Zealand interest rate differential, the US – Australian interest rate differential, Australian M1, and the CPIs of both Australia and New Zealand. These results can be found in Appendix 1. Appendix 1 also shows the number of lags included in the test, whether or not a trend is included and the t-statistics associated with the ADF test.

The optimal number of lags to include in the model is found by using the following procedure. The Schwartz Bayesian Criterion (SBC) is used as a starting point. However, the model SBC selected does not always take into account error autocorrelation. If the model SBC selected does not result in the errors being autocorrelated, then the number of lags included in the ADF test is based on the model SBC selected. In the case where error autocorrelation is present, lags are either added or removed so that error autocorrelation does not exist. The number of lags included in the ADF test ranges from zero lags to four lags so that error autocorrelation is not present in these models.

The results show whether a trend is included in the ADF test or not. A trend is included if the ordinary least squares (OLS) regressions found the trend to be significant at the 5% level. Including a trend in the model changes the critical values when testing for a unit root. Results may be distorted if this is not taken into account. Most of the ADF tests do not include a trend. If a trend is found, these are in the actual data, not the first differences.

Finally, included in the results table are the t-statistics for the ADF test. If the series is stationary, the absolute value of the t-statistic would be greater than the absolute value of the critical value. If the series is found to be stationary, the t-statistic has a single astrix next to it, for significance at the 5% level and a double astrix for significance at the 1% level.

If the results are found to be I(0) stationary, then there is no need to calculate the first differences of these series to test whether these are stationary. However, if the series is not found to be stationary then the first differences of these series are calculated and these are tested for stationarity. All the first differenced series calculated are found to be stationary.

7.2 Results of Cointegration Tests

A number of cointegration tests were carried out for both New Zealand and Australia. For New Zealand, each exchange rate (nominal and real) was included in three models: the benchmark model, weighted average successful bids as a measure of monetary policy, and M1 as a measure of monetary policy. The variables that are included in each model for New Zealand are presented on Table 7.1. For Australia cointegration is also tested for three models, these being the benchmark model, the 11am cash rate as a measure of monetary policy, and M1 as a measure of monetary policy. Table 7.2 shows the variables included and specified in

Table 7.1: Table Displaying the Variables included in each Model for New Zealand

Model 1: Benchmark	Model 2: Weighted Average Successful Bids a Measure of Monetary Policy	Model 3: M1 as a Measure of Monetary Policy
New Zealand Volume of Production Index	New Zealand Volume of Production Index	New Zealand Volume of Production Index
New Zealand Consumer Price Levels	New Zealand Consumer Price Levels	New Zealand Consumer Price Levels
New Zealand M1	Foreign Interest Rate	Foreign Interest Rate
Foreign – New Zealand Interest Differential	Weighted Average Successful Bids from OMO	New Zealand M1
The Exchange Rate (Real or Nominal)	New Zealand M1	New Zealand 90 Day Bank Bill Rate
	The Exchange Rate (Real or Nominal)	The Exchange Rate (Real or Nominal)

Table 7.2: Table Displaying the Variables included in each Model for Australia

Model 1: Benchmark	Model 2: The 11am Cash Rate as a Measure of Monetary Policy	Model 3: M1 as a Measure of Monetary Policy
Melbourne Institute Index of Production	Melbourne Institute Index of Production	Melbourne Institute Index of Production
Australian Consumer Price Levels	Australian Consumer Price Levels	Australian Consumer Price Levels
Australian M1	Foreign Interest Rate	Foreign Interest Rate
Foreign – Australian Interest Differential	Australian 11am Call Rate	Australian M1
The Exchange Rate (Real or Nominal)	Australian M1	Australian 3 Month Treasury Bill Rate
	The Exchange Rate (Real or Nominal)	The Exchange Rate (Real or Nominal)

that order for each model estimated for Australia. The variables that are found to be stationary from the ADF test are included in the VECM (6.8) as exogenous I(0) variables when testing for cointegration.

The results of the cointegration tests for New Zealand are presented in Table 7.3. The number of lags included in the cointegration test is limited to six because the addition of a lag to each variable means that the model loses degrees of freedom. The optimal number of lags suggested for the model is based on the Akaike Information Criterion (AIC) and the Schwartz Bayesian Criterion (SBC). However, in most cases the number of lags SBC suggest is less than what AIC suggest. To find the number of lags to include in the model, serial correlation was tested for. Although there is always serial correlation in the models with up to six lags, the number of lags with the least serial correlation is the one selected. In all cases the intercept and time trend are found to be significant at the 5% level so they are included in the cointegration tests.

For New Zealand the number of cointegrating relationships is shown in Table 7.3. The tests for cointegration are based on the maximal eigenvalue and trace statistic, both at the 95% critical value. The results show that there is at least one cointegrating relationship in the model. In most cases the maximal eigenvalue and trace statistic gives the same results but they differ occasionally. The trace statistic always found that there are two cointegrating relationships for each test of cointegration except for the NZ – UK nominal exchange rate in the benchmark model where there is only one cointegrating relationship. The maximal eigenvalue also suggests that there are two cointegrating relationships for each test but a number of tests found that there is only one cointegrating relationship when looking at the 95% critical value.

The actual statistics for the maximal eigenvalue and trace statistic tests of cointegration for New Zealand are shown in Appendix 2.1, which include the results for the 95% critical value and results at the 90% critical value.

The results to the cointegration tests for Australia are shown in Table 7.4. The number of lags included in the model was found using the same process as for New Zealand. The intercept term and time trend were tested to see if they should be included in the model. Not all the models have both an intercept term and time trend like the models for New Zealand. However, most of the models include both an intercept and time trend.

Table 7.3: Results of Cointegration Tests for New Zealand

Exchange Rate	Model	No. of Lags	Intercept	Trend	No. of Cointegrating Relationships Maximal Eigenvalue	 Trace Statistic
NZ – Australia (Real)	Benchmark	3	Yes	Yes	2	2
	Weighted Average Successful Bids	4	Yes	Yes	2	2
	M1	4	Yes	Yes	2	2
NZ – Australia (Nominal)	Benchmark	3	Yes	Yes	2	2
	Weighted Average Successful Bids	4	Yes	Yes	2	2
	M1	4	Yes	Yes	2	2
NZ - Japan (Real)	Benchmark	4	Yes	Yes	2	2
	Weighted Average Successful Bids	5	Yes	Yes	2	2
	M1	3	Yes	Yes	2	2
NZ - Japan (Nominal)	Benchmark	4	Yes	Yes	2	2
	Weighted Average Successful Bids	5	Yes	Yes	2	2
	M1	3	Yes	Yes	1	2
NZ - UK (Real)	Benchmark	2	Yes	Yes	1	2
	Weighted Average Successful Bids	4	Yes	Yes	2	2
	M1	2	Yes	Yes	2	2
NZ - UK (Nominal)	Benchmark	2	Yes	Yes	1	1
	Weighted Average Successful Bids	4	Yes	Yes	2	2
	M1	2	Yes	Yes	2	2
NZ - US (Real)	Benchmark	4	Yes	Yes	2	2
	Weighted Average Successful Bids	4	Yes	Yes	2	2
	M1	2	Yes	Yes	1	2
NZ - US (Nominal)	Benchmark	4	Yes	Yes	2	2
	Weighted Average Successful Bids	5	Yes	Yes	1	2
	M1	5	Yes	Yes	1	2

Table 7.4: Results of Cointegration Tests for Australia

Exchange Rate	Model	No. of Lags	Intercept	Trend	No. of Cointegrating Relationships	
					Maximal Eigenvalue	Trace Statistic
Australia – Japan (Real)	Benchmark	4	No	Yes	1	3
	11am Cash Rate	5	Yes	Yes	3	3
	M1	2	Yes	Yes	1	4
Australia – Japan (Nominal)	Benchmark	5	No	No	1	1
	11am Cash Rate	2	Yes	Yes	0	2
	M1	2	Yes	Yes	0	2
Australia – NZ (Real)	Benchmark	5	No	Yes	2	2
	11am Cash Rate	4	Yes	Yes	3	3
	M1	5	Yes	Yes	3	3
Australia – NZ (Nominal)	Benchmark	5	Yes	Yes	2	2
	11am Cash Rate	4	Yes	Yes	3	3
	M1	5	Yes	Yes	3	3
Australia - UK (Real)	Benchmark	2	No	Yes	0	2
	11am Cash Rate	5	Yes	Yes	1	2
	M1	3	Yes	Yes	1	1
Australia - UK (Nominal)	Benchmark	2	No	No	1	1
	11am Cash Rate	5	Yes	Yes	3	3
	M1	5	Yes	Yes	1	2
Australia - US (Real)	Benchmark	2	Yes	No	1	1
	11am Cash Rate	5	Yes	Yes	2	3
	M1	2	Yes	No	2	2
Australia - US (Nominal)	Benchmark	2	Yes	No	1	1
	11am Cash Rate	5	Yes	Yes	2	2
	M1	2	Yes	No	1	2

At the 95% critical value, the number of cointegrating relationships suggested by the maximal eigenvalue often differs to the number of relationships suggested by the trace statistic. When there is a difference in the number of relationships, the maximal eigenvalue usually suggests there are less cointegrating relationships than that suggested by the trace statistic. The trace statistic never suggests that there are no cointegrating relationships in any of the models. Although the maximal eigenvalue suggests that there are no cointegrating relationships for the Australian – Japanese nominal exchange rate in the M1 model, and the Australian – UK real exchange rate in the benchmark model but this is not the case at the 90% critical value. See Appendix 2.2 for the actual statistics of the cointegration tests for Australia.

7.3 VAR Results

Two types of tests were carried out on the vector autoregression (VAR) models. Firstly, the orthogonalized impulse response functions and orthogonalized forecast error variance decompositions were estimated. Others have used this method such as Eichenbaum and Evans (1995), Grilli and Roubini (1995), and Cushman and Zha (1997). Generalized impulse response functions and generalized forecast error variance decompositions were estimated using the same data.

To determine the impact of monetary shocks on exchange rates, three VAR models were estimated for each individual exchange rate. The three models are the benchmark specification, and two models based on two different measures of monetary policy are shown in Tables 7.1 and 7.2. The first of these models use a proxy to the Federal funds rate, for New Zealand being the weighted average successful bids from open market operations. For Australia the 11am cash rate is used. The second of these models uses M1 as the measure of monetary policy as a proxy for US non-borrowed to total reserves for both countries. The models differ due to different variables included in each model as shown in Table 7.1 and 7.2.

The results were generated using monthly data for the period March 1985 to March 1998. All variables included in the VAR model are stationary. Not all variables are stationary in their levels, so the first differences of each variable was estimated and since all first differences are found to be stationary, first differences were used in the VAR models. All VARs were estimated using six lags for all the variables. For New Zealand the Akaike Information Criterion (AIC) selected six lags for each VAR model estimated. For Australia, six lags were also used for each VAR model estimated. An intercept term and/or trend was included in the VAR if they were found to be significant at the 5% level, otherwise they were excluded from the model.

The presentation of the VAR results has been divided into four main sections. Firstly, the results for the orthogonalized impulse responses are discussed in Section 7.3.1 followed by a discussion on the generalized impulse responses in Section 7.3.2. The next two sections include a discussion on the variance decomposition of each exchange rate examined. The orthogonalized forecast error variance decompositions are discussed in Section 7.3.3 followed by a discussion on the generalized forecast error variances in Section 7.3.4

7.3.1 Orthogonalized Impulse Responses

This section discusses the orthogonalized impulse responses of the New Zealand dollar and Australian dollar when there is a positive, one standard deviation shock on a monetary variable. Firstly, there is a discussion on the responses of the New Zealand dollar to a monetary shock with the same approach being used for Australia.

New Zealand

As mentioned previously, three VAR models were estimated and these differ in terms of the variables included in each model. Six monetary variables were shocked and these are M1 in all three models, the foreign – New Zealand interest rate differential, weighted average successful bids from OMO, and the short-term New Zealand interest rate. The orthogonalized impulse response functions are displayed in Appendices 3.1 to 3.6. When interpreting the graphs of the impulse responses, it should be noted that a positive response is interpreted as a depreciation of the New Zealand dollar while a negative response is interpreted as an appreciation of the New Zealand dollar. The orthogonalized impulse responses were estimated for both the real and nominal exchange rates and the results are very similar. There are minor differences but these are not found to be significant. Table 7.5 summarizes the results of the orthogonalized impulse response functions to a positive, one standard deviation monetary shock on the New Zealand dollar.

Table 7. 5: Matrix of Orthogonalized Responses of the New Zealand Dollar to a Positive, One Standard Deviation Monetary Shock

		Variables Shocked		
		M1 in Model 1	M1 in Model 2	M1 in Model 3
New Zealand Dollar Exchange Rate (Real and Nominal)	Australian Dollar	Initial response: small depreciation of the NZD (New Zealand dollar). Volatile movement follow. As the forecast horizon increases, the volatility is reduced and the NZD reverts to its long run equilibrium rate. The maximal impact occurs 2 months after the shock on M1 but this is due do an appreciation of the NZD exceeding the long run equilibrium rate.	Very small depreciation of the NZD initially. Very volatile movement of the NZD follow. Volatility is reduced as the forecast horizon increases. Maximal impact occurs 6 months later due to an appreciation of the NZD which exceeds the long run equilibrium rate. As the forecast horizon increases, the NZD reverts to the long run equilibrium exchange rate.	Small depreciation of the NZD initially. Followed by volatile movement of the NZD which is reduced as the forecast horizon increases. Maximal impact of the shock occurs 6 months after the monetary shock due to an appreciation of the NZD which exceeds the long run equilibrium rate. The NZD stabilises at the long run equilibrium rate as the forecast horizon increases.
	Japanese Yen	Initial response: NZD appreciates against the Yen. The maximal impact of the shock occurs contemporaneously. A little volatility is present which is reduced as the forecast horizon increases. At same tine, the NZD reverts back to the long run equilibrium exchange rate.	Initially, the NZD appreciates. The maximal impact of the shock occurs contemporaneously. Some volatility to begin with, but this is reduced as the forecast horizon increases. Also the NZD reverts to the long run equilibrium exchange rate at the same time.	Initial response: significant appreciation of the NZD. The maximal impact of the shock occurs contemporaneously. As the forecast horizon increases, the NZD reverts to its long run equilibrium rate.
	UK Pound	NZD appreciates against the Pound initially. The maximal impact occurs contemporaneously. There is very little volatility. NZD reverts to the long run equilibrium rate as the forecast horizon increases.	Initial response: appreciation of the NZD. The maximal impact occurs contemporaneously. The volatility that exists is reduced as the forecast horizon increases. The NZD also reverts to the long run equilibrium rate.	A significant appreciation of the NZD. The maximal impact occurs contemporaneously. The NZD reverts to the long run equilibrium rate as the forecast horizon increases. Volatility is also reduced as the forecast horizon increases.
	US Dollar	Initial response: An appreciation of the NZD. The NZD is very volatile, so where the maximal impact occurs is inconclusive. As the forecast horizon increases, the volatility is reduced and the NZD reverts to its long run equilibrium rate.	The NZD appreciates against the USD initially. The maximal impact cannot be determined due to the NZD being very volatile. As the forecast horizon increases, volatility is reduced and the NZD reverts to its long run equilibrium rate.	Initially, the NZD appreciated against the USD. Volatile movement of the NZD follow so the maximal impact of the shock cannot be determined. The volatility is reduced and the NZD reverts to its long run equilibrium rate as the forecast horizon increases.

Table 7.5 Continued				
		Variables Shocked		
		Foreign – NZ Interest Differential	Weighted Average Successful Bids from Open Market Operations	Short-term New Zealand Interest Rates
New Zealand Dollar Exchange Rate (Real and Nominal)	Australian Dollar	Initial response: a depreciation of the NZD. Followed by some volatile movement of the NZD so where the maximal impact occurs cannot be determined. As the forecast horizon increases, the movement of the NZD become less volatile and the NZD stabilises around its long run equilibrium exchange rate.	Initially, a sharp depreciation of the NZD occurs in response to the monetary shock. The maximal impact of the shock occurs contemporaneously. This is followed by an appreciation of the NZD which fluctuates around its long run equilibrium rate.	Initial response: a very small depreciation of the NZD. This is followed by some volatile movement of the NZD in which the volatility is reduced as the forecast horizon increases. At the same time the movement of the NZD fluctuates around the long run equilibrium exchange rate.
	Japanese Yen	A depreciation of the NZD occurs initially. This is followed by some volatile movement of the NZD which becomes less volatile as the forecast horizon increases. The maximal impact of the shock occurs 5 months after the monetary shock, but this is due to an appreciation of the NZD which exceeds the long run equilibrium rate.	The NZD depreciates initially. The maximal impact of the shock cannot be determined due to the exchange rate being quite volatile. However, the volatility is reduced and the NZD stabilises around the long run equilibrium exchange rate as the forecast horizon increases.	Initial response: an appreciation of the NZD. Some volatile movement of the NZD follow this but the volatility is reduced as the forecast horizon increases. The maximal impact does not occur contemporaneously, but occurs 3 months after the monetary shock.
	UK Pound	Initial response: a large depreciation of the NZD. The maximal impact of the shock occurs 1 month after the monetary shock for the real exchange rate, and occurs contemporaneously for the nominal exchange rate. The NZD appreciates back to the long run equilibrium rate where it stabilises.	A very small appreciation of the NZD occurs initially. The maximal impact of the shock occurs 2 months later. Followed by this is a depreciation of the NZD and as the forecast horizon increases, the NZD stabilises around its long run equilibrium exchange rate.	Initial response: an appreciation of the NZD in which the maximal impact of the shock occurs contemporaneously. The NZD depreciates back to the long run equilibrium rate and continues to fluctuate around there as the forecast horizon increases.
	US Dollar	Initially, a small depreciation of the NZD occurs. The maximal impact does not occur contemporaneously, but is delayed until three months after the monetary shock. As the forecast horizon increases, the NZD stabilises around its long run equilibrium rate.	Initially, a small depreciation of the NZD occurs. This is followed by a sharp appreciation of the NZD at which the maximal impact occurs 2 months after the monetary shock. The NZD fluctuates around it long run equilibrium rate as the forecast horizon increases.	Initial response: an appreciation of the NZD. However, the maximal impact does not occur until 3 months after the monetary shock. As the forecast horizon increases, the NZD stabilises around the long run equilibrium exchange rate.

The first variable shocked is M1. A positive shock on M1 is associated with an increase in M1 and this is interpreted as a monetary expansion. Although theory suggests that an expansion in monetary policy leads to a fall in interest rates, and a depreciation in the domestic currency, the results show that this is not the case when there is a positive shock on M1. The responses of the New Zealand dollar in each model are very similar when there is a shock on M1. From Table 7.5 and the impulse response functions in Appendices 3.1 to 3.3, the results show that the New Zealand dollar appreciates in three out of the four cases (against the Yen, the Pound, and the US dollar) initially due to a positive one standard deviation shock on M1. The New Zealand dollar however, depreciates against the Australian dollar initially. After the initial impact on the exchange rates, this is followed by some volatile movement in the New Zealand dollar. The overshooting hypothesis only holds for two out of the four New Zealand dollar exchange rates (the Yen and the Pound). The overshooting hypothesis suggests that a monetary shock results in the exchange rate overreacting initially and the maximal impact of the shock occurring contemporaneously, followed by the exchange rate adjusting back to its long run equilibrium rate as the forecast horizon increases. For the Yen and Pound, the New Zealand dollar overreacts in response to a monetary expansion, with an appreciation, which exceeds the long run equilibrium exchange rate. As the forecast horizon increases, the New Zealand dollar returns to its long run equilibrium rate.

The fourth variable shocked is the foreign – New Zealand interest rate differential. A positive shock on the foreign – New Zealand interest rate differential is associated with an increase in the interest rate differential. This could mean either an increase in the foreign interest rate, or a decrease in the New Zealand interest rate. A depreciation of the New Zealand dollar is expected if there is an increase in the foreign – New Zealand interest rate differential. The results on Table 7.5 and the impulse response functions in Appendix 3.4 show that when there is a shock on the interest rate differential, the initial impact is a depreciation in the New Zealand dollar against all four exchange rates. In all cases some volatile exchange rate movement follow this initial depreciation. There is weak support for the overshooting hypothesis as the New Zealand dollar is volatile and the maximal impact of the shock cannot always be determined and at times the maximal impact of the shock on the New Zealand dollar is delayed.

The fifth variable shocked is weighted average successful bids from open market operations (BIDS). A positive shock on BIDS is usually a result of a contraction in monetary policy. If this is the case, then an appreciation of the New Zealand dollar is expected. The results are summarized on Table 7.5. The results on Table 7.5 and the impulse response functions in Appendix 3.5 show that a positive shock on BIDS does not necessarily result in an appreciation of the New Zealand dollar. When there is a positive shock on BIDS, the New Zealand dollar appreciates against the Pound initially. However, the New Zealand dollar depreciates initially against the other three exchange rates. In the case of the US dollar, an appreciation of the New Zealand dollar follows and this dominates. The overshooting theory only holds in the case of the Australian dollar, where the New Zealand dollar overreacts to a positive shock on BIDS but this is due to a depreciation of the New Zealand dollar not an appreciation as expected. The overshooting hypothesis does not hold for the other exchange rates because the maximal impact of the shock occurs later or cannot be determined due to the volatility of the exchange rate.

Finally, the short-term New Zealand interest rate is shocked. In theory a positive shock on interest rates is associated with an increase in interest rates. An increase in interest rates is usually the response of a contraction in monetary policy. When there is a contraction in monetary policy an appreciation of the domestic currency is expected. The results in Table 7.5 and the impulse responses in Appendix 3.6 show that the New Zealand dollar does appreciate against the Yen, the Pound, and the US dollar initially. As the forecast horizon increases, the movement in the New Zealand dollar stabilises around the long run equilibrium exchange rate. Finally the results show that there is weak support for the overshooting hypothesis which only holds in the case of the Pound, where the maximal impact of the monetary shock occurs contemporaneously.

Australia

The same three VAR models were estimated for Australia. The variables shocked are M1 in all three models, the foreign – Australian interest rate differential, the 11am cash rate, and the short-term Australian interest rate. The results from the impulse response functions are summarized in Table 7.6 and the actual impulse response functions are displayed in Appendices 3.7 to 3.12. A positive response is interpreted as a depreciation of the Australian dollar while a negative response is interpreted as an appreciation of the Australian dollar. The impulse responses of the real exchange rates are found to be similar to that of the nominal exchange rates.

Table 7. 6: Matrix of Orthogonalized Responses of the Australian Dollar to a Positive, One Standard Deviation Monetary Shock

		Variables Shocked		
		M1 in Model 1	M1 in Model 2	M1 in Model 3
Australian Dollar Exchange Rate (Real and Nominal)	Japanese Yen	Initial response: appreciation of the Australian dollar (AUD) against the Yen. Volatile movement of the AUD follow. The volatility is reduced as the forecast horizon increases. The maximal impact of the shock occurs 2 months after the shock on M1 due to a depreciation of the AUD which exceeds the long run equilibrium rate.	Initially, there is a significant appreciation of the AUD. The maximal impact of the shock occurs contemporaneously. Some volatility exists to begin with. As the forecast horizon increases, the volatility is reduced and the movement of the AUD stabilise around the long run equilibrium rate.	Initially, the AUD appreciates against the Yen. The maximal impact of the shock cannot be determined due to the volatility of the exchange rate. This volatility is reduced as the forecast horizon increases. Also, the AUD movement fluctuate around its long run equilibrium rate.
	New Zealand Dollar	Initially, a depreciation of the AUD against the NZD. This is followed by some volatile movement of the AUD which decreases as the forecast horizon increases. Due to the volatility, the maximal impact of the shock cannot be determined.	Initial response: a depreciation of the AUD. For 14 months after the shock on M1, the movement of the AUD is very volatile, so the maximal impact of the shock cannot be determined.	The AUD depreciates against the NZD initially. The AUD fluctuates around the long run equilibrium rate although there is volatility in the movement. This volatility decreases as the forecast horizon increases. Due to the volatility that exists, where the maximal impact occurs is inconclusive.
	UK Pound	Initially, a very small depreciation of the AUD. The maximal impact of the shock does not occur until 3 months after the shock on M1 but this is due to an appreciation of the AUD exceeding the long run equilibrium rate. As the forecast horizon increases, the AUD reverts to its long run equilibrium rate.	Initially, the AUD real exchange rate appreciates, but there is very little response for the nominal exchange rate. In both cases, the maximal impact occurs 3 months after the shock on M1 due to an appreciation of the AUD which exceeds the long run equilibrium rate. The AUD reverts back to its long run equilibrium rate as the forecast horizon increases.	Initial response: a small depreciation of the AUD against the Pound. Three months after the shock on M1, the maximal impact occurs, but this is due to an appreciation of the AUD not a depreciation. As the forecast horizon increases, the AUD stabilises around its long run equilibrium rate.
	US Dollar	Initial response: a small depreciation of the AUD against the USD. The maximal impact occurs 5 months after the monetary shock. Eleven months after the monetary shock, the AUD begins to stabilise around its long run equilibrium rate.	Initially, there is very little change in the real exchange rate. There is a small depreciation of the AUD nominal exchange rate against the USD. The AUD movement fluctuate around its long run equilibrium rate, but a little volatility exists. Due to the volatility, where the maximal impact of the shock occurs is inconclusive.	Initial response: a small depreciation of the AUD. For 9 months after the shock, there is some volatility in the AUD so where the maximal impact of the shock occurs cannot be determined. As the forecast horizon increases, the volatility is reduced and the AUD movement fluctuate around the long run equilibrium rate.

Table 7.6 Continued

		Variables Shocked		
		Foreign – Australian Interest Differential	Australian 11 am Cash Rate	Short-term Australian Interest Rates
Australian Dollar Exchange Rate (Real and Nominal)	Japanese Yen	Initial response: the AUD depreciates against the Yen. The maximal impact of the shock occurs contemporaneously. This is followed by the movement of AUD stabilising around the long run equilibrium exchange rate 11 months after the monetary shock.	Initially, the AUD appreciates against the Yen. Some volatility exists as the movement of the AUD fluctuate around its long run equilibrium rate. It is not certain where the maximal impact of the shock occurs due to the volatility that exists. The volatility decreases as the forecast horizon increases.	The AUD appreciates significantly in response to the monetary shock. The maximal impact of the shock occurs contemporaneously. After the initial appreciation, the AUD reverts back to its long run equilibrium exchange rate and there are small fluctuations around it.
	New Zealand Dollar	Initially, there is a depreciation of the AUD. Movement of the AUD fluctuate around the long run equilibrium exchange rate but are quite volatile to begin with. The volatility decreases as the forecast horizon increases. The maximal impact occurs 3 months after the monetary shock.	Initial response: an appreciation of the AUD. The maximal impact does not occur contemporaneously, but occurs 1 month after the monetary shock. This is followed by a depreciation of the AUD which exceeds the long run equilibrium exchange rate before the AUD reverts back to the long run exchange rate.	Initial response: a significant appreciation of the AUD in which the maximal impact of the shock occurs contemporaneously. This is followed by some volatile movement of the AUD which fluctuates around the long run equilibrium rate. As the forecast horizon increases, the volatility is reduced.
	UK Pound	Initial response: a significant depreciation of the AUD at which the maximal impact of the shock occurs contemporaneously. This is followed by an appreciation of the AUD which exceeds the long run equilibrium rate. Eight months after the shock, the AUD stabilises around the long run equilibrium exchange rate.	Initial response: a large appreciation of the AUD. The maximal impact of the shock is delayed. It occurs 2 months later for the real exchange rate, and 3 months after the monetary shock for the nominal exchange rate. This is then followed by a depreciation of the AUD which stabilises around the long run equilibrium rate.	Initially, there is a significant appreciation of the AUD against the Pound in which the maximal impact of the shock occurs contemporaneously. This is followed by the AUD reverting back to its long run equilibrium exchange rate.
	US Dollar	Initially, there is a significant depreciation of the AUD. The maximal impact of the shock is delayed. It occurs 2 months later for the real exchange rate, and 1 month after the monetary shock for the real exchange rate. The AUD then reverts back to the long run equilibrium exchange rate, but some volatility exists.	Initially, there is very little response to the monetary shock. The AUD then appreciates against the USD in which the maximal impact of the shock occurs 1 month after the monetary shock. The AUD then reverts to the long run exchange rate where it fluctuates.	Initial response: an appreciation of the AUD in which the maximal impact occurs contemporaneously. This is followed by the AUD reverting back to its long run equilibrium rate. Some volatility exists but this is reduced as the forecast horizon increases.

The first variable shocked is M1. When there is a positive shock on M1 or an expansion in monetary policy, the domestic currency is expected to depreciate. An expansion in monetary policy lowers interest rates and hence there will be an outflow of capital so the domestic currency depreciates. Appendices 3.7 to 3.9 show the impulse response functions of the Australian dollar when there is a positive shock on M1in each model and the responses of the Australian dollar are found to be similar. The results are summarized on Table 7.6. A positive shock on M1 results in the Australian dollar depreciating against the New Zealand dollar, the Pound, and the US dollar initially, although these depreciations are small. However, the Australian dollar appreciates against the Yen initially, but the maximal impact is due to a depreciation which exceeds the long run equilibrium exchange rate. In most cases, the overshooting hypothesis is rejected as the maximal impact of the shock on M1 does not occur contemporaneously, but is either delayed or cannot be determined due to the volatility of the exchange rate.

The fourth variable shocked is the foreign – Australian interest rate differential. A positive shock on the foreign – Australian interest rate differential is associated with an increase in the interest rate differential. This could mean either an increase in the foreign interest rate, or a decrease in the Australian interest rate. When there is an increase in the foreign – domestic interest rate differential, a depreciation of the domestic currency is expected. The impulse response functions are given in Appendix 3.10 and the results are summarized on Table 7.6 which shows that in all cases the Australian dollar depreciates initially in response to a positive shock on the interest differential although how much the dollar depreciates by varies in size for each exchange rate. In most cases the Australian dollar appreciates back to its long run equilibrium rate, however, in the case of the Australian – New Zealand exchange rate, some volatility exists which decreases as the forecast horizon increases. The overshooting hypothesis holds in two out of the four cases (the Yen and the Pound), where the depreciation of the Australian dollar exceeds its long run equilibrium rate and the maximal impact of the monetary shock occurs contemporaneously and as the forecast horizon increases, the Australian dollar returns to its long run equilibrium rate. The maximal impact of the shock for the New Zealand dollar and the US dollar is delayed so the overshooting hypothesis does not hold.

The fifth variable shocked is the Australian 11am cash rate. A positive shock on the 11am cash rate is associated with an increase in the cash rate. An increase in the cash rate is usually a result of a contraction in monetary policy. So an appreciation of the Australian dollar is expected when there is a positive shock on the Australian 11am cash rate. Table 7.6 and the impulse responses in Appendix 3.11 show how the Australian dollar responds to a positive shock on the cash rate. The results show that a contraction in monetary policy leads to an appreciation of the Australian dollar and then returns to its long run equilibrium rate as the forecast horizon increases. The overshooting hypothesis is once again rejected, as the maximal impact from a shock on the cash rate is always delayed.

Finally, the short-term Australian interest rate is shocked. A positive shock on the domestic interest rate is a result of monetary conditions being tightened. An increase in interest rates usually leads to an appreciation of the domestic currency. The impulse responses in Appendix 3.12 and the results summarized on Table 7.6 show that theory does hold as the Australian dollar appreciates by a significant amount against each currency and as the forecast horizon increases, the Australian dollar stabilises at the long run equilibrium exchange rate. When there is a positive shock on the short-term Australian interest rate, the overshooting hypothesis holds for all four Australian exchange rates. The Australian dollar overreacts in response to a positive shock on short-term Australian interest rates by appreciating and then adjusts back to its long run equilibrium rate as the forecast horizon increases.

7.3.2 Generalized Impulse Responses

The generalized impulse responses were estimated for New Zealand and Australian exchange rates using the same data as for the orthogonalized impulse responses. Again the VARs for the same three models were estimated. The same variables in the models were shocked. When the generalized impulse response functions are examined more closely, it is found that the results are very similar to those of the orthogonalized impulse responses. The impulse responses were estimated for both the real and nominal exchange rates and the results are found to be similar.

New Zealand

The generalized impulse response functions for the New Zealand dollar are displayed in Appendices 3.13 to 3.19. A positive response on the New Zealand dollar is interpreted as a depreciation of the New Zealand dollar and a negative response is an appreciation of the New

Zealand dollar. These impulse responses are interpreted and the results are summarized on Table 7.7.

The first variable shocked is M1. A positive shock on M1 or a monetary expansion should lead to a depreciation of the domestic currency, maybe not immediately but at some point in time. Appendices 3.13 to 3.15 show the generalized impulse response functions of the New Zealand dollar when there is a positive shock on M1 in each model and the results are very similar for all three models. There are minor differences but these are not significant. The results are summarized on Table 7.7 and they show that the New Zealand dollar appreciates initially in three out of four cases (against the Yen, Pound, and US dollar) as a result of the monetary expansion. Although the dollar movement are volatile, the appreciations of the New Zealand dollar, which exceeds the long run exchange rate, are very dominant relative to the overall movement in these exchange rates. In the case of the Australian dollar, the New Zealand dollar does depreciate initially in response to a positive shock on M1. However, the maximal impact of the shock is due to an appreciation of the New Zealand dollar which exceeds the long run equilibrium exchange rate. The overshooting theory only holds for the Yen, that is the New Zealand dollar appreciates initially (rather than depreciate) in response to a shock on M1 and the maximal impact occurs contemporaneously. For the other exchange rates, the overshooting hypothesis does not hold because the movement were very volatile and at times the point of maximal impact cannot be determined.

The fourth variable shocked is the foreign – New Zealand interest rate differential. An increase in the foreign – domestic interest rate differential is a result of either the foreign interest rate rising or a fall in the domestic interest rate. A fall in domestic interest rates is usually a result of an expansion in monetary policy. Either an increase in foreign interest rates and or a reduction in the domestic interest rates should lead to a depreciation of the domestic currency at some point in time. The results in Table 7.7 and the impulse responses in Appendix 3.16 show that this is exactly what the New Zealand dollar does against all the currencies before stabilizing around the long run equilibrium exchange rate. The overshooting hypothesis holds for the Australian dollar and the Pound as the New Zealand dollar depreciates against these exchange rates and the maximal impact of the shock occurs contemporaneously. This is not the case for the Yen and the US dollar as the maximal impact of the shock is delayed.

Table 7. 7: Matrix of Generalized Responses of the New Zealand Dollar to a Positive, One Standard Deviation Monetary Shock

		Variables Shocked		
		M1 in Model 1	M1 in Model 2	M1 in Model 3
New Zealand Dollar Exchange Rate (Real and Nominal)	Australian Dollar	Initial response: a small depreciation of the NZD. The maximal impact of the shock occurs 2 months after the shock on M1 and this is due to an appreciation of the NZD exceeding the long run equilibrium rate. The NZD then reverts to the long run equilibrium exchange rate and as the forecast horizon increases, the volatility decreases.	Initially, there is a depreciation of the NZD. The NZD fluctuates around it long run equilibrium rate, however, there is volatility in the movement of the NZD. This volatility is reduced as the forecast horizon increases. Due to the volatility, where the maximal impact of the shock occurs cannot be determined.	Initially, there is a depreciation of the NZD against the AUD. Movement of the exchange rate are quite volatile to begin with so where the maximal impact of the shock occurs cannot be determined. As the forecast horizon increases, the volatility of the NZD decreases while the NZD fluctuates around the long run equilibrium exchange rate.
	Japanese Yen	Initially, there is an appreciation of the NZD in which the maximal impact of the shock occurs contemporaneously. Following this, the NZD reverts back to the long run equilibrium exchange rate. In the case of the real exchange rate, there is some volatility but this decreases as the forecast horizon increases.	An appreciation of the NZD occurs initially in response to a shock on M1. Where the maximal impact of the shock occurs cannot be determined due to the volatility that exists. As the forecast horizon increases, the NZD fluctuates around the long run equilibrium exchange rate and the volatility decreases.	Initial response: an appreciation of the NZD against the Yen. For the nominal exchange rate, the maximal impact of the shock occurs contemporaneously. Due to the volatility of the real exchange rate, where the maximal impact of the occurs is not certain. As the forecast horizon increases, the volatility decreases while the NZD fluctuates around the long run equilibrium exchange rate.
	UK Pound	Initial response: an appreciation of the NZD. Due to the volatility of the exchange rate, it is not certain where the maximal impact of the shock occurs. As the forecast horizon increases, the NZD reverts to the long run equilibrium exchange rate and the volatility is reduced.	Initial response: an appreciation of the NZD. However, the maximal impact of the shock does not occur until 4 months after the shock on M1. The movement of the NZD fluctuate around the long run equilibrium exchange rate and the volatility decreases as the forecast horizon increases.	Initially, there is an appreciation of the NZD. Some volatile movement of NZD follow this so where the maximal impact of the shock occurs is not certain. As the forecast horizon increases, the volatility decreases and the NZD stabilises at its long run equilibrium rate.
	US Dollar	Initially, there is an appreciation of the NZD against the USD. The maximal impact occurs 2 months after the shock on M1. The NZD fluctuates around its long run equilibrium rate and the movement become less volatile as the forecast horizon increases.	Initial response: an appreciation of the NZD. The movement of the NZD are very volatile so where the maximal impact occurs cannot be determined. As the forecast horizon increases, the NZD reverts to its long run equilibrium rate and at the same time the NZD becomes less volatile.	Initial response: an appreciation of the NZD. Due to the NZD being volatile, it is not certain where the maximal impact of the shock occurs. The NZD fluctuates around its long run equilibrium rate and the volatility is reduced as the forecast horizon increases.

