The Implementation of Monetary Policy in New Zealand: What Factors Affect the 90-Day Bank Bill Rate?

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Abstract: This paper discusses the implementation of monetary policy in New Zealand and its flow-on effects on the 90-day bank bill rate over the 1999-2005 period. Our findings indicate that the maturity spectrum ratio exerted a positive effect on the mean of the 90-day bank bill rate while the allotment ratio did not. The allotment ratio though affected the volatility of the most important short-term interest rate in New Zealand. Moreover, the New Zealand 90-day bank bill rate had a tendency to revert to the level set by its Australian counterpart, though at a relatively slow speed. No such link exists between the NZ 90-day rate and the US 90-day rate.

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We wish to thank Nick Smith for his insightful comments.

At present the majority of central banks in the industrialized world implement monetary policy by setting a short-term nominal interest rate. The interest rate in question is often the overnight cash rate. To steer the overnight cash rate, a central bank typically relies on both standing facilities and open-market operations. Standing facilities can be thought of as an automatic conduit through which liquidity enters or leaves the financial sector of the economy. Trading banks that need additional cash balances to cover their position can access the standing facility at a rate slightly higher than the cash rate. Alternatively, trading banks that have surplus cash balances can park them overnight at a rate slightly below the cash rate. Standing facilities are not a new concept per se. They were widely used during the days of the operation of the gold standard. However, in those days the standing facilities were one-sided in the sense that the central bank would only provide liquid funds to trading banks in exchange for discountable securities.[1] There were no arrangements whereby trading banks could deposit surplus reserves. In this set-up the discount rate played a key role in the implementation of monetary policy as it served as the benchmark for short-term interest rates in the financial market.

Through discretionary open-market operations the central bank manages the liquidity of the financial sector of the economy. A central bank structures its open-market operations in such a way so as to keep the overnight cash rate at the target level. Open-market operations are central to the implementation of monetary policy in the Euro area, the United States, Australia, New Zealand and many other countries. However, the frequency of use (daily versus weekly operations) and modes of operation (outright purchases and sales of securities vs repurchase agreements, fixed versus variable rate tenders) differ markedly amongst central banks. For instance, the Federal Reserve Board has a habit of purchasing securities outright while the European Central Bank prefers to engage mainly in weekly reverse repurchase agreements to provide additional liquidity. Interestingly, the European Central Bank switched from fixed to variable rate tender auctions in June 2000 to relieve the overbidding problem.[2]

[1] Indeed to this day, the standing facility operated by the Federal Reserve System in the United States is one-sided. Trading banks can borrow reserves from the Fed but cannot deposit surplus funds and earn interest on them.

[2] For a study of the overbidding problem encountered by the European Central Bank, see Nautz and Oechssler (2003). Ayuso and Repullo (2003) argue that the extreme overbidding phenomenon associated with fixed rate tenders is consistent with an asymmetric loss function that punishes low interbank rates more severely than high interbank rates.

This paper studies the day-to-day implementation of monetary policy in New Zealand over the March 1999- June 2005 period. Of central concern is how the daily conduct of monetary policy affected the behaviour of the 90-day bank bill rate. Our empirical study aims to verify to what extent the structure of open-market operations affected the mean and volatility of this market-determined interest rate over the sample period. Essentially, our aim is to determine whether the methods used by the Reserve Bank of New Zealand to provide adequate liquidity to the financial sector of the New Zealand economy had any bearing on the behaviour of the 90-day bank bill rate. We also examine whether short-term interest rates in foreign capital markets had any measurable impact on the 90-day bank bill rate in New Zealand. Towards this end, we study the behaviour of comparable short-term interest rates in Australia, an important regional financial market, and the United States, the world's largest financial market. The point of departure of our analysis is, however, a fairly detailed examination of changes in the stance of monetary policy in New Zealand, Australia, and the United States over the sample period. The reason for scrutinizing the timing of changes in monetary policy is to establish whether there is a systematic leader-follower pattern in the conduct of monetary policy that is also evident in the market-determined short term interest rates. Did the Reserve Bank of New Zealand change the overnight cash rate because the central bank of the United States and/or Australia had done so or did the Reserve Bank of New Zealand chart its own *independent* course in the conduct of monetary policy? For each of the three countries, we also make an attempt to measure the impact effect of changes in the stance of monetary policy on the respective 90-day rate. Moreover, we examine to what extent market-determined short term interest rates in the three countries anticipated changes in the policy instrument.

Our most important results can be summarized briefly here. In New Zealand the 90-day bank bill rate moved in anticipation of changes in the stance of monetary policy. At the same time, the *impact* effect of a change in the overnight cash rate on the 90-day bank bill rate was very pronounced and much stronger in New Zealand than in Australia or the United States. Regarding the hypothesised link between the structure of open-market operations and behaviour of the 90-day bank bill rate in New Zealand, we find that the maturity structure of open-market operations affected the mean and to a lesser extent the variance of the 90-day bank bill rate. The level of the 90-day bank bill rate in New Zealand also appeared to adjust to the level of the 90-day

bank bill rate in Australia, albeit at a slow speed. There is no evidence that 90-day rates in New Zealand responded to 90-day rates in the United States over the whole sample period. More generally, our findings suggest that short-term interest rates in Oceania moved independently of those in the United States for much of the sample period. This conclusion emerges after reviewing the timing of changes in the policy instrument in the three countries. Only at the beginning of the sample period was there a limited degree of policy coordination when the US monetary authorities took the lead in changing the stance of monetary policy and both Reserve Banks followed suit. By 2001 this leader-follower pattern had disappeared.

The remainder of the paper is organised as follows. Section II offers a brief analysis of monetary policy changes in New Zealand, Australia, and the United States. Section III provides an overview of the implementation of monetary policy in New Zealand. Section IV presents the empirical findings of our study of the effects of open-market operations and foreign interest rate linkages on the behaviour of the 90-day bank bill rate in New Zealand. Section V offers a brief summary and conclusion.

II. A Short Descriptive Analysis of Monetary Policy Changes in New Zealand, Australia, and the United States

Our primary focus in this section is on the monetary policy changes that occurred in New Zealand, Australia, and the United States over the period from March 17th, 1999 to June 30th, 2005. The beginning of the sample period coincides with the switch by the Reserve Bank of New Zealand from targeting cash settlement balances to targeting the overnight cash rate. Table 1 lists the dates of the policy changes, the new target, the size of the target change as well as additional information that characterizes the conduct of monetary policy in the three countries. The ancillary information consists of the day of the week the policy change was announced, the duration of the announced policy change in trading and calendar days, respectively, and the flow-on effect on short-term market interest rates. The last two columns give an indication of the same-day effect of the change in the official overnight cash rate in New Zealand and Australia and the federal funds rate in the United States on key short-term market interest rates. In New Zealand and Australia the 90-day bank bill rate is arguably the most important short-term market interest rate. For the United States, we chose the 90-day commercial paper rate. The three interest rates represent

the yields on short-term debt instruments issued by banks and corporate entities to secure financial capital.