Table 7.7 Continued

		Variables Shocked		
		Foreign – NZ Interest Differential	Weighted Average Successful Bids from Open Market Operations	Short-term New Zealand Interest Rates
New Zealand Dollar Exchange Rate (Real and Nominal)	Australian Dollar	Initial response: a depreciation of the NZD. The maximal impact of the shock occurs contemporaneously. Some volatile movement follow this. As the forecast horizon increases, the NZD reverts to the long run equilibrium exchange rate and the volatility decreases.	Initial response: a significant depreciation of the NZD in which the maximal impact of the shock occurs contemporaneously. Followed by this are fluctuations of the NZD around the long run equilibrium exchange rate.	Initially, there is very little response. The real exchange rate appreciated while the nominal exchange rate depreciated. This is followed by some volatile movement of the NZD around the long run equilibrium rate, which decreases as the forecast horizon increases. Due to the volatility, the maximal impact of the shock cannot be determined.
	Japanese Yen	Initial response: a depreciation of the NZD. This is followed by fluctuations around the long run equilibrium rate. The maximal impact occurs 5 months after the monetary shock but this is due to an appreciation of the NZD exceeding the long run equilibrium exchange rate. As the forecast horizon increases, the NZD reverts back to the long run equilibrium exchange rate.	Initially, there is a depreciation of the NZD. The maximal impact does not occur contemporaneously. The NZD fluctuates around the long run equilibrium exchange rate but due to the volatility that exists, where the maximal impact of the shock occurs is not certain. As the forecast horizon increases, the volatility decreases.	Initial response: an appreciation of the NZD. This is followed by fluctuations around the long run equilibrium rate, which are volatile to begin with. As the forecast horizon increases, the volatility decreases. The maximal impact occurs 3 months after the monetary shock due to an appreciation of the NZD, which exceeds the long run equilibrium exchange rate.
	UK Pound	Initial response: a significant depreciation of the NZD in which the maximal impact of the shock occurs contemporaneously. This is followed by the NZD appreciating and then reverting to its long run equilibrium rate as the forecast horizon increases.	Initial response: an appreciation of the NZD. However, the maximal impact of the shock does not occur until 2 months later. The NZD fluctuates round the long run equilibrium exchange rate and as the forecast horizon increases the volatility is reduced.	Initially, there is a significant appreciation of the NZD against the Pound in which the maximal impact of the shock occurs contemporaneously. The NZD then reverts to its long run equilibrium exchange rate where it fluctuates but these fluctuations are small.
	US Dollar	Initially, there is a small depreciation of the NZD against the USD. The maximal impact of the shock is delayed and does not occur until 3 months after the monetary shock. Following from this, the NZD appreciates and fluctuates around its long run equilibrium rate.	Initial response: a depreciation of the NZD. This is followed by a sharp appreciation of the NZD, which exceeds the long run equilibrium exchange rate, and the maximal impact occurs 2 months after the monetary shock. This is followed by the NZD fluctuating around the long run equilibrium rate. The volatility decreases as the forecast horizon increases.	Initial response: A small appreciation of the NZD. The maximal impact is delayed and does not occur until 3 months after the monetary shock. The NZD then reverts to the long run equilibrium exchange rate where it fluctuates.

The fifth variable shocked is weighted average successful bids from open market operations (BIDS). A positive shock on or an increase in BIDS is usually a response to a tightening of monetary conditions. If BIDS is pushed up, then the domestic currency is expected to appreciate. The impulse response functions in Appendix 3.17 and the results summarized on Table 7.7 show that the New Zealand dollar does not always respond in the way theory suggests and the results are mixed. The New Zealand dollar does appreciate against the Pound initially, but this is followed by volatile movement of the exchange rate. Although the New Zealand depreciates against the US dollar initially, the maximal impact of the shock is due to an appreciation of the New Zealand dollar exceeding the long run equilibrium rate. However, in the case of the Australian dollar and the Yen, appreciations of the New Zealand dollar do not dominate the movement of these exchange rates in any way. Once again the overshooting hypothesis does not hold, although in the case of the Australian dollar the maximal impact occurs contemporaneously but this is due to the New Zealand dollar depreciating against the Australian dollar in response to a positive shock on BIDS before returning to its long run equilibrium rate.

The sixth variable shocked is the short-term New Zealand interest rate. A positive shock on the domestic interest rate is usually a response to tighter monetary conditions. When the domestic interest rate rises, the domestic currency is expected to appreciate, maybe not immediately. The results from the impulse response functions in Appendix 3.18 are summarized in Table 7.7 and they show the New Zealand dollar does appreciate initially in response to a positive shock on short-term interest rates. In the case of the Yen, Pound, and the US dollar, this theory does hold as the New Zealand dollar appreciates then returns to its long run equilibrium exchange rate as the forecast horizon increases. In the case of the Australian dollar, the initial response of the New Zealand dollar is small and the movement in the exchange rate are volatile so neither an appreciation or depreciation dominates. The overshooting hypothesis only holds in the case of the Pound, where the New Zealand dollar appreciates initially and the maximal impact of the shock occurs contemporaneously. The overshooting hypothesis does not hold for the Australian dollar because the initial response of the exchange rate is small and the maximal impact of the shock does not occur until later. In the case of the Yen and the US dollar, the maximal impact of the shock is delayed and does not occur until three months after the monetary shock in both cases.

Australia

The same variables were shocked for Australia as for New Zealand. The generalized impulse response functions are displayed in Appendices 3.19 to 3.24. The results are all summarized in Table 7.8. The generalized impulse responses are very similar to the orthogonalized impulse response.

The first variable shocked is M1 and this is shocked for all three models. The domestic currency is expected to depreciate when there is an expansion in monetary policy or a positive shock on M1. The impulse response functions of the Australian dollar to a positive shock on M1 for each model are displayed in Appendices 3.19 to 3.21. The results are summarized in Table 7.8, which shows that the Australian dollar responds to the shock on M1 in the same way for all three models. There are minor differences but these are not found to be significant. In three out of the four exchange rates (the New Zealand dollar, the Pound and US dollar), the Australian dollar depreciates immediately in response to a monetary expansion. However, in the case of the Pound, the maximal impact of the shock is due to an appreciation of the Australian dollar, which exceeds the long run equilibrium exchange rate. The Australian dollar appreciates against the Yen initially and volatile movement of the exchange rate follow this. There is no evidence here to support the overshooting hypothesis suggested by Dornbusch (1976). The initial impact on the Australian dollar is small so the maximal impact of the shock is delayed in all cases.

The fourth variable shocked is the foreign – Australian interest rate differential. Theory suggests that a positive shock on the foreign – domestic interest rate differential leads to a depreciation of the domestic currency. The impulse response functions in Appendix 3.22 and the results summarized on Table 7.8 show that the Australian dollar depreciates against all the currencies initially when there is a positive shock on the interest rate differential. The maximal impact of the shock occurs contemporaneously for the Yen, the Pound, and the US dollar nominal exchange rate so there is support for Dornbusch's overshooting hypothesis. This is followed by an appreciation of the Australian dollar, which is expected to exceed the long run exchange rate at some point in time. Finally, as the forecast horizon increases, the dollar stabilises around the long run equilibrium exchange rate. For the New Zealand dollar, the maximal impact of the shock occurs three months after the initial shock so the overshooting hypothesis is rejected in this case. Some volatile movement of the exchange rate then follow which becomes less volatile as the forecast horizon increases.

Table 7. 8: Matrix of Generalized Responses of the Australian Dollar to a Positive, One Standard Deviation Monetary Shock

		Variables Shocked		
		M1 in Model 1	M1 in Model 2	M1 in Model 3
Australian Dollar Exchange Rate (Real and Nominal)	Japanese Yen	Initial response: an appreciation of the AUD. This is followed by a depreciation of the AUD exceeding the long run equilibrium exchange rate, in which the maximal impact occurs 2 months after the shock on M1. The AUD then fluctuates around its long run equilibrium rate and as the forecast horizon increases, the volatility decreases.	Initially, there is an appreciation of the AUD against the Yen. Due to the volatility that exists, it cannot be concluded where the maximal impact of the shock occurs. As the forecast horizon increases, the AUD fluctuates around the long run equilibrium rate and the volatility decreases.	Initial response: an appreciation of the AUD. Due to the volatility that exists, where the maximal impact of the shock occurs cannot be determined. The AUD fluctuates around the long run equilibrium exchange rate and becomes less volatile as the forecast horizon increases.
	New Zealand Dollar	Initial response: a depreciation of the AUD against the NZD. This is followed by fluctuations of the AUD around the long run equilibrium exchange rate. The maximal impact occurs 6 months after the shock on M1.	Initial response: a depreciation of the AUD. Very volatile movement of the AUD around the long run equilibrium exchange rate follow this, so it cannot be concluded where the maximal impact of the shock occurs. The AUD becomes much less volatile 14 months after the monetary shock.	Initially, there is a depreciation of the AUD. Volatile movement of the AUD, which fluctuates around the long run equilibrium exchange rate, follow this. The maximal impact of the shock does not occur until 6 months after the monetary shock.
	UK Pound	Initially, there is a small depreciation of the AUD against the Pound. The maximal impact of the shock does not occur until 3 months after the monetary shock but this is due to an appreciation of the AUD. Following from this, the AUD reverts back to its long run equilibrium rate.	Initially, there is very little response, maybe a slight appreciation of the AUD. The maximal impact of the shock is due to an appreciation of the AUD exceeding the long run equilibrium exchange rate, which occurs 3 months later. The AUD then reverts to its long run equilibrium rate where it stabilises.	Initial response: a small depreciation of the AUD. The maximal impact of the shock occurs 3 months later but this is due to an appreciation of the AUD exceeding the long run equilibrium exchange rate. This is followed by the AUD reverting to its long run equilibrium rate where it stabilises.
	US Dollar	Initial response: a small depreciation of the AUD. For the real exchange rate, due to the volatility, where the maximal impact occurs cannot be determined. In the case of the nominal exchange rate, the maximal impact occurs 5 months after the shock on M1. In both cases, the AUD reverts to the long run equilibrium rate and becomes less volatile as the forecast horizon increases.	Initially, there is very little response in the exchange rate. Due to the volatility that exists, where the maximal impact of the shock occurs cannot be determined. The AUD begins to stabilise at the long run equilibrium exchange rate 12 months after the shock on M1.	Initially, there is very little response to the shock on M1, maybe a slight depreciation of the AUD. Where the maximal impact of the shock occurs cannot be determined due to the volatility that exists. As the forecast horizon increases, the AUD becomes less volatile and stabilises around the long run equilibrium exchange rate.

Table 7.8 Continued

		Variables Shocked		
		Foreign – Australian Interest Differential	Australian 11 am Cash Rate	Short-term Australian Interest Rates
Australian Dollar Exchange Rate (Real and Nominal)	Japanese Yen	Initially, there is a depreciation of the AUD in which the maximal impact of the shock occurs contemporaneously. This is followed by fluctuations around the long run equilibrium exchange rate, which become less volatile as the forecast horizon increases.	Initial response: an appreciation of the AUD. However, the maximal impact of the shock does not occur until 5 months after the monetary shock due to a depreciation of the AUD exceeding the long run equilibrium rate. The AUD stabilises around the long run equilibrium rate 13 months after the monetary shock.	Initial response: a significant appreciation of the AUD in which the maximal impact of the shock occurs contemporaneously. The AUD then depreciates and fluctuates around its long run equilibrium rate. As the forecast horizon increases, the AUD becomes less volatile.
	New Zealand Dollar	Initial response: a depreciation of the AUD. Some volatile movement of the AUD around the long run equilibrium exchange rate follow this. However, the maximal impact occurs 3 months after the monetary shock. The AUD becomes less volatile as the forecast horizon increases.	Initially, there is a significant appreciation of the AUD, but the maximal impact of the shock does not occur until 1 month later. This is followed by the AUD depreciating and then reverting back to its long run equilibrium rate where it fluctuates around.	Initially, there is a significant appreciation of the AUD. The maximal impact of the shock occurs contemporaneously. This is followed by the AUD depreciating back to the long run equilibrium rate where the AUD fluctuates around. The fluctuations are volatile at first, but the volatility decreases as the forecast horizon increases.
	UK Pound	Initially, there is a significant depreciation of the AUD against the Pound. The maximal impact of the shock occurs contemporaneously. The AUD then appreciates back to its long run equilibrium rate where it stabilises.	Initially, there is an appreciation of the AUD, however the maximal impact of shock does not occur until 2 months after the monetary shock for the real exchange rate, and 3 months later for the nominal exchange rate. The AUD depreciates then fluctuates around its long run equilibrium rate.	Initial response: an appreciation of the AUD. The maximal impact of the shock occurs contemporaneously. The AUD then reverts to its long run equilibrium exchange rate where it stabilises.
	US Dollar	Initial response: a depreciation of the AUD. In the case of the nominal exchange rate, the maximal impact occurs contemporaneously, and occurs 1 month later in the case of the real exchange rate. In both cases, this is followed by fluctuations around the long run equilibrium exchange rate.	Initially, there is very little response in the AUD. The AUD fluctuates around the long run equilibrium exchange rate, but where the maximal impact of the shock occurs cannot be determined. As the forecast horizon increases, the AUD becomes less volatile.	Initial response: an appreciation of the AUD. The maximal impact of the shock occurs contemporaneously. This is followed by fluctuations around the long run equilibrium exchange rate, which are quite volatile. Ten months after the monetary shock, the AUD stabilises at the long run equilibrium rate.

The fifth variable shocked is the Australian 11am cash rate. An increase in the 11am cash rate is a sign of tighter monetary conditions, so one would expect the Australian dollar to appreciate in response to a positive shock on the Australian 11am cash rate. The impulse response functions in Appendix 3.23 and the results on Table 7.8 show an interesting result, that is all the exchange rates respond in a similar way when there is a shock on the cash rate, although there are some differences in the size of the response and when the maximal impact of the shock occurs. In all cases an appreciation of the Australian dollar takes place initially, but the maximal impact is not always due to an appreciation. The results show that that overshooting hypothesis is rejected once again since the maximal impact of the shock does not occur contemporaneously but is delayed in all four cases.

Finally, the short-term Australian interest rate is shocked. A positive shock on short-term interest rates leads to an appreciation of the domestic currency due to the inflow of capital into the country because of higher interest rates. From the impulse response functions in Appendix 3.24, the results are summarized in Table 7.8. The results show that for all four exchange rates, the Australian dollar appreciates initially and the maximal impact of the shock occurs contemporaneously so there is strong support for the overshooting hypothesis when there is a shock on the foreign – Australian interest differential. The Australian dollar then depreciates against the Pound, and stabilises around the long run exchange rate. The Australian dollar also depreciates against all the other currencies but this results in the Australian dollar exceeding its long run equilibrium rate for each exchange rate before becoming stable around the long run equilibrium rate.

7.3.3 Orthogonalized Forecast Error Variance Decompositions

The orthogonalized forecast error variances of the New Zealand dollar and Australian dollar exchange rates, both real and nominal are discussed in this section. This section discusses how much of the exchange rate variability is explained by the monetary variables for each model. The variables included in each model is displayed in Table 7.1 for New Zealand and Table 7.2 for Australia. Firstly, there is a discussion on the variance decomposition of the New Zealand dollar exchange rates. This is followed by a discussion on the forecast error variances of the Australian dollar exchange rates.

New Zealand

Tables 7.9 to 7.12 provides the orthogonalized forecast error variance decompositions for the New Zealand dollar against the Australian dollar, the Yen, the Pound, and the US dollar respectively for both the real and nominal exchange rates in the benchmark model (Model 1) for a 25 month forecast horizon. The results show that the majority of the movement in the exchange rates are explained by their past values. However, as the forecast horizon increases, the variability of the exchange rates are explained less by its past values and the explanatory power of the other variables increase.

Examining the variance decompositions of the New Zealand dollar against the Australian dollar in Table 7.9 more closely, the variance decomposition of the real exchange rate (RNZAU) is similar to the decomposition of the nominal exchange rate (NNZAU). In both cases, the monetary variables, M1 and the interest rate differential explain very little of the variability of the New Zealand dollar movement against the Australian dollar initially and as the forecast horizon increases. Most of the variability in the New Zealand dollar, both real and nominal, is explained by production and the CPI.

Table 7.10 displays the variance decompositions for the New Zealand dollar against the Yen. Firstly, examining the real exchange rate (RNZJP), initially (zero-month forecast horizon), M1 is the second most important variable in explaining the movement in RNZJP after the CPI. Meanwhile the interest rate differential explains very little of the variability in RNZJP. In the 25-month horizon, production and the CPI play the most important roles in explaining the real exchange variability. Meanwhile the interest differential and M1 explains much less of the variability in RNZJP in the 25-month horizon. The results for the nominal exchange rate (NNZP) differ slightly because the CPI does not have such an important role in explaining the movement of NNZP. Initially, M1 has the greatest influence on the movement of NNZJP while the interest differential has the least impact. In the 25-month forecast horizon, each variable explains between 4 and 5 percent of the variability in NNZJP with the CPI having the least influence on the movement of NNZJP.

Table 7.11 displays the orthogonalized forecast error variance decompositions for the New Zealand dollar against the Pound. The variance decompositions are similar for the real (RNZUK) and nominal (NNZUK) exchange rates. The CPI is the most important variable in explaining the movement of the New Zealand dollar, both initially and as the forecast

Table 7.9: Orthogonalized Forecast Error Variance Decompositions of the New Zealand – Australian Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	AUS-NZID	RNZAU
RNZAU	0	0.0391	0.0914	0.0001	0.0341	0.8355
	1	0.0340	0.1429	0.0003	0.0463	0.7764
	5	0.1121	0.1479	0.0177	0.0585	0.6638
	10	0.1427	0.1453	0.0258	0.0766	0.6096
	15	0.1434	0.1445	0.0272	0.0784	0.6065
	20	0.1431	0.1463	0.0276	0.0789	0.6040
	25	0.1431	0.1464	0.0276	0.0792	0.6036

Variable Explained	Forecast Period	PRO	CPI	M1	AUS-NZID	NNZAU
NNZAU	0	0.0403	0.0428	0.0006	0.0243	0.8919
	1	0.0357	0.0814	0.0014	0.0357	0.8457
	5	0.1065	0.1044	0.0176	0.0496	0.7220
	10	0.1245	0.1076	0.0253	0.0678	0.6748
	15	0.1254	0.1075	0.0264	0.0694	0.6713
	20	0.1251	0.1092	0.0267	0.0701	0.6689
	25	0.1251	0.1093	0.0267	0.0702	0.6686

Table 7.10: Orthogonalized Forecast Error Variance Decompositions of the New Zealand – Japanese Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	JP-NZID	RNZJP
RNZJP	0	0.0160	0.0887	0.0292	0.0062	0.8599
	1	0.0350	0.0817	0.0255	0.0055	0.8524
	5	0.0364	0.0850	0.0386	0.0406	0.7994
	10	0.0607	0.0892	0.0380	0.0428	0.7694
	15	0.0618	0.0902	0.0391	0.0439	0.7649
	20	0.0617	0.0902	0.0393	0.0440	0.7647
	25	0.0619	0.0902	0.0392	0.0442	0.7645

Variable Explained	Forecast Period	PRO	CPI	M1	JP-NZID	NNZJP
NNZJP	0	0.0108	0.0292	0.0391	0.0108	0.9100
	1	0.0306	0.0256	0.0342	0.0098	0.8998
	5	0.0313	0.0330	0.0408	0.0421	0.8528
	10	0.0447	0.0377	0.0417	0.0440	0.8319
	15	0.0459	0.0400	0.0423	0.0454	0.8264
	20	0.0459	0.0401	0.0424	0.0456	0.8261
	25	0.0461	0.0401	0.0424	0.0457	0.8257

Table 7.11: Orthogonalized Forecast Error Variance Decompositions of the New Zealand – UK Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	UK-NZID	RNZUK
RNZUK	0	0.0008	0.1378	0.0190	0.0163	0.8261
	1	0.0007	0.1232	0.0188	0.0406	0.8167
	5	0.0081	0.1480	0.0226	0.0445	0.7768
	10	0.0225	0.1493	0.0242	0.0442	0.7598
	15	0.0234	0.1502	0.0243	0.0449	0.7572
	20	0.0241	0.1503	0.0243	0.0452	0.7561
	25	0.0242	0.1503	0.0243	0.0452	0.7559

Variable Explained	Forecast Period	PRO	CPI	M1	UK-NZID	NNZUK
NNZUK	0	0.0001	0.0719	0.0270	0.0258	0.8752
	1	0.0002	0.0676	0.0269	0.0448	0.8605
	5	0.0053	0.1092	0.0324	0.0472	0.8059
	10	0.0117	0.1112	0.0353	0.0479	0.7938
	15	0.0123	0.1125	0.0352	0.0485	0.7915
	20	0.0126	0.1129	0.0352	0.0487	0.7906
	25	0.0128	0.1129	0.0352	0.0487	0.7904

Table 7.12: Orthogonalized Forecast Error Variance Decompositions of the New Zealand – US Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	US-NZID	RNZUS
RNZUS	0	0.0939	0.0914	0.0273	0.0022	0.7851
	1	0.0888	0.0975	0.0269	0.0041	0.7827
	5	0.1113	0.1073	0.0488	0.0708	0.6619
	10	0.1930	0.1097	0.0451	0.0931	0.5591
	15	0.1897	0.1106	0.0527	0.0956	0.5515
	20	0.1894	0.1121	0.0527	0.0955	0.5502
	25	0.1892	0.1126	0.0527	0.0958	0.5497

Variable Explained	Forecast Period	PRO	CPI	M1	US-NZID	NNZUS
NNZUS	0	0.0807	0.0197	0.0269	0.0020	0.8706
	1	0.0770	0.0198	0.0262	0.0056	0.8715
	5	0.0925	0.0485	0.0623	0.0849	0.7119
	10	0.1555	0.0585	0.0587	0.0954	0.6320
	15	0.1533	0.0607	0.0638	0.0972	0.6251
	20	0.1531	0.0619	0.0639	0.0975	0.6236
	25	0.1532	0.0623	0.0639	0.0976	0.6230

horizon increases. Initially the other variables explain very little of the movement in the New Zealand dollar with production being the least important variable in explaining the variability in the New Zealand dollar. In the 25-month horizon, all of the variables explain more of the movement in the New Zealand dollar but this is still small relative to how much the CPI explains.

The orthogonalized forecast error variance decompositions of the New Zealand dollar against the US dollar are displayed in Table 7.12. In the case of the real exchange rate (RNZUS), production and the CPI are the most important variables in explaining the variability of RNZUS initially and as the forecast horizon increases. Meanwhile M1 and the interest differential explain very little of the movement of the New Zealand dollar. The variance decompositions differ slightly for the nominal exchange rate (NNZUS). Production is still the most important variable in explaining the variability of the New Zealand dollar against the US dollar, and the CPI is not so important in explaining the movement in NNZUS. As the forecast horizon increases, the CPI becomes the least important variable in explaining the movement of NNZUS and the monetary variables, M1 and the interest rate differential explain more of the movement in the nominal exchange rate than the CPI.

The orthogonalized forecast error variance decompositions were also estimated for the New Zealand dollar exchange rates in Model 2 and in Model 3. The differences between the models are due to the different variables included in each model and also the ordering of the variables. The variance decompositions of the New Zealand dollar in Model 2 are displayed in Appendix 4.1 and the variance decompositions of the New Zealand dollar in Model 3 are displayed in Appendix 4.2. The results show that past exchange rate values explain the majority of the movement in the New Zealand dollar, both real and nominal. However, as the forecast horizon increases, past exchange rate values explain less of movement in the New Zealand dollar while the other variables explain more of the variability. In most cases production and the CPI explain most of the variability in the New Zealand dollar while the monetary variables explain less.

Australia

Tables 7.13 to 7.16 provide the forecast error variances of the Australian dollar in the benchmark specification (Model 1) for a 25-month forecast horizon. Again the results show

Table 7.13: Orthogonalized Forecast Error Variance Decompositions of the Australian – Japanese Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	JP-AUSID	RAUJP
RAUJP	0	0.0009	0.0001	0.0085	0.0465	0.9440
	1	0.0011	0.0016	0.0069	0.0598	0.9306
	5	0.0504	0.0547	0.0275	0.0627	0.8047
	10	0.0596	0.0785	0.0284	0.0690	0.7644
	15	0.0627	0.0797	0.0306	0.0697	0.7573
	20	0.0627	0.0812	0.0317	0.0700	0.7545
	25	0.0627	0.0817	0.0318	0.0700	0.7538

Variable Explained	Forecast Period	PRO	CPI	M1	JP-AUSID	NAUJP
NAUJP	0	0.0001	0.0176	0.0050	0.0432	0.9342
	1	0.0003	0.0198	0.0040	0.0513	0.9246
	5	0.0486	0.0708	0.0206	0.0599	0.8001
	10	0.0583	0.0954	0.0219	0.0670	0.7574
	15	0.0604	0.0968	0.0240	0.0672	0.7516
	20	0.0605	0.0979	0.0249	0.0675	0.7493
	25	0.0605	0.0983	0.0250	0.0674	0.7488

Table 7.14: Orthogonalized Forecast Error Variance Decompositions of the Australian – New Zealand Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	NZ-AUSID	RAUNZ
RAUNZ	0	0.0000	0.0626	0.0047	0.0394	0.8934
	1	0.0001	0.0632	0.0059	0.0580	0.8728
	5	0.0320	0.1508	0.0073	0.1070	0.7029
	10	0.0642	0.1504	0.0130	0.1216	0.6508
	15	0.0632	0.1511	0.0152	0.1254	0.6451
	20	0.0636	0.1517	0.0153	0.1267	0.6427
	25	0.0637	0.1518	0.0154	0.1269	0.6423

Variable Explained	Forecast Period	PRO	CPI	M1	NZ-AUSID	NAUNZ
NAUNZ	0	0.0000	0.0661	0.0044	0.0325	0.8970
	1	0.0000	0.0684	0.0108	0.0483	0.8724
	5	0.0402	0.1661	0.0099	0.0956	0.6881
	10	0.0820	0.1604	0.0154	0.1103	0.6319
	15	0.0806	0.1601	0.0180	0.1154	0.6258
	20	0.0812	0.1606	0.0182	0.1170	0.6231
	25	0.0814	0.1606	0.0183	0.1171	0.6226

Table 7.15: Orthogonalized Forecast Error Variance Decompositions of the Australian – UK Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	UK-AUSID	RAUUK
RAUUK	0	0.0012	0.0001	0.0003	0.0763	0.9221
	1	0.0011	0.0106	0.0007	0.1256	0.8620
	5	0.0197	0.0157	0.0668	0.1346	0.7633
	10	0.0375	0.0326	0.0642	0.1406	0.7252
	15	0.0378	0.0349	0.0640	0.1399	0.7233
	20	0.0378	0.0355	0.0640	0.1400	0.7227
	25	0.0379	0.0355	0.0640	0.1401	0.7225
Variable Explained	**Forecast Period**	**PRO**	**CPI**	**M1**	**UK-AUSID**	**NAUUK**
NAUUK	0	0.0006	0.0103	0.0020	0.0691	0.9179
	1	0.0008	0.0239	0.0019	0.1033	0.8700
	5	0.0229	0.0259	0.0703	0.1149	0.7660
	10	0.0431	0.0437	0.0674	0.1222	0.7237
	15	0.0433	0.0462	0.0673	0.1218	0.7214
	20	0.0433	0.0467	0.0672	0.1220	0.7208
	25	0.0434	0.0467	0.0672	0.1220	0.7207

Table 7.16: Orthogonalized Forecast Error Variance Decompositions of the Australian – US Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	US-AUSID	RAUUS
RAUUS	0	0.0061	0.0054	0.0015	0.0207	0.9663
	1	0.0057	0.0228	0.0029	0.0440	0.9245
	5	0.1107	0.0350	0.0252	0.0596	0.7695
	10	0.1137	0.1050	0.0327	0.0590	0.6896
	15	0.1216	0.1066	0.0323	0.0597	0.6799
	20	0.1219	0.1072	0.0326	0.0599	0.6784
	25	0.1220	0.1073	0.0326	0.0599	0.6781
Variable Explained	**Forecast Period**	**PRO**	**CPI**	**M1**	**US-AUSID**	**NAUUS**
NAUUS	0	0.0037	0.0586	0.0033	0.0207	0.9136
	1	0.0039	0.0742	0.0055	0.0380	0.8784
	5	0.1066	0.0705	0.0255	0.0468	0.7506
	10	0.1103	0.1280	0.0320	0.0487	0.6809
	15	0.1156	0.1290	0.0318	0.0495	0.6742
	20	0.1158	0.1296	0.0320	0.0495	0.6730
	25	0.1159	0.1297	0.0321	0.0496	0.6728

that the majority of the movement in the exchange rates, both real and nominal, are explained by their past values. As the forecast horizon increases, the explanatory power of the other variables in the model increase while past exchange rate values explain less.

Table 7.13 shows the variance decompositions of the Australian dollar against the Yen. The overall decompositions are similar for the real and nominal exchange rates, although the percentages differ. Initially, the interest differential is the most important variable in explaining the variability of the Australian dollar. As the forecast horizon increases, the CPI becomes the most important variable in explaining the movement of the Australian dollar. This is followed by the interest differential and production while M1 explains the least of the movement of the Australian dollar.

Table 7.14 shows the orthogonalized forecast error variance decompositions of the Australian dollar against the New Zealand dollar. The variance decomposition of the nominal exchange rate (NAUNZ) is similar to the decomposition of the real exchange rate (RAUNZ), although the percentages differ. The CPI and the interest rate differential have the greatest impact on the movement of the Australian dollar while M1, the other monetary variable has the least influence on the movement of the Australian dollar as the forecast horizon increases.

Table 7.15 provides the variance decompositions of the Australian dollar against the Pound. The results are similar for both the real (RAUUK) and the nominal (NAUUK) exchange rates. The interest rate differential plays the largest role in explaining the variability of the Australian dollar initially, and as the forecast horizon increases. As the forecast horizon increases, M1 plays the second most important role in explaining the movement of the Australian dollar and at the same time production and the CPI explain the least of the variability in the Australian dollar.

The forecast error variances of the Australian dollar against the US dollar are displayed on Table 7.16. Examining the real exchange rate (RAUUS) more closely, the interest differential initially plays the most important role in explaining the movement of RAUUS while the other variables explain less. As the forecast horizon increases, production and the CPI become the most important variables in explaining the variability of RAUUS. The variance decomposition is similar for the nominal exchange rate (NAUUS) except the CPI has a greater role in explaining the variability of NAUUS initially, and as the forecast horizon increases. As the forecast horizon increases, production becomes the second most important variable in explaining the movement of NAUUS while the monetary variables, M1 and the interest differential have the least impact on the variability of NAUUS.

The orthogonalized forecast error variance decompositions were also estimated for the Australian dollar exchange rates in Model 2 and Model 3. The orthogonalized forecast error variances for the Australian dollar exchange rates in Model 2 are displayed in Appendix 4.3. Appendix 4.4 gives the orthogonalized forecast error variance decompositions for the Australian dollar exchange rates in Model 3. Although the proportions differ, the overall decompositions are similar to that of Model 1 (the benchmark specification). The results show that past exchange rate values explain the majority of the variability in the Australian dollar, both real and nominal. As the forecast horizon increases, other variables explain more of the movement in the Australian dollar while past exchange rate values explain less. For Model 2, the variance decompositions show that the CPI and production usually explain a significant amount of the variability in the Australian dollar, however, the cash rate also explains a significant amount of the variability in the Australian dollar. Meanwhile M1 only explains a small amount of the movement of the Australian dollar. The variance decompositions of the Australian dollar in Model 3 show that the CPI usually explains most of the variability in the Australian dollar while M1 has the least impact on the Australian dollar. The Australian interest rate plays an important role in explaining the variability in the New Zealand dollar and Pound exchange rates.

7.3.4 Generalized Forecast Error Variance Decomposition

This section discusses the generalized forecast error variances of the New Zealand dollar and the Australian dollar exchange rates. The original output of the generalized forecast error variances are not standardised unlike the orthogonalized forecast error variances, that is all the proportions add up to one. After standardizing the generalized forecast error variances, the decompositions are found to be similar to the orthogonalized forecast error variance decompositions, although the percentages differ. First there is a discussion on the variance decompositions of the New Zealand dollar, followed by a discussion on the variance decompositions of the Australian dollar.

New Zealand

Tables 7.17 to 7.20 show the forecast error variances for the New Zealand dollar in the benchmark specification (Model 1). Like the orthogonalized variance decompositions, the past exchange rate values explain most of the movement in the New Zealand dollar and as the forecast horizon increases, the other variables explain more of the variability of the New Zealand dollar while the past exchange rate values explain less.

Table 7.17 provides the generalized forecast error variances of the New Zealand dollar against the Australian dollar. For both the real (RNZAU) and the nominal (NNZAU) exchange rates, initially each variable explains some of the variability of the exchange rate. As the forecast horizon increases, each variable explains more. In the 25-month horizon production and the CPI explain most of the variability in the New Zealand dollar, this is closely followed by the interest differential while M1 explains very little of the movement in the New Zealand dollar.

The generalized forecast error variance decompositions of the New Zealand dollar against the Japanese Yen is displayed in Table 7.18. In the case of the real exchange rate (RNZJP), the CPI explains most of the variability in the exchange rate, initially and as the forecast horizon increases. The other variables explain much less of the movement in RNZJP with the monetary variables, M1 and the interest differential explaining the least. The variance decomposition differs slightly for the nominal exchange rate (NNZJP) due to the CPI explaining much less of the variability in the NNZJP. As the forecast horizon increases, the interest differential becomes the most important variable in explaining the movement of NNZJP. However, M1 has the least important role in explaining the variability of NNZJP.

Table 7.19 provides the forecast error variances of the New Zealand dollar against the UK Pound. The variance decompositions for the real (RNZUK) and nominal (NNZUK) exchange rates are very similar. The CPI plays the greatest role in explaining the variability of the New Zealand dollar initially and as the forecast horizon increases. This is followed by the interest differential which explains much less of the movement in the New Zealand dollar. Meanwhile, production and M1 have the least impact on the variability of the New Zealand dollar.