The information arrayed in Table 2 proves helpful in interpreting the statistics contained in Table 1. Over the sample period the stance of monetary policy was changed most often in the United States. The Federal Open Market Committee saw fit to change the target for the federal funds rate on 28 occasions. There were 24 changes in the official cash rate in New Zealand. Australia had the fewest policy changes with 16. The Reserve Bank of New Zealand increased the target for the overnight cash rate 16 times and lowered it eight times. The Reserve Bank of Australia tightened the stance of monetary policy ten times and eased on six occasions. The Federal Open Market Committee raised the federal funds rate 15 times and lowered it 13 times. Most of the policy changes in the three countries occurred in steps of 25 basis points. Still, the Federal Open Market Committee lowered the federal funds rate by 50 basis points on nine occasions. Indeed the majority of these downward adjustments occurred *prior* to the terrorist attack on September 11th, 2001. Further scrutiny of the policy changes in the United States reveals that the Federal Open Market Committee eased the stance of monetary policy more aggressively in steps of 50 basis points rather than 25 basis points (9 as opposed to 4) but preferred to tighten the stance of policy in steps of 25 basis points rather than 50 basis points (14 as opposed to 1). No such pattern is evident in the behaviour of either the Reserve Bank of New Zealand or the Reserve Bank of Australia. Both central banks showed far less willingness to ease the stance of monetary policy in steps of 50 basis points, relying instead more often on 25 basis point decreases. Notice though that the Reserve Bank of New Zealand raised the overnight cash rate by 50 basis points on three occasions while the central banks of Australia and the United States did so only once, respectively.

Turning our attention to the coordination of policy moves between New Zealand on the one hand and Australia and the United States on the other, we find that monetary policy changes in New Zealand *followed* monetary policy changes in the United States pretty closely from November 1999 to mid-November 2001. Of the ten policy changes that occurred in New Zealand during this period, all of them were in the same direction as interest changes in the US; five policy changes in New Zealand occurred within 24 hours of the announcement of policy changes in the United

States.[3] The Reserve Bank of Australia also followed the US lead in changing interest rates over the November 1999 to December 2001 period. A series of interest hikes had raised the overnight cash rate from 5 to 6.25 percent by August 2000, only to be followed by a series of decreases. The synchronous policy moves underscore the fact that in the early part of the sample period, the economies of New Zealand, Australia, and the United States were in the same phase of the business cycle.

The leader-follower pattern evident in the behaviour of the three central banks disappears at the end of 2001. Nor is there much evidence for a close coordination of monetary policies between the Reserve Bank of New Zealand and the Reserve Bank of Australia since then. It is true that in May and June 2002 the Australian central bank tightened the stance of monetary policy and that the Reserve Bank of New Zealand followed suit. But the cycle of monetary policy tightenings had begun in New Zealand as early as March 20th, 2002, thus preceding the move by the Australian central bank by approximately 50 days. The seeming coordinated policy move in March 2005 between the two central banks came on the heels of a series of tightenings in New Zealand in 2004.

It is instructive to examine the range of settings of the policy instrument in the three countries. According to Table 2, the overnight cash rate in Australia had the narrowest range, varying from a low of 4.25 percent to a high of 6.25 percent. The range was slightly wider in New Zealand where the lowest and highest settings coincide with the instrument settings observed at the beginning and end of the sample period. The United States experienced the widest swings in the policy instrument due to the continued decreases in the federal funds rage target which began in January 2001 and ended in June 2004 when the federal funds rate target was raised from 1 to 1.25 percent. Notice that in the United States the target for the federal funds rate at the beginning of the sample period (4.75 percent) exceeded the target at the end of the sample period (3.25 percent). Just the opposite holds for the target for the overnight cash rate in Australia and in New Zealand. In both countries, the target rate at the end of the sample period exceeded the target at the beginning, with the difference amounting to 2.25 percent in New Zealand but only 0.75 percent in Australia.

[3] Because of the 18 hour time difference between New Zealand and the Eastern Time Zone of the United States, the move to adjust interest rates in New Zealand on September 19th, 2001 in the wake of the easing of monetary policy in the US on September 17th falls roughly into the 24 hour window. The dates of the closely coordinated policy changes were: Nov. 17th, 1999, May 15th, 2000, April 19th, 2001, and May 16th, 2001.

Comparing the average length of duration, we find that the average duration in calendar days of a given policy stance was about 3 months for New Zealand and the United States. For Australia the average length was considerably higher. There the policy setting was left unchanged on average for almost 5 months.

The last two columns of Table 1 capture the effect of changes in the overnight interest rate on the 90-day bank bill or commercial paper rate.[4] Our conjecture is that the size and sign of this effect depend on the extent to which the conduct of monetary policy is transparent. If a high degree of transparency characterizes the conduct of monetary policy, then the impact effect of a change in monetary policy on the short-term market interest rate ought to be negligibly small. The absence of a flow-on effect is due to the fact that financial market participants have already factored in the change in the policy setting before the announced change actually occurs. That is, market short-term interest rates adjust in the same direction as the anticipated change in the setting of the policy instrument quite a few days before the announcement is made. There are, however, occasions when *announced changes* in monetary policy take financial market participants by surprise. In such situations market short-term interest rates react sensitively to and in the same direction as the announced policy change.[5] If this is the norm, then the conduct of monetary policy lacks transparency.

Inspection of the final two columns of Table 1 reveals that the same day response of market interest rates to changes in the policy setting varied considerably in the three countries. There were occasions when the market appeared to be surprised by the announced change as indicated by the sizeable adjustments in the 90-day rates. For instance, in New Zealand, on two occasions a 25 basis point decrease in the overnight cash rate prompted an almost one-for-one decrease in the 90-day bank bill rate of 23 and 24 basis points, respectively. In Australia in February 2001 a 50 basis point decrease in the cash rate led to a decrease in the 90-day bank bill rate of 31 basis points while a 25 basis points increase in the cash rate in November 2003 prompted a 16 basis point increase in the bank bill rate. The commercial paper rate in the US reacted less sensitively to changes in the federal funds rate target. The most pronounced drop in the commercial paper rate (21 basis points) occurred in response

[4] Monetary policy changes are announced in the morning, usually around the time when financial markets open for the day.

[5] There are also occasions when the central bank surprises market participants by *not* changing the overnight interest rate or signaling that no policy changes are to be expected in the imminent future even though a change in monetary policy had been expected by the market.

to a 50 basis point decrease in the federal funds rate target in November 2002. The final column of Table 1 examines whether changes in the setting of the policy instrument were accompanied by changes in short-term market interest rate in the same direction. In New Zealand, one quarter of policy tightenings or easings (six of 24 policy changes) were not accompanied by a matching response in the 90-day bank bill rate. For the United States the results are similar. Six of 28 policy changes prompted movements in the commercial paper rate in the opposite direction.[6] Of the 16 policy changes that occurred in Australia, only nine were accompanied by movements in the 90-day bank bill in the same direction.

The summary information that appears below the shaded part of Table 2 sheds further light on the relationship between changes in the instrument setting and the same-day response of market interest rates. Taking account only of absolute changes in market interest rates, we find that market interest rates responded most to policy changes in New Zealand. Looking at monetary easings and tightenings in isolation, we find that monetary easings prompted relatively larger changes (≥ 20 basis points) in market interest rates than monetary tightenings in New Zealand. For the United States, we find that monetary tightenings prompted a fairly weak response or no response at all from the same-day 90-day paper rate. On four occasions there was no response at all to the monetary tightening and on ten occasions the matching increase in the 90-day paper rate was less than five basis points. In contrast, the effect of monetary easings on the same-day 90-day paper rate appeared to have been more pronounced.

Assessing the same-day effect on 90-day rates is just part of the story of how changes in the stance of monetary policy affect market interest rates. Financial markets are inherently forward-looking. If the stance of monetary policy is expected to change, then market interest rates ought to reflect the impending change of policy. It is therefore necessary to look at the correlation between changes in the 90-day rates and changes in the instrument of monetary policy. We consider 12 leads and lags of the change in the 90-day bill (paper) rate relative to the change in the policy instrument. Figures 1-3 depict the patterns of correlation for the three countries. The correlations measure the extent of co-movement of a change in the policy instrument

[6] If no change in the commercial paper rate occurred on the day of the announced policy change in the United States, we assigned a "+" nevertheless as we want to single out the policy changes that led to movements in the 90 day commercial paper rate in the *opposite* direction. The same rationale applies to our examination of the Australian data.

at time zero with the observed changes in the 90-day rate up to 12 days before (- 1 to -12 along the horizontal axis) and 12 days following (1 to 12 along the horizontal axis) the change in policy.

There are two noteworthy features about the correlation pattern for New Zealand.[7] First, as shown in Figure 1, the contemporaneous correlation between changes in the policy instrument and changes in the 90-day bill rate is observed to be around *0.3*. Second, changes in the 90-day bank bill rate on days preceding the change in policy [-4,- 5, -7, and -11] and changes in the policy instrument are positively correlated, thus indicative of some anticipatory movement in the 90-day bill rates prior to the actual policy change. The respective correlation coefficients are *0.052, 0.108, 0.08,* and *0.076* and are statistically significant at the 5 percent level. For Australia, the picture is somewhat different. According to Figure 2, the contemporaneous correlation between changes in the 90-day bill rate and changes in the overnight cash rate is *0.107,* and thus roughly about a third of what it is in New Zealand. In addition, the correlation between changes in the 90-day bill rate before and after the announced monetary action with the change in the policy instrument is far less pronounced than in New Zealand. For the United States both lags and leads of changes in the 90-day paper rate share a positive relationship with changes in the policy instrument. Notice that both $Corr(\Delta i^{90}_{t+4,}\Delta i^{policy}_{t})=0.153$ and $Corr(\Delta i^{90}_{t-7,}\Delta i^{policy}_{t})=0.183$ are substantially higher than the contemporaneous correlation which hovers around *0.1,* giving rise to the twin peaks that appear in Figure 3.

Taken altogether, our findings suggest that the 90-day bank bill rate in New Zealand reacted more sensitively to announced policy changes than the 90-day bill rate in Australia. Over the March 1999-June 2005 period, the contemporaneous correlation between changes in the setting of the policy instrument and daily market interest rates was considerably higher in New Zealand than in Australia. In addition, the New Zealand 90-day bank bill rate moved in anticipation of policy changes to a much greater extent than its Australian counterpart. Both leads and lags of changes in the 90-day commercial paper rate in the United States were systematically related to changes in the target of the federal funds rate. The same day response of the market

[7] The correlations appear in Table A1 in the appendix.

interest rate to changes in the setting of the policy instrument in the United States was rather muted though in direct comparison to the response observed in New Zealand.

Having considered changes in monetary policy and the resulting flow-on effects on market-determined short-term interest rates in each country over the sample period, we can now go on and consider the extent to which the two interest rates in New Zealand followed the same path as interest rates in Australia and the United States. Figure 4 and 5, respectively, shows the difference between the market-determined 90-day rates and the setting of the policy instruments in New Zealand relative to Australia and the United States.

Figure 4 highlights the difference in both the setting of the policy instrument and the 90-day rate in New Zealand vis-à-vis interest rates in the United States. At the beginning of the sample period, both interest rates were lower in New Zealand than in the US; from mid-February 2000 to early January 2001 the overnight cash rate and the federal funds rate were equal, reflecting the leader-follower pattern in the conduct of monetary policy described above. Nevertheless, the NZ 90-day bank bill rate was always above the US 90-day commercial paper rate.[8] The systematic widening difference between New Zealand and US interest rates that became apparent in 2001 and continued thereafter was due to two factors. First, the US monetary authorities lowered the federal funds rate faster and more aggressively than the Reserve Bank of New Zealand. Second, in March 2002 the Reserve Bank of New Zealand began to tighten the stance of monetary policy while the Federal Open Market Committee in the United States continued to ease. The difference between the NZ 90-day bank bill rate and the US 90-day commercial paper rate hit its peak on May 25, 2004 when it reached 479 basis points. After that a steady decline set in. Lying slightly below the 400 basis points mark, the difference was still pronounced though at the end of the sample period.

The comparison of interest rates in New Zealand with those in Australia yields less dramatic results. Initially, the setting of the policy instrument in New Zealand lay slightly below the setting in Australia, giving rise to a slight, negative 90-day bank bill rate differential. This is very much in line with what is observed for the NZ-US interest rate differential although the NZ-AUS interest rate difference is not as stark. Beginning in early February 2000, the 90-day interest rate differential turned positive

[8] This may be indicative of the risk premium on private debt being higher in New Zealand than in the United States.

and remained positive until March 2004 as the Reserve Bank of New Zealand began to raise the overnight case rate. From June 2002 to November 2003 there were no changes in the setting of the overnight cash rate in Australia. In sharp contrast, in New Zealand the overnight cash rate was lowered on three occasions in steps of 25 basis points. From late January 2004 to late April 2004 the overnight cash rate was the same in both countries. During this short interval, the difference between the New Zealand and Australian 90-day bank bill rates began to turn negative and remained so for a short while. 2004 saw six increases of 25 basis points each in the overnight cash rate in New Zealand while none occurred in Australia. As a consequence of the multiple increases in the overnight cash rate in New Zealand, the 90-day interest rate differential became positive again. Notice though that this interest rate differential never exceeded 150 basis points during the entire sample period.