Table 7.20 shows the forecast error variance decompositions of the New Zealand dollar against the US dollar. In the case of the real exchange rate (RNZUS), production and the CPI

Table 7.17: Generalized Forecast Error Variance Decompositions of the New Zealand – Australian Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	AUS-NZID	RNZAU
RNZAU	0	0.0323	0.0885	0.0034	0.0476	0.8282
	1	0.0274	0.1251	0.0047	0.0670	0.7757
	5	0.0912	0.1331	0.0262	0.0790	0.6705
	10	0.1171	0.1308	0.0319	0.0931	0.6272
	15	0.1179	0.1303	0.0328	0.0945	0.6246
	20	0.1176	0.1315	0.0331	0.0953	0.6225
	25	0.1176	0.1316	0.0331	0.0954	0.6223

Variable Explained	Forecast Period	PRO	CPI	M1	AUS-NZID	NNZAU
NNZAU	0	0.0355	0.0482	0.0042	0.0314	0.8807
	1	0.0309	0.0785	0.0064	0.0496	0.8346
	5	0.0920	0.1032	0.0278	0.0645	0.7126
	10	0.1077	0.1056	0.0330	0.0810	0.6727
	15	0.1086	0.1056	0.0336	0.0825	0.6698
	20	0.1083	0.1067	0.0338	0.0836	0.6676
	25	0.1083	0.1068	0.0338	0.0837	0.6674

Table 7.18: Generalized Forecast Error Variance Decompositions of the New Zealand – Japanese Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	JP-NZID	RNZJP
RNZJP	0	0.0140	0.0883	0.0125	0.0069	0.8783
	1	0.0308	0.0847	0.0112	0.0060	0.8672
	5	0.0326	0.0884	0.0229	0.0370	0.8191
	10	0.0548	0.0894	0.0227	0.0392	0.7939
	15	0.0559	0.0900	0.0238	0.0408	0.7895
	20	0.0558	0.0900	0.0240	0.0409	0.7892
	25	0.0560	0.0900	0.0240	0.0411	0.7890

Variable Explained	Forecast Period	PRO	CPI	M1	JP-NZID	NNZJP
NNZJP	0	0.0100	0.0327	0.0237	0.0102	0.9233
	1	0.0284	0.0300	0.0214	0.0101	0.9101
	5	0.0293	0.0379	0.0267	0.0411	0.8649
	10	0.0421	0.0404	0.0274	0.0432	0.8469
	15	0.0432	0.0420	0.0280	0.0450	0.8418
	20	0.0432	0.0421	0.0282	0.0451	0.8414
	25	0.0434	0.0421	0.0282	0.0453	0.8410

Table 7.19: Generalized Forecast Error Variance Decompositions of the New Zealand – UK Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	UK-NZID	RNZUK
RNZUK	0	0.0007	0.1144	0.0057	0.0272	0.8520
	1	0.0006	0.1046	0.0067	0.0469	0.8412
	5	0.0070	0.1305	0.0148	0.0503	0.7974
	10	0.0195	0.1313	0.0164	0.0511	0.7816
	15	0.0203	0.1318	0.0166	0.0521	0.7792
	20	0.0209	0.1319	0.0166	0.0522	0.7783
	25	0.0211	0.1320	0.0166	0.0523	0.7781

Variable Explained	Forecast Period	PRO	CPI	M1	UK-NZID	NNZUK
NNZUK	0	0.0001	0.0611	0.0130	0.0347	0.8911
	1	0.0002	0.0587	0.0137	0.0483	0.8791
	5	0.0048	0.1003	0.0261	0.0498	0.8189
	10	0.0107	0.1024	0.0283	0.0513	0.8073
	15	0.0112	0.1032	0.0283	0.0522	0.8051
	20	0.0115	0.1037	0.0283	0.0523	0.8042
	25	0.0116	0.1037	0.0283	0.0523	0.8040

Table 7.20: Generalized Forecast Error Variance Decompositions of the New Zealand – US Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	US-NZID	RNZUS
RNZUS	0	0.0759	0.1110	0.0044	0.0008	0.8079
	1	0.0725	0.1136	0.0061	0.0038	0.8040
	5	0.0932	0.1258	0.0342	0.0635	0.6833
	10	0.1713	0.1175	0.0333	0.0777	0.6002
	15	0.1687	0.1176	0.0396	0.0803	0.5938
	20	0.1683	0.1190	0.0399	0.0802	0.5926
	25	0.1683	0.1194	0.0400	0.0803	0.5920

Variable Explained	Forecast Period	PRO	CPI	M1	US-NZID	NNZUS
NNZUS	0	0.0711	0.0386	0.0093	0.0002	0.8808
	1	0.0685	0.0377	0.0097	0.0041	0.8800
	5	0.0832	0.0683	0.0527	0.0788	0.7169
	10	0.1448	0.0682	0.0510	0.0857	0.6503
	15	0.1429	0.0696	0.0558	0.0873	0.6443
	20	0.1427	0.0708	0.0562	0.0876	0.6427
	25	0.1429	0.0712	0.0562	0.0877	0.6420

have the most important roles in explaining the variability of RNZUS, while the monetary variables, M1 and the interest differential have the least impact. The variance decomposition differs slightly for the nominal exchange rate (NNZUS) due to the CPI explaining much less of the variability in NNZUS. Production still has the greatest role in explaining the movement of exchange rate. As the forecast horizon increases, the interest differential explains more of the movement in NNZUS than the CPI, while M1 explains very little of the variability in NNZUS.

The generalized forecast error variance decompositions were also estimated for the New Zealand dollar in the other two models. Appendix 4.5 displays the generalized forecast error variance decompositions for the New Zealand dollar in Model 2. The results show that M1 plays the least important role in explaining the variability in the New Zealand dollar in all cases. Weighted average successful bids from open market operations (BIDS) plays an important role in explaining the variability of the New Zealand dollar – Yen exchange rate. However, BIDS plays a less important role in explaining the variability of the other exchange rates as Production, the CPI and the foreign interest rate play more important roles in explaining the movement of these exchange rates. The generalized forecast error variance decompositions for the New Zealand dollar in Model 3 are displayed in Appendix 4.6. The results show that the monetary variables, M1 and the New Zealand interest rate explain very little of the movement in the New Zealand dollar while production, the CPI, and the foreign interest rate explain the most.

Australia

Tables 7.21 to 7.24 displays the generalized forecast error variances for the Australian dollar against the Yen, the New Zealand dollar, the Pound, and the US dollar in the benchmark model (Model 1). The variance decompositions show that past exchange rate values have the greatest role in explaining the variability in the Australian dollar. As the forecast horizon increases, past exchange rate values explain less and other variables explain more of the movement in the Australian dollar.

Table 7.21 provides the variance decompositions of the Australian dollar against the Yen. The results are very similar for the real and nominal exchange rates. Initially, the interest differential explains most of the variability in the Australian dollar. As the forecast horizon

Table 7.21: Generalized Forecast Error Variance Decompositions of the Australian – Japanese Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	JP-AUSID	RAUJP
RAUJP	0	0.0009	0.0001	0.0086	0.0360	0.9544
	1	0.0011	0.0014	0.0069	0.0500	0.9406
	5	0.0480	0.0557	0.0266	0.0630	0.8067
	10	0.0566	0.0764	0.0279	0.0727	0.7664
	15	0.0595	0.0776	0.0304	0.0727	0.7597
	20	0.0595	0.0789	0.0315	0.0734	0.7567
	25	0.0595	0.0794	0.0317	0.0734	0.7560

Variable Explained	Forecast Period	PRO	CPI	M1	JP-AUSID	NAUJP
NAUJP	0	0.0001	0.0162	0.0050	0.0492	0.9296
	1	0.0002	0.0180	0.0040	0.0579	0.9199
	5	0.0448	0.0684	0.0204	0.0762	0.7902
	10	0.0533	0.0890	0.0222	0.0870	0.7485
	15	0.0553	0.0903	0.0244	0.0868	0.7431
	20	0.0554	0.0913	0.0252	0.0872	0.7409
	25	0.0554	0.0917	0.0253	0.0872	0.7404

Table 7.22: Generalized Forecast Error Variance Decompositions of the Australian – New Zealand Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	NZ-AUSID	RAUNZ
RAUNZ	0	0.0000	0.0565	0.0032	0.0371	0.9032
	1	0.0001	0.0567	0.0047	0.0532	0.8854
	5	0.0290	0.1341	0.0047	0.0951	0.7371
	10	0.0578	0.1336	0.0123	0.1066	0.6898
	15	0.0569	0.1343	0.0143	0.1098	0.6847
	20	0.0572	0.1347	0.0144	0.1110	0.6827
	25	0.0573	0.1348	0.0144	0.1111	0.6823

Variable Explained	Forecast Period	PRO	CPI	M1	NZ-AUSID	NAUNZ
NAUNZ	0	0.0000	0.0598	0.0031	0.0309	0.9062
	1	0.0000	0.0615	0.0092	0.0449	0.8844
	5	0.0365	0.1490	0.0074	0.0859	0.7212
	10	0.0744	0.1438	0.0143	0.0974	0.6701
	15	0.0731	0.1435	0.0167	0.1019	0.6648
	20	0.0736	0.1439	0.0168	0.1032	0.6625
	25	0.0739	0.1439	0.0168	0.1033	0.6621

Table 7.23: Generalized Forecast Error Variance Decompositions of the Australian – UK Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	UK-AUSID	RAUUK
RAUUK	0	0.0011	0.0001	0.0002	0.0682	0.9305
	1	0.0010	0.0096	0.0006	0.1165	0.8723
	5	0.0184	0.0161	0.0682	0.1180	0.7793
	10	0.0354	0.0305	0.0658	0.1236	0.7447
	15	0.0357	0.0327	0.0658	0.1231	0.7428
	20	0.0357	0.0332	0.0657	0.1232	0.7422
	25	0.0358	0.0333	0.0657	0.1232	0.7420

Variable Explained	Forecast Period	PRO	CPI	M1	UK-AUSID	NAUUK
NAUUK	0	0.0006	0.0091	0.0017	0.0683	0.9203
	1	0.0007	0.0214	0.0017	0.1022	0.8740
	5	0.0212	0.0252	0.0715	0.1047	0.7775
	10	0.0402	0.0405	0.0689	0.1110	0.7394
	15	0.0405	0.0428	0.0690	0.1106	0.7372
	20	0.0405	0.0433	0.0689	0.1107	0.7366
	25	0.0406	0.0433	0.0689	0.1107	0.7365

Table 7.24: Generalized Forecast Error Variance Decompositions of the Australian – US Exchange Rate in Model 1

Variable Explained	Forecast Period	PRO	CPI	M1	US-AUSID	RAUUS
RAUUS	0	0.0059	0.0042	0.0008	0.0195	0.9696
	1	0.0054	0.0204	0.0026	0.0447	0.9269
	5	0.1091	0.0410	0.0166	0.0575	0.7758
	10	0.1123	0.1060	0.0239	0.0597	0.6981
	15	0.1200	0.1078	0.0238	0.0605	0.6879
	20	0.1203	0.1084	0.0242	0.0606	0.6864
	25	0.1205	0.1085	0.0243	0.0607	0.6861

Variable Explained	Forecast Period	PRO	CPI	M1	US-AUSID	NAUUS
NAUUS	0	0.0034	0.0507	0.0017	0.0265	0.9176
	1	0.0035	0.0636	0.0045	0.0435	0.8849
	5	0.0995	0.0695	0.0167	0.0470	0.7673
	10	0.1033	0.1205	0.0223	0.0518	0.7021
	15	0.1082	0.1216	0.0223	0.0526	0.6952
	20	0.1084	0.1222	0.0227	0.0527	0.6941
	25	0.1085	0.1222	0.0227	0.0527	0.6938

increases, the CPI becomes the most important variable in explaining the movement of the Australian dollar followed by the interest differential. Meanwhile M1 has the least influence on the movement of the Australian dollar.

The generalized forecast error variances of the Australian dollar against the New Zealand dollar are presented in Table 7.22. The variance decompositions for both the real and nominal exchange rates show that the CPI has the greatest influence on the movement of the Australian dollar and this is followed by the interest differential while M1 has very little impact on the movement of the Australian dollar.

Table 7.23 provides the variance decompositions of the Australian dollar against the Pound. Although the proportions differ, the overall results are similar for the real (RAUUK) and nominal (NAUUK) exchange rates. The results show that the UK – Australian interest differential has the greatest influence on the movement of the Australian dollar initially, while all the other variables explain less than one percent of the movement in the Australian dollar. As the forecast horizon increases, the monetary variables, the interest differential and M1 have the greatest role in explaining the variability of the exchange rate.

Table 7.24 provides the forecast error variances of the Australian dollar against the US dollar. The decomposition of the real exchange rate (RAUUS) and the decomposition of the nominal exchange rate (NAUUS) are similar. The variance decompositions show that as the forecast horizon increases, production and the CPI explain most the variability in the Australian dollar while the monetary variables explain very little of the movement of the Australian dollar.

The generalized forecast error variances of the Australian dollar in Model 2 and Model 3 were also estimated and these are displayed in Appendices 4.7 and 4.8. The variance decompositions for Model 2 in Appendix 4.7 show that production and the CPI play a significant role in explaining the movement of the Australian dollar while the monetary variables, the cash rate and M1 explain less. However, in the case of the Australian – UK exchange rate, the monetary variables, the cash rate and M1 explain most of the variability in the exchange rate. The cash rate also has the most impact on the movement of the Australian dollar against the New Zealand dollar. The results displayed Appendix 4.8 are similar. That is production and the CPI play an important role in explaining the movement of the Australian dollar while the monetary variables, M1 and the Australian interest rate explain only a small amount of the variability. However, there are exceptions, the monetary variables, the

Australian interest rate and M1 explain most of the variability in the Australian – UK exchange rate and the Australian interest rate also has the most important role in explaining the movement in the Australian – New Zealand exchange rate.

CHAPTER 8

Conclusion

This study examined the impact of monetary policy shocks on the New Zealand dollar and the Australian dollar exchange rates under a flexible exchange rate system. The sample period was from March 1985 to March 1998 and monthly data was used for this study. For New Zealand the nominal and real exchange rates examined are the New Zealand dollar against the Australian dollar, the Yen, the UK Pound, and the US dollar. The Australian exchange rates examined are the Australian dollar against the Yen, the New Zealand dollar, the UK Pound, and the US dollar.

Three VAR models were estimated to see the effects of monetary policy on the exchange rate and the models differ due to the variables included in each model. The first model estimated was the benchmark specification, which included the foreign – domestic interest differential as a measure of monetary policy. The second model included a proxy for the US Federal funds rate as a measure of monetary policy. For New Zealand the proxy used was weighted average successful bids from open market operations and for Australia, the 11am cash rate was used. Finally, the third model included M1 as a measure of monetary policy for both New Zealand and Australia as a proxy for non-borrowed to total reserves which US studies have used as a measure of monetary policy.

From the VAR models, the impulse response functions and the forecast error variance decompositions (both orthogonalized and generalized) were estimated. The impulse response functions show how the exchange rate responds to a positive, one standard deviation monetary shock. The forecast error variance decompositions show how much of the variability of the exchange rate is explained by the monetary variables and how much is explained by the other variables in the model. Other studies have examined the impact of monetary shocks on exchange rates using orthogonalized impulse response functions and orthogonalized forecast error variance decompositions so comparisons can be made. The generalized impulse response functions and generalized forecast error variance decompositions were also estimated but this is a more recently developed method so the impact of monetary shocks on exchange rates has not been examined before using this approach to the writer's knowledge. The main difference between the orthogonalized approach and the generalized approach is that the ordering of the variables is important in the orthogonalized approach.

The generalized impulse responses and the generalized forecast error variance decompositions gave similar results to the orthogonalized impulse responses and orthogonalized forecast error variance decompositions. The reason is because the covariance matrix of shocks is diagonal or almost diagonal.

The impulse responses and variance decompositions of the nominal exchange rates are similar to those of the real exchange rate, but the results were not identical. This was expected given that the movement in the nominal exchange rate is highly correlated with the movement in the real exchange rate.

The variance decompositions show that monetary shocks do contribute to the variability of the New Zealand dollar but monetary shocks do not explain the majority of the movement in the New Zealand dollar. This is consistent with other studies such as Eichenbaum and Evans (1995) who also found that monetary shocks explains some of the variability in the US dollar but monetary shocks play only a small role in explaining the variability of the exchange rate. The forecast error variances of this study showed that past exchange rate values explain the majority of the variability in the New Zealand dollar. Following from this the CPI and production explain more of the variability in the exchange rates than the monetary variables: M1, the foreign – New Zealand interest differential, weighted average successful bids from open market operations, and the New Zealand interest rate.

For Australia, the variance decompositions are similar to that of New Zealand. Again past exchange rate values explain most of the variability in the exchange rate. In most cases the CPI and production have the greatest roles in explaining the variability of the Australian dollar. However, the variance decompositions for the Australian dollar also differs slightly to those of the New Zealand dollar as the monetary variables occasionally explain more of the movement in the Australian dollar. An example is the Australian – UK exchange rate, where the monetary variables (in the three different models): M1, the UK – Australian interest rate differential, the Australian cash rate, and the Australian interest rate explain most of the movement in the Australian – UK exchange rate.

The impulse response functions show that the New Zealand dollar and Australian dollar do not always respond to a positive, one standard deviation shock on monetary policy the way theory suggests. Firstly, Dornbusch's (1976) overshooting hypothesis suggests that an expansion in monetary policy leads to a depreciation of the domestic currency in which the maximal impact of the shock occurs contemporaneously. The results show that there is almost no support for the overshooting hypothesis. The impulse responses show that the exchange rate does not overreact to a monetary shock initially, then return to its long run equilibrium rate over time as the overshooting hypothesis suggests. Studies by Lewis (1993), Evans (1994), Eichenbaum and Evans (1995), and Grilli and Roubini (1995) also found that the overshooting hypothesis does not hold when they examined the impact of monetary shocks on exchange rates. These studies found that the exchange rate appreciated in response to a contraction in monetary policy but the maximal impact of the shock was always delayed. However, the results of this study differ to other studies as the results in this study show that monetary shocks lead to volatile movement in the New Zealand dollar and Australian dollar and the timing of the maximal impact of the shock occurs cannot always be determined.

The second important result found, when examining how exchange rates respond to a monetary shock, is that the New Zealand and Australian dollars do not always respond to monetary shocks in the way theory suggests. A number of theorists have suggested that a contraction (expansion) in monetary policy leads to an appreciation (depreciation) of the domestic currency. Most empirical studies also find that this theory holds. However, the results of this study are mixed.

When the foreign – New Zealand interest differential and the New Zealand interest rate were shocked, the results were consistent with the theory. A positive, one standard deviation shock on the foreign – New Zealand interest rate differential (an expansion in monetary policy) led to the New Zealand dollar depreciating against all the currencies. A positive shock on short-term New Zealand interest rates resulted in an appreciation of the New Zealand dollar in three out of four exchange rates examined. However, when the other two monetary variables, weighted average successful bids from open market operations and M1 were shocked, the results were not consistent with the theory. The exchange rate puzzle found in other studies is found for the New Zealand dollar. The exchange rate puzzle suggests that a tightening of monetary policy leads to a depreciation of the domestic currency rather than an appreciation as theory suggests. When there was a positive shock on weighted average successful bids from open market operations (contraction in monetary policy), the result is a depreciation of the New Zealand dollar for three of the four exchange rates. A positive shock on M1 (expansion in monetary policy) resulted in an appreciation of the New Zealand dollar for three out of the four exchange rates.

An explanation for the exchange rate puzzle suggested by Grilli and Roubini (1995) is that interest rate innovations are an endogenous response to underlying inflation. For a given inflation rate, an increase in interest rates leads to an appreciation of the currency. If the increase in interest rates is due to a positive expected inflation shock, a depreciation is observed rather than an appreciation. If monetary authorities tighten policy and increase interest rates when they observe rising prices and a depreciating currency, interest rate innovations are associated with observed inflation and currency depreciation.

The results were mixed when the impact of monetary shocks on the New Zealand dollar was examined. This suggests that the exchange rate responds in a different way to changes in monetary policy for small, open economies such as New Zealand compared to larger, open economies such as the US. New Zealand is a small and open economy so is sensitive to foreign shocks and these have not been taken into consideration in the VAR models estimated. Another possible reason for the inconsistency of the results is due to the way monetary policy is implemented in New Zealand. The way monetary policy is implemented in New Zealand is very different from the way other countries implement monetary policy as detailed in Chapter 2.

For Australia, the response of the Australian dollar to a monetary shock is more consistent with theory and other studies. Firstly, a positive shock on M1 does result in the Australian dollar depreciating against the other currencies as expected, however there was some volatility in the movement of the Australian dollar. The Australian dollar also depreciated in response to a positive shock on the foreign – Australian interest differential as expected, but the maximal impact of the shock did not always occur contemporaneously. When there was a positive, one standard deviation shock on the 11am cash rate, the Australian dollar appreciated against all the currencies as expected, but the maximal impact of the shock was delayed in all cases. Finally, a positive shock on short-term Australian interest rates led to an appreciation of the Australian dollar against all the currencies and the maximal impact of the shock occurred contemporaneously for all the currencies, supporting the overshooting hypothesis.

Bibliography

Batten, D.S. and Thornton, D.L. (1985). The discount rate, interest rates and foreign exchange rates: An analysis with daily data. *Federal Reserve Bank of St. Louis Review*, 67(2), 22-30.

Beaumont, C. and Reddell, M. (1990). How monetary policy influences inflation. *Reserve Bank Bulletin*, 53(4), 358-378.

Bernanke, B. and Blinder, A. (1992). The Federal funds rate and the channels of monetary transmission. *American Economic Review*, 82, 901-921.

Bonser-Neal, C., Roley, V.V. and Sellon, G.H. (1998). Monetary policy actions, intervention, and exchange rates: A reexamination of the empirical relationships using Federal funds rate target data. *Journal of Business*, 71(2), 147-177.

Clements, M.P. and Hendry, D.F. (1995). Forecasting in cointegrated systems. *Journal of Applied Econometrics*, 10, 127-146.

Costello, P. (1996). Statement of the conduct of monetary policy. *Reserve Bank of Australia Bulletin*, September, 1-3.

Cushman, D.O. and Zha, T. (1997). Identifying monetary policy in a small open economy under flexible exchange rates. *Journal of Monetary Economics*, 39(3), 433-448.

Dornbusch, R. (1976). Expectations and exchange rate dynamics. *Journal of Political Economy*, 84(6), 1161-1176.

Dornbusch, R., and Fischer, S. (1994). *Macroeconomics*. (6^{th} ed.). New York: McGraw-Hill.

Doughty, A. (1991). The relationship between fiscal and monetary policy. *Reserve Bank Bulletin*, 54(3), 228-234.

Eichenbaum, M. and Evans, C.L. (1995). Some empirical evidence on the effects of shocks to monetary policy on exchange rates. *Quarterly Journal of Economics*, 110(4), 975-1009.

Enders, W. (1995). *Applied econometrics time series.* New York: John Wiley & Sons, Inc.

Evans, C.L. (1994). Interest rate shocks and the Dollar. *Economic Perspective*, 8, 11-24.

Floyd, J.E. (1996). Monetary policy and the real exchange rate: Some evidence. *University of Toronto Working Paper.*

Giaccotto, C., Johnson, R.S., and Zuber, R. (1993). A case study of the impact of monetary policy on exchange rates. *Journal of Economic and Business*, 45, 285-296.

Glick, R. and Hutchison, M. (1989). Exchange rates and monetary policy. *FRB San Francisco Economic Review*, 2, 17-29.

Grilli, V. and Roubini, N. (1995). Liquidity and exchange rates: Puzzling evidence from the G-7 countries. *NBER Working Paper.*

Gujarati, D.N. (1995). *Basic econometrics.* (3rd ed). New York: McGraw-Hill.

Hacche, G. and Townend, J. (1981). Exchange rates and monetary policy: Modelling sterling's effective exchange rate, 1972-80. *Oxford Economic Papers*, 33(Supp), 201-247.

Hicks, J.R. and Wheller, D. (1990). *Money and capital markets in Australia.* Sydney: Harcout Brace Jovanovich.

Hoffman, D.L, and Rasche, R.H. (1996). Assessing forecast performance in a cointegrated system. *Journal of Applied Econometrics*, 11, 495-517.

Hunt, B. and Terry, C. (1994). *Financial instruments and markets.* Melbourne: Thomas Nelson Australia.

Huxford, J. and Reddell, M. (1996). Implementing monetary policy in New Zealand. *Reserve Bank Bulletin*, 59, (4), 309-322.

Kearney, A.A. (1995). The changing influence of money and monetary policy on exchange rates. *Economic Inquiry*, 33, (2), 203-215.

Koop, G., Pesaran, M.H. and Potter, S.M. (1996). Impulse response analysis in nonlinear multivariate models. *Journal of Econometrics*, 74, 119-147.

Korteweg, P. (1980). Exchange-rate policy, monetary policy, and real exchange rate variability. *Essays in International Finance*, 140, 1-28.

Lewis, K.K. (1993). Are foreign exchange intervention and monetary policy related and does it really matter? *NBER Working Paper No. 4377.*

Linklater, J. (1992). *Inside the Bank: The role of the Reserve Bank of Australia in the economic, banking and financial systems.* St Leonards, NSW: Allen & Unwin.

Lloyd, K. (1991). The changing monetary transmission mechanism in New Zealand since 1960. *Reserve Bank Bulletin*, 54(4), 312-329.

Mackinnon, J.G. (1991). 'Critical values for cointegration tests, in Engle, R.F. and Granger, C.W.J. (Eds). *Long run economic relationships: Readings in cointegration.* Oxford: Oxford University Press.

Makin, T. (1997). The main determinants of Australia's exchange rate. *Australian Economic Review*, 30(3), 329-339.

Mayes, D.G. and Riches, B. (1996). The effectiveness of monetary policy in New Zealand. *Reserve Bank Bulletin*, 59(1).

Naka, A. and Tufte, D. (1997). Examining impulse response functions in cointegrated systems. *Journal of Applied Econometrics*, 29, 1593-1603.

Pesaran, M.H. and Pesaran, B. (1997). *Working with Microfit 4.0: Interactive econometric analysis*. Oxford: Oxford University Press.

Pesaran, M.H. and Shin, (1997). *Generalized impulse response analysis in linear multivariate models*, unpublished manuscript, Cambridge University.

Reserve Bank of Australia. (1997). Overview of the Reserve Bank of Australia, *http://www.rba.gov.au/about/ab_over.html*

Reserve Bank of Australia. (1998). The implementation of monetary policy, *http://www.rba.gov.au/about/ab_monpol.html*

Reserve Bank of New Zealand. (1985). Exchange rate policy developments. *Reserve Bank Bulletin*, 48(5), 228-234.

Reserve Bank of New Zealand. (1985). Liquidity management policy. *Reserve Bank Bulletin*, 48(5), 235-242.

Reserve Bank of New Zealand. (1985). Monetary policy in New Zealand. *Reserve bank Bulletin*, 48(6), 293-300.

Reserve Bank of New Zealand. (1987a). A layman's guide to monetary policy in the New Zealand context. *Reserve Bank Bulletin*, 50(2), 64-110.

Reserve Bank of New Zealand. (1987b). The basics of liquidity management. *Reserve Bank Bulletin*, 50(3), 197-202.

Reserve Bank of New Zealand. (1998). What is the monetary conditions index, *http://www.rbnz.got.nz/fs3.htm*

Romer, C.D. and Romer, D.H. (1989). Does monetary policy matter? A new test in the spirit of Friedman and Schwartz. In Blanchard, O.J. and Fischer, S. (eds), *NBER Macroeconomics Annual 1989*. Cambridge, Mass.: MIT Press.

Rudebusch, G.D. (1995a). Federal Reserve interest rate targeting, rational expectations, and the term structure. *Journal of Monetary Economics*, 35, 245-74.

Rudebusch, G.D. (1995b). Erratum. *Journal of Monetary Economics,* 36, 679.

Sanders, D.H., Murph, A.F. and Eng, R.J. (1980). *Statistics: A fresh approach.* (2nd ed.). Tokyo: McGraw-Hill Kogalusha.

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

Sims, C. (1981). An autoregressive index model for the US 1948-1975, in Ramsey, J.B. (Ed). *Large Scale Econometric Models*. The Netherlands: North-Holland.

Sims, C.A. (1992). Interpreting the macroeconomic time series facts: The effects of monetary policy. *European Economic Review*, 36, 975-1011.

Spencer, G. (1990). Monetary Policy: The New Zealand experience 1985-1990, in Reserve Bank of New Zealand. (Eds.). *Monetary Policy and the New Zealand Financial System.* (3rd ed.). Wellington: Reserve Bank of New Zealand.

Stockman, A.C. (1998). New evidence connecting exchange rates to business cycles. *Federal Reserve Bank of Richmond Economic Quarterly*, 84(2), 73-89.

Tait, J. and Reddell, M. (1991). The operation of monetary policy. *Reserve Bank Bulletin*, 54(1), 44-57.

Takagi, S. (1991). Exchange rate expectations. *IMF Staff Papers*, 38(1), 156-181.

Thornton, D.L. (1989). The effect of unanticipated money on the money and foreign exchange markets. *Journal of International Money and Finance*, 8, 573-587.

Watsham, T.J. and Parramore, K. (1997). *Quantitative methods in finance.* (1st ed.). London; Boston: International Thomson Publishing Inc.

Appendix 1: Results of Stationarity Tests

Variable	Data Type	No. of Lags	Trend Included	T-Statistic
Nominal Exchange Rates				
New Zealand - Australia	Levels	1	No	-2.4917
New Zealand - Australia	1st Differences	0	No	-11.0902**
New Zealand - Japan	Levels	1	No	-2.3265
New Zealand - Japan	1st Differences	0	No	-9.1615**
New Zealand - UK	Levels	2	No	-1.6961
New Zealand - UK	1st Differences	1	No	-9.8917**
New Zealand - US	Levels	1	No	-2.8293
New Zealand - US	1st Differences	3	No	-7.0065**
Australia - New Zealand	Levels	1	No	-2.4917
Australia - New Zealand	1st Differences	0	No	-11.0902**
Australia - Japan	Levels	2	No	-3.0142*
Australia - UK	Levels	2	No	-3.5934**
Australia - US	Levels	1	No	-2.8567
Australia - US	1st Differences	1	No	-7.9183**
New Zealand TWI	Levels	1	No	-1.9560
New Zealand TWI	1st Differences	0	No	-15.3321**
Australian TWI	Levels	0	No	-3.2597*

* Significant at the 5% level

** Significant at the 1% level

Trend not included: Critical Values: -2.88 (5%) and –3.474 (1%)

Trend included: Critical Values: -3.439 (5%) and –4.02 (1%)

Variable	Data Type	No. of Lags	Trend Included	T-Statistic
Real Exchange Rates				
New Zealand - Australia	Levels	1	No	-2.8000
New Zealand - Australia	1st Differences	0	No	-10.8246**
New Zealand - Japan	Levels	1	No	-2.1453
New Zealand - Japan	1st Differences	0	No	-9.1153**
New Zealand - UK	Levels	2	No	-1.9044
New Zealand - UK	1st Differences	1	No	-9.5981**
New Zealand - US	Levels	1	No	-3.6178**
Australia - New Zealand	Levels	1	No	-2.8000
Australia - New Zealand	1st Differences	0	No	-10.8246**
Australia - Japan	Levels	2	No	-2.5538
Australia - Japan	1st Differences	1	No	-7.6169**
Australia - UK	Levels	3	No	-2.4944
Australia - UK	1st Differences	2	No	-7.5605**
Australia - US	Levels	1	No	-2.7988
Australia - US	1st Differences	0	No	-9.2903**

* Significant at the 5% level

** Significant at the 1% level

Trend not included: Critical Values: -2.88 (5%) and –3.474 (1%)

Trend included: Critical Values: -3.439 (5%) and –4.02 (1%)

Variable	Data Type	No. of Lags	Trend Included	T-Statistic
3mth T-Bill Rate				
New Zealand	Levels	4	No	-2.2854
New Zealand	1st Differences	3	No	-6.9905**
Australia	Levels	1	Yes	-2.5502
Australia	1st Differences	0	No	-8.0438**
Japan	Levels	2	No	-0.79521
Japan	1st Differences	1	No	-6.6459**
US	Levels	1	No	-1.6958
US	1st Differences	0	No	-10.0794**
UK	Levels	1	No	-1.3599
UK	1st Differences	0	No	-9.9388**
Interest Rate Differentials				
Australia – New Zealand	Levels	2	No	-3.1318*
Japan – New Zealand	Levels	2	No	-2.3936
Japan – New Zealand	1st Differences	1	No	-9.2561**
US – New Zealand	Levels	2	No	-2.4337
US – New Zealand	1st Differences	1	No	-8.9395**
UK – New Zealand	Levels	2	No	-2.3445
UK – New Zealand	1st Differences	3	No	-6.8749**
New Zealand – Australia	Levels	2	No	-3.1318*
Japan – Australia	Levels	1	No	-1.6831
Japan – Australia	1st Differences	0	No	-9.2030**
US – Australia	Levels	1	Yes	-4.0242**
UK – Australia	Levels	1	Yes	-3.0084
UK – Australia	1st Differences	1	No	-9.6015**

* Significant at the 5% level

** Significant at the 1% level

Trend not included: Critical Values: -2.88 (5%) and –3.474 (1%)

Trend included: Critical Values: -3.439 (5%) and –4.02 (1%)

Variable	Data Type	No. of Lags	Trend Included	T-Statistic
Discount Rate Proxy				
NZ Weighted Average Bids	Levels	0	No	-1.8992
NZ Weighted Average Bids	1st Differences	1	No	-10.2645**
Australian 11am Call Rate	Levels	2	No	-1.0970
Australian 11am Call Rate	1st Differences	1	No	-7.3347**
M1				
New Zealand	Levels	1	No	-2.9305*
Australia	Levels	0	Yes	-2.1086
Australia	1st Differences	0	No	-12.6791**
CPIs				
New Zealand	Levels	1	No	-5.3431**
Australia	Levels	1	No	-6.2408**
Industrial Production				
NZ Vol. of Production Index	Levels	7	No	-1.0282
NZ Vol. of Production Index	1st Differences	3	No	-4.6212**
Melbourne Institute Index	Levels	4	Yes	-2.3502
Melbourne Institute Index	1st Differences	3	No	-3.7761**

* Significant at the 5% level

** Significant at the 1% level

Trend not included: Critical Values: -2.88 (5%) and –3.474 (1%)

Trend included: Critical Values: -3.439 (5%) and –4.02 (1%)

Appendix 2.1: Results of Cointegration Tests for New Zealand

New Zealand – Australia Real Exchange Rate, Benchmark

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

154 observations from 1985M6 to 1998M3 . Order of VAR = 3.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	33.2603	25.4200	23.1000
r<= 1	r = 2	31.3394	19.2200	17.1800
r<= 2	r = 3	4.7635	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

154 observations from 1985M6 to 1998M3 . Order of VAR = 3.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	69.3631	42.3400	39.3400
r<= 1	r>= 2	36.1028	25.7700	23.0800
r<= 2	r = 3	4.7635	12.3900	10.5500

New Zealand – Australia Real Exchange Rate Weighted Average Successful Bids

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	44.5757	37.8600	35.0400
r<= 1	r = 2	39.5283	31.7900	29.1300
r<= 2	r = 3	23.2770	25.4200	23.1000
r<= 3	r = 4	6.9110	19.2200	17.1800
r<= 4	r = 5	4.5541	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	118.8462	87.1700	82.8800
r<= 1	r>= 2	74.2705	63.0000	59.1600
r<= 2	r>= 3	34.7422	42.3400	39.3400
r<= 3	r>= 4	11.4652	25.7700	23.0800
r<= 4	r = 5	4.5541	12.3900	10.5500

New Zealand – Australia Real Exchange Rate, M1

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	52.3913	37.8600	35.0400
r<= 1	r = 2	39.5059	31.7900	29.1300
r<= 2	r = 3	22.0050	25.4200	23.1000
r<= 3	r = 4	7.0525	19.2200	17.1800
r<= 4	r = 5	3.8825	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	124.8372	87.1700	82.8800
r<= 1	r>= 2	72.4459	63.0000	59.1600
r<= 2	r>= 3	32.9400	42.3400	39.3400
r<= 3	r>= 4	10.9350	25.7700	23.0800
r<= 4	r = 5	3.8825	12.3900	10.5500

New Zealand – Australia Nominal Exchange Rate, Benchmark

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

154 observations from 1985M6 to 1998M3 . Order of VAR = 3.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	31.6330	25.4200	23.1000
r<= 1	r = 2	26.2568	19.2200	17.1800
r<= 2	r = 3	4.5756	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

154 observations from 1985M6 to 1998M3 . Order of VAR = 3.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	62.4654	42.3400	39.3400
r<= 1	r>= 2	30.8324	25.7700	23.0800
r<= 2	r = 3	4.5756	12.3900	10.5500

New Zealand – Australia Nominal Exchange Rate, Weighted Average Successful Bids

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	47.8561	37.8600	35.0400
r<= 1	r = 2	39.6409	31.7900	29.1300
r<= 2	r = 3	22.6884	25.4200	23.1000
r<= 3	r = 4	6.9051	19.2200	17.1800
r<= 4	r = 5	4.5714	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	121.6619	87.1700	82.8800
r<= 1	r>= 2	73.8058	63.0000	59.1600
r<= 2	r>= 3	34.1649	42.3400	39.3400
r<= 3	r>= 4	11.4765	25.7700	23.0800
r<= 4	r = 5	4.5714	12.3900	10.5500

New Zealand – Australia Nominal Exchange Rate, M1

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	56.1496	37.8600	35.0400
r<= 1	r = 2	39.2432	31.7900	29.1300
r<= 2	r = 3	21.7469	25.4200	23.1000
r<= 3	r = 4	6.9028	19.2200	17.1800
r<= 4	r = 5	3.8482	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	127.8906	87.1700	82.8800
r<= 1	r>= 2	71.7410	63.0000	59.1600
r<= 2	r>= 3	32.4978	42.3400	39.3400
r<= 3	r>= 4	10.7510	25.7700	23.0800
r<= 4	r = 5	3.8482	12.3900	10.5500

New Zealand – Japan Real Exchange Rate, Benchmark

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*******************************************************************************
 153 observations from 1985M7  to 1998M3 . Order of VAR = 4.
*******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r = 1         44.9615           31.7900                 29.1300
 r<= 1       r = 2         26.8285           25.4200                 23.1000
 r<= 2       r = 3         12.2747           19.2200                 17.1800
 r<= 3       r = 4          5.2841           12.3900                 10.5500
*******************************************************************************
```