III. The Implementation of Monetary Policy in New Zealand

Since March 17th, 1999 the Reserve Bank of New Zealand has been relying on an operating procedure that has the official cash rate as its fulcrum.[9] The Reserve Bank sets a target for the overnight cash rate. The current operating procedure rests on two pillars. The first pillar is the provision of a standing facility whereby the Reserve Bank stands ready to accept surplus cash settlement balances from and lend additional cash settlement balances to registered financial institutions at interest rates that lie 25 basis points below and 25 basis points above the official cash rate, respectively. The second pillar is the daily interaction with the financial market through open-market operations. The intended aim of this operating procedure is twofold: first, to ensure that the overnight market interest rate at which banks borrow from and lend to each other remains within this corridor of ± 25 basis points around the official cash rate. Second, the cash rate target serves as a benchmark for short-term interest rates in the domestic financial market. A further characteristic of the current regime is that the Reserve Bank has set an objective of NZ$ 20 million for the volume of “free” cash settlement balances at the end of each trading day.[10]

[9] The operation of the cash rate system in New Zealand has been described by Archer et al (1999) and Brookes and Hampton (2000). Frazer (2004) gives an overview of the liquidity management operations of RBNZ.

[10] Under unusual circumstances this quantity target is altered. For instance, on February 2nd, 2006, the target was raised temporarily to NZ$ 500 million. Shortly thereafter it was raised even higher to NZ$ 2

The purpose of open-market operations is to smooth the liquidity flows in and out of the financial sector.[11] If the expected liquidity position of trading banks is covered by the successful implementation of open-market operations, then trading banks should be no more likely to have to seek additional funds from the standing facility than to have surplus cash balances at the end of the day. This implies that the cash rate is at the centre of a symmetric corridor. Algebraically, the overnight case rate is a weighted average of the two interest rates that define the corridor where either interest rate is weighted by the respective probability of lacking or excess liquidity in the financial sector.

$$i_t = i_t^b P(L_t^d - L_t^s > 0) + i_t^d P(L_t^d - L_t^s < 0) \quad (1)$$

where i_t = overnight cash rate

i_t^b = interest rate at which trading banks borrow funds from the Reserve Bank

i_t^d = interest rate at which trading banks deposit surplus funds at the Reserve Bank

$P(L_t^d - L_t^s > 0)$ = probability that banks' liquidity needs exceed liquidity supply.

$P(L_t^s - L_t^d > 0)$ = probability that liquidity supply exceeds banks' liquidity needs.

As the intended aim of open-market operations is to make the two probabilities equal, it follows that equation (1) reduces to

$$i_t = i_t^b(\frac{1}{2}) + i_t^d(\frac{1}{2}) \quad (2)$$

In New Zealand the width of the corridor is 50 basis points.[12]

Hence $i_t^d = i_t^b - 0.5$ (3)

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billion. At the time the Reserve Bank cited the shortage of government stock, which serves as collateral in open-market operations and other financial transactions, as being behind the temporary increase in the volume of cash settlement balances. According to the statement released by RBNZ, this move had no implications for the conduct of monetary policy.

[11] This explanation draws on Bindseil and Wuertz (2005). Their paper provides an overview of issues in the implementation of monetary policy. The operation of the interest rate corridor has also been aptly described by Woodford (2001)

[12] Interest rates are expressed as percentage points i.e. 5 percent.

Substituting (3) into (2) yields

$$i_t = i_t^b - 0.25 \qquad (4)$$

The rate at which trading banks borrow from the standing facility at the Reserve Bank exceeds the cash rate by 25 basis points. Similarly, the deposit rate i_t^d lies 25 basis points below the cash rate.

The provision of adequate liquidity to the financial sector of the economy is central to the successful implementation of the current cash rate system. To ensure that sufficient cash settlement balances are maintained in the settlement accounts of the major financial institutions of the country, the Reserve Bank conducts open-market operations.[13] These operations are conducted daily at 9:30 am by means of variable rate tenders.[14] All registered participants have 15 minutes to submit their bids. To meet its objective for cash settlement balances at the end of each trading day, the Reserve Bank needs to have precise information about the government's transactions with the public. The expected daily flows of funds from and into the government's coffers occur through the trading banks and hence affect their liquidity position. The Reserve Bank aims to anticipate these flows by coordinating its open-market operations with the help of advice from the New Zealand Office Debt Management Office (NZDMO). This advice comes in the form of detailed information about expected disbursements of government funds to the public such as the payment of pensions, payment of salaries, the maturity of long-term government debt or the collection of tax revenue and customs duties. Once the Reserve Bank has up-to-date information about the expected inflows and outflows of cash from the financial sector, it is in a position to structure its open-market operations to meet the liquidity needs of the financial sector. More specifically, the Reserve Bank can then determine and announce to the registered participants the size and maturity dates of its open-market operations. If the Reserve Bank wishes to inject additional cash balances into the financial sector, the Bank offers to engage in a *reverse* repurchase agreement (repo). If it desires to withdraw cash, it offers to engage in an ordinary repurchase

[13] Foreign exchange swaps are another instrument of monetary policy that the Reserve Bank uses to affect liquidity conditions in financial markets. Since August 2005, the Reserve Bank has indeed relied on the occasional foreign exchange swap to inject additional liquidity.

[14] With a few exceptions, open-market operations were conducted on every trading day over the March 17th 1999-June 30th 2005 period.

agreement.[15] These transactions involve the immediate exchange of cash balances for securities or vice versa and fix the date on which the transaction is reversed. The Reserve Bank also announces the minimum (maximum) interest rate that it is willing to accept (pay) on a given security that is involved in a transaction.[16]

Figures 6 and 7 provide some feedback on the maturity spectrum of open-market operations conducted by the Reserve Bank over the period beginning on March 17th , 1999 and ending on June 30th, 2005. Figure 6 shows the volume of transactions that the Reserve Bank offered to undertake for a range of different maturity dates. There are two noteworthy features about the volume of transactions on offer. First, the data reveal a series of spikes and a distinct saw-tooth pattern on three occasions. Second, barring a few exceptions, the term to maturity of available transactions becomes shorter beginning in the first half of 2004 and continuing to the end of the sample period.