```
  Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
*******************************************************************************
 153 observations from 1985M7  to 1998M3 . Order of VAR = 4.
*******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r>= 1         89.3489           63.0000                 59.1600
 r<= 1       r>= 2         44.3874           42.3400                 39.3400
 r<= 2       r>= 3         17.5588           25.7700                 23.0800
 r<= 3       r = 4          5.2841           12.3900                 10.5500
*******************************************************************************
```

New Zealand – Japan Real Exchange Rate, Weighted Average Successful Bids

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*******************************************************************************
 152 observations from 1985M8  to 1998M3 . Order of VAR = 5.
*******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r = 1         61.1990           37.8600                 35.0400
 r<= 1       r = 2         38.1926           31.7900                 29.1300
 r<= 2       r = 3         20.6370           25.4200                 23.1000
 r<= 3       r = 4         12.0369           19.2200                 17.1800
 r<= 4       r = 5          4.0899           12.3900                 10.5500
*******************************************************************************
```

```
  Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
*******************************************************************************
 152 observations from 1985M8  to 1998M3 . Order of VAR = 5.
*******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r>= 1        136.1555           87.1700                 82.8800
 r<= 1       r>= 2         74.9565           63.0000                 59.1600
 r<= 2       r>= 3         36.7639           42.3400                 39.3400
 r<= 3       r>= 4         16.1268           25.7700                 23.0800
 r<= 4       r = 5          4.0899           12.3900                 10.5500
*******************************************************************************
```

New Zealand – Japan Real Exchange Rate, M1

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

154 observations from 1985M6 to 1998M3 . Order of VAR = 3.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	53.4494	37.8600	35.0400
r<= 1	r = 2	31.9219	31.7900	29.1300
r<= 2	r = 3	21.5993	25.4200	23.1000
r<= 3	r = 4	10.5676	19.2200	17.1800
r<= 4	r = 5	7.1787	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

154 observations from 1985M6 to 1998M3 . Order of VAR = 3.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	124.7170	87.1700	82.8800
r<= 1	r>= 2	71.2676	63.0000	59.1600
r<= 2	r>= 3	39.3457	42.3400	39.3400
r<= 3	r>= 4	17.7463	25.7700	23.0800
r<= 4	r = 5	7.1787	12.3900	10.5500

New Zealand – Japan Nominal Exchange Rate, Benchmark

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	43.0457	31.7900	29.1300
r<= 1	r = 2	26.1914	25.4200	23.1000
r<= 2	r = 3	12.8538	19.2200	17.1800
r<= 3	r = 4	5.1614	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	87.2523	63.0000	59.1600
r<= 1	r>= 2	44.2065	42.3400	39.3400
r<= 2	r>= 3	18.0152	25.7700	23.0800
r<= 3	r = 4	5.1614	12.3900	10.5500

New Zealand – Japan Nominal Exchange Rate, Weighted Average Successful Bids

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*******************************************************************************
 152 observations from 1985M8  to 1998M3 . Order of VAR = 5.
*******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r = 1         63.3983          37.8600                35.0400
 r<= 1       r = 2         36.3872          31.7900                29.1300
 r<= 2       r = 3         21.3312          25.4200                23.1000
 r<= 3       r = 4         11.7778          19.2200                17.1800
 r<= 4       r = 5          3.6386          12.3900                10.5500
*******************************************************************************
```

```
  Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
*******************************************************************************
 152 observations from 1985M8  to 1998M3 . Order of VAR = 5.
*******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r>= 1        136.5331          87.1700                82.8800
 r<= 1       r>= 2         73.1348          63.0000                59.1600
 r<= 2       r>= 3         36.7476          42.3400                39.3400
 r<= 3       r>= 4         15.4164          25.7700                23.0800
 r<= 4       r = 5          3.6386          12.3900                10.5500
*******************************************************************************
```

New Zealand – Japan Nominal Exchange Rate, M1

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*******************************************************************************
 154 observations from 1985M6  to 1998M3 . Order of VAR = 3.
*******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r = 1         55.0314          37.8600                35.0400
 r<= 1       r = 2         29.3619          31.7900                29.1300
 r<= 2       r = 3         22.3177          25.4200                23.1000
 r<= 3       r = 4         10.4548          19.2200                17.1800
 r<= 4       r = 5          6.2959          12.3900                10.5500
*******************************************************************************
```

```
  Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
*******************************************************************************
 154 observations from 1985M6  to 1998M3 . Order of VAR = 3.
*******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r>= 1        123.4617          87.1700                82.8800
 r<= 1       r>= 2         68.4303          63.0000                59.1600
 r<= 2       r>= 3         39.0683          42.3400                39.3400
 r<= 3       r>= 4         16.7507          25.7700                23.0800
 r<= 4       r = 5          6.2959          12.3900                10.5500
*******************************************************************************
```

New Zealand – UK Real Exchange Rate, Benchmark

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	41.5973	31.7900	29.1300
r<= 1	r = 2	21.6676	25.4200	23.1000
r<= 2	r = 3	17.6833	19.2200	17.1800
r<= 3	r = 4	3.4624	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	84.4106	63.0000	59.1600
r<= 1	r>= 2	42.8133	42.3400	39.3400
r<= 2	r>= 3	21.1457	25.7700	23.0800
r<= 3	r = 4	3.4624	12.3900	10.5500

New Zealand – UK Real Exchange Rate, Weighted Average Successful Bids

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	42.8381	37.8600	35.0400
r<= 1	r = 2	38.6103	31.7900	29.1300
r<= 2	r = 3	15.2245	25.4200	23.1000
r<= 3	r = 4	9.8639	19.2200	17.1800
r<= 4	r = 5	7.7901	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	114.3270	87.1700	82.8800
r<= 1	r>= 2	71.4889	63.0000	59.1600
r<= 2	r>= 3	32.8785	42.3400	39.3400
r<= 3	r>= 4	17.6540	25.7700	23.0800
r<= 4	r = 5	7.7901	12.3900	10.5500

New Zealand – UK Real Exchange Rate, M1

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	43.3581	37.8600	35.0400
r<= 1	r = 2	40.5364	31.7900	29.1300
r<= 2	r = 3	18.3058	25.4200	23.1000
r<= 3	r = 4	11.8785	19.2200	17.1800
r<= 4	r = 5	8.9678	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	123.0467	87.1700	82.8800
r<= 1	r>= 2	79.6886	63.0000	59.1600
r<= 2	r>= 3	39.1522	42.3400	39.3400
r<= 3	r>= 4	20.8463	25.7700	23.0800
r<= 4	r = 5	8.9678	12.3900	10.5500

New Zealand – UK Nominal Exchange Rate, Benchmark

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	39.1445	31.7900	29.1300
r<= 1	r = 2	21.2867	25.4200	23.1000
r<= 2	r = 3	13.8278	19.2200	17.1800
r<= 3	r = 4	3.6878	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	77.9467	63.0000	59.1600
r<= 1	r>= 2	38.8022	42.3400	39.3400
r<= 2	r>= 3	17.5156	25.7700	23.0800
r<= 3	r = 4	3.6878	12.3900	10.5500

New Zealand – UK Nominal Exchange Rate, Weighted Average Successful Bids

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
******************************************************************************
 153 observations from 1985M7  to 1998M3 . Order of VAR = 4.
******************************************************************************
 Null    Alternative    Statistic     95% Critical Value     90% Critical Value
 r = 0      r = 1        41.2458           37.8600                35.0400
 r<= 1      r = 2        37.8518           31.7900                29.1300
 r<= 2      r = 3        14.5557           25.4200                23.1000
 r<= 3      r = 4         9.4260           19.2200                17.1800
 r<= 4      r = 5         6.2988           12.3900                10.5500
******************************************************************************
```

```
  Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
******************************************************************************
 153 observations from 1985M7  to 1998M3 . Order of VAR = 4.
******************************************************************************
 Null    Alternative    Statistic     95% Critical Value     90% Critical Value
 r = 0      r>= 1       109.3781           87.1700                82.8800
 r<= 1      r>= 2        68.1323           63.0000                59.1600
 r<= 2      r>= 3        30.2805           42.3400                39.3400
 r<= 3      r>= 4        15.7248           25.7700                23.0800
 r<= 4      r = 5         6.2988           12.3900                10.5500
******************************************************************************
```

New Zealand – UK Nominal Exchange Rate, M1

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
******************************************************************************
 155 observations from 1985M5  to 1998M3 . Order of VAR = 2.
******************************************************************************
 Null    Alternative    Statistic     95% Critical Value     90% Critical Value
 r = 0      r = 1        39.7463           37.8600                35.0400
 r<= 1      r = 2        38.8535           31.7900                29.1300
 r<= 2      r = 3        14.7959           25.4200                23.1000
 r<= 3      r = 4        11.3874           19.2200                17.1800
 r<= 4      r = 5         8.7253           12.3900                10.5500
******************************************************************************
```

```
  Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
******************************************************************************
 155 observations from 1985M5  to 1998M3 . Order of VAR = 2.
******************************************************************************
 Null    Alternative    Statistic     95% Critical Value     90% Critical Value
 r = 0      r>= 1       113.5083           87.1700                82.8800
 r<= 1      r>= 2        73.7621           63.0000                59.1600
 r<= 2      r>= 3        34.9086           42.3400                39.3400
 r<= 3      r>= 4        20.1127           25.7700                23.0800
 r<= 4      r = 5         8.7253           12.3900                10.5500
******************************************************************************
```

New Zealand – US Real Exchange Rate, Benchmark

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
******************************************************************************
 153 observations from 1985M7  to 1998M3 . Order of VAR = 4.
******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r = 1         33.2342           25.4200                23.1000
 r<= 1       r = 2         24.3308           19.2200                17.1800
 r<= 2       r = 3          1.8992           12.3900                10.5500
******************************************************************************
```

```
  Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
******************************************************************************
 153 observations from 1985M7  to 1998M3 . Order of VAR = 4.
******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r>= 1         59.4643           42.3400                39.3400
 r<= 1       r>= 2         26.2300           25.7700                23.0800
 r<= 2       r = 3          1.8992           12.3900                10.5500
******************************************************************************
```

New Zealand – US Real Exchange Rate, Weighted Average Successful Bids

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
******************************************************************************
 153 observations from 1985M7  to 1998M3 . Order of VAR = 4.
******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r = 1         36.3434           31.7900                29.1300
 r<= 1       r = 2         28.8755           25.4200                23.1000
 r<= 2       r = 3         13.8861           19.2200                17.1800
 r<= 3       r = 4          4.4480           12.3900                10.5500
******************************************************************************
```

```
  Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
******************************************************************************
 153 observations from 1985M7  to 1998M3 . Order of VAR = 4.
******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r>= 1         83.5530           63.0000                59.1600
 r<= 1       r>= 2         47.2096           42.3400                39.3400
 r<= 2       r>= 3         18.3341           25.7700                23.0800
 r<= 3       r = 4          4.4480           12.3900                10.5500
******************************************************************************
```

New Zealand – US Real Exchange Rate, M1

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	37.3336	31.7900	29.1300
r<= 1	r = 2	24.1112	25.4200	23.1000
r<= 2	r = 3	14.7401	19.2200	17.1800
r<= 3	r = 4	8.6218	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	84.8067	63.0000	59.1600
r<= 1	r>= 2	47.4731	42.3400	39.3400
r<= 2	r>= 3	23.3619	25.7700	23.0800
r<= 3	r = 4	8.6218	12.3900	10.5500

New Zealand – US Nominal Exchange Rate, Benchmark

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	40.9305	31.7900	29.1300
r<= 1	r = 2	32.4276	25.4200	23.1000
r<= 2	r = 3	15.8873	19.2200	17.1800
r<= 3	r = 4	2.6467	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	91.8921	63.0000	59.1600
r<= 1	r>= 2	50.9616	42.3400	39.3400
r<= 2	r>= 3	18.5340	25.7700	23.0800
r<= 3	r = 4	2.6467	12.3900	10.5500

New Zealand – US Nominal Exchange Rate, Weighted Average Successful Bids

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	56.0565	37.8600	35.0400
r<= 1	r = 2	29.8552	31.7900	29.1300
r<= 2	r = 3	21.8103	25.4200	23.1000
r<= 3	r = 4	9.8025	19.2200	17.1800
r<= 4	r = 5	6.4921	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	124.0166	87.1700	82.8800
r<= 1	r>= 2	67.9601	63.0000	59.1600
r<= 2	r>= 3	38.1048	42.3400	39.3400
r<= 3	r>= 4	16.2946	25.7700	23.0800
r<= 4	r = 5	6.4921	12.3900	10.5500

New Zealand – US Nominal Exchange Rate, M1

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	46.8453	37.8600	35.0400
r<= 1	r = 2	28.4249	31.7900	29.1300
r<= 2	r = 3	22.0704	25.4200	23.1000
r<= 3	r = 4	9.7905	19.2200	17.1800
r<= 4	r = 5	6.6431	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	113.7741	87.1700	82.8800
r<= 1	r>= 2	66.9288	63.0000	59.1600
r<= 2	r>= 3	38.5039	42.3400	39.3400
r<= 3	r>= 4	16.4336	25.7700	23.0800
r<= 4	r = 5	6.6431	12.3900	10.5500

Appendix 2.2: Results of Cointegration Tests for Australia

Australia – Japan Real Exchange Rate, Benchmark

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	29.8563	25.4200	23.1000
r<= 1	r = 2	17.3492	19.2200	17.1800
r<= 2	r = 3	13.3790	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	60.5845	42.3400	39.3400
r<= 1	r>= 2	30.7282	25.7700	23.0800
r<= 2	r = 3	13.3790	12.3900	10.5500

Australia – Japan Real Exchange Rate, 11 am Cash Rate

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	39.8172	31.7900	29.1300
r<= 1	r = 2	26.3905	25.4200	23.1000
r<= 2	r = 3	25.1542	19.2200	17.1800
r<= 3	r = 4	11.0671	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	102.4290	63.0000	59.1600
r<= 1	r>= 2	62.6118	42.3400	39.3400
r<= 2	r>= 3	36.2213	25.7700	23.0800
r<= 3	r = 4	11.0671	12.3900	10.5500

Australia – Japan Real Exchange Rate, M1

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	33.1793	31.7900	29.1300
r<= 1	r = 2	23.5738	25.4200	23.1000
r<= 2	r = 3	14.8944	19.2200	17.1800
r<= 3	r = 4	13.0689	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	84.7165	63.0000	59.1600
r<= 1	r>= 2	51.5371	42.3400	39.3400
r<= 2	r>= 3	27.9633	25.7700	23.0800
r<= 3	r = 4	13.0689	12.3900	10.5500

Australia – Japan Nominal Exchange Rate, Benchmark

Cointegration with no intercepts or trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	17.8322	11.0300	9.2800
r<= 1	r = 2	1.5705	4.1600	3.0400

Cointegration with no intercepts or trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	19.4028	12.3600	10.2500
r<= 1	r = 2	1.5705	4.1600	3.0400

Australia – Japan Nominal Exchange Rate, 11am Cash Rate

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	24.7178	25.4200	23.1000
r<= 1	r = 2	19.2300	19.2200	17.1800
r<= 2	r = 3	6.5971	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	50.5449	42.3400	39.3400
r<= 1	r>= 2	25.8271	25.7700	23.0800
r<= 2	r = 3	6.5971	12.3900	10.5500

Australia – Japan Nominal Exchange Rate, M1

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	24.8659	25.4200	23.1000
r<= 1	r = 2	19.1852	19.2200	17.1800
r<= 2	r = 3	10.2548	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	54.3059	42.3400	39.3400
r<= 1	r>= 2	29.4400	25.7700	23.0800
r<= 2	r = 3	10.2548	12.3900	10.5500

Australia – New Zealand Real Exchange Rate, Benchmark

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	38.3039	19.2200	17.1800
r<= 1	r = 2	21.8526	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	60.1565	25.7700	23.0800
r<= 1	r = 2	21.8526	12.3900	10.5500

Australia – New Zealand Real Exchange Rate, 11am Cash Rate

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	55.4947	31.7900	29.1300
r<= 1	r = 2	32.8140	25.4200	23.1000
r<= 2	r = 3	23.9221	19.2200	17.1800
r<= 3	r = 4	10.0210	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

153 observations from 1985M7 to 1998M3 . Order of VAR = 4.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	122.2519	63.0000	59.1600
r<= 1	r>= 2	66.7572	42.3400	39.3400
r<= 2	r>= 3	33.9431	25.7700	23.0800
r<= 3	r = 4	10.0210	12.3900	10.5500

Australia – New Zealand Real Exchange Rate, M1

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	59.9438	31.7900	29.1300
r<= 1	r = 2	38.9345	25.4200	23.1000
r<= 2	r = 3	23.8014	19.2200	17.1800
r<= 3	r = 4	12.2949	12.3900	10.5500

```
 Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
*******************************************************************************
 152 observations from 1985M8  to 1998M3 . Order of VAR = 5.
*******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r>= 1        134.9746          63.0000                 59.1600
 r<= 1       r>= 2         75.0308          42.3400                 39.3400
 r<= 2       r>= 3         36.0963          25.7700                 23.0800
 r<= 3       r = 4         12.2949          12.3900                 10.5500
*******************************************************************************
```

Australia – New Zealand Nominal Exchange Rate, Benchmark

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*******************************************************************************
 152 observations from 1985M8  to 1998M3 . Order of VAR = 5.
*******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r = 1         38.5757          19.2200                 17.1800
 r<= 1       r = 2         22.6935          12.3900                 10.5500
*******************************************************************************
```

```
  Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
*******************************************************************************
 152 observations from 1985M8  to 1998M3 . Order of VAR = 5.
*******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r>= 1         61.2692          25.7700                 23.0800
 r<= 1       r = 2         22.6935          12.3900                 10.5500
*******************************************************************************
```

Australia – New Zealand Nominal Exchange Rate, 11am Cash Rate

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*******************************************************************************
 153 observations from 1985M7  to 1998M3 . Order of VAR = 4.
*******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r = 1         57.0701          31.7900                 29.1300
 r<= 1       r = 2         35.1604          25.4200                 23.1000
 r<= 2       r = 3         24.5026          19.2200                 17.1800
 r<= 3       r = 4          9.0714          12.3900                 10.5500
*******************************************************************************
```

```
  Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
*******************************************************************************
 153 observations from 1985M7  to 1998M3 . Order of VAR = 4.
*******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r>= 1        125.8045          63.0000                 59.1600
 r<= 1       r>= 2         68.7344          42.3400                 39.3400
 r<= 2       r>= 3         33.5740          25.7700                 23.0800
 r<= 3       r = 4          9.0714          12.3900                 10.5500
*******************************************************************************
```

Australia – New Zealand Nominal Exchange Rate, M1

Cointegration with unrestricted intercepts and restricted trends in the VAR

Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	59.1663	31.7900	29.1300
r<= 1	r = 2	37.6115	25.4200	23.1000
r<= 2	r = 3	22.6191	19.2200	17.1800
r<= 3	r = 4	11.2060	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR

Cointegration LR Test Based on Trace of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	130.6029	63.0000	59.1600
r<= 1	r>= 2	71.4366	42.3400	39.3400
r<= 2	r>= 3	33.8251	25.7700	23.0800
r<= 3	r = 4	11.2060	12.3900	10.5500

Australia – UK Real Exchange Rate, Benchmark

Cointegration with unrestricted intercepts and restricted trends in the VAR

Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	22.1291	25.4200	23.1000
r<= 1	r = 2	16.1790	19.2200	17.1800
r<= 2	r = 3	9.7007	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR

Cointegration LR Test Based on Trace of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	48.0088	42.3400	39.3400
r<= 1	r>= 2	25.8797	25.7700	23.0800
r<= 2	r = 3	9.7007	12.3900	10.5500

Australia – UK Real Exchange Rate, 11am Cash Rate

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	44.5207	31.7900	29.1300
r<= 1	r = 2	25.4153	25.4200	23.1000
r<= 2	r = 3	15.1419	19.2200	17.1800
r<= 3	r = 4	7.0413	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	92.1192	63.0000	59.1600
r<= 1	r>= 2	47.5984	42.3400	39.3400
r<= 2	r>= 3	22.1832	25.7700	23.0800
r<= 3	r = 4	7.0413	12.3900	10.5500

Australia – UK Real Exchange Rate, M1

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

154 observations from 1985M6 to 1998M3 . Order of VAR = 3.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	34.3119	31.7900	29.1300
r<= 1	r = 2	19.9799	25.4200	23.1000
r<= 2	r = 3	11.7669	19.2200	17.1800
r<= 3	r = 4	6.6646	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

154 observations from 1985M6 to 1998M3 . Order of VAR = 3.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	72.7232	63.0000	59.1600
r<= 1	r>= 2	38.4113	42.3400	39.3400
r<= 2	r>= 3	18.4314	25.7700	23.0800
r<= 3	r = 4	6.6646	12.3900	10.5500

Australia – UK Nominal Exchange Rate, Benchmark

```
Cointegration with no intercepts or trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*******************************************************************************
 155 observations from 1985M5  to 1998M3 . Order of VAR = 2.
*******************************************************************************
 Null     Alternative      Statistic      95% Critical Value      90% Critical Value
 r = 0        r = 1         16.7063            11.0300                 9.2800
 r<= 1        r = 2        .0036061             4.1600                 3.0400
*******************************************************************************
```

```
             Cointegration with no intercepts or trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
*******************************************************************************
 155 observations from 1985M5  to 1998M3 . Order of VAR = 2.
*******************************************************************************
 Null     Alternative      Statistic      95% Critical Value      90% Critical Value
 r = 0        r>= 1         16.7099            12.3600                10.2500
 r<= 1        r = 2        .0036061             4.1600                 3.0400
*******************************************************************************
```

Australia – UK Nominal Exchange Rate, 11am Cash Rate

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*******************************************************************************
 152 observations from 1985M8  to 1998M3 . Order of VAR = 5.
*******************************************************************************
 Null     Alternative      Statistic      95% Critical Value      90% Critical Value
 r = 0        r = 1         37.4649            25.4200                23.1000
 r<= 1        r = 2         20.5480            19.2200                17.1800
 r<= 2        r = 3         14.7595            12.3900                10.5500
*******************************************************************************
```

```
  Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
*******************************************************************************
 152 observations from 1985M8  to 1998M3 . Order of VAR = 5.
*******************************************************************************
 Null     Alternative      Statistic      95% Critical Value      90% Critical Value
 r = 0        r>= 1         72.7725            42.3400                39.3400
 r<= 1        r>= 2         35.3076            25.7700                23.0800
 r<= 2        r = 3         14.7595            12.3900                10.5500
*******************************************************************************
```

Australia – UK Nominal Exchange Rate, M1

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*******************************************************************************
 152 observations from 1985M8  to 1998M3 . Order of VAR = 5.
*******************************************************************************
 Null     Alternative      Statistic      95% Critical Value      90% Critical Value
 r = 0        r = 1         32.0215            25.4200                23.1000
 r<= 1        r = 2         16.8147            19.2200                17.1800
 r<= 2        r = 3         11.6506            12.3900                10.5500
*******************************************************************************
```

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
        Cointegration LR Test Based on Trace of the Stochastic Matrix
******************************************************************************
 152 observations from 1985M8  to 1998M3 . Order of VAR = 5.
******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r>= 1         60.4868           42.3400                39.3400
 r<= 1       r>= 2         28.4653           25.7700                23.0800
 r<= 2       r = 3         11.6506           12.3900                10.5500
******************************************************************************
```

Australia – US Real Exchange Rate, Benchmark

```
Cointegration with restricted intercepts and no trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
******************************************************************************
 155 observations from 1985M5  to 1998M3 . Order of VAR = 2.
******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r = 1         30.4164           15.8700                13.8100
 r<= 1       r = 2          4.3218            9.1600                 7.5300
******************************************************************************
```

```
       Cointegration with restricted intercepts and no trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
******************************************************************************
 155 observations from 1985M5  to 1998M3 . Order of VAR = 2.
******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r>= 1         34.7383           20.1800                17.8800
 r<= 1       r = 2          4.3218            9.1600                 7.5300
******************************************************************************
```

Australia – US Real Exchange Rate, 11am Cash Rate

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
******************************************************************************
 152 observations from 1985M8  to 1998M3 . Order of VAR = 5.
******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r = 1         38.7467           31.7900                29.1300
 r<= 1       r = 2         32.9511           25.4200                23.1000
 r<= 2       r = 3         17.8109           19.2200                17.1800
 r<= 3       r = 4          8.0649           12.3900                10.5500
******************************************************************************
```

```
  Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
******************************************************************************
 152 observations from 1985M8  to 1998M3 . Order of VAR = 5.
******************************************************************************
 Null     Alternative     Statistic     95% Critical Value     90% Critical Value
 r = 0       r>= 1         97.5735           63.0000                59.1600
 r<= 1       r>= 2         58.8268           42.3400                39.3400
 r<= 2       r>= 3         25.8757           25.7700                23.0800
 r<= 3       r = 4          8.0649           12.3900                10.5500
******************************************************************************
```

Australia – US Real Exchange Rate, M1

```
Cointegration with restricted intercepts and no trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*******************************************************************************
 155 observations from 1985M5  to 1998M3 . Order of VAR = 2.
*******************************************************************************
 Null      Alternative      Statistic      95% Critical Value      90% Critical Value
 r = 0        r = 1          63.6900            28.2700                 25.8000
 r<= 1        r = 2          24.6504            22.0400                 19.8600
 r<= 2        r = 3          15.0467            15.8700                 13.8100
 r<= 3        r = 4           4.8644             9.1600                  7.5300
*******************************************************************************
```

```
       Cointegration with restricted intercepts and no trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
*******************************************************************************
 155 observations from 1985M5  to 1998M3 . Order of VAR = 2.
*******************************************************************************
 Null      Alternative      Statistic      95% Critical Value      90% Critical Value
 r = 0        r>= 1         108.2515            53.4800                 49.9500
 r<= 1        r>= 2          44.5615            34.8700                 31.9300
 r<= 2        r>= 3          19.9111            20.1800                 17.8800
 r<= 3        r = 4           4.8644             9.1600                  7.5300
*******************************************************************************
```

Australia – US Nominal Exchange Rate, Benchmark

```
Cointegration with restricted intercepts and no trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*******************************************************************************
 155 observations from 1985M5  to 1998M3 . Order of VAR = 2.
*******************************************************************************
 Null      Alternative      Statistic      95% Critical Value      90% Critical Value
 r = 0        r = 1          25.7243            15.8700                 13.8100
 r<= 1        r = 2           6.0063             9.1600                  7.5300
*******************************************************************************
```

```
       Cointegration with restricted intercepts and no trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
*******************************************************************************
 155 observations from 1985M5  to 1998M3 . Order of VAR = 2.
*******************************************************************************
 Null      Alternative      Statistic      95% Critical Value      90% Critical Value
 r = 0        r>= 1          31.7306            20.1800                 17.8800
 r<= 1        r = 2           6.0063             9.1600                  7.5300
*******************************************************************************
```

Australia – US Nominal Exchange Rate, 11am Cash Rate

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	39.8178	31.7900	29.1300
r<= 1	r = 2	34.3114	25.4200	23.1000
r<= 2	r = 3	15.0324	19.2200	17.1800
r<= 3	r = 4	8.7459	12.3900	10.5500

Cointegration with unrestricted intercepts and restricted trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

152 observations from 1985M8 to 1998M3 . Order of VAR = 5.

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	97.9076	63.0000	59.1600
r<= 1	r>= 2	58.0898	42.3400	39.3400
r<= 2	r>= 3	23.7784	25.7700	23.0800
r<= 3	r = 4	8.7459	12.3900	10.5500

Australia – US Nominal Exchange Rate, M1

Cointegration with restricted intercepts and no trends in the VAR
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

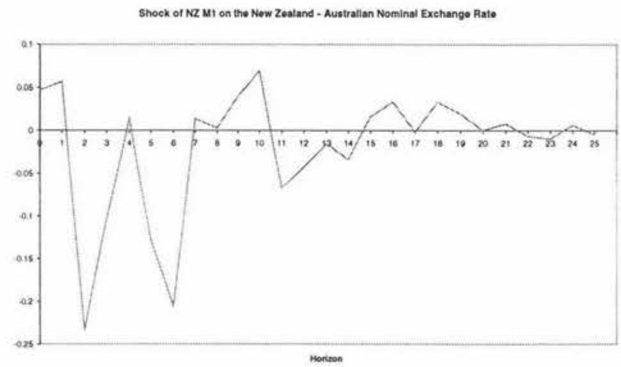
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	64.8434	28.2700	25.8000
r<= 1	r = 2	21.3175	22.0400	19.8600
r<= 2	r = 3	14.2352	15.8700	13.8100
r<= 3	r = 4	4.3212	9.1600	7.5300

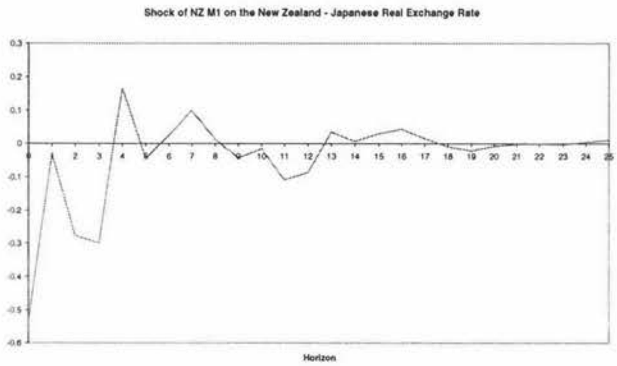
Cointegration with restricted intercepts and no trends in the VAR
Cointegration LR Test Based on Trace of the Stochastic Matrix

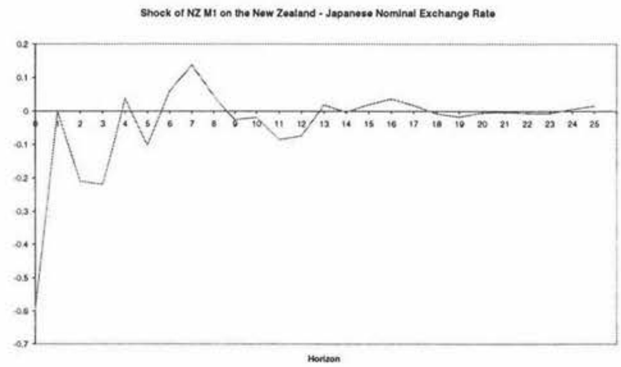
155 observations from 1985M5 to 1998M3 . Order of VAR = 2.

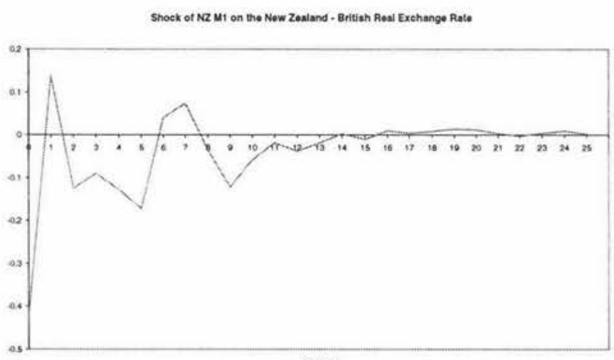
Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	104.7174	53.4800	49.9500
r<= 1	r>= 2	39.8740	34.8700	31.9300
r<= 2	r>= 3	18.5565	20.1800	17.8800
r<= 3	r = 4	4.3212	9.1600	7.5300

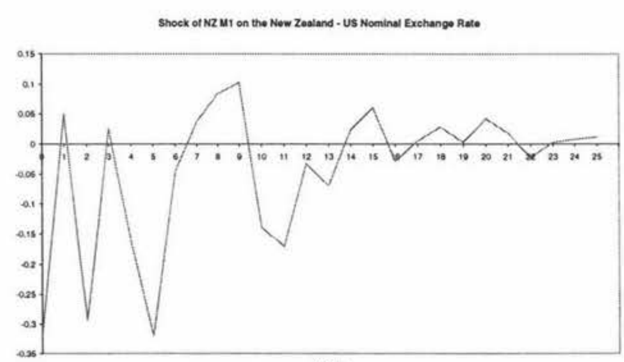
Appendix 3.1: Orthogonalized Impulse Responses of the New Zealand Dollar from a Shock on M1 in Model 1 for a 25 Month Forecast Horizon







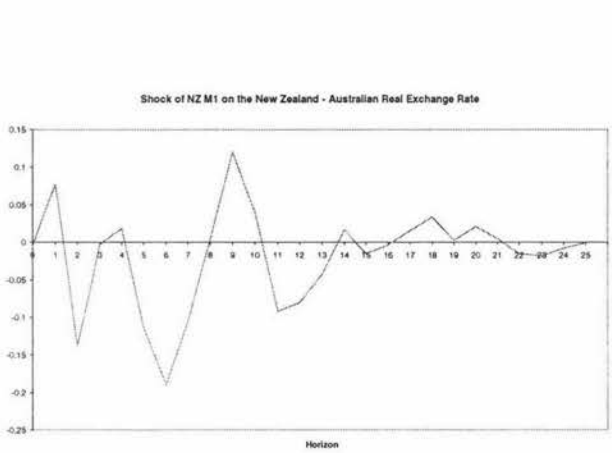


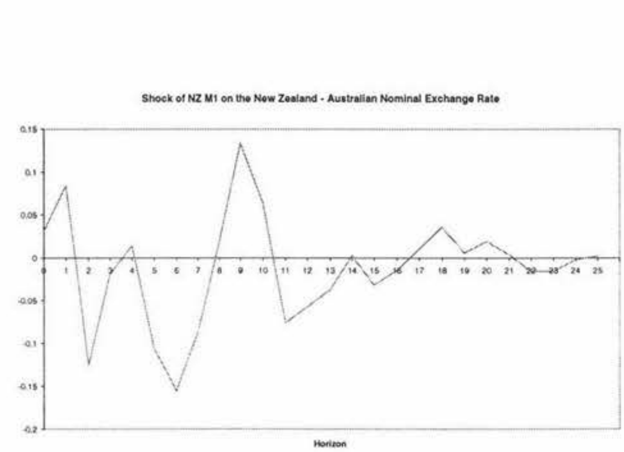


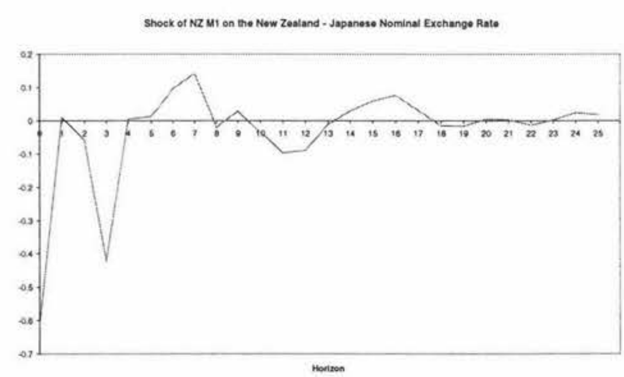
a)

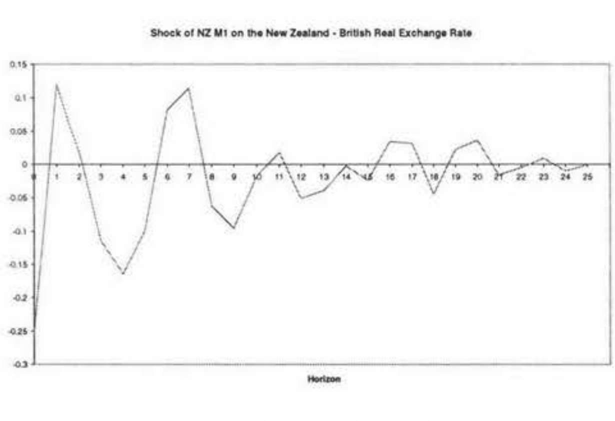
b)

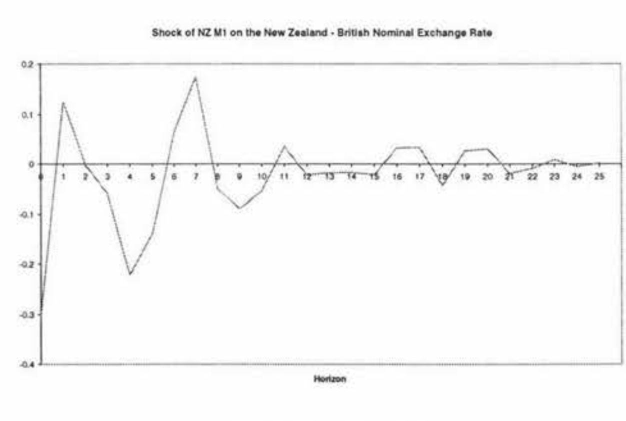
Appendix 3.2: Orthogonalized Impulse Responses of the New Zealand Dollar from a Shock on M1 in Model 2 for a 25 Month Forecast Horizon