Closer examination of the open-market operations reveals that with one exception all spikes are accounted for by transactions whereby the Reserve Bank offered to sell Treasury Bills to withdraw cash from the financial sector. The three distinct saw teeth are due to reverse repurchase agreements that were offered to offset the injection of cash brought about by maturing government debt on February 15th 2000, February 15th, 2001, and March 15th, 2002. Consider the first saw tooth. Its shape was arguably influenced by the Y2K factor. Also from October 11th, 1999 onward, the Reserve Bank offered reverse repurchase agreements that matured on January 12th and January 27th, 2000 to soak up potential excess liquidity. On the same day in October, the Bank also began to offer reverse repurchase agreements with maturity date February 15th, 2000 and repeated this offer on every trading day until February 15th. The willingness by the Reserve Bank to inject cash daily over this 4-month period is behind the saw tooth pattern. Figure 6, however, is just part of the story as it reflects only the volume of transactions *offered* by the Reserve Bank. The *actual* transactions that occurred on each trading day between the Reserve Bank and the registered participants in open market operations appear in Figure 7. It is apparent that the distinct saw tooth pattern of Figure 6 is absent from Figure 7. Evidently,

[15] The Reserve Bank also occasionally invites bids for seasonal treasury bills with a maturity of 1 to 3 months.

[16] The Reserve Bank also informs the participants of the actual cash settlement balances that were left in the banking sector at the end of the preceding trading day and of its estimate for the flow of funds into and out of the financial sector on the trading day.

financial institutions did not take up the offer of reverse repurchase agreements that were made well in advance of the maturity date of government bonds but deferred accepting reverse repurchase agreements until shortly before the government bonds matured. For instance, the first actual completion of a reverse repurchase agreement with maturity date February 15, 2000 occurred on December 1, 1999, approximately 50 days after it had been first offered on October 11th, 1999. Notice that beginning midyear in 2004 the volume of offered transactions looks very similar to actual transactions. The term to maturity of actual reverse and ordinary repurchase agreements also declined somewhat.

To complete the description of how the Reserve Bank interacts with financial institutions in the day-to-day implementation of monetary policy, we also have to examine the bids for reverse and ordinary repurchase agreements. Figure 8 depicts the volume of bids submitted by registered participants in open-market operations. In addition, Figure 8 also shows the volume of transactions per maturity as offered by the Reserve Bank. In the overwhelming majority of the cases, the volume bid by the registered participants far exceeded the volume of offers announced by the Reserve Bank. While there is no discernible pattern in the behaviour of the bids per maturity submitted by financial institutions, total volume offered by the Reserve Bank remained low and steady until mid-September 2001 ("9/11") after which the Reserve Bank increased its volume of reverse repurchase agreements markedly.[17] There are a few solid spikes, indicating that at times the volume of cash offered by the Reserve Bank exceeded the volume bid. Towards the end of 2004 there is a marked decline in the size of offers per maturity. Indeed the volume of transactions offered at the end of the sample period is approximately the same as at the beginning. Also notice that the bidding behaviour by the registered participants changed at the end of the sample period. The size of bids declined markedly relative to the beginning of the sample period.

Given the above information about open-market operations, we now propose to construct two variables that capture important characteristics of the implementation of monetary policy in New Zealand. The first variable describes the extent to which the Reserve Bank accommodated the bids submitted by the registered participants.

[17] Over the September 12, 2001 – April 1, 2005 period the Reserve Bank of NZ undertook only 13 ordinary repurchase agreements. With the exception of four transactions involving Treasury Bills all other transactions carried out during this period were reverse repurchase agreements.

We call this variable the *allotment ratio (AR)*. This ratio is simply the total amount transacted in an open-market operation divided by the volume of bids submitted by the registered participants on a given day. The second variable indicates the importance of one-day reverse and ordinary repurchase agreements in open-market operations. We call this variable the *maturity spectrum ratio (MS)*.[18] This ratio is the proportion of the volume of one-day reverse or ordinary repurchase agreements divided by the volume of *all* repurchase agreements. Figures 9 and 10 illustrate the frequency distribution of the allotment ratio and the maturity spectrum ratio. Inspection of Figure 9 reveals that in 1999 and 2000 a number of open-market operations resulted in no transactions. Since 2001 zero allotment ratios have been much rarer. Full allotment occurred in nearly ten percent of all transactions. The mean allotment ratio over the sample period is 0.483 which suggest that on average the Reserve Bank accepted nearly 50 percent of the total volume of bids received. The allotment ratio remained fairly stable over the sample period. However, there is a noticeable surge in the allotment ratio at the end of the sample period. According to Figure 10, the MS ratio at the end of the sample period is very different from the MS ratio at the beginning of the sample period. The presence of sizeable gaps along the time axis suggests that virtually no open-market transactions involving one-day repos were carried out as the new operating system was being put in place. However, there is a tight cluster of daily open-market operations that involved overnight repos near the end of the sample period. This suggests that one-day repos became the preferred vehicle to change liquidity conditions in the New Zealand financial market only a few years after the change in the operating regime. Also note that in 2004 and the first part of 2005 the MS ratio is frequently unity which suggests that only overnight repos and reverse repos were carried out. Over the whole sample period, the mean ratio of the volume of one-day repos to the volume of *all* repos was *0.102*.

[18] Jordan and Kugler (2004) examine the effect of the allotment and the maturity spectrum ratios on the 30, 60, and 90-day LIBOR in the implementation of monetary policy in Switzerland.

IV. The Behaviour of the 90-Day Bank Bill Rate in New Zealand: Examining the Effects of Open-Market Operations and the Existence of Foreign Interest Rate Linkages.

In the previous two sections we discussed various aspects of monetary policymaking. Section II analyzed the timing and size of monetary policy changes and their flow-on effects on short-term interest rates in New Zealand, Australia, and the United States. Section III took a close look at the way the Reserve Bank of New Zealand affects liquidity conditions in the domestic financial market. The purpose of the current section is twofold. First, we examine whether the behaviour of the 90-day bank bill rate in New Zealand is influenced by the structure of open-market operations. More specifically, we seek to establish to what extent the allotment ratio (*AR*) and the maturity spectrum ratio (*MS*), two variables which capture important elements of open market operations, influence the path of the 90-day bank bill rate. The second question we address concerns the possible link between short-term interest rates in New Zealand on the one hand and short-term interest rates abroad, i.e. short-term interest rates in Australia and the United States. The financial market of New Zealand is fairly small and fully integrated with capital markets elsewhere. There are no restrictions on the flow of capital in and out of New Zealand. It is therefore natural to ask whether short-term interest rates in New Zealand respond to short-term interest rates in the region, i.e. in Australia or to short-term interest rates set in the world's largest economy, the United States.