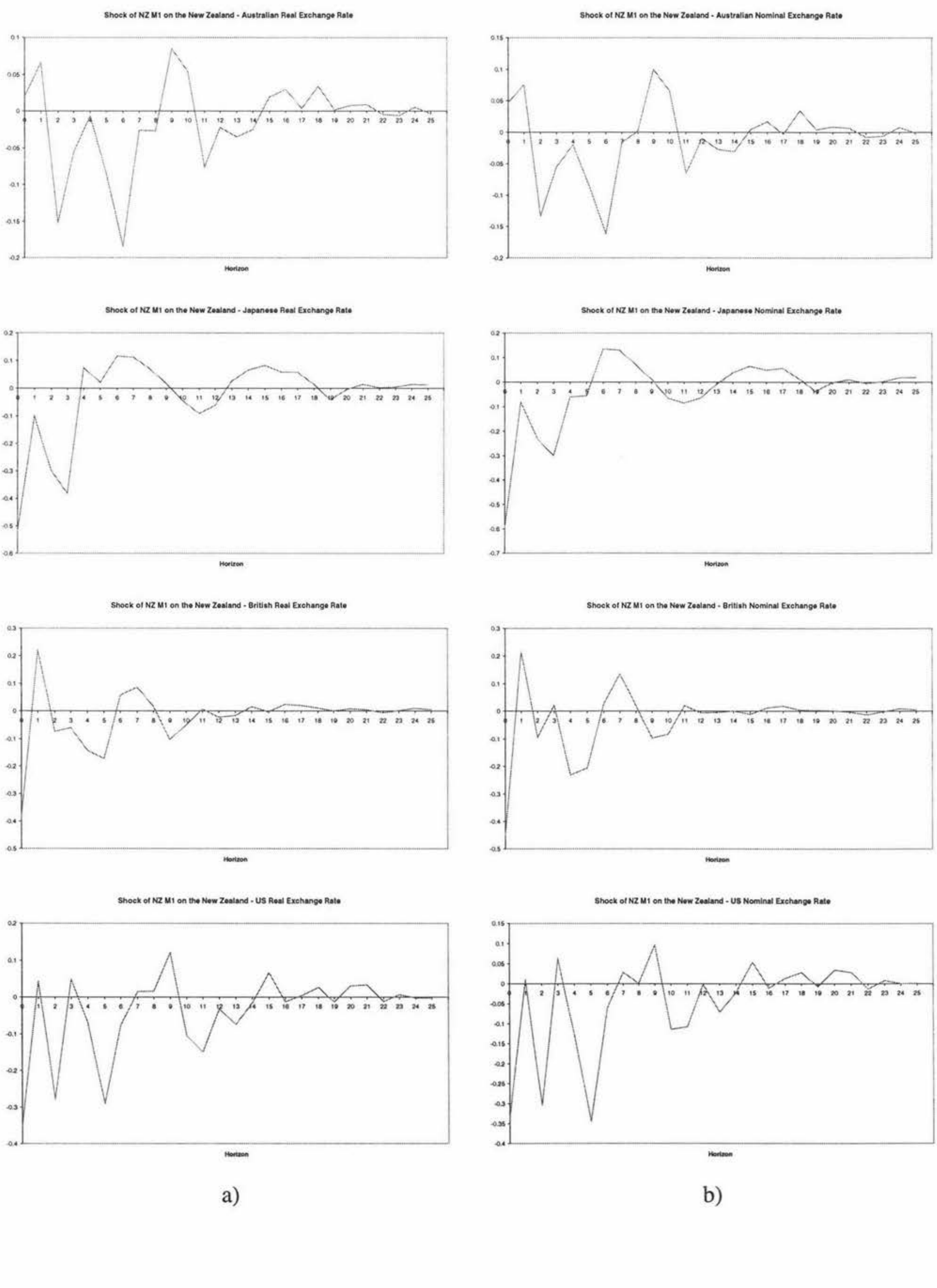






a) b)

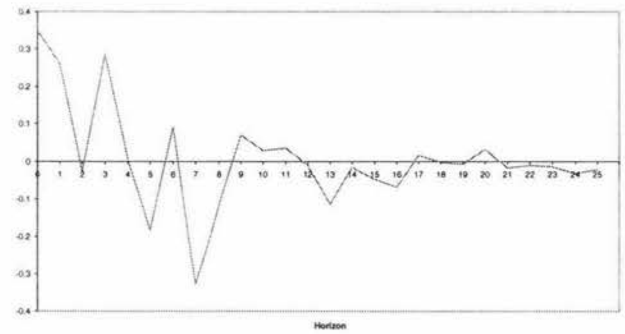
Appendix 3.3: Orthogonalized Impulse Responses of the New Zealand Dollar from a Shock on M1 in Model 3 for a 25 Month Forecast Horizon



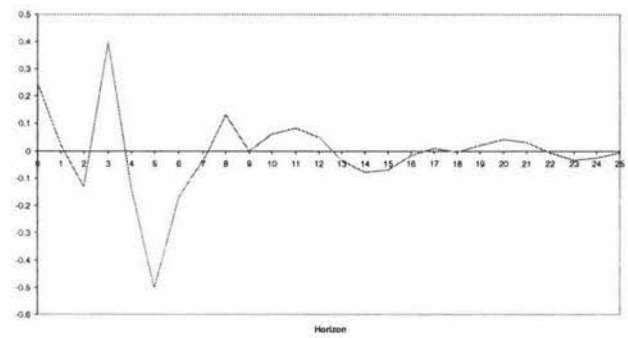
a) b)

Appendix 3.4: Orthogonalized Impulse Responses of the New Zealand Dollar from a Shock on the Foreign – New Zealand Interest Rate Differential for a 25 Month Forecast Horizon

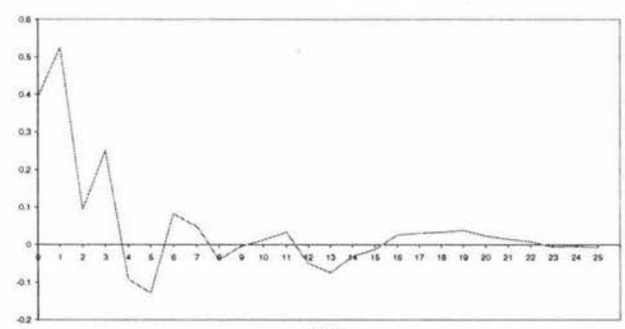
Shock of the Australian - New Zealand Interest Rate Differential on the Real Exchange Rate



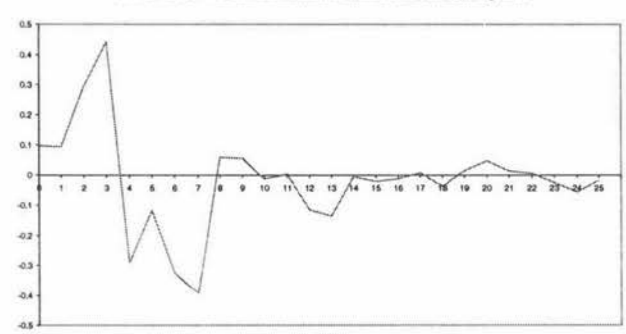
Shock of the Japanese - New Zealand Interest Rate Differential on the Real Exchange Rate



Shock of the UK - NZ Interest Rate Differential on the Real Exchange Rate

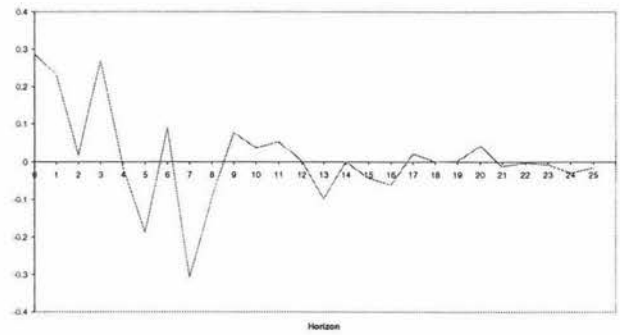


Shock of the US - New Zealand Interest Rate Differential on the Real Exchange Rate

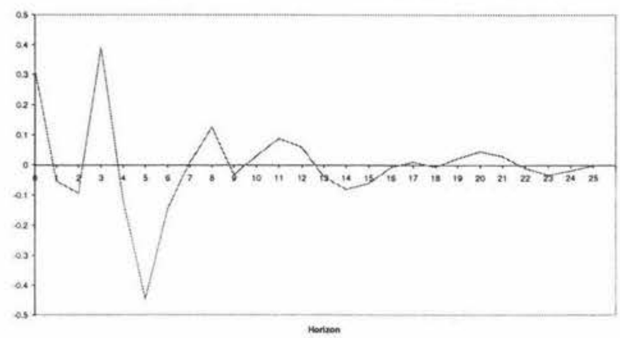


a)

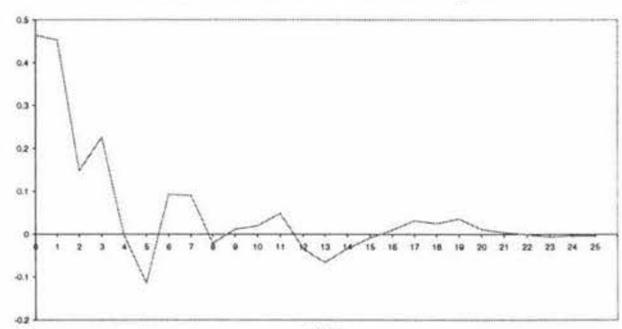
Shock of the Australian - New Zealand Interest Rate Differential on the Nominal Exchange Rate



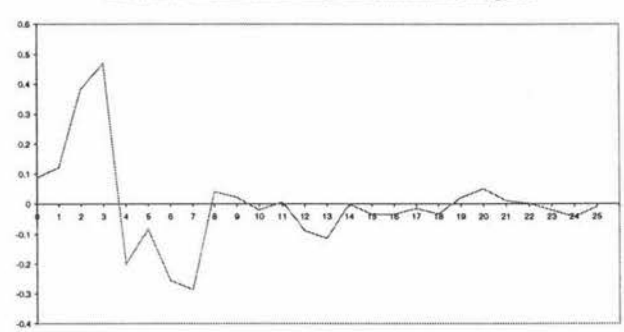
Shock of the Japanese - New Zealand Interest Rate Differential on the Nominal Exchange Rate



Shock of UK - NZ Interest Rate Differential on the Nominal Exchange Rate

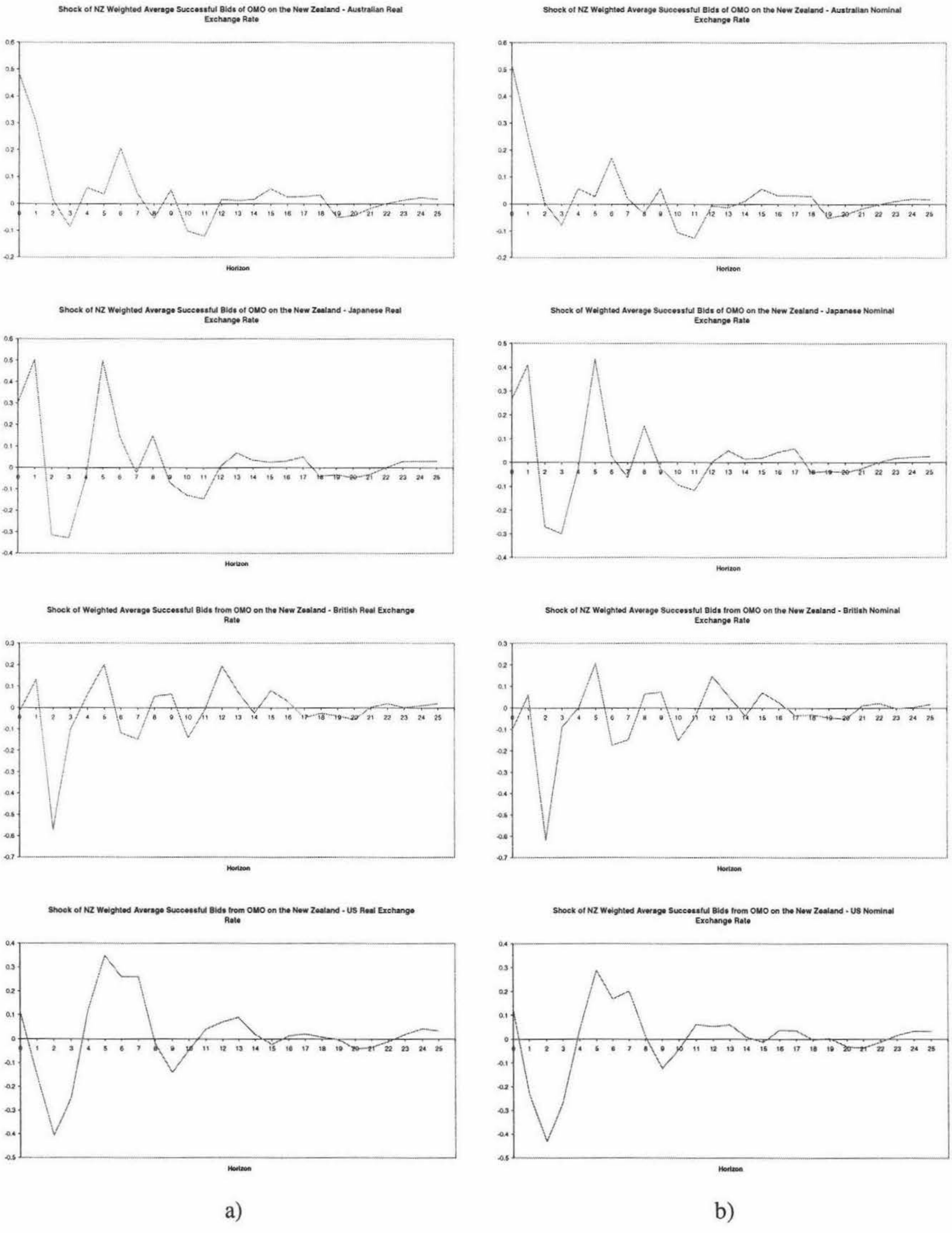


Shock of the US - New Zealand Interest Rate Differential on the Nominal Exchange Rate



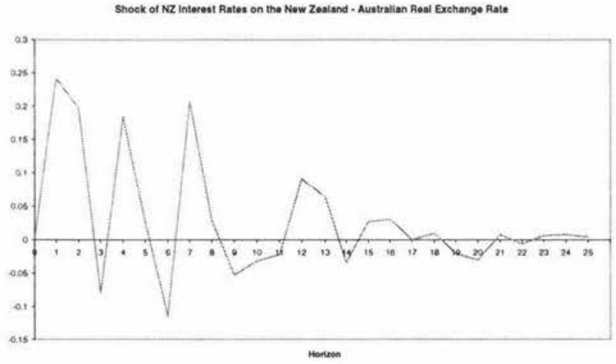
b)

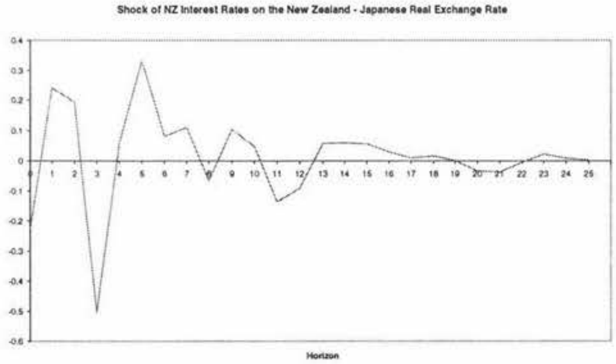
Appendix 3.5: Orthogonalized Impulse Responses of the New Zealand Dollar from a Shock on New Zealand Weighted Average Successful Bids from Open Market Operations for a 25 Month Forecast Horizon

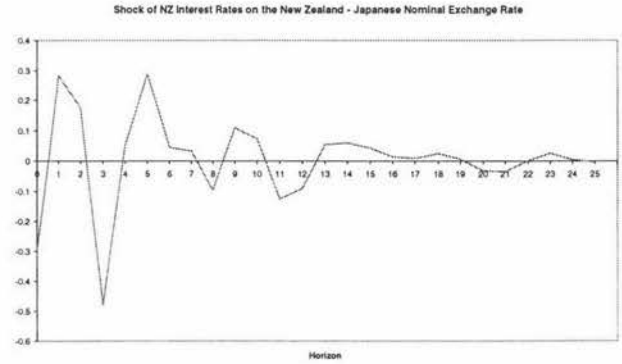


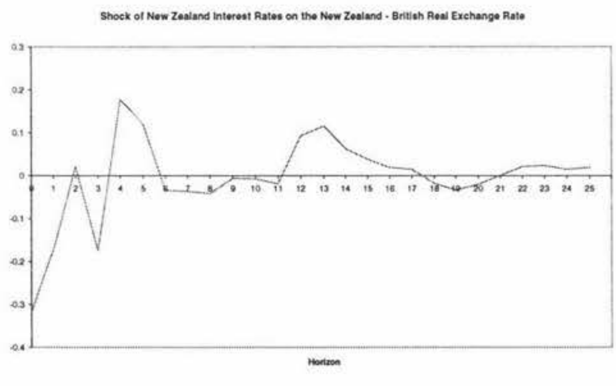
a) b)

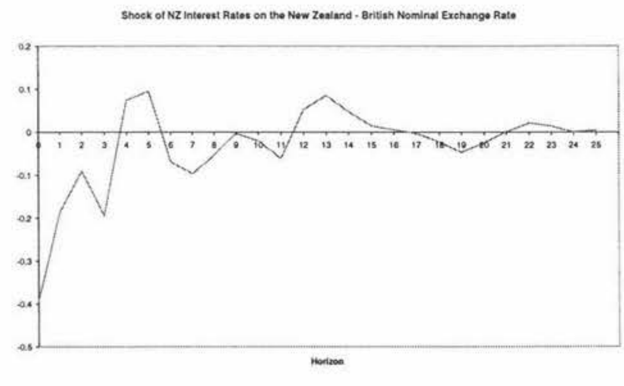
Appendix 3.6: Orthogonalized Impulse Responses of the New Zealand Dollar from a Shock on New Zealand Interest Rates for a 25 Month Forecast Horizon

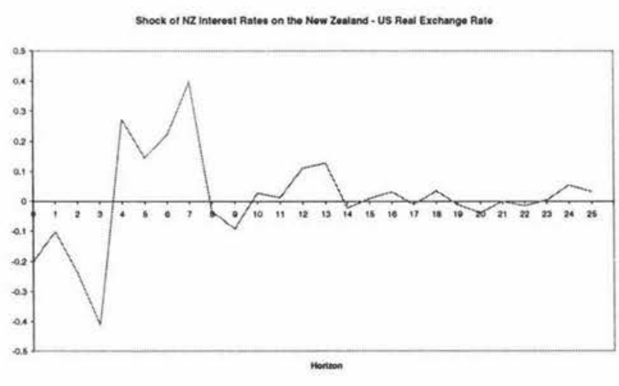






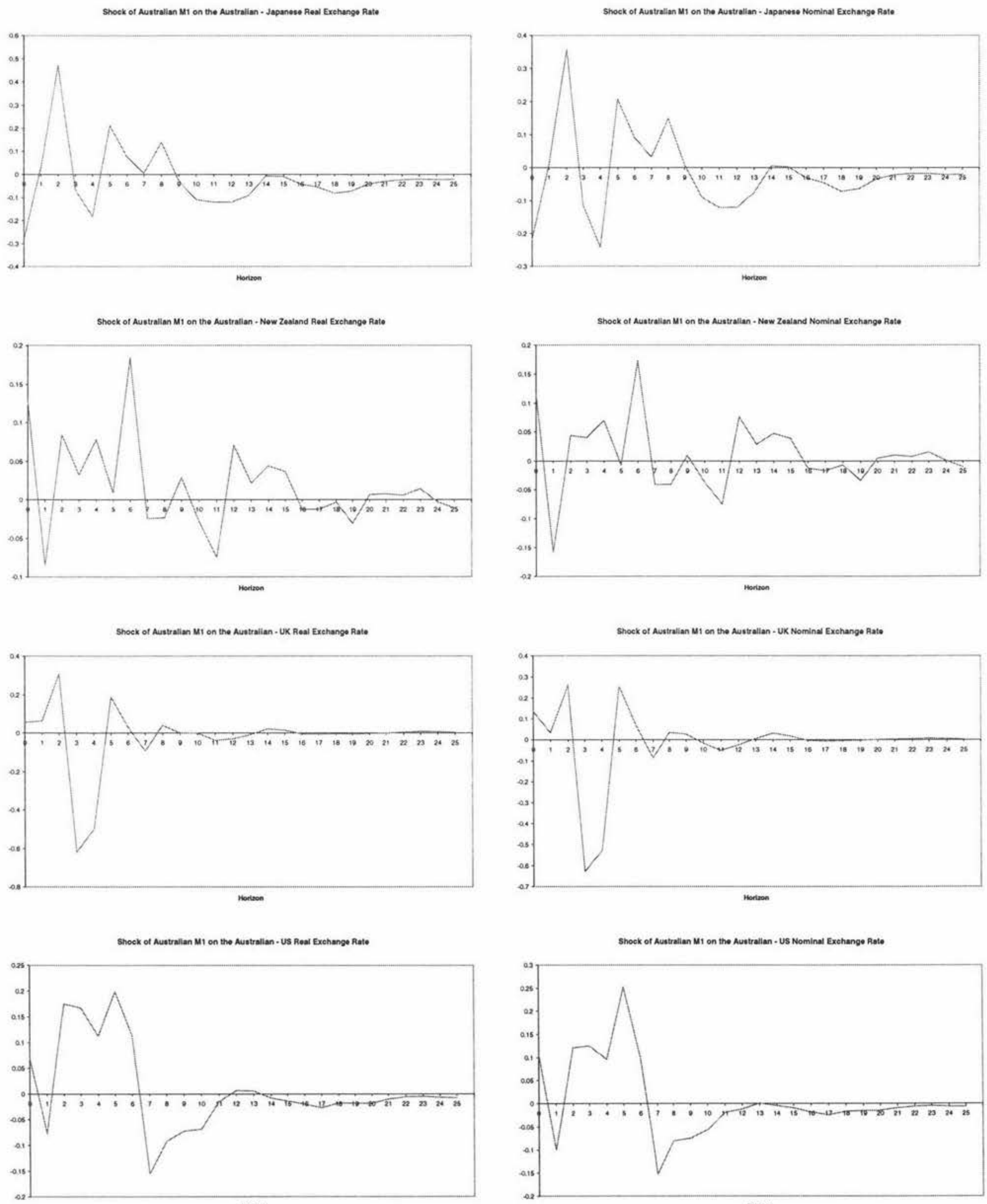






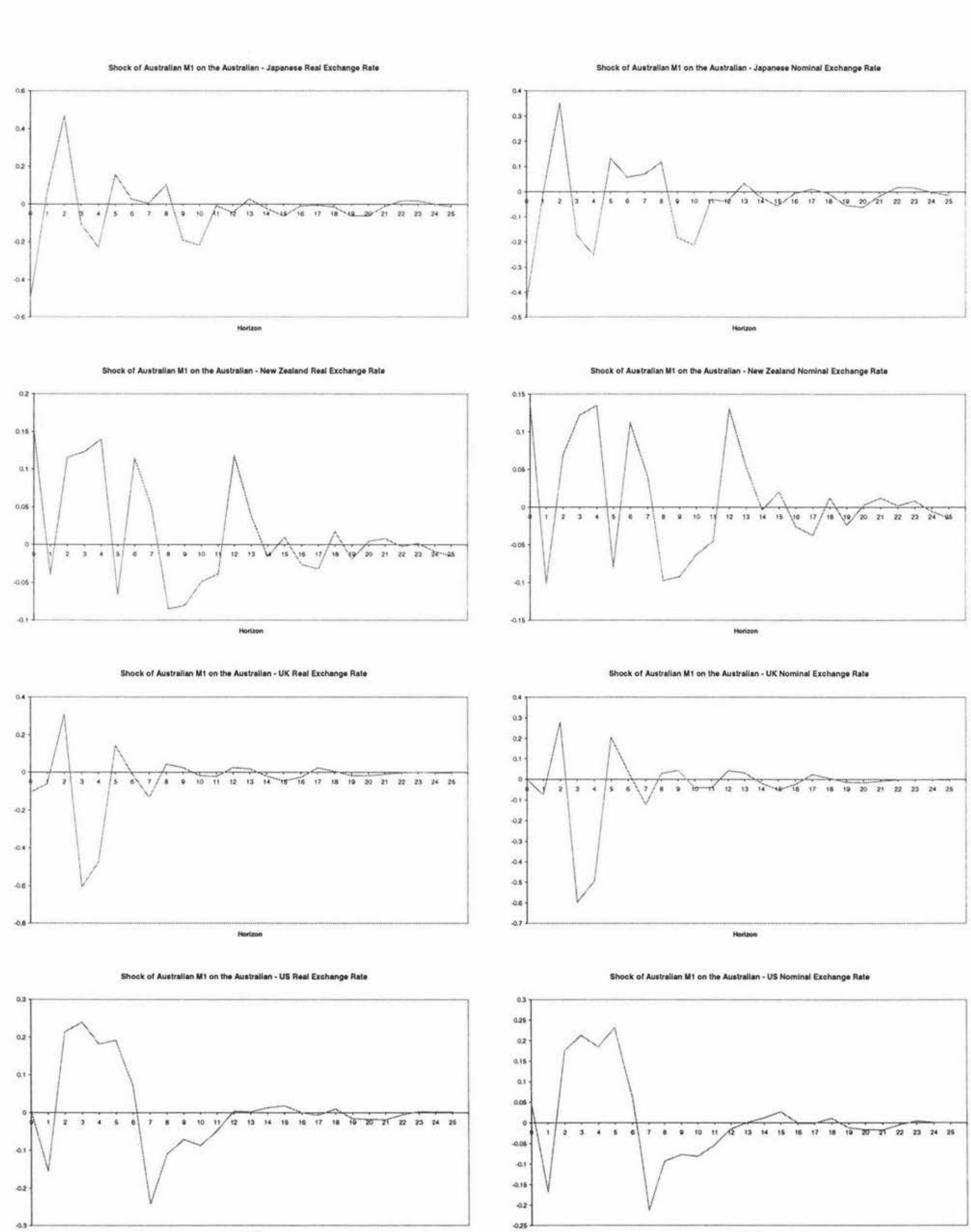
a) b)

Appendix 3.7: Orthogonalized Impulse Responses of the Australian Dollar from a Shock on M1 in Model 1 for a 25 Month Forecast Horizon



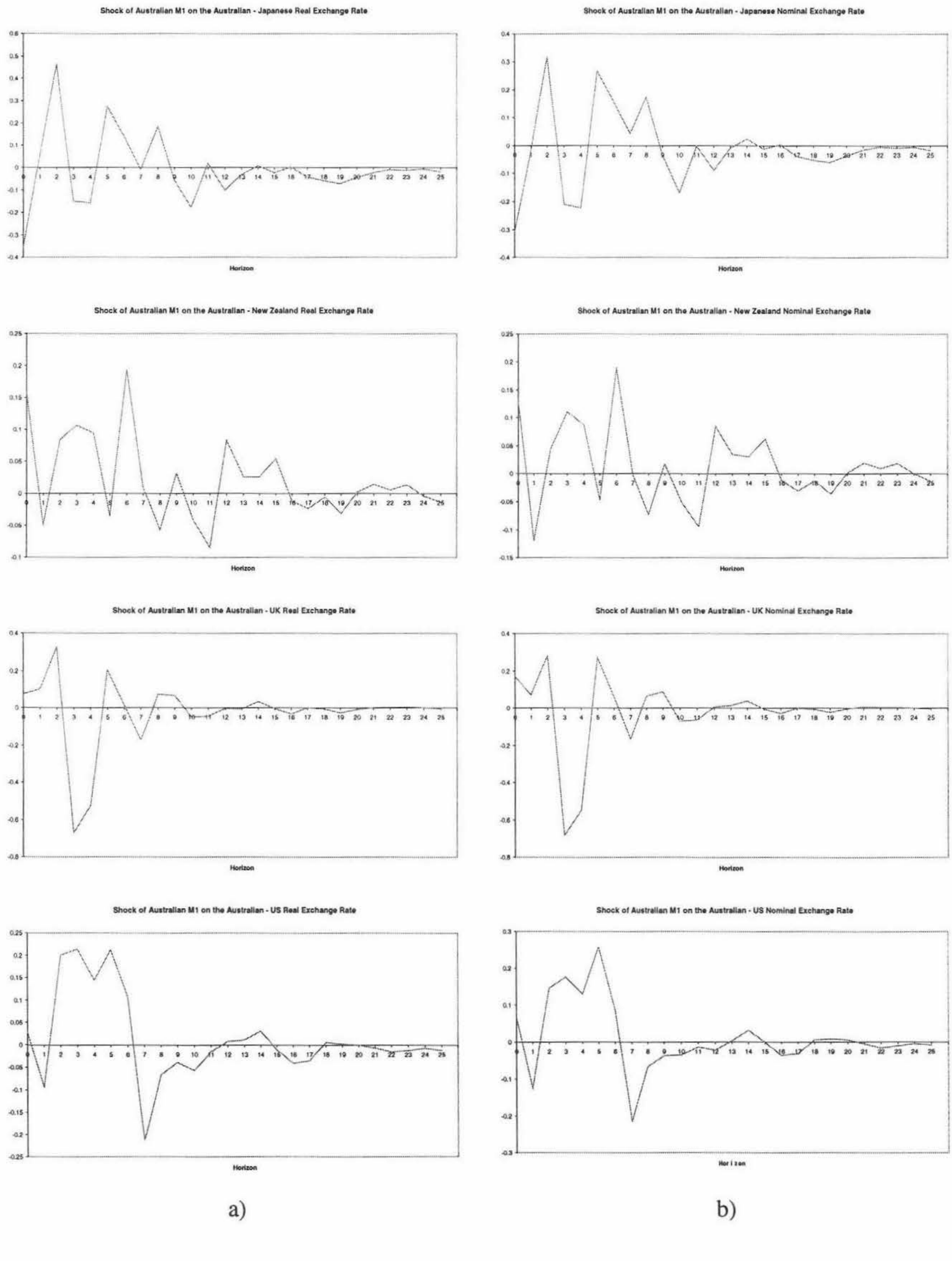
a) b)

Appendix 3.8: Orthogonalized Impulse Responses of the Australian Dollar from a Shock on M1 in Model 2 for a 25 Month Forecast Horizon



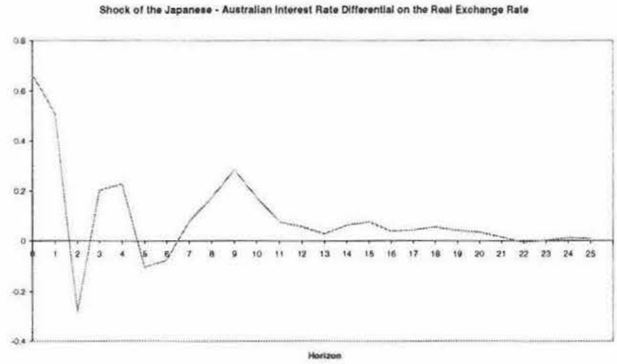
a) b)

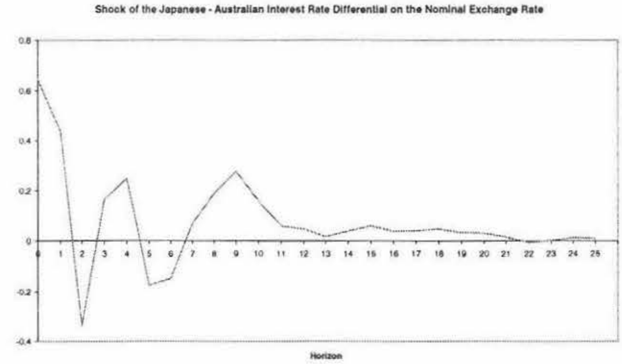
Appendix 3.9: Orthogonalized Impulse Responses of the Australian Dollar from a Shock on M1 in Model 3 for a 25 Month Forecast Horizon

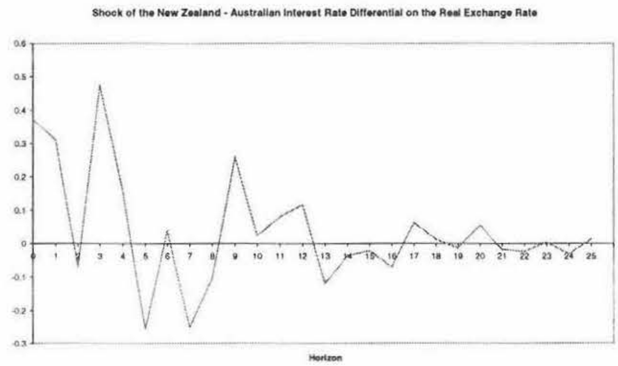


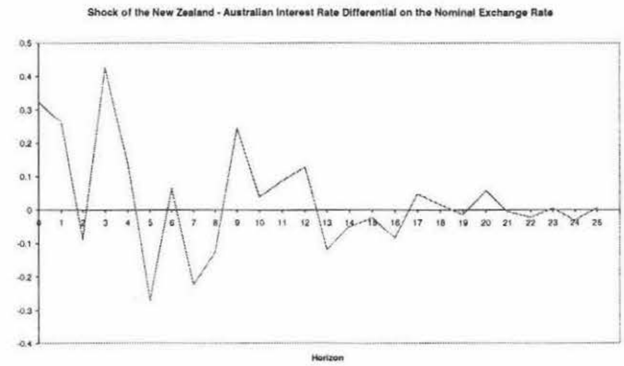
a) b)

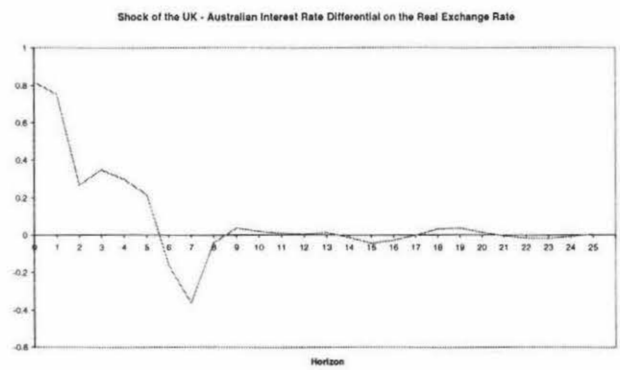
Appendix 3.10: Orthogonalized Impulse Responses of the Australian Dollar from a Shock on the Foreign – Australian Interest Rate Differential for a 25 Month Forecast Horizon