To assess the effects on the mean of the 90-day bank bill rate of the liquidity management operations undertaken by the Reserve Bank and to verify the existence of an interest rate link with foreign capital markets, we propose the following regression equation:

$$\Delta r_t^{NZ} = \alpha_0 + \sum_{j=1}^{n} \alpha_j \Delta r_{t-j}^{NZ} + \beta_1 (r_{t-1}^{NZ} - r_{t-1}^{AUS}) + \beta_2 (r_{t-1}^{NZ} - r_{t-1}^{US}) + \beta_3 AR_t + \beta_4 MS_t + \beta_5 D1_t + \beta_6 D2_t + \beta_7 D3_t + v_t \quad (5)$$

The change in the NZ 90-day bank bill rate is regressed on its own lags, the lag of the difference between the NZ 90-day bank bill rate and the Australian 90-day bank bill rate, the lag of the difference between the NZ 90-day bank bill rate and the US 90-day

commercial paper rate, the allotment ratio, the maturity spectrum ratio and three dummy variables. *D1* captures the effect of monetary policy tightenings while *D2* captures the effects of monetary policy easings. *D3* is meant to capture the effect of special events such as "9/11". Special events are interpreted as days on which the 90-day-bank bill rate changed by more than 15 basis points.[19] We also estimate the following specification for the time-varying variance of the NZ 90-day bank bill rate:

$$h_t = c_0 + c_1 v_{t-1}^2 + c_2 h_{t-1} + c_3 (r_{t-1}^{NZ} - r_{t-1}^{AUS}) + c_4 (r_{t-1}^{NZ} - r_{t-1}^{US}) + c_5 AR_t + c_6 MS_t + c_7 D1_t + c_8 D2_t + c_9 D3_t \quad (6)$$

The empirical estimates of the relevant coefficients appear in the top two panels of Table 3. Our preferred empirical specification for the conditional mean equation contains only the fifth lag of the dependent variable as a right-hand side variable. All other lagged dependent variables have coefficients that are statistically insignificant. The bottom panel of both tables also provides some feedback on the goodness of fit and the standard error of the regression for equation (5).

According to the findings of Table 3, there is substantial evidence for the claim that the 90-day bank bill rate in New Zealand is far more responsive to its Australian counterpart than to its American counterpart. In case the 90-day rate in New Zealand exceeds the 90-day rate in Australia, there is a tendency for the New Zealand rate on the following day to revert to the level set by the Australian rate. If the NZ 90-day bank bill rate exceeds the Australian rate by one percent, then the New Zealand rate is expected to decrease by 0.3 basis points per day towards the Australian rate.[20] Thus the adjustment speed is rather slow but it is statistically significant at the 1 percent level. No such adjustment mechanism shows up in the results for the lag of the difference between the NZ 90-day and US 90-day interest rates.[21] The second noteworthy finding relates to the positive effect of the maturity

[19] *D3=1* on October 1st, 1999, December 13th, 1999, September 12th, 2001, and December 4th, 2002, and zero otherwise. Three of the above dates are associated with easily identifiable events. On October 1st, 1999, NZ Treasury finalized its economic outlook for the years ahead. The terrorist attack in the United States occurred on September 12th, 2001. NZ time. On December 4th, 2002 the Reserve Bank announced that it would not change the overnight cash rate. Apparently financial market participants had expected an increase in the overnight cash rate as the 90-day bank bill rate decreased markedly on the day of the announcement.

[20] We also estimated the effect of the lagged difference between the NZ and US 90-day rate on the Australian 90-day bill rate. The error correction coefficient was statistically insignificant. Thus, there is feedback from Australian to New Zealand interest rates but not the other way around.

[21] The correlation between the lags of the two interest rate differentials is *0.47*.

spectrum ratio on the change in the NZ 90-day bank bill rate.[22] The greater the proportion of ordinary or reverse one-day repos relative to all transactions conducted by the Reserve Bank, the greater the impact on the 90-day bank bill rate. It thus seems that the behaviour of the 90-day bank bill rate depends to some extent on the way the Reserve Bank structures its open-market operations. The more the Reserve Bank engages in overnight repo transactions the more it moves the 90-day bank bill rate. It is conceivable that the Reserve Bank's injection of additional cash into the financial sector and then its subsequent withdrawal on the following day – as most repos were of the reverse type – left the financial participants with little room to manoeuvre. The shorter the average maturity of reverse repos, the larger the average shortage of cash available to trading banks.[23] This effect filtered through to the wider financial market, resulting in upward pressure on the 90-day bank bill rate. In contrast, the allotment ratio does not seem to exert any effect on the mean of the 90-day bank bill rate. This implies that the extent to which the Reserve Bank accommodates the bids for repo transactions by the financial sector has no repercussions for the behaviour of the mean of the 90-day bank bill rate. Notice that the coefficients on the two dummy variables, which indicate changes in monetary policy, bear the expected sign and are both highly significant. The third dummy variable which captures idiosyncratic effects is also highly significant.

The estimates of the coefficients for the variance equation appear in the second panel from the top. We observe that the allotment ratio has a positive and highly significant effect on the volatility of the 90-day bank bill rate.[24] Greater preparedness on the part of the Reserve Bank to meet the demand for transactions by

[22] The open-market operations carried out by the Reserve Bank precede the determination of the 90-day bank bill rate. As a result, there is no problem of endogeneity between the dependent variable and MS_t and AR_t.

[23] William A. Allen (2004), p. 27 expresses a similar view.

[24] We performed two diagnostic tests to check the adequacy of the model. First, the squared standardized residuals were checked for the presence of serial correlation. A simple Lagrange Multiplier test revealed that the squares of the standardized residuals were not autocorrelated. Second, we looked at the Akaike Information Criterion and the Schwartz Bayesian Criterion to determine the number of lags of the dependent variable in the regression equation. Finally, we checked whether the standardized residuals were normally distributed. The fractiles of the standardized residuals were plotted against the fractiles of the normal distribution, resulting in a straight line as shown in Figure 1A in the appendix. The distribution of the residuals appears to be not very different from a standard normal distribution. There are a few outliers in the tails of the distribution, however, suggesting the existence of "fat tails". These outliers are somewhat of a concern as they are responsible for the rejection of the hypothesis that the residuals are normally distributed. In addition, the kurtosis of the residuals is 8.71 which exceeds 3, the kurtosis of the normal distribution. As such, the outcome of the coefficient tests has to be interpreted with some care.

the financial sector leads to greater volatility in the behaviour of the 90-day bank bill rate. Put simply, the 90-day bank bill rate bounces around more the larger the proportion of bids proffered by the registered participants result in actual transactions. This result has an important policy implication. If the Reserve Bank wished to reduce the volatility of the market-determined 90-day bank bill rate, it could lower the allotment ratio in its open-market operations. The MS ratio exerts a positive albeit a much weaker effect on the variance compared to the mean of the 90-day bank bill rate. The lagged difference between the New Zealand and Australian 90-day bank bill rate does not affect the conditional variance of the NZ 90-day rate. The inverse relationship between the size of the lag of the NZ-US interest differential and the variance of the NZ 90-day bill rate is somewhat puzzling at first sight. Closer inspection of the data reveals that the inverse relationship is due to the huge swings in the US 90-day paper rate that drives the difference between the NZ-US 90-day interest rate differential. Notice that the coefficients on the regressors in the equation for the conditional variance are substantially smaller than the coefficients in the equation for the conditional mean. This suggests that the impact of the regressors on the conditional variance – while being statistically significant - may indeed be low in terms of economic significance.[25]

V. Summary and Conclusion

This paper discusses the implementation of monetary policy in New Zealand over the 1999-2005 period from an empirical perspective. The current operating procedure of the Reserve Bank is geared towards maintaining the overnight cash rate at the announced target level. The overnight cash rate target in turn serves as the benchmark for market-determined interest rates. Through open-market operations the Reserve Bank of New Zealand attempts to control the volume of liquidity that is consistent with the announced target for the overnight interest rate. Open-market operations complement the standing facilities that trading banks in New Zealand can access to borrow or deposit funds.

[25] We also experimented with adding leads of changes in the 90-day bank bill rate to the specification. The leads are proxies for the forward-looking expectations of changes in the 90-day bank bill rate. However, adding the leads to the specification creates an endogeneity problem. The results reported in Table 3 concerning the allotment and maturity spectrum ratios are robust to this change in the specification of the regression equation.

Against this background, we examine whether the way in which the Reserve Bank structures its open-market operations influences the behaviour of the key short-term interest rate in New Zealand, the 90-day bank bill rate. We create two variables that capture important characteristics of the structure of open-market operations carried out by the Reserve Bank. They are the allotment ratio and the maturity spectrum ratio. The former measures the extent to which the Reserve Bank accommodates the bids submitted by trading banks in the daily auctions. The latter variable reflects the importance of the provision of overnight liquidity in the transactions entered into by the Reserve Bank with the registered participants.

Our empirical findings suggest that the higher the share of overnight repos in the total volume of transactions, the greater the effect on the 90-day bank bill rate. While the maturity structure ratio thus has a discernible effect on the 90-day bank bill rate no such effect is exerted through the allotment ratio. Assessing the impact of the maturity spectrum ratio and the allotment ratio on the volatility of the 90-day bank bill rate, we find that volatility increases in line with increases in the allotment ratio but is only weakly responsive to changes in the maturity spectrum ratio. If the volatility of the 90-day bank bill rate is deemed too high, then our results imply that the Reserve Bank ought to reduce the allotment of bids as it would lead to less erratic behaviour of the 90-day bank bill rate.

Given its small size, the financial market of New Zealand is subject to the influence of external factors such as conditions in financial markets abroad. The most natural foreign candidates that might influence the behaviour of the 90-day rate in New Zealand are its counterparts in Australia and the United States. We find indeed that the Zealand 90-day bank bill rate has a tendency to revert to the level set by its Australian counterpart, though at a relatively slow speed. No such link exists between the NZ 90-day bank bill rate and the US 90-day commercial paper rate. This result is largely due to the fact that monetary policy changes in New Zealand and the United States went in opposite directions for a substantial length of time over the sample period.

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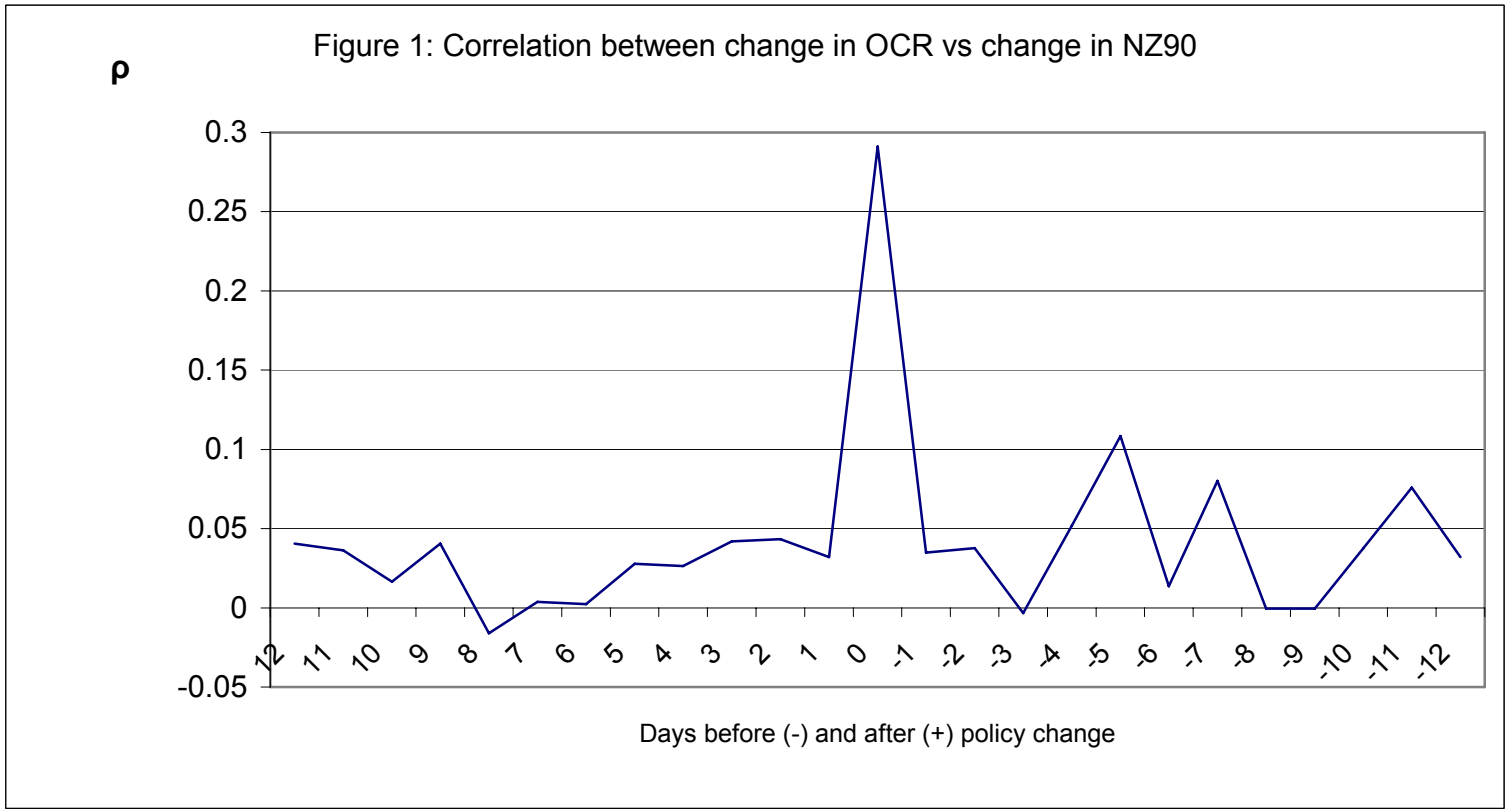
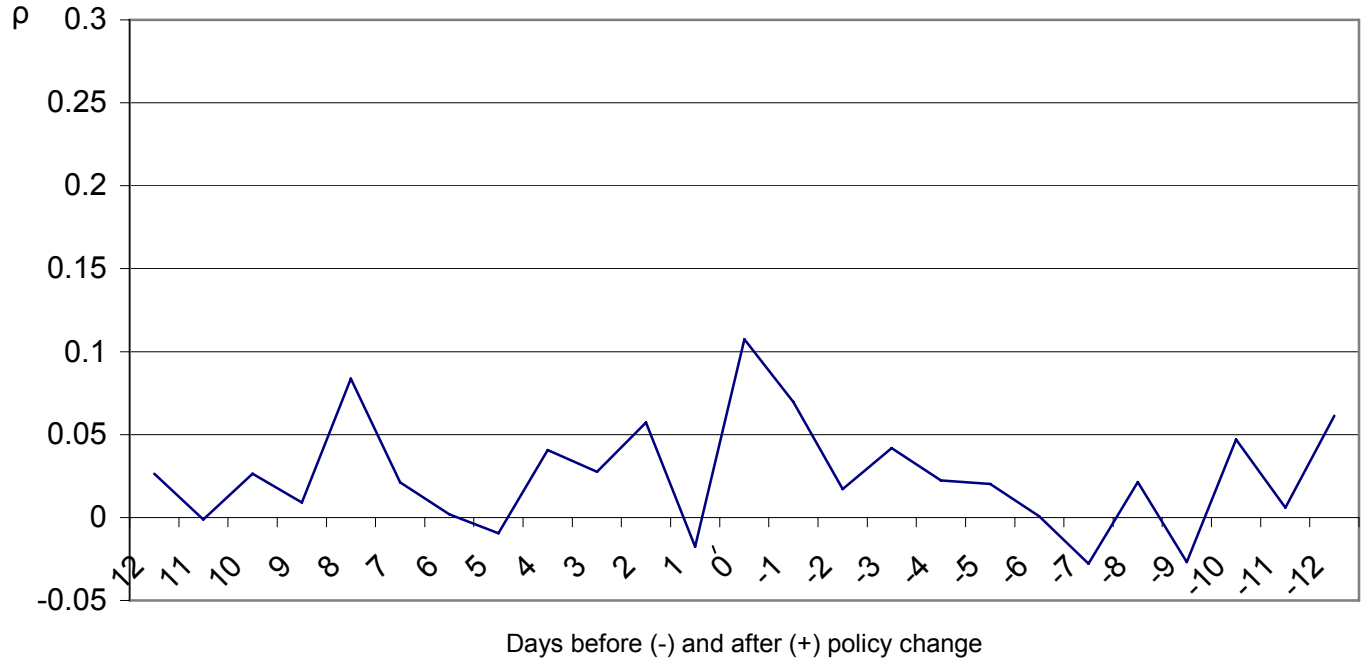