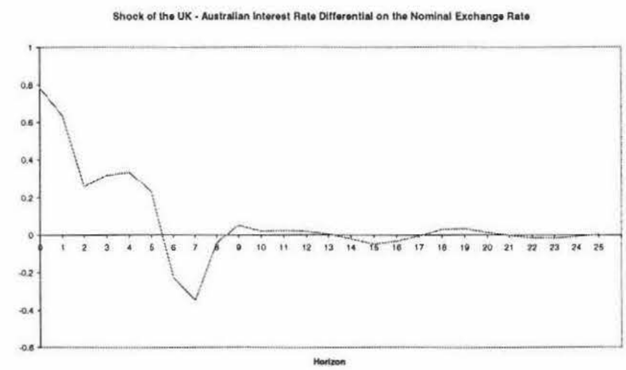


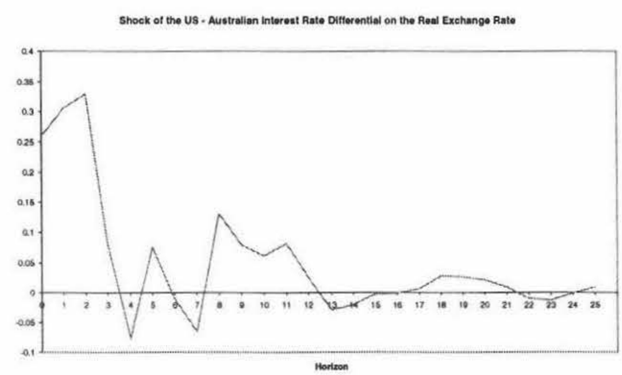


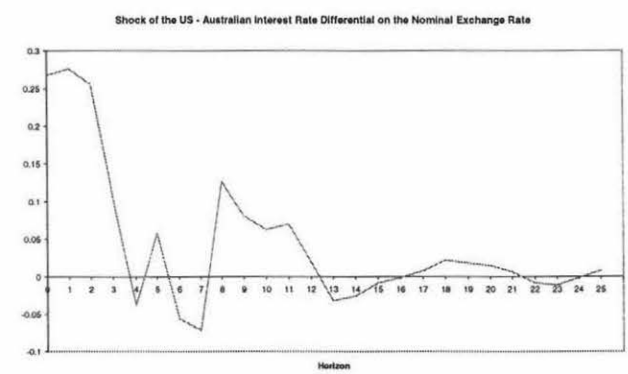






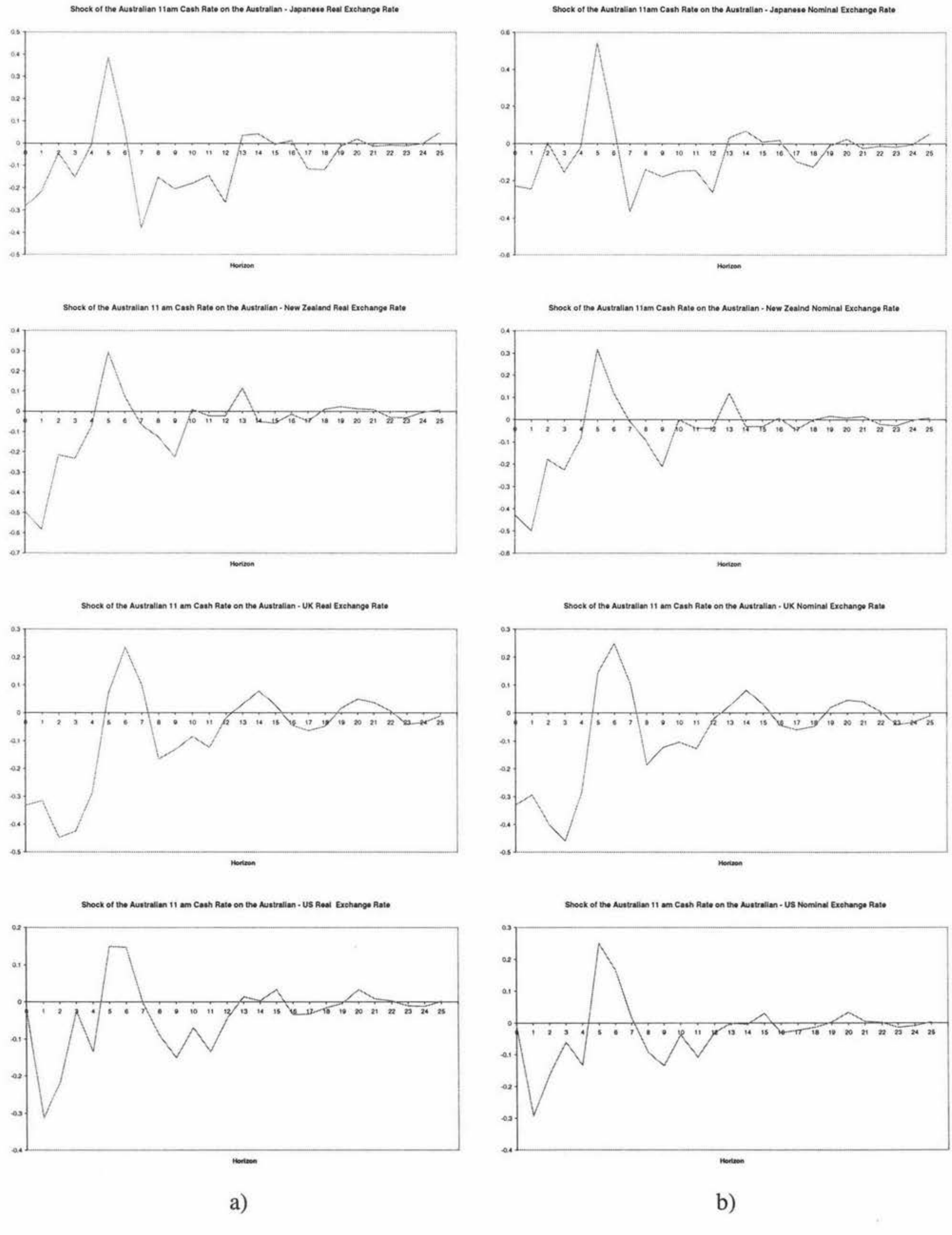






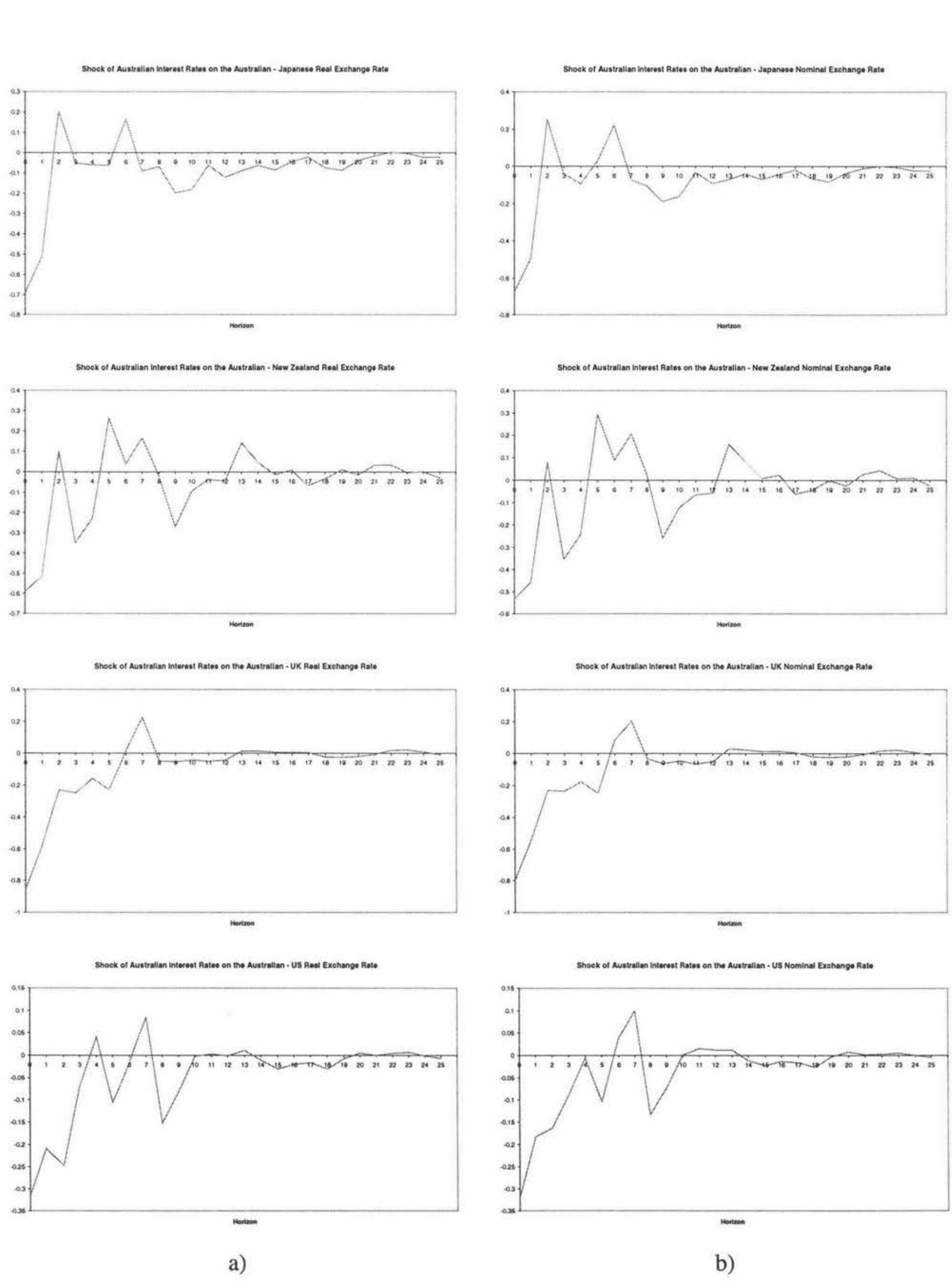
a) b)

Appendix 3.11: Orthogonalized Impulse Responses of the Australian Dollar from a Shock on the Australian 11 am Cash Rate for a 25 Month Forecast Horizon



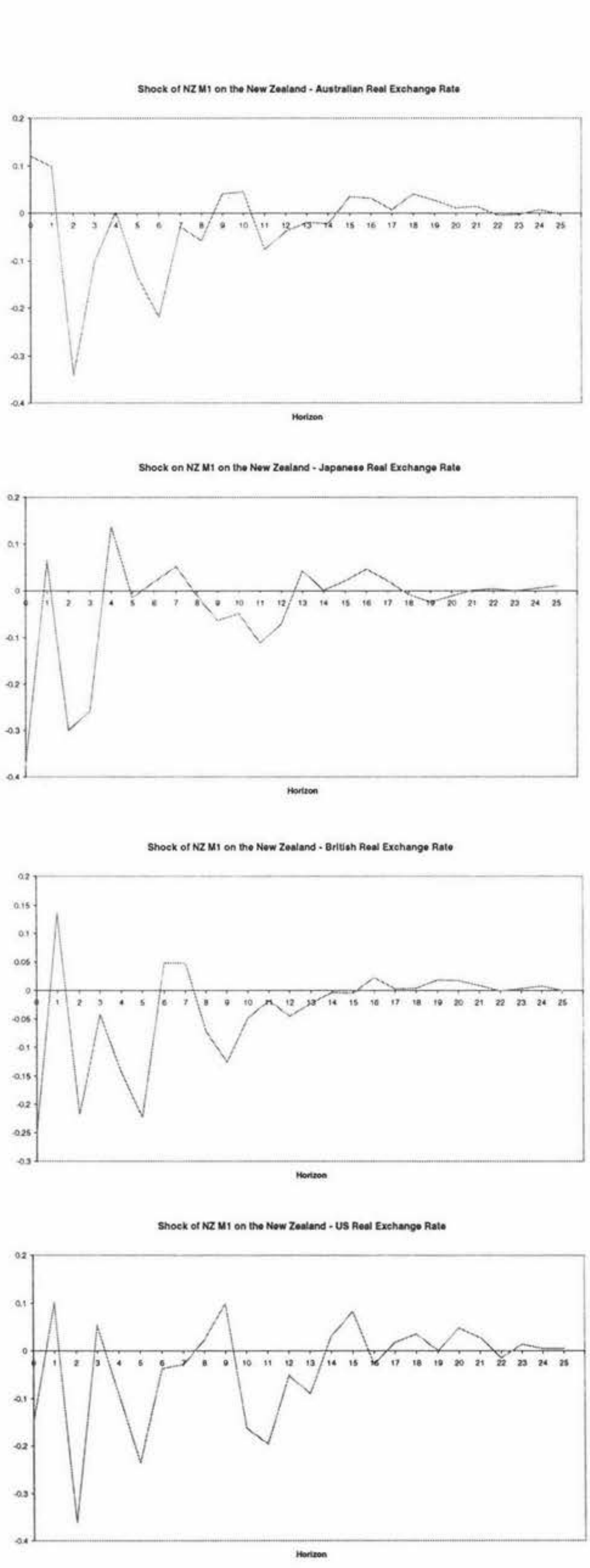
a) b)

Appendix 3.12: Orthogonalized Impulse Responses of the Australian Dollar from a Shock on Australian Interest Rates for a 25 Month Forecast Horizon

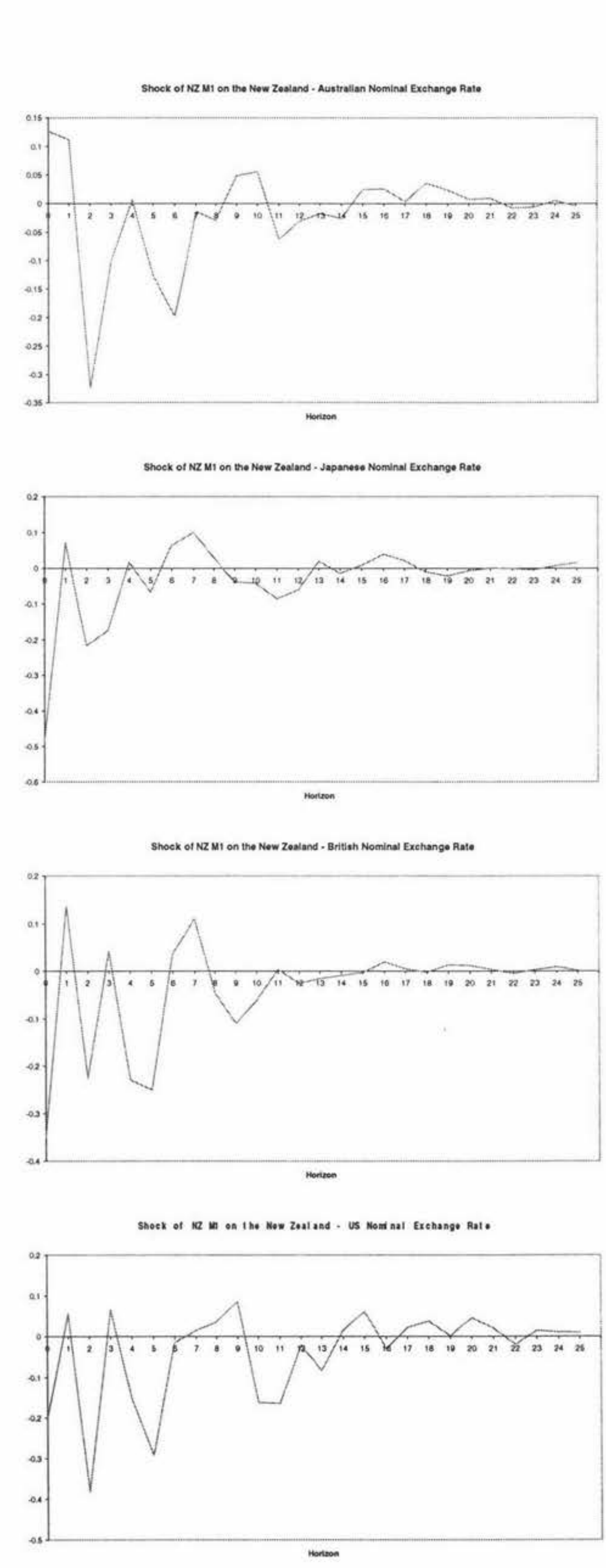


a) b)

Appendix 3.13: Generalized Impulse Responses of the New Zealand Dollar from a Shock on M1 in Model 1 for a 25 Month Forecast Horizon

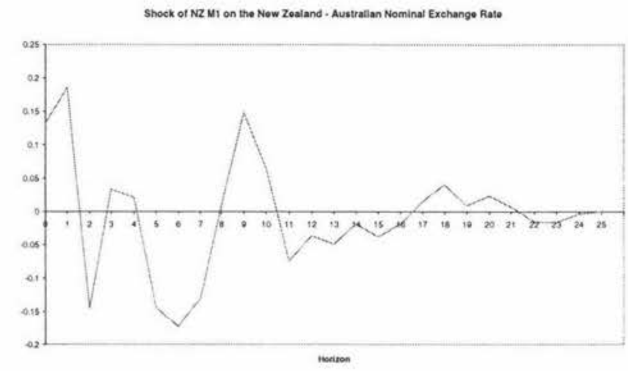


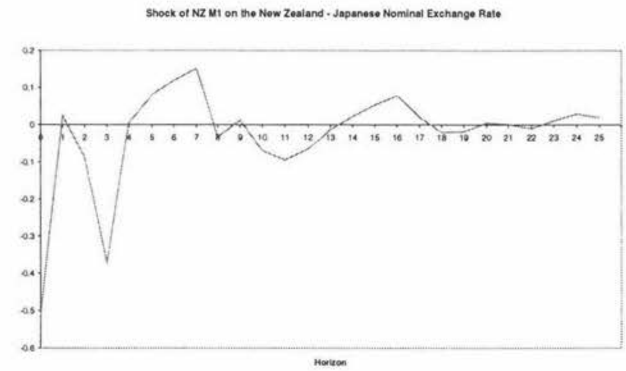
a)

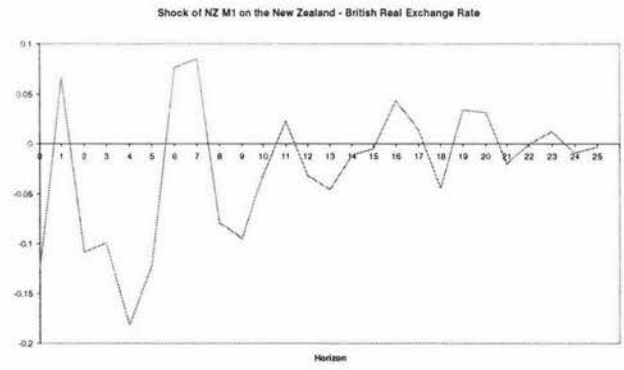


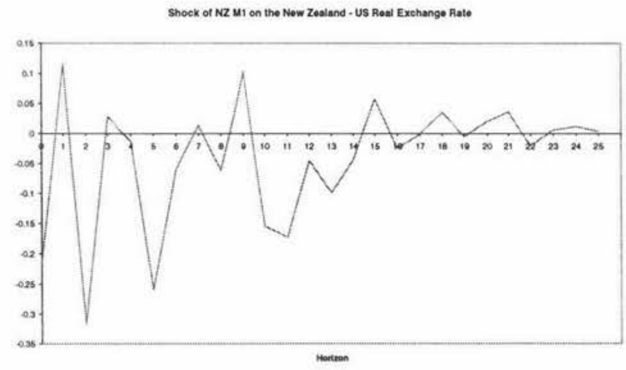
b)

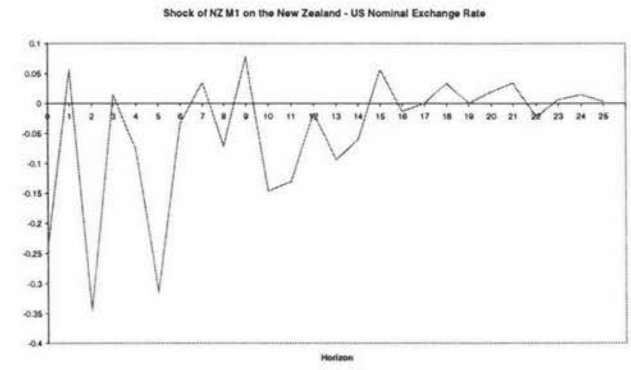
Appendix 3.14: Generalized Impulse Responses of the New Zealand Dollar from a Shock on M1 in Model 2 for a 25 Month Forecast Horizon





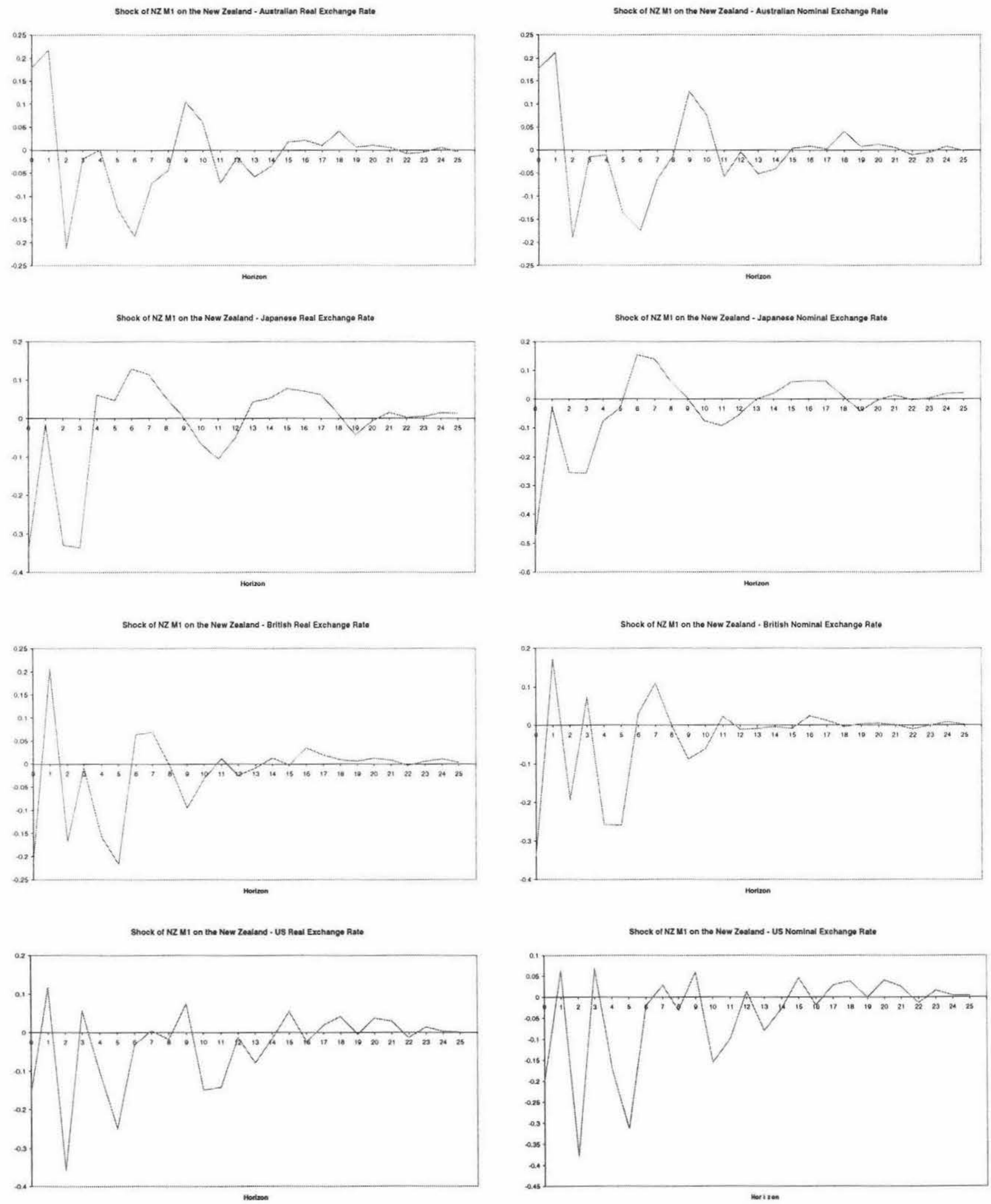






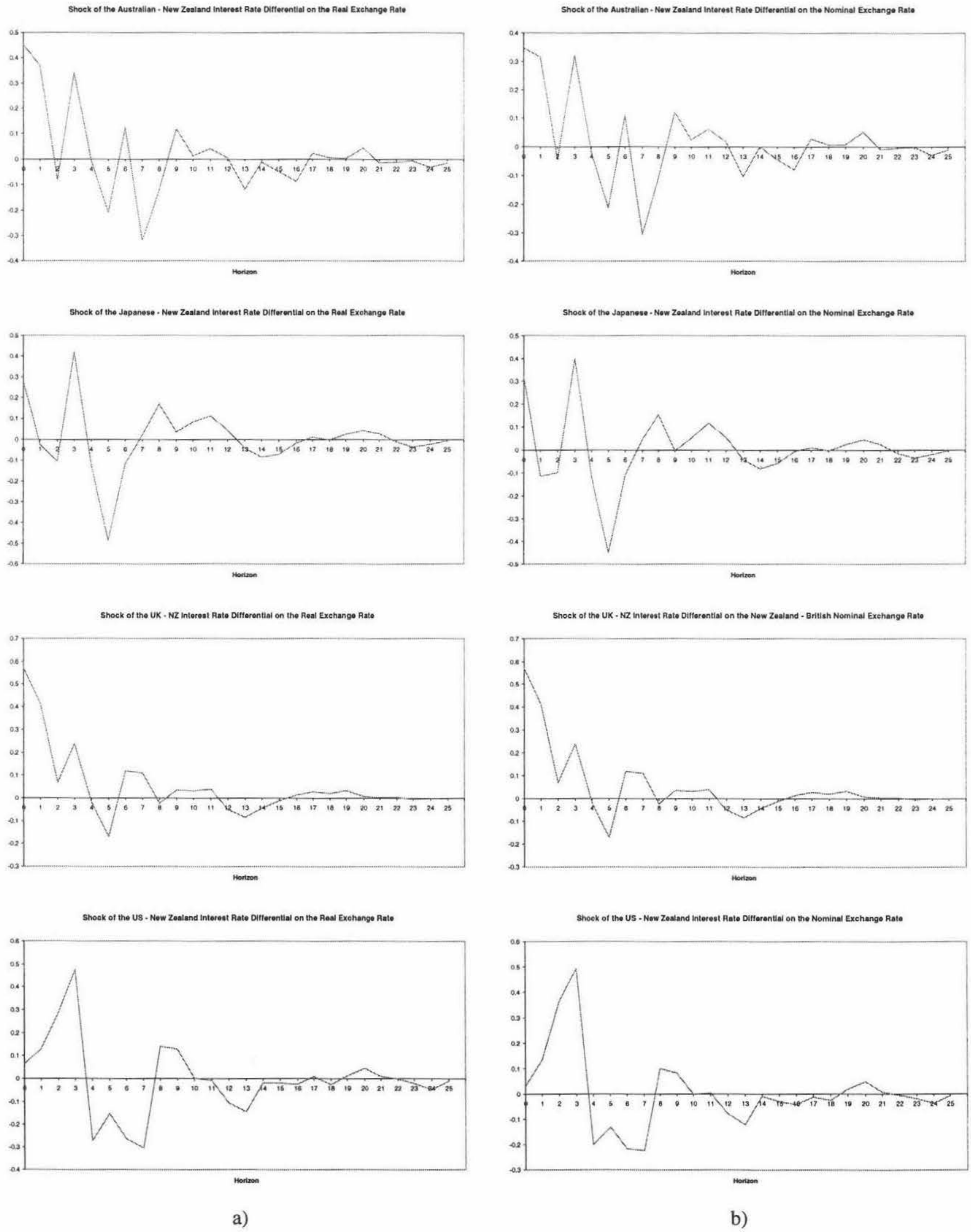
a) b)

Appendix 3.15: Generalized Impulse Responses of the New Zealand Dollar from a Shock on M1 in Model 3 for a 25 Month Forecast Horizon



a) b)

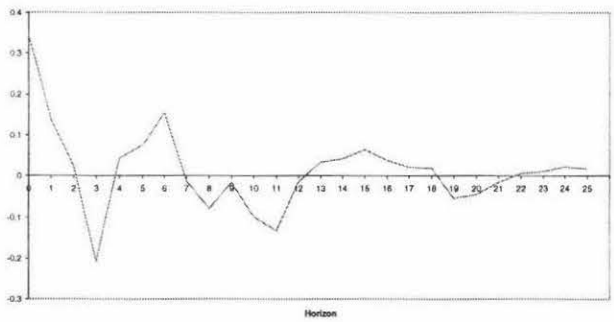
Appendix 3.16: Generalized Impulse Responses of the New Zealand Dollar from a Shock on the Foreign – New Zealand Interest Rate Differential for a 25 Month Forecast Horizon



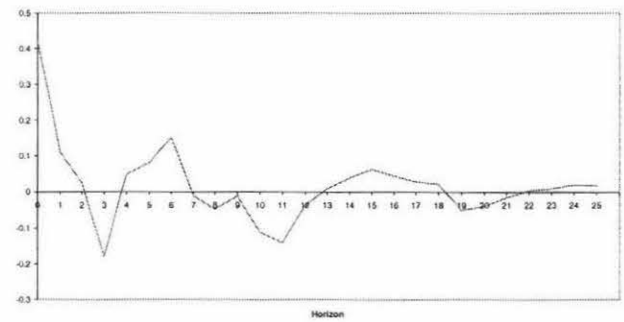
a) b)

Appendix 3.17: Generalized Impulse Responses of the New Zealand Dollar from a Shock on New Zealand Weighted Average Successful Bids from Open Market Operations for a 25 Month Forecast Horizon

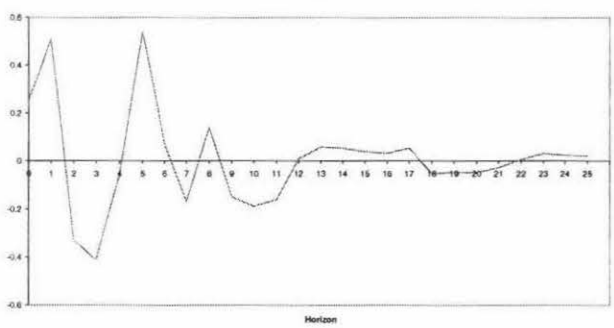
Shock of NZ Weighted Average Successful Bids of OMO on the New Zealand - Australian Real Exchange Rate



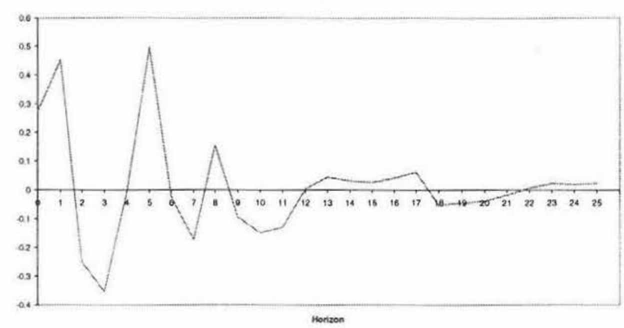
Shock of NZ Weighted Average Successful Bids of OMO on the New Zealand - Australian Nominal Exchange Rate



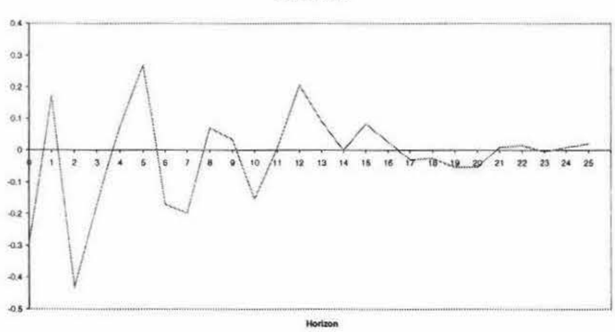
Shock of Weighted Average Successful Bids of OMO on the New Zealand - Japanese Real Exchange Rate



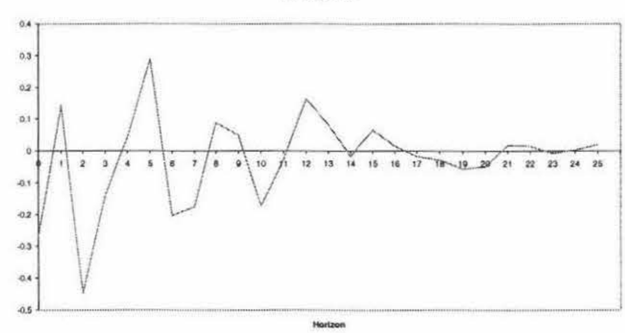
Shock of NZ Weighted Average Successful Bids from OMO on the New Zealand - Japanese Nominal Exchange Rate



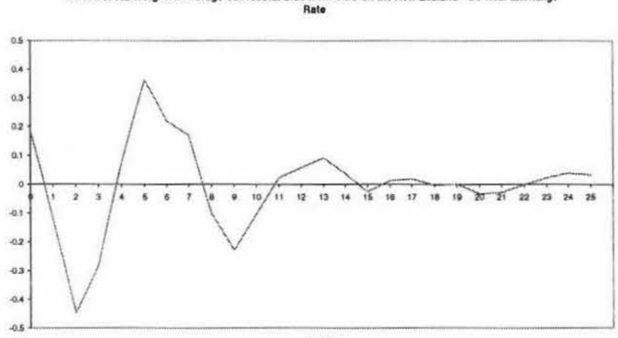
Shock of NZ Weighted Average Successful Bids from OMO on the New Zealand - British Real Exchange Rate



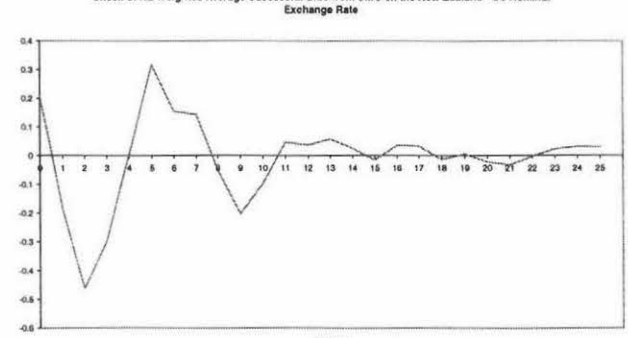
Shock of NZ Weighted Average Successful Bids from OMO on the New Zealand - British Nominal Exchange Rate



Shock of NZ Weighted Average Successful Bids from OMO on the New Zealand - US Real Exchange Rate

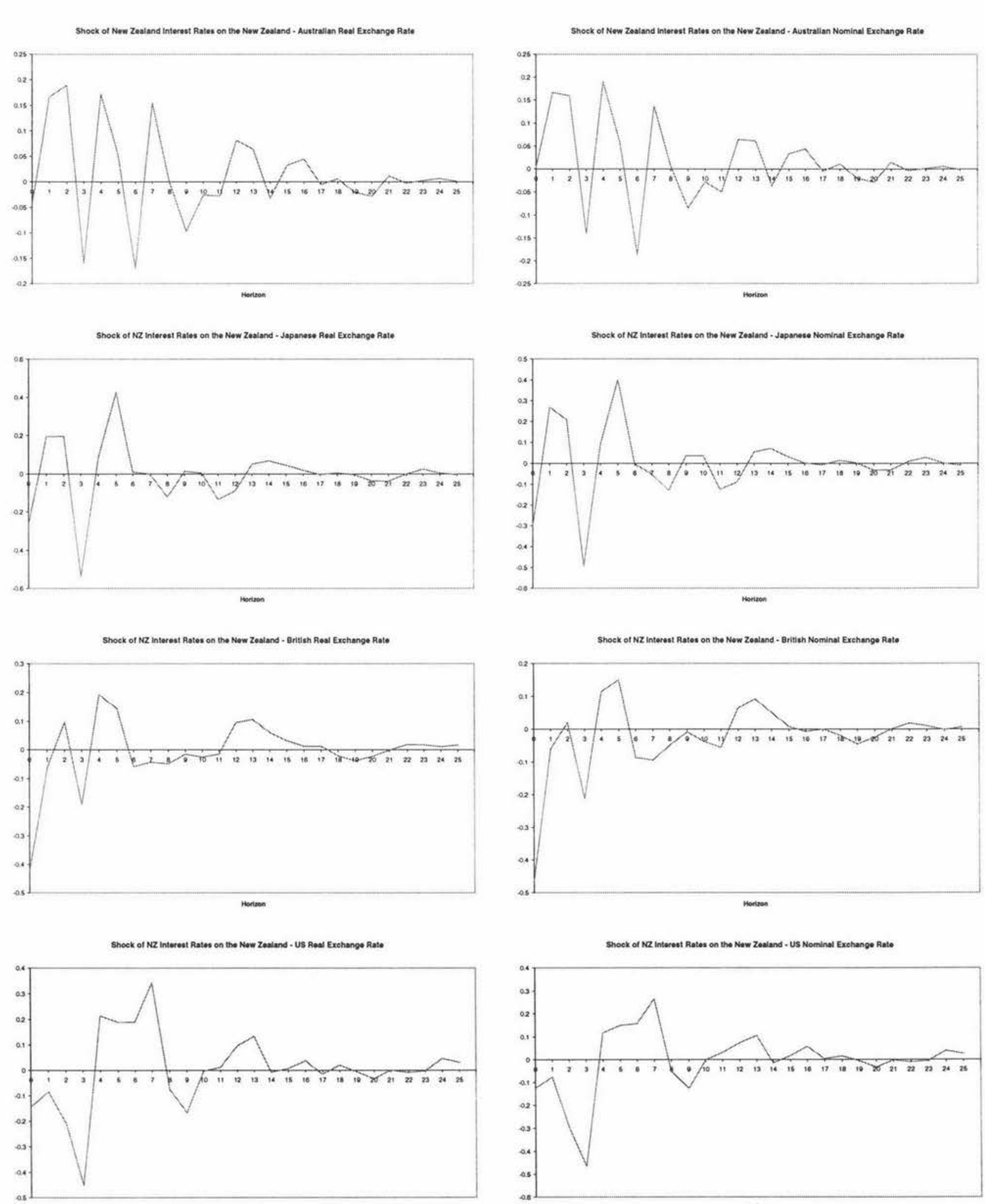


Shock of NZ Weighted Average Successful Bids from OMO on the New Zealand - US Nominal Exchange Rate



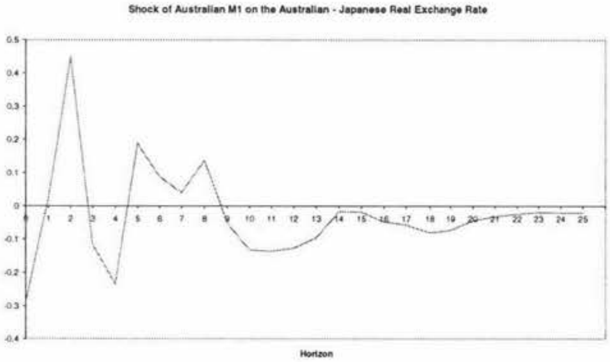
a) b)

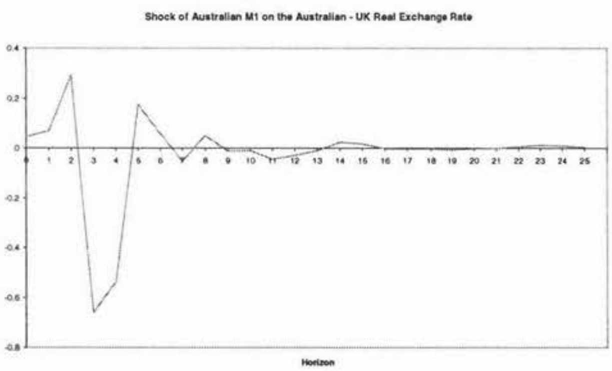
Appendix 3.18: Generalized Impulse Responses of the New Zealand Dollar from a Shock on New Zealand Interest Rates for a 25 Month Forecast Horizon

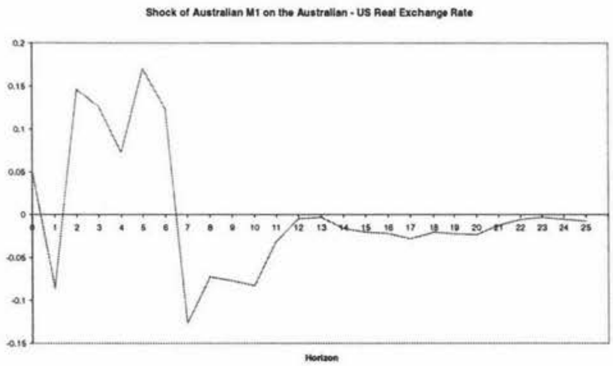


a) b)

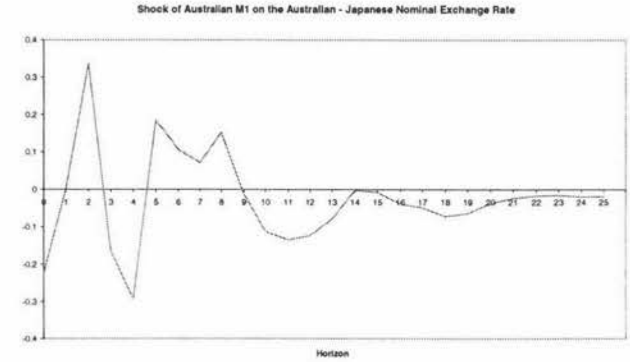
Appendix 3.19: Generalized Impulse Responses of the Australian Dollar from a Shock on M1 in Model 1 for a 25 Month Forecast Horizon

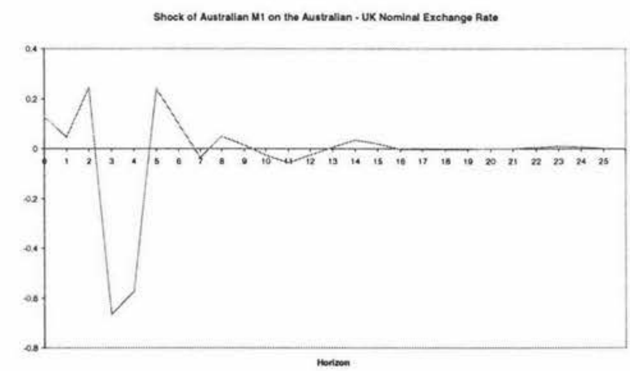


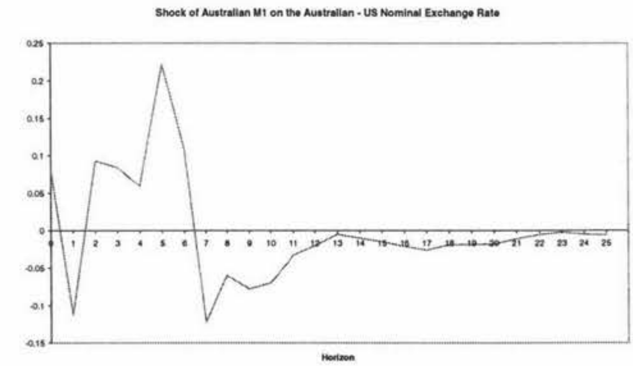




a)

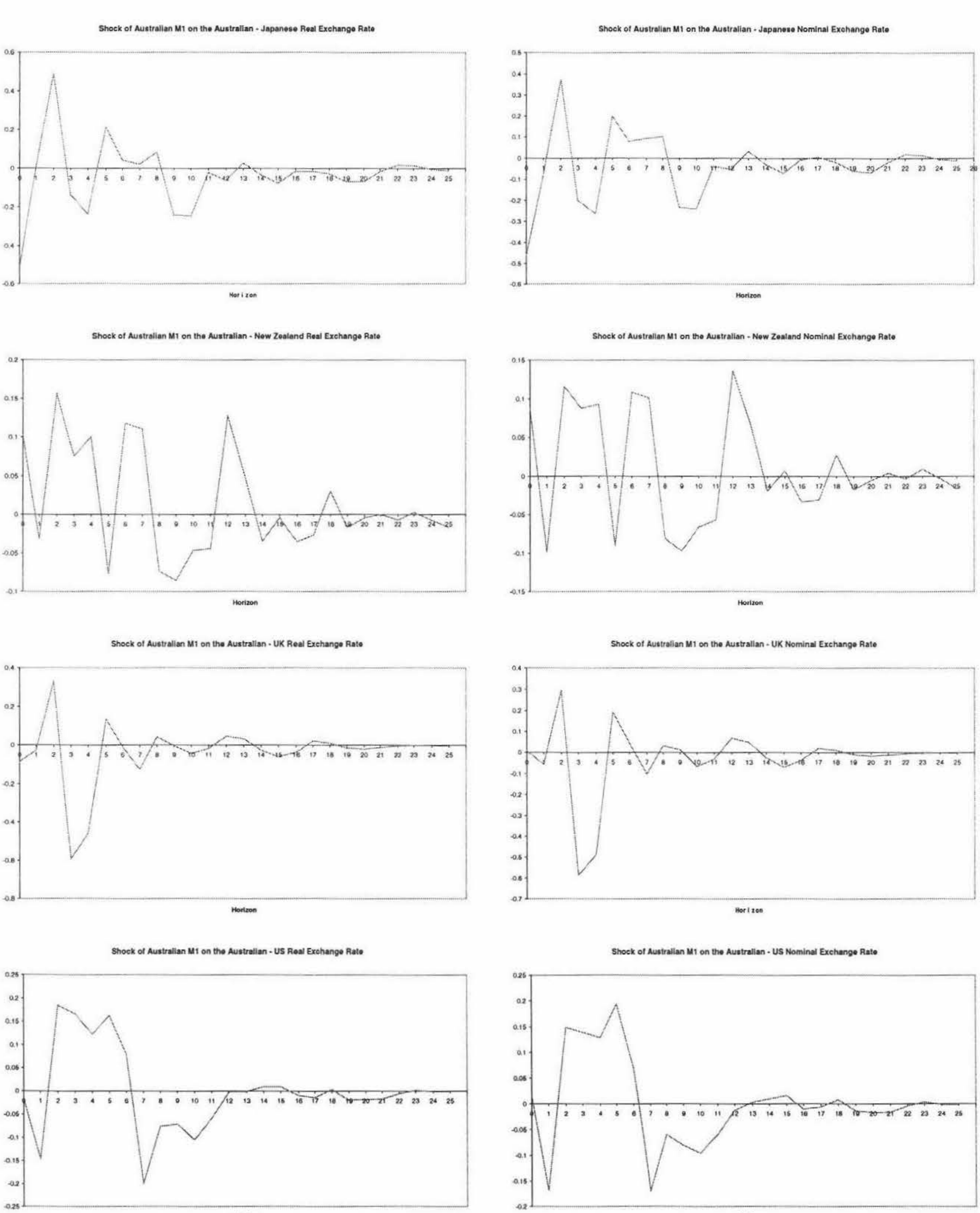






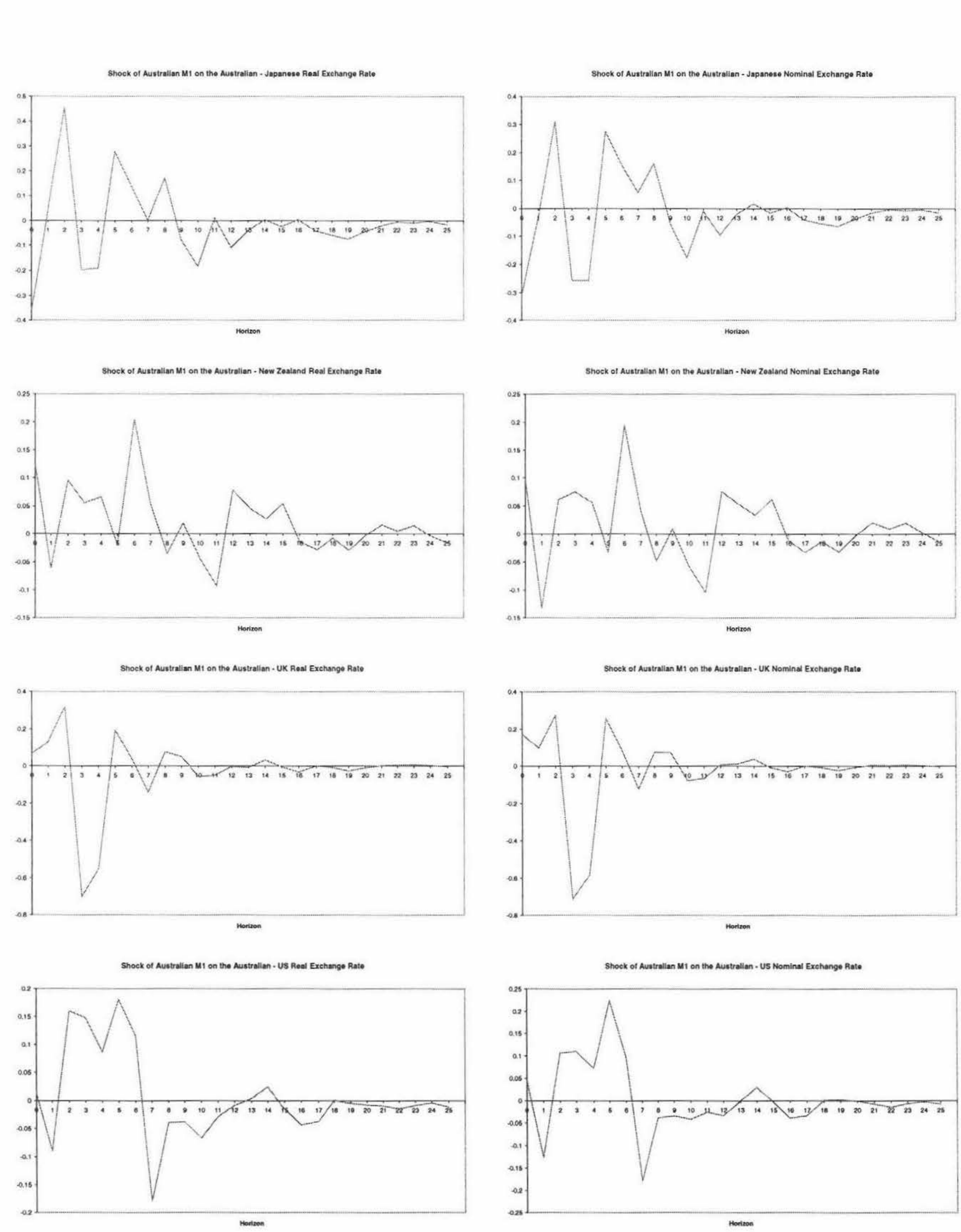
b)

Appendix 3.20: Generalized Impulse Responses of the Australian Dollar from a Shock on M1 in Model 2 for a 25 Month Forecast Horizon



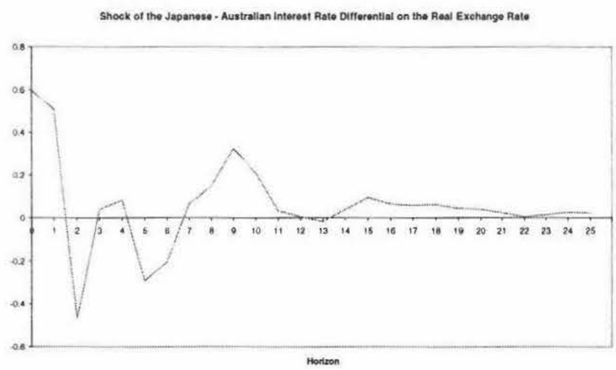
a) b)

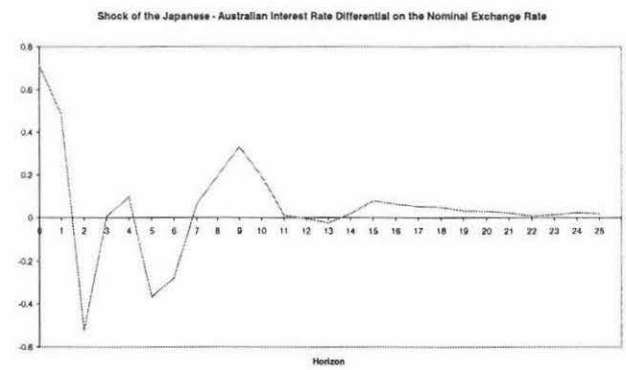
Appendix 3.21: Generalized Impulse Responses of the Australian Dollar from a Shock on M1 in Model 3 for a 25 Month Forecast Horizon

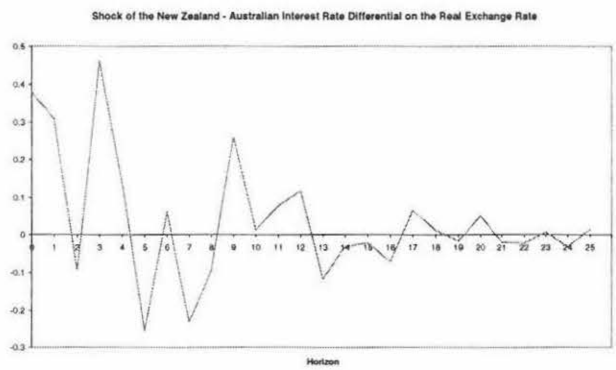


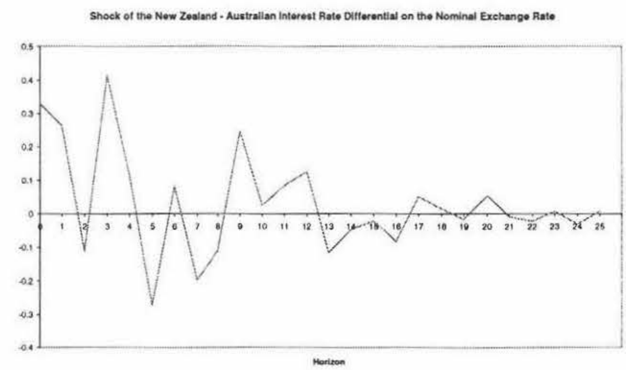
a) b)

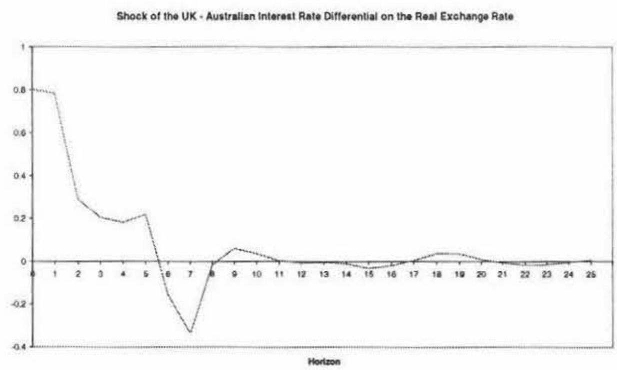
Appendix 3.22: Generalized Impulse Responses of the Australian Dollar from a Shock on the Foreign – Australian Interest Rate Differential for a 25 Month Forecast Horizon

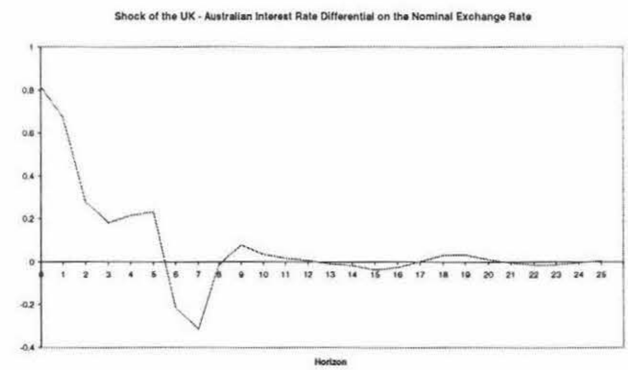


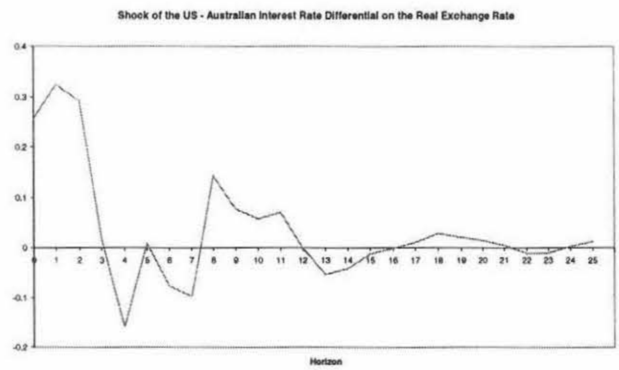


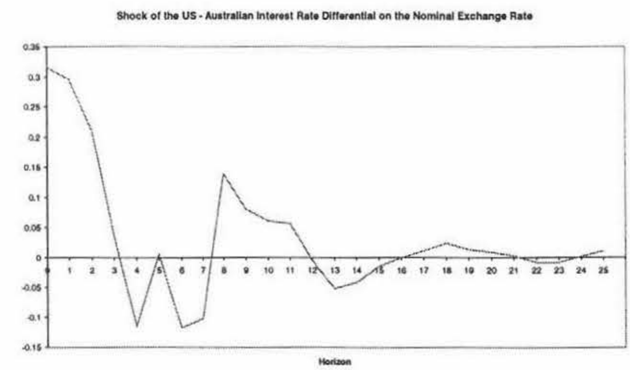






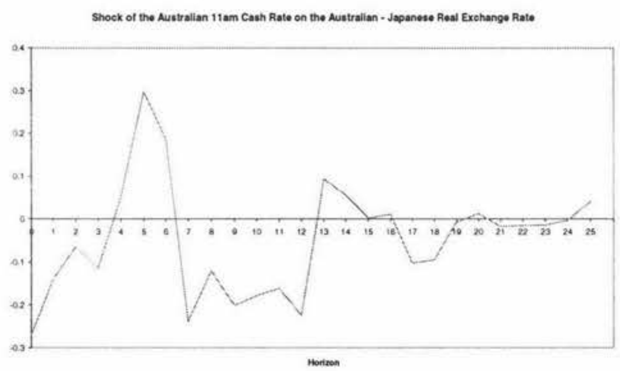


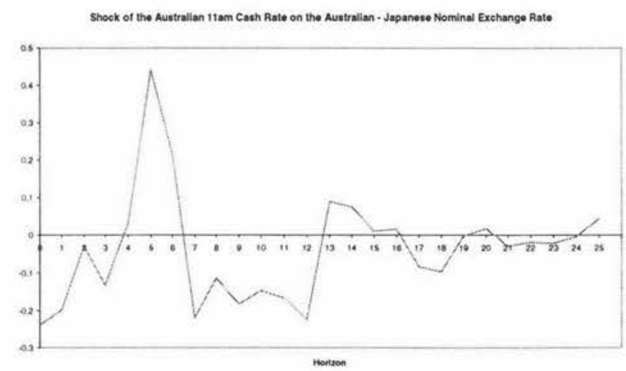


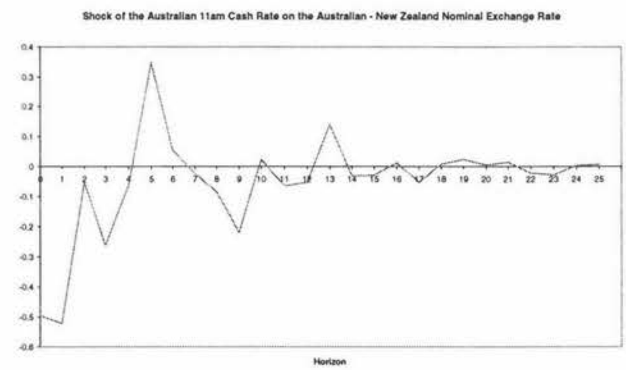


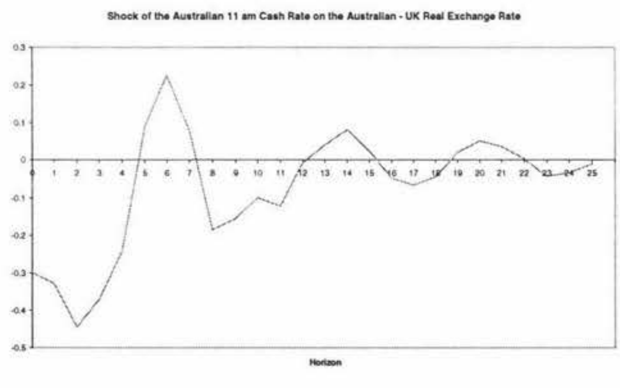
a) b)

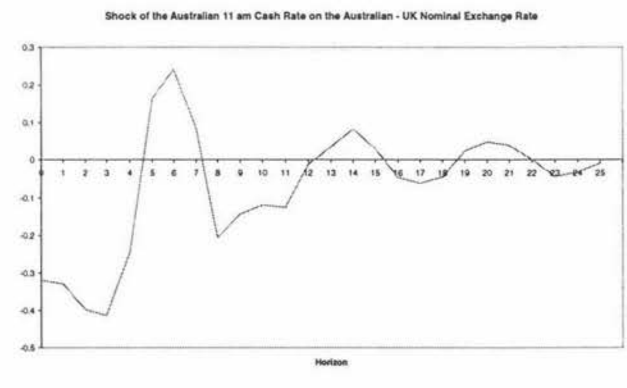
Appendix 3.23: Generalized Impulse Responses of the Australian Dollar from a Shock on the Australian 11 am Cash Rate for a 25 Month Forecast Horizon

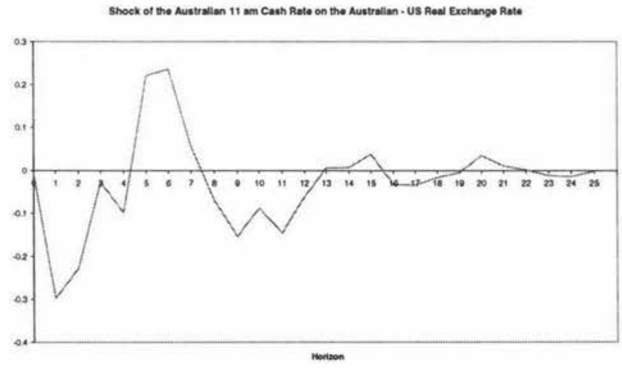


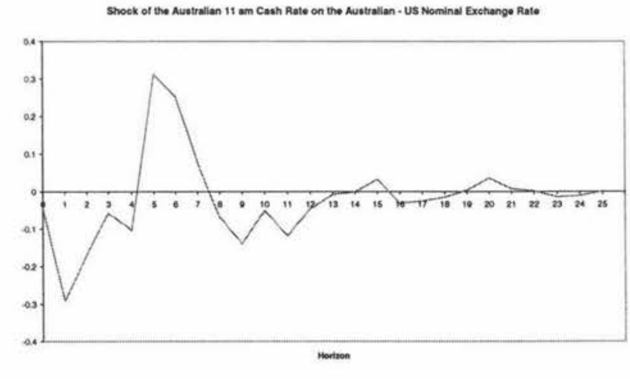






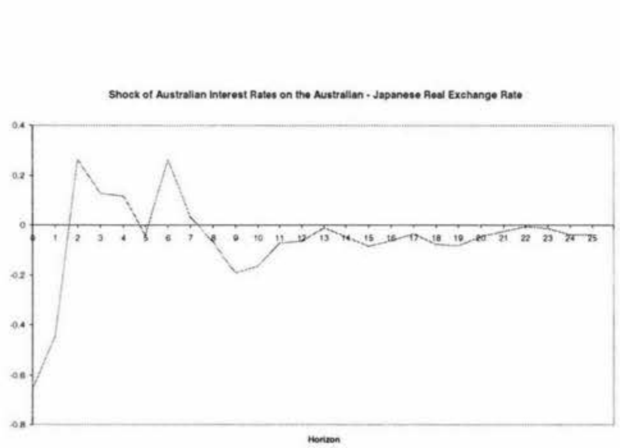


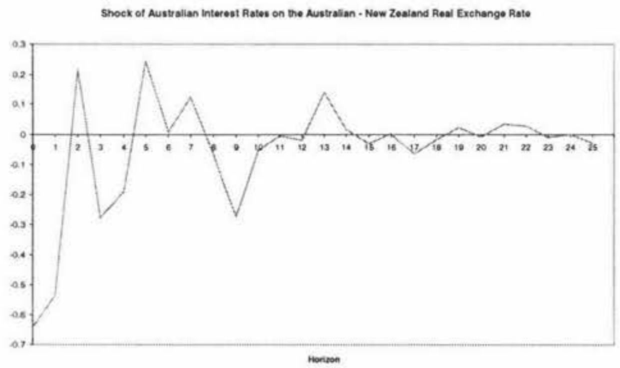


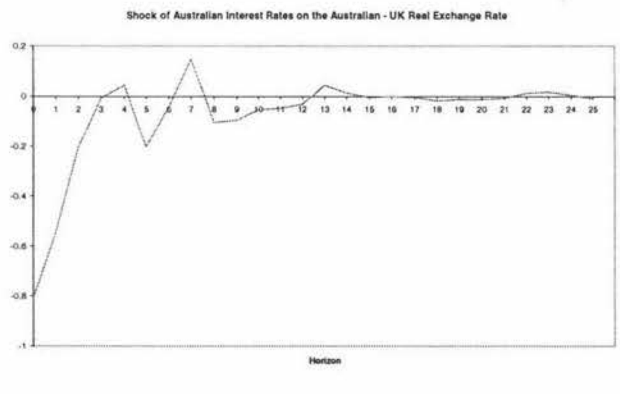


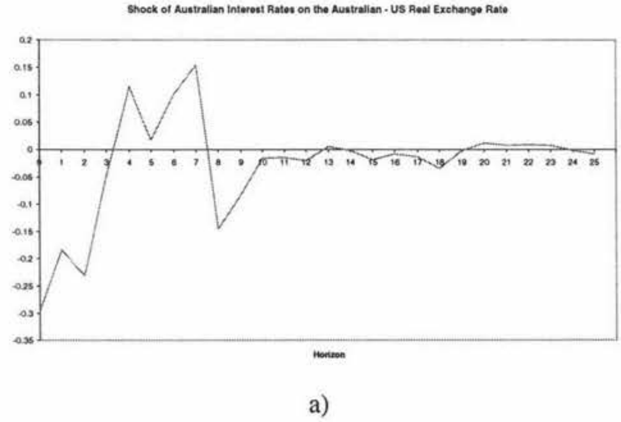
a) b)

Appendix 3.24: Generalized Impulse Responses of the Australian Dollar from a Shock on Australian Interest Rates for a 25 Month Forecast Horizon

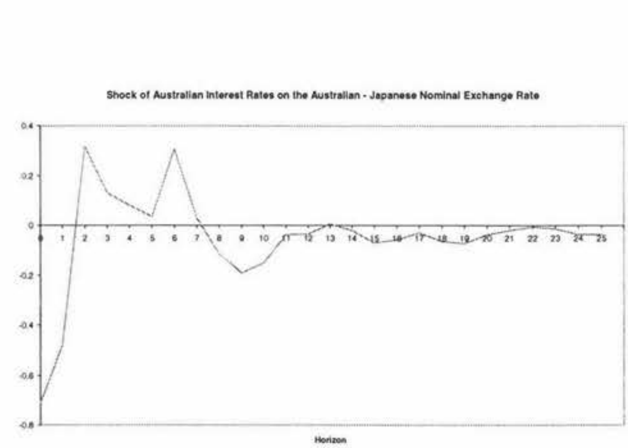


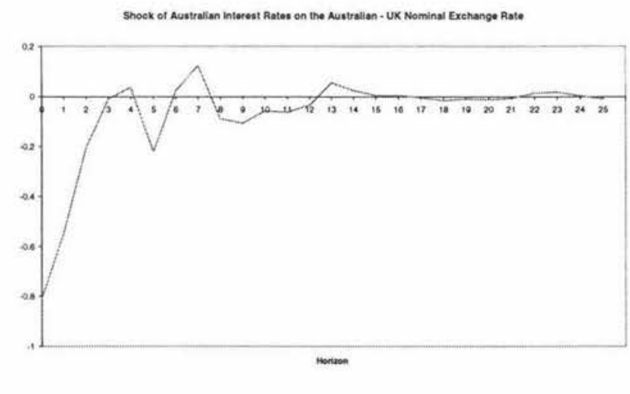


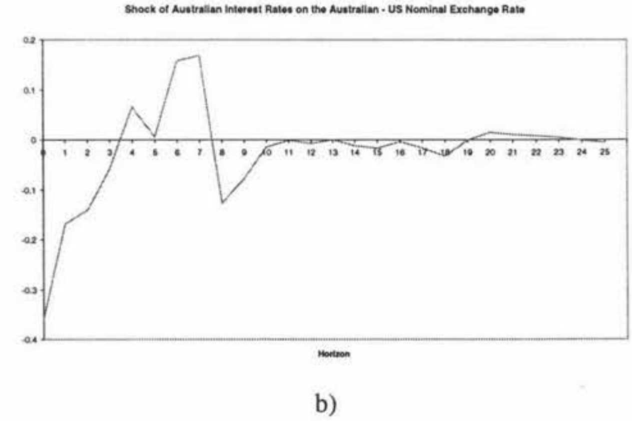




a)







b)

Appendix 4.1: Orthogonalized Forecast Error Variance Decompositions of the New Zealand Dollar in Model 2 for a 25 Month Forecast Horizon

Table 1: Variance Decomposition of the New Zealand – Australian Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	AUSIR	BIDS	M1	RNZAU
RNZAU	0	0.0328	0.1082	0.0478	0.0715	0.0000	0.7396
	1	0.0296	0.1578	0.1065	0.0829	0.0015	0.6217
	5	0.1433	0.1386	0.1298	0.0621	0.0070	0.5193
	10	0.1713	0.1342	0.1302	0.0658	0.0167	0.4818
	15	0.1699	0.1350	0.1321	0.0675	0.0192	0.4763
	20	0.1704	0.1348	0.1322	0.0682	0.0194	0.4751
	25	0.1704	0.1347	0.1324	0.0683	0.0194	0.4747

Variable Explained	Forecast Period	PRO	CPI	AUSIR	BIDS	M1	NNZAU
NNZAU	0	0.0388	0.0537	0.0398	0.0845	0.0003	0.7829
	1	0.0354	0.0952	0.0932	0.0902	0.0022	0.6838
	5	0.1346	0.0968	0.1318	0.0663	0.0069	0.5637
	10	0.1475	0.0970	0.1411	0.0683	0.0159	0.5302
	15	0.1462	0.0987	0.1423	0.0703	0.0175	0.5249
	20	0.1467	0.0985	0.1425	0.0711	0.0178	0.5234
	25	0.1468	0.0984	0.1427	0.0712	0.0179	0.5230

Table 2: Variance Decomposition of the New Zealand – Japanese Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	JAPIR	BIDS	M1	RNZJP
RNZJP	0	0.0260	0.0599	0.0009	0.0098	0.0322	0.8712
	1	0.0356	0.0514	0.0052	0.0316	0.0275	0.8486
	5	0.0397	0.0625	0.0234	0.0637	0.0456	0.7651
	10	0.0721	0.0692	0.0301	0.0642	0.0437	0.7207
	15	0.0737	0.0696	0.0309	0.0649	0.0447	0.7162
	20	0.0735	0.0698	0.0318	0.0652	0.0453	0.7142
	25	0.0736	0.0699	0.0319	0.0654	0.0453	0.7139

Variable Explained	Forecast Period	PRO	CPI	JAPIR	BIDS	M1	NNZJP
NNZJP	0	0.0176	0.0133	0.0006	0.0080	0.0429	0.9177
	1	0.0270	0.0131	0.0029	0.0234	0.0372	0.8964
	5	0.0297	0.0252	0.0245	0.0515	0.0491	0.8200
	10	0.0526	0.0334	0.0274	0.0515	0.0488	0.7862
	15	0.0537	0.0343	0.0277	0.0521	0.0498	0.7823
	20	0.0537	0.0346	0.0286	0.0527	0.0502	0.7803
	25	0.0538	0.0346	0.0286	0.0528	0.0502	0.7799

Table 3: Variance Decomposition of the New Zealand – UK Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	UKIR	BIDS	M1	RNZUK
RNZUK	0	0.0027	0.1589	0.0280	0.0000	0.0071	0.8032
	1	0.0029	0.1388	0.0868	0.0017	0.0076	0.7621
	5	0.0098	0.1562	0.0946	0.0328	0.0105	0.6961
	10	0.0242	0.1567	0.0990	0.0363	0.0127	0.6710
	15	0.0275	0.1563	0.0992	0.0397	0.0130	0.6642
	20	0.0280	0.1565	0.0994	0.0402	0.0134	0.6624
	25	0.0281	0.1566	0.0995	0.0403	0.0134	0.6621

Variable Explained	Forecast Period	PRO	CPI	UKIR	BIDS	M1	NNZUK
NNZUK	0	0.0019	0.0774	0.0303	0.0013	0.0118	0.8774
	1	0.0017	0.0732	0.0738	0.0015	0.0119	0.8380
	5	0.0049	0.1138	0.0762	0.0404	0.0163	0.7484
	10	0.0136	0.1152	0.0790	0.0464	0.0199	0.7259
	15	0.0179	0.1163	0.0793	0.0486	0.0199	0.7180
	20	0.0186	0.1168	0.0796	0.0490	0.0203	0.7157
	25	0.0186	0.1169	0.0799	0.0490	0.0204	0.7153

Table 4: Variance Decomposition of the New Zealand – US Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	USIR	BIDS	M1	RNZUS
RNZUS	0	0.0963	0.1088	0.0019	0.0031	0.0300	0.7600
	1	0.0905	0.1121	0.0324	0.0080	0.0285	0.7285
	5	0.1093	0.1141	0.0353	0.0680	0.0493	0.6241
	10	0.2058	0.1118	0.0425	0.0747	0.0449	0.5203
	15	0.2019	0.1163	0.0430	0.0749	0.0507	0.5133
	20	0.2010	0.1187	0.0431	0.0746	0.0505	0.5122
	25	0.2008	0.1189	0.0431	0.0749	0.0505	0.5118

Variable Explained	Forecast Period	PRO	CPI	USIR	BIDS	M1	NNZUS
NNZUS	0	0.0841	0.0303	0.0033	0.0042	0.0305	0.8477
	1	0.0788	0.0295	0.0285	0.0166	0.0285	0.8181
	5	0.0893	0.0521	0.0414	0.0777	0.0616	0.6779
	10	0.1668	0.0570	0.0522	0.0778	0.0562	0.5900
	15	0.1640	0.0633	0.0520	0.0774	0.0605	0.5827
	20	0.1636	0.0657	0.0519	0.0774	0.0602	0.5813
	25	0.1636	0.0661	0.0518	0.0777	0.0603	0.5806

Appendix 4.2: Orthogonalized Forecast Error Variance Decompositions of the New Zealand Dollar in Model 3 for a 25 Month Forecast Horizon

Table 1: Variance Decomposition of the New Zealand – Australian Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	AUSIR	M1	NZIR	RNZAU
RNZAU	0	0.0256	0.1165	0.0528	0.0001	0.0000	0.8050
	1	0.0222	0.1772	0.1268	0.0012	0.0144	0.6583
	5	0.1330	0.1618	0.1464	0.0069	0.0246	0.5273
	10	0.1584	0.1620	0.1466	0.0136	0.0321	0.4872
	15	0.1576	0.1604	0.1488	0.0148	0.0340	0.4844
	20	0.1579	0.1607	0.1488	0.0151	0.0343	0.4833
	25	0.1578	0.1609	0.1488	0.0151	0.0343	0.4831

Variable Explained	Forecast Period	PRO	CPI	AUSIR	M1	NZIR	NNZAU
NNZAU	0	0.0321	0.0572	0.0463	0.0007	0.0001	0.8636
	1	0.0278	0.1098	0.1154	0.0021	0.0132	0.7318
	5	0.1269	0.1178	0.1479	0.0069	0.0227	0.5777
	10	0.1366	0.1230	0.1547	0.0134	0.0310	0.5412
	15	0.1362	0.1224	0.1562	0.0143	0.0328	0.5382
	20	0.1366	0.1225	0.1563	0.0145	0.0331	0.5370
	25	0.1366	0.1227	0.1563	0.0145	0.0331	0.5368

Table 2: Variance Decomposition of the New Zealand – Japanese Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	JAPIR	M1	NZIR	RNZJP
RNZJP	0	0.0174	0.0803	0.0010	0.0280	0.0053	0.8679
	1	0.0310	0.0710	0.0090	0.0247	0.0097	0.8546
	5	0.0330	0.0720	0.0336	0.0403	0.0397	0.7814
	10	0.0565	0.0776	0.0419	0.0405	0.0402	0.7433
	15	0.0576	0.0773	0.0423	0.0414	0.0420	0.7394
	20	0.0576	0.0774	0.0430	0.0419	0.0420	0.7381
	25	0.0577	0.0774	0.0430	0.0419	0.0421	0.7379