Figure 1: Correlation between change in OCR vs change in NZ90
ρ
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
Days before (-) and after (+) policy change

Figure 2: Correlation between change in AUSOCR vs change in AUS90



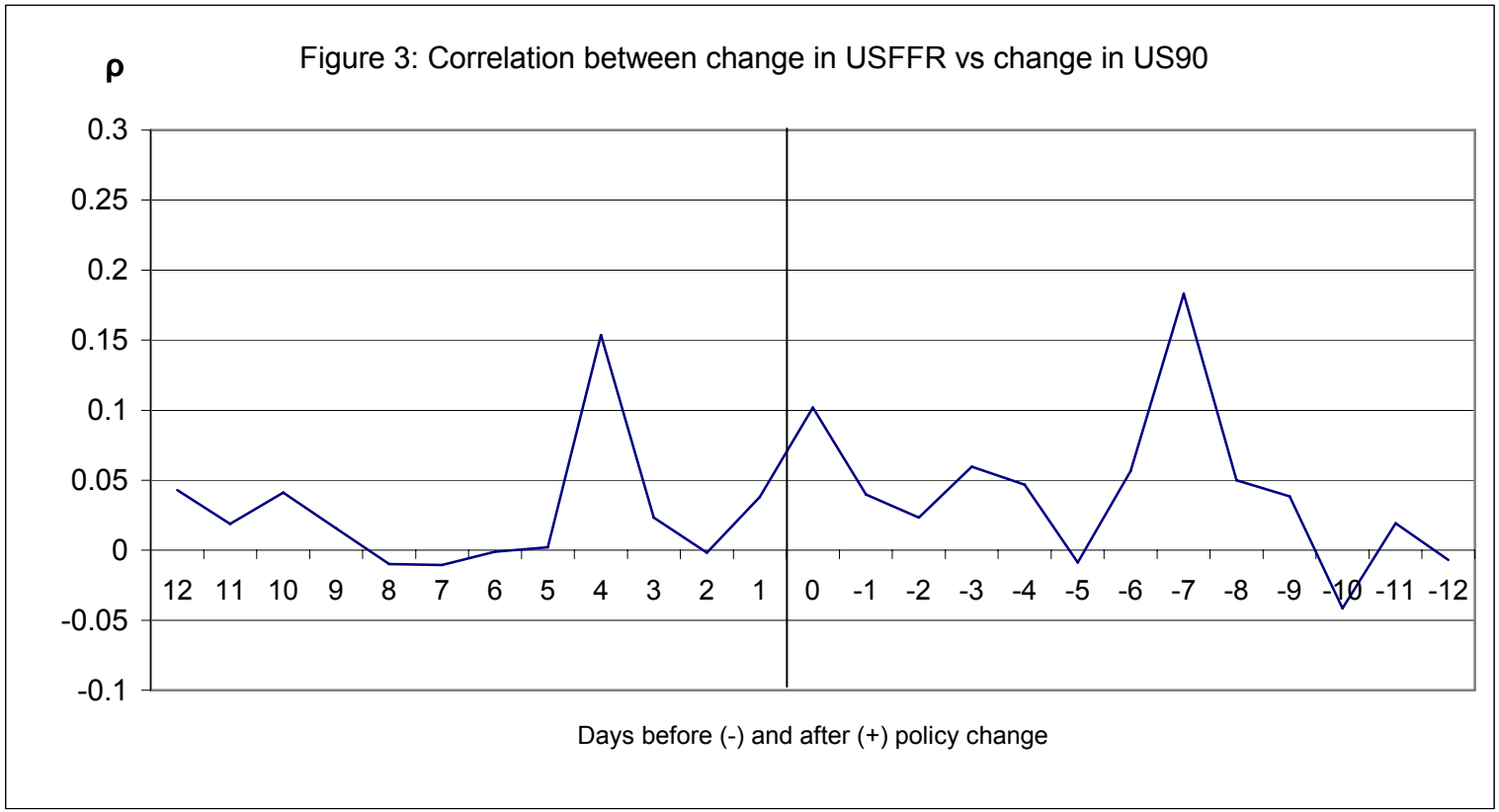