Variable Explained	Forecast Period	PRO	CPI	JAPIR	M1	NZIR	NNZJP
NNZJP	0	0.0112	0.0237	0.0008	0.0393	0.0100	0.9151
	1	0.0242	0.0205	0.0050	0.0345	0.0162	0.8996
	5	0.0259	0.0262	0.0343	0.0435	0.0440	0.8261
	10	0.0413	0.0345	0.0373	0.0450	0.0442	0.7975
	15	0.0420	0.0350	0.0372	0.0458	0.0462	0.7939
	20	0.0421	0.0353	0.0382	0.0462	0.0461	0.7922
	25	0.0422	0.0353	0.0382	0.0462	0.0462	0.7918

Table 3: Variance Decomposition of the New Zealand – UK Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	UKIR	M1	NZIR	RNZUK
RNZUK	0	0.0001	0.1441	0.0324	0.0159	0.0109	0.7967
	1	0.0001	0.1260	0.0887	0.0185	0.0123	0.7544
	5	0.0068	0.1460	0.0906	0.0209	0.0170	0.7187
	10	0.0193	0.1478	0.0927	0.0222	0.0168	0.7012
	15	0.0200	0.1473	0.0937	0.0222	0.0189	0.6980
	20	0.0201	0.1477	0.0936	0.0222	0.0191	0.6972
	25	0.0202	0.1478	0.0936	0.0222	0.0192	0.6970

Variable Explained	Forecast Period	PRO	CPI	UKIR	M1	NZIR	NNZUK
NNZUK	0	0.0000	0.0739	0.0358	0.0243	0.0182	0.8478
	1	0.0002	0.0708	0.0759	0.0259	0.0194	0.8078
	5	0.0035	0.1128	0.0735	0.0315	0.0220	0.7566
	10	0.0086	0.1143	0.0749	0.0340	0.0231	0.7450
	15	0.0091	0.1148	0.0754	0.0339	0.0244	0.7423
	20	0.0094	0.1154	0.0754	0.0339	0.0246	0.7413
	25	0.0094	0.1154	0.0754	0.0339	0.0247	0.7411

Table 4: Variance Decomposition of the New Zealand – US Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	USIR	M1	NZIR	RNZUS
RNZUS	0	0.0845	0.1129	0.0026	0.0292	0.0097	0.7610
	1	0.0783	0.1209	0.0212	0.0274	0.0112	0.7411
	5	0.1004	0.1232	0.0370	0.0500	0.0633	0.6260
	10	0.1875	0.1230	0.0395	0.0434	0.0783	0.5282
	15	0.1850	0.1255	0.0396	0.0470	0.0807	0.5223
	20	0.1843	0.1279	0.0396	0.0469	0.0806	0.5208
	25	0.1839	0.1285	0.0396	0.0469	0.0809	0.5202

Variable Explained	Forecast Period	PRO	CPI	USIR	M1	NZIR	NNZUS
NNZUS	0	0.0755	0.0346	0.0032	0.0294	0.0099	0.8474
	1	0.0708	0.0358	0.0217	0.0276	0.0121	0.8321
	5	0.0834	0.0589	0.0477	0.0643	0.0698	0.6759
	10	0.1536	0.0649	0.0513	0.0575	0.0764	0.5964
	15	0.1515	0.0694	0.0506	0.0596	0.0781	0.5908
	20	0.1512	0.0715	0.0505	0.0595	0.0784	0.5889
	25	0.1510	0.0721	0.0505	0.0595	0.0786	0.5884

Appendix 4.3: Orthogonalized Forecast Error Variance Decompositions of the Australian Dollar in Model 2 for a 25 Month Forecast Horizon

Table 1: Variance Decomposition of the Australian – Japanese Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	JAPIR	CASH	M1	RAUJP
RAUJP	0	0.0047	0.0006	0.0001	0.0091	0.0287	0.9568
	1	0.0077	0.0043	0.0109	0.0112	0.0225	0.9433
	5	0.0594	0.0380	0.0310	0.0219	0.0411	0.8086
	10	0.0694	0.0666	0.0422	0.0360	0.0435	0.7423
	15	0.0704	0.0673	0.0449	0.0415	0.0431	0.7328
	20	0.0702	0.0682	0.0457	0.0430	0.0433	0.7296
	25	0.0703	0.0688	0.0456	0.0431	0.0433	0.7289

Variable Explained	Forecast Period	PRO	CPI	JAPIR	CASH	M1	NAUJP
NAUJP	0	0.0024	0.0029	0.0000	0.0060	0.0218	0.9669
	1	0.0066	0.0141	0.0066	0.0099	0.0169	0.9459
	5	0.0597	0.0425	0.0282	0.0319	0.0313	0.8065
	10	0.0715	0.0739	0.0365	0.0432	0.0349	0.7400
	15	0.0730	0.0744	0.0389	0.0486	0.0347	0.7304
	20	0.0729	0.0747	0.0397	0.0500	0.0350	0.7277
	25	0.0730	0.0752	0.0396	0.0501	0.0350	0.7271

Table 2: Variance Decomposition of the Australian – New Zealand Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	NZIR	CASH	M1	RAUNZ
RAUNZ	0	0.0008	0.0468	0.0163	0.0713	0.0068	0.8581
	1	0.0030	0.0479	0.0146	0.1431	0.0061	0.7854
	5	0.0351	0.1136	0.0482	0.1497	0.0149	0.6385
	10	0.0605	0.1119	0.0526	0.1509	0.0192	0.6048
	15	0.0614	0.1142	0.0569	0.1512	0.0218	0.5946
	20	0.0621	0.1148	0.0571	0.1510	0.0221	0.5927
	25	0.0624	0.1149	0.0571	0.1512	0.0222	0.5922

Variable Explained	Forecast Period	PRO	CPI	NZIR	CASH	M1	NAUNZ
NAUNZ	0	0.0003	0.0472	0.0117	0.0581	0.0060	0.8766
	1	0.0033	0.0503	0.0106	0.1188	0.0081	0.8089
	5	0.0421	0.1238	0.0406	0.1322	0.0157	0.6455
	10	0.0748	0.1188	0.0478	0.1325	0.0211	0.6050
	15	0.0746	0.1216	0.0515	0.1330	0.0249	0.5944
	20	0.0756	0.1223	0.0520	0.1327	0.0253	0.5921
	25	0.0760	0.1223	0.0521	0.1328	0.0253	0.5915

Table 3: Variance Decomposition of the Australian – UK Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	UKIR	CASH	M1	RAUUK
RAUUK	0	0.0022	0.0030	0.0046	0.0125	0.0013	0.9764
	1	0.0020	0.0240	0.0302	0.0212	0.0015	0.9211
	5	0.0206	0.0288	0.0470	0.0561	0.0601	0.7874
	10	0.0336	0.0344	0.0608	0.0627	0.0588	0.7497
	15	0.0361	0.0364	0.0615	0.0640	0.0586	0.7436
	20	0.0369	0.0371	0.0614	0.0646	0.0585	0.7415
	25	0.0369	0.0373	0.0613	0.0649	0.0585	0.7411

Variable Explained	Forecast Period	PRO	CPI	UKIR	CASH	M1	NAUUK
NAUUK	0	0.0019	0.0006	0.0048	0.0122	0.0000	0.9806
	1	0.0021	0.0331	0.0159	0.0197	0.0005	0.9287
	5	0.0251	0.0353	0.0332	0.0549	0.0594	0.7921
	10	0.0407	0.0408	0.0468	0.0624	0.0579	0.7513
	15	0.0437	0.0429	0.0478	0.0636	0.0579	0.7442
	20	0.0446	0.0437	0.0477	0.0642	0.0578	0.7420
	25	0.0446	0.0438	0.0477	0.0645	0.0578	0.7416

Table 4: Variance Decomposition of the Australian – US Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	USIR	CASH	M1	RAUUS
RAUUS	0	0.0075	0.0002	0.0002	0.0001	0.0000	0.9921
	1	0.0075	0.0077	0.0045	0.0260	0.0063	0.9480
	5	0.1188	0.0202	0.0194	0.0368	0.0387	0.7661
	10	0.1185	0.0789	0.0213	0.0431	0.0503	0.6879
	15	0.1189	0.0792	0.0249	0.0463	0.0502	0.6805
	20	0.1202	0.0793	0.0251	0.0468	0.0502	0.6785
	25	0.1202	0.0795	0.0251	0.0468	0.0502	0.6782

Variable Explained	Forecast Period	PRO	CPI	USIR	CASH	M1	NAUUS
NAUUS	0	0.0050	0.0179	0.0002	0.0000	0.0007	0.9762
	1	0.0056	0.0302	0.0024	0.0216	0.0078	0.9324
	5	0.1148	0.0339	0.0176	0.0380	0.0379	0.7579
	10	0.1153	0.0831	0.0214	0.0443	0.0468	0.6890
	15	0.1159	0.0836	0.0242	0.0462	0.0471	0.6830
	20	0.1167	0.0837	0.0243	0.0466	0.0470	0.6816
	25	0.1167	0.0838	0.0243	0.0467	0.0471	0.6814

Appendix 4.4: Orthogonalized Forecast Error Variance Decompositions of the Australian Dollar in Model 3 for a 25 Month Forecast Horizon

Table 7.1: Variance Decomposition of the Australian – Japanese Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	JAPIR	M1	AUSIR	RAUJP
RAUJP	0	0.0011	0.0033	0.0003	0.0142	0.0542	0.9269
	1	0.0041	0.0034	0.0030	0.0112	0.0643	0.9139
	5	0.0488	0.0559	0.0309	0.0332	0.0561	0.7751
	10	0.0623	0.0845	0.0458	0.0359	0.0583	0.7132
	15	0.0636	0.0876	0.0478	0.0362	0.0600	0.7049
	20	0.0633	0.0897	0.0480	0.0367	0.0607	0.7016
	25	0.0638	0.0904	0.0479	0.0367	0.0607	0.7004

Variable Explained	Forecast Period	PRO	CPI	JAPIR	M1	AUSIR	NAUJP
NAUJP	0	0.0002	0.0297	0.0000	0.0102	0.0492	0.9107
	1	0.0030	0.0284	0.0002	0.0080	0.0592	0.9011
	5	0.0494	0.0765	0.0284	0.0254	0.0545	0.7657
	10	0.0646	0.1037	0.0409	0.0287	0.0578	0.7043
	15	0.0662	0.1063	0.0431	0.0289	0.0585	0.6971
	20	0.0659	0.1075	0.0433	0.0294	0.0592	0.6948
	25	0.0662	0.1080	0.0433	0.0294	0.0592	0.6939

Table 2: Variance Decomposition of the Australian – New Zealand Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	NZIR	M1	AUSIR	RAUNZ
RAUNZ	0	0.0006	0.0657	0.0040	0.0070	0.0978	0.8249
	1	0.0009	0.0691	0.0041	0.0065	0.1455	0.7740
	5	0.0311	0.1462	0.0352	0.0103	0.1604	0.6168
	10	0.0535	0.1438	0.0404	0.0168	0.1653	0.5802
	15	0.0535	0.1475	0.0438	0.0194	0.1654	0.5705
	20	0.0537	0.1483	0.0441	0.0196	0.1654	0.5689
	25	0.0537	0.1485	0.0442	0.0196	0.1656	0.5684

Variable Explained	Forecast Period	PRO	CPI	NZIR	M1	AUSIR	NAUNZ
NAUNZ	0	0.0004	0.0721	0.0021	0.0052	0.0896	0.8306
	1	0.0009	0.0815	0.0025	0.0083	0.1335	0.7733
	5	0.0341	0.1632	0.0286	0.0112	0.1577	0.6051
	10	0.0645	0.1573	0.0352	0.0181	0.1655	0.5594
	15	0.0646	0.1600	0.0386	0.0214	0.1672	0.5481
	20	0.0646	0.1613	0.0391	0.0217	0.1671	0.5462
	25	0.0647	0.1615	0.0391	0.0218	0.1674	0.5455

Table 3: Variance Decomposition of the Australian – UK Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	UKIR	M1	AUSIR	RAUUK
RAUUK	0	0.0004	0.0001	0.0009	0.0006	0.0820	0.9158
	1	0.0007	0.0119	0.0276	0.0016	0.1061	0.8521
	5	0.0195	0.0169	0.0490	0.0734	0.1034	0.7377
	10	0.0387	0.0296	0.0577	0.0727	0.1022	0.6991
	15	0.0387	0.0320	0.0578	0.0725	0.1019	0.6971
	20	0.0386	0.0329	0.0578	0.0725	0.1019	0.6962
	25	0.0387	0.0330	0.0578	0.0725	0.1019	0.6961

Variable Explained	Forecast Period	PRO	CPI	UKIR	M1	AUSIR	NAUUK
NAUUK	0	0.0002	0.0106	0.0013	0.0031	0.0697	0.9151
	1	0.0010	0.0269	0.0141	0.0033	0.0917	0.8629
	5	0.0241	0.0278	0.0365	0.0772	0.0915	0.7429
	10	0.0451	0.0411	0.0457	0.0763	0.0904	0.7014
	15	0.0450	0.0436	0.0459	0.0763	0.0904	0.6988
	20	0.0450	0.0447	0.0458	0.0762	0.0904	0.6979
	25	0.0450	0.0447	0.0458	0.0762	0.0904	0.6978

Table 4: Variance Decomposition of the Australian – US Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	USIR	M1	AUSIR	RAUUS
RAUUS	0	0.0043	0.0049	0.0000	0.0002	0.0296	0.9609
	1	0.0040	0.0198	0.0060	0.0026	0.0383	0.9293
	5	0.1210	0.0346	0.0179	0.0320	0.0440	0.7505
	10	0.1187	0.1104	0.0193	0.0398	0.0454	0.6664
	15	0.1200	0.1115	0.0238	0.0396	0.0451	0.6600
	20	0.1210	0.1119	0.0240	0.0400	0.0452	0.6581
	25	0.1212	0.1120	0.0241	0.0400	0.0452	0.6576

Variable Explained	Forecast Period	PRO	CPI	USIR	M1	AUSIR	NAUUS
NAUUS	0	0.0022	0.0554	0.0000	0.0013	0.0291	0.9121
	1	0.0021	0.0685	0.0034	0.0052	0.0346	0.8862
	5	0.1188	0.0672	0.0152	0.0307	0.0356	0.7326
	10	0.1175	0.1317	0.0186	0.0380	0.0378	0.6564
	15	0.1174	0.1327	0.0226	0.0380	0.0377	0.6516
	20	0.1181	0.1331	0.0228	0.0383	0.0378	0.6500
	25	0.1183	0.1332	0.0228	0.0383	0.0378	0.6496

Appendix 4.5: Generalized Forecast Error Variance Decompositions of the New Zealand Dollar in Model 2 for a 25 Month Forecast Horizon

Table 1: Variance Decomposition of the New Zealand – Australian Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	AUSIR	BIDS	M1	RNZAU
RNZAU	0	0.0253	0.0925	0.0815	0.0277	0.0032	0.7697
	1	0.0224	0.1244	0.1482	0.0264	0.0096	0.6690
	5	0.1159	0.1182	0.1517	0.0280	0.0147	0.5716
	10	0.1411	0.1141	0.1482	0.0311	0.0240	0.5415
	15	0.1402	0.1146	0.1506	0.0338	0.0256	0.5352
	20	0.1406	0.1145	0.1505	0.0346	0.0259	0.5339
	25	0.1407	0.1145	0.1506	0.0347	0.0260	0.5336

Variable Explained	Forecast Period	PRO	CPI	AUSIR	BIDS	M1	NNZAU
NNZAU	0	0.0313	0.0515	0.0604	0.0448	0.0044	0.8075
	1	0.0281	0.0803	0.1224	0.0407	0.0112	0.7173
	5	0.1136	0.0895	0.1383	0.0378	0.0157	0.6051
	10	0.1256	0.0886	0.1432	0.0404	0.0254	0.5767
	15	0.1247	0.0896	0.1454	0.0435	0.0266	0.5702
	20	0.1252	0.0895	0.1454	0.0444	0.0268	0.5688
	25	0.1253	0.0895	0.1455	0.0445	0.0269	0.5683

Table 2: Variance Decomposition of the New Zealand – Japanese Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	JAPIR	BIDS	M1	RNZJP
RNZJP	0	0.0230	0.0677	0.0043	0.0062	0.0137	0.8851
	1	0.0318	0.0599	0.0070	0.0265	0.0118	0.8631
	5	0.0359	0.0680	0.0245	0.0642	0.0283	0.7792
	10	0.0655	0.0714	0.0301	0.0676	0.0283	0.7371
	15	0.0672	0.0722	0.0307	0.0686	0.0293	0.7320
	20	0.0671	0.0724	0.0316	0.0691	0.0298	0.7301
	25	0.0671	0.0724	0.0317	0.0692	0.0298	0.7297

Variable Explained	Forecast Period	PRO	CPI	JAPIR	BIDS	M1	NNZJP
NNZJP	0	0.0163	0.0194	0.0017	0.0079	0.0274	0.9274
	1	0.0251	0.0170	0.0040	0.0254	0.0239	0.9046
	5	0.0278	0.0284	0.0251	0.0582	0.0339	0.8267
	10	0.0494	0.0334	0.0272	0.0615	0.0354	0.7931
	15	0.0505	0.0345	0.0274	0.0623	0.0362	0.7891
	20	0.0505	0.0348	0.0283	0.0629	0.0366	0.7870
	25	0.0507	0.0349	0.0284	0.0629	0.0366	0.7865

Table 3: Variance Decomposition of the New Zealand – UK Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	UKIR	BIDS	M1	RNZUK
RNZUK	0	0.0023	0.1354	0.0108	0.0084	0.0014	0.8417
	1	0.0025	0.1210	0.0645	0.0098	0.0016	0.8005
	5	0.0085	0.1410	0.0750	0.0294	0.0064	0.7397
	10	0.0212	0.1403	0.0794	0.0351	0.0082	0.7159
	15	0.0241	0.1402	0.0797	0.0387	0.0083	0.7089
	20	0.0246	0.1406	0.0802	0.0391	0.0087	0.7069
	25	0.0246	0.1406	0.0803	0.0391	0.0088	0.7066

Variable Explained	Forecast Period	PRO	CPI	UKIR	BIDS	M1	NNZUK
NNZUK	0	0.0017	0.0709	0.0159	0.0083	0.0056	0.8976
	1	0.0015	0.0680	0.0604	0.0093	0.0052	0.8556
	5	0.0045	0.1090	0.0652	0.0335	0.0134	0.7745
	10	0.0126	0.1097	0.0674	0.0414	0.0162	0.7526
	15	0.0166	0.1111	0.0677	0.0441	0.0163	0.7443
	20	0.0172	0.1118	0.0683	0.0444	0.0167	0.7415
	25	0.0172	0.1119	0.0686	0.0445	0.0168	0.7411

Table 4: Variance Decomposition of the New Zealand – US Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	USIR	BIDS	M1	RNZUS
RNZUS	0	0.0753	0.1270	0.0003	0.0064	0.0083	0.7826
	1	0.0718	0.1272	0.0235	0.0086	0.0102	0.7587
	5	0.0902	0.1328	0.0282	0.0656	0.0320	0.6514
	10	0.1776	0.1218	0.0353	0.0713	0.0311	0.5629
	15	0.1746	0.1251	0.0361	0.0712	0.0357	0.5573
	20	0.1737	0.1270	0.0362	0.0708	0.0356	0.5566
	25	0.1736	0.1271	0.0361	0.0710	0.0357	0.5563

Variable Explained	Forecast Period	PRO	CPI	USIR	BIDS	M1	NNZUS
NNZUS	0	0.0716	0.0523	0.0015	0.0096	0.0128	0.8522
	1	0.0682	0.0505	0.0229	0.0166	0.0128	0.8290
	5	0.0784	0.0737	0.0360	0.0799	0.0474	0.6845
	10	0.1498	0.0723	0.0460	0.0813	0.0450	0.6057
	15	0.1477	0.0771	0.0462	0.0805	0.0485	0.6000
	20	0.1473	0.0792	0.0461	0.0802	0.0484	0.5989
	25	0.1473	0.0795	0.0460	0.0805	0.0485	0.5983

Appendix 4.6: Generalized Forecast Error Variance Decompositions of the New Zealand Dollar in Model 3 for a 25 Month Forecast Horizon

Table 1: Variance Decomposition of the New Zealand – Australian Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	AUSIR	M1	NZIR	RNZAU
RNZAU	0	0.0200	0.0990	0.0882	0.0079	0.0005	0.7844
	1	0.0167	0.1368	0.1700	0.0148	0.0055	0.6562
	5	0.1052	0.1324	0.1705	0.0198	0.0173	0.5548
	10	0.1279	0.1320	0.1671	0.0258	0.0243	0.5230
	15	0.1274	0.1308	0.1686	0.0268	0.0257	0.5207
	20	0.1276	0.1311	0.1687	0.0270	0.0260	0.5196
	25	0.1276	0.1312	0.1686	0.0270	0.0261	0.5195

Variable Explained	Forecast Period	PRO	CPI	AUSIR	M1	NZIR	NNZAU
NNZAU	0	0.0269	0.0556	0.0693	0.0087	0.0000	0.8395
	1	0.0224	0.0922	0.1494	0.0165	0.0059	0.7136
	5	0.1062	0.1046	0.1609	0.0210	0.0179	0.5893
	10	0.1159	0.1080	0.1638	0.0279	0.0258	0.5586
	15	0.1155	0.1076	0.1649	0.0286	0.0274	0.5560
	20	0.1159	0.1076	0.1651	0.0288	0.0277	0.5549
	25	0.1159	0.1078	0.1651	0.0288	0.0277	0.5547

Table 2: Variance Decomposition of the New Zealand – Japanese Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	JAPIR	M1	NZIR	RNZJP
RNZJP	0	0.0153	0.0821	0.0059	0.0106	0.0066	0.8794
	1	0.0278	0.0764	0.0103	0.0092	0.0087	0.8676
	5	0.0299	0.0774	0.0343	0.0242	0.0437	0.7905
	10	0.0519	0.0786	0.0409	0.0256	0.0429	0.7601
	15	0.0530	0.0784	0.0413	0.0267	0.0444	0.7561
	20	0.0531	0.0785	0.0419	0.0274	0.0444	0.7547
	25	0.0532	0.0785	0.0419	0.0274	0.0445	0.7545

Variable Explained	Forecast Period	PRO	CPI	JAPIR	M1	NZIR	NNZJP
NNZJP	0	0.0103	0.0278	0.0029	0.0237	0.0094	0.9258
	1	0.0228	0.0248	0.0061	0.0209	0.0146	0.9108
	5	0.0245	0.0305	0.0345	0.0299	0.0498	0.8308
	10	0.0394	0.0343	0.0365	0.0328	0.0496	0.8075
	15	0.0401	0.0348	0.0364	0.0335	0.0514	0.8038
	20	0.0402	0.0352	0.0372	0.0341	0.0513	0.8020
	25	0.0403	0.0352	0.0372	0.0342	0.0514	0.8016

Table 3: Variance Decomposition of the New Zealand – UK Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	UKIR	M1	NZIR	RNZUK
RNZUK	0	0.0001	0.1183	0.0198	0.0041	0.0163	0.8415
	1	0.0001	0.1056	0.0687	0.0070	0.0149	0.8038
	5	0.0059	0.1272	0.0732	0.0132	0.0204	0.7601
	10	0.0168	0.1279	0.0768	0.0142	0.0205	0.7439
	15	0.0174	0.1275	0.0778	0.0142	0.0221	0.7409
	20	0.0175	0.1278	0.0778	0.0143	0.0223	0.7402
	25	0.0176	0.1279	0.0778	0.0143	0.0223	0.7400

Variable Explained	Forecast Period	PRO	CPI	UKIR	M1	NZIR	NNZUK
NNZUK	0	0.0000	0.0626	0.0248	0.0119	0.0224	0.8783
	1	0.0002	0.0609	0.0625	0.0134	0.0203	0.8426
	5	0.0032	0.1021	0.0617	0.0256	0.0240	0.7835
	10	0.0078	0.1035	0.0635	0.0270	0.0252	0.7729
	15	0.0083	0.1038	0.0641	0.0270	0.0265	0.7704
	20	0.0085	0.1043	0.0641	0.0270	0.0267	0.7694
	25	0.0085	0.1043	0.0641	0.0270	0.0267	0.7693

Table 4: Variance Decomposition of the New Zealand – US Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	USIR	M1	NZIR	RNZUS
RNZUS	0	0.0673	0.1254	0.0019	0.0046	0.0039	0.7968
	1	0.0629	0.1286	0.0165	0.0067	0.0049	0.7805
	5	0.0833	0.1358	0.0306	0.0341	0.0500	0.6663
	10	0.1647	0.1248	0.0343	0.0317	0.0631	0.5815
	15	0.1628	0.1264	0.0344	0.0346	0.0652	0.5765
	20	0.1621	0.1284	0.0344	0.0348	0.0651	0.5751
	25	0.1619	0.1289	0.0345	0.0349	0.0653	0.5747

Variable Explained	Forecast Period	PRO	CPI	USIR	M1	NZIR	NNZUS
NNZUS	0	0.0654	0.0532	0.0027	0.0090	0.0035	0.8662
	1	0.0617	0.0529	0.0186	0.0093	0.0045	0.8529
	5	0.0738	0.0764	0.0425	0.0528	0.0600	0.6946
	10	0.1403	0.0731	0.0466	0.0494	0.0674	0.6231
	15	0.1387	0.0764	0.0462	0.0513	0.0688	0.6186
	20	0.1383	0.0784	0.0461	0.0515	0.0690	0.6167
	25	0.1383	0.0789	0.0461	0.0516	0.0691	0.6161

Appendix 4.7: Generalized Forecast Error Variance Decompositions of the Australian Dollar in Model 2 for a 25 Month Forecast Horizon

Table 1: Variance Decomposition of the Australian – Japanese Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	JAPIR	CASH	M1	RAUJP
RAUJP	0	0.0045	0.0009	0.0002	0.0079	0.0289	0.9575
	1	0.0075	0.0038	0.0122	0.0079	0.0227	0.9459
	5	0.0578	0.0428	0.0361	0.0143	0.0445	0.8044
	10	0.0681	0.0675	0.0436	0.0245	0.0487	0.7476
	15	0.0692	0.0680	0.0458	0.0296	0.0486	0.7387
	20	0.0690	0.0690	0.0469	0.0307	0.0489	0.7355
	25	0.0691	0.0696	0.0468	0.0308	0.0489	0.7348
Variable Explained	Forecast Period	PRO	CPI	JAPIR	CASH	M1	NAUJP
NAUJP	0	0.0023	0.0024	0.0000	0.0063	0.0235	0.9656
	1	0.0064	0.0119	0.0085	0.0082	0.0188	0.9462
	5	0.0578	0.0454	0.0339	0.0220	0.0361	0.8047
	10	0.0695	0.0722	0.0384	0.0304	0.0416	0.7479
	15	0.0710	0.0726	0.0402	0.0357	0.0415	0.7389
	20	0.0710	0.0731	0.0412	0.0365	0.0419	0.7364
	25	0.0710	0.0736	0.0411	0.0367	0.0419	0.7357

Table 2: Variance Decomposition of the Australian – New Zealand Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	NZIR	CASH	M1	RAUNZ
RAUNZ	0	0.0007	0.0398	0.0248	0.0818	0.0026	0.8504
	1	0.0025	0.0399	0.0223	0.1421	0.0024	0.7909
	5	0.0295	0.0953	0.0558	0.1454	0.0093	0.6648
	10	0.0512	0.0947	0.0597	0.1450	0.0148	0.6346
	15	0.0519	0.0965	0.0629	0.1460	0.0176	0.6251
	20	0.0525	0.0970	0.0632	0.1459	0.0180	0.6234
	25	0.0528	0.0971	0.0632	0.1460	0.0180	0.6229
Variable Explained	Forecast Period	PRO	CPI	NZIR	CASH	M1	NAUNZ
NAUNZ	0	0.0003	0.0410	0.0203	0.0677	0.0022	0.8686
	1	0.0028	0.0429	0.0189	0.1213	0.0041	0.8099
	5	0.0360	0.1062	0.0528	0.1298	0.0101	0.6650
	10	0.0646	0.1030	0.0593	0.1283	0.0162	0.6286
	15	0.0643	0.1051	0.0625	0.1297	0.0202	0.6183
	20	0.0652	0.1057	0.0629	0.1295	0.0205	0.6161
	25	0.0655	0.1057	0.0630	0.1296	0.0206	0.6156

Table 3: Variance Decomposition of the Australian – UK Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	UKIR	CASH	M1	RAUUK
RAUUK	0	0.0021	0.0033	0.0042	0.0099	0.0008	0.9797
	1	0.0019	0.0236	0.0321	0.0195	0.0008	0.9221
	5	0.0205	0.0299	0.0491	0.0493	0.0571	0.7942
	10	0.0334	0.0347	0.0623	0.0568	0.0559	0.7570
	15	0.0359	0.0364	0.0626	0.0581	0.0560	0.7510
	20	0.0367	0.0370	0.0625	0.0588	0.0560	0.7490
	25	0.0367	0.0372	0.0625	0.0591	0.0560	0.7485

Variable Explained	Forecast Period	PRO	CPI	UKIR	CASH	M1	NAUUK
NAUUK	0	0.0018	0.0005	0.0051	0.0112	0.0000	0.9814
	1	0.0020	0.0323	0.0181	0.0206	0.0003	0.9267
	5	0.0248	0.0360	0.0358	0.0510	0.0575	0.7949
	10	0.0403	0.0407	0.0490	0.0593	0.0559	0.7548
	15	0.0432	0.0424	0.0496	0.0605	0.0563	0.7479
	20	0.0441	0.0431	0.0495	0.0611	0.0563	0.7458
	25	0.0442	0.0433	0.0495	0.0614	0.0563	0.7453

Table 4: Variance Decomposition of the Australian – US Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	USIR	CASH	M1	RAUUS
RAUUS	0	0.0074	0.0004	0.0004	0.0000	0.0001	0.9917
	1	0.0075	0.0074	0.0039	0.0233	0.0057	0.9522
	5	0.1201	0.0260	0.0220	0.0398	0.0248	0.7673
	10	0.1193	0.0830	0.0254	0.0522	0.0342	0.6859
	15	0.1195	0.0830	0.0289	0.0563	0.0344	0.6779
	20	0.1208	0.0831	0.0290	0.0567	0.0345	0.6758
	25	0.1208	0.0832	0.0291	0.0568	0.0345	0.6755

Variable Explained	Forecast Period	PRO	CPI	USIR	CASH	M1	NAUUS
NAUUS	0	0.0049	0.0161	0.0006	0.0005	0.0001	0.9778
	1	0.0054	0.0275	0.0020	0.0216	0.0071	0.9363
	5	0.1132	0.0374	0.0195	0.0439	0.0238	0.7623
	10	0.1131	0.0840	0.0246	0.0564	0.0307	0.6912
	15	0.1137	0.0842	0.0271	0.0588	0.0311	0.6851
	20	0.1145	0.0843	0.0272	0.0592	0.0312	0.6837
	25	0.1145	0.0844	0.0272	0.0593	0.0312	0.6834

Appendix 4.8: Generalized Forecast Error Variance Decompositions of the Australian Dollar in Model 3 for a 25 Month Forecast Horizon

Table 1: Variance Decomposition of the Australian – Japanese Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	JAPIR	M1	AUSIR	RAUJP
RAUJP	0	0.0011	0.0028	0.0000	0.0136	0.0455	0.9370
	1	0.0039	0.0027	0.0031	0.0106	0.0513	0.9285
	5	0.0458	0.0578	0.0383	0.0326	0.0486	0.7770
	10	0.0589	0.0810	0.0464	0.0352	0.0528	0.7257
	15	0.0603	0.0840	0.0478	0.0357	0.0534	0.7188
	20	0.0600	0.0860	0.0484	0.0363	0.0543	0.7151
	25	0.0605	0.0868	0.0485	0.0362	0.0544	0.7137

Variable Explained	Forecast Period	PRO	CPI	JAPIR	M1	AUSIR	NAUJP
NAUJP	0	0.0002	0.0266	0.0011	0.0096	0.0496	0.9130
	1	0.0027	0.0249	0.0015	0.0076	0.0565	0.9067
	5	0.0448	0.0743	0.0370	0.0257	0.0548	0.7634
	10	0.0588	0.0954	0.0431	0.0287	0.0598	0.7142
	15	0.0604	0.0980	0.0443	0.0290	0.0598	0.7085
	20	0.0602	0.0990	0.0447	0.0295	0.0604	0.7062
	25	0.0605	0.0996	0.0448	0.0295	0.0605	0.7052

Table 2: Variance Decomposition of the Australian – New Zealand Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	NZIR	M1	AUSIR	RAUNZ
RAUNZ	0	0.0005	0.0553	0.0015	0.0037	0.0983	0.8408
	1	0.0007	0.0569	0.0014	0.0037	0.1358	0.8014
	5	0.0261	0.1233	0.0279	0.0056	0.1422	0.6749
	10	0.0452	0.1220	0.0326	0.0121	0.1444	0.6438
	15	0.0452	0.1252	0.0360	0.0146	0.1438	0.6353
	20	0.0454	0.1259	0.0363	0.0148	0.1436	0.6340
	25	0.0454	0.1261	0.0363	0.0149	0.1437	0.6336

Variable Explained	Forecast Period	PRO	CPI	NZIR	M1	AUSIR	NAUNZ
NAUNZ	0	0.0003	0.0609	0.0004	0.0025	0.0930	0.8429
	1	0.0007	0.0673	0.0005	0.0060	0.1285	0.7970
	5	0.0288	0.1383	0.0214	0.0070	0.1410	0.6635
	10	0.0549	0.1346	0.0274	0.0134	0.1452	0.6245
	15	0.0551	0.1371	0.0309	0.0167	0.1454	0.6149
	20	0.0551	0.1382	0.0313	0.0169	0.1451	0.6133
	25	0.0552	0.1384	0.0313	0.0170	0.1453	0.6127

Table 3: Variance Decomposition of the Australian – UK Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	UKIR	M1	AUSIR	RAUUK
RAUUK	0	0.0004	0.0001	0.0009	0.0005	0.0679	0.9302
	1	0.0006	0.0111	0.0253	0.0019	0.0870	0.8741
	5	0.0185	0.0172	0.0472	0.0744	0.0803	0.7624
	10	0.0368	0.0283	0.0563	0.0731	0.0797	0.7257
	15	0.0368	0.0305	0.0564	0.0730	0.0797	0.7236
	20	0.0368	0.0314	0.0564	0.0731	0.0797	0.7227
	25	0.0368	0.0315	0.0564	0.0730	0.0797	0.7226

Variable Explained	Forecast Period	PRO	CPI	UKIR	M1	AUSIR	NAUUK
NAUUK	0	0.0002	0.0096	0.0012	0.0029	0.0658	0.9203
	1	0.0009	0.0246	0.0125	0.0034	0.0854	0.8732
	5	0.0224	0.0270	0.0349	0.0775	0.0788	0.7594
	10	0.0423	0.0385	0.0444	0.0763	0.0774	0.7211
	15	0.0422	0.0410	0.0446	0.0763	0.0776	0.7184
	20	0.0422	0.0419	0.0446	0.0763	0.0776	0.7175
	25	0.0422	0.0420	0.0446	0.0763	0.0776	0.7174

Table 4: Variance Decomposition of the Australian – US Exchange Rate

Variable Explained	Forecast Period	PRO	CPI	USIR	M1	AUSIR	RAUUS
RAUUS	0	0.0042	0.0038	0.0000	0.0000	0.0252	0.9668
	1	0.0038	0.0178	0.0049	0.0021	0.0313	0.9401
	5	0.1195	0.0435	0.0190	0.0188	0.0372	0.7620
	10	0.1172	0.1144	0.0219	0.0257	0.0437	0.6770
	15	0.1185	0.1154	0.0265	0.0258	0.0434	0.6704
	20	0.1195	0.1157	0.0266	0.0262	0.0435	0.6686
	25	0.1197	0.1158	0.0267	0.0263	0.0435	0.6681

Variable Explained	Forecast Period	PRO	CPI	USIR	M1	AUSIR	NAUUS
NAUUS	0	0.0020	0.0479	0.0001	0.0005	0.0336	0.9160
	1	0.0019	0.0592	0.0025	0.0042	0.0365	0.8957
	5	0.1113	0.0698	0.0154	0.0179	0.0340	0.7516
	10	0.1102	0.1275	0.0201	0.0235	0.0428	0.6759
	15	0.1102	0.1284	0.0238	0.0238	0.0425	0.6713
	20	0.1108	0.1287	0.0240	0.0241	0.0426	0.6698
	25	0.1110	0.1288	0.0241	0.0242	0.0426	0.6694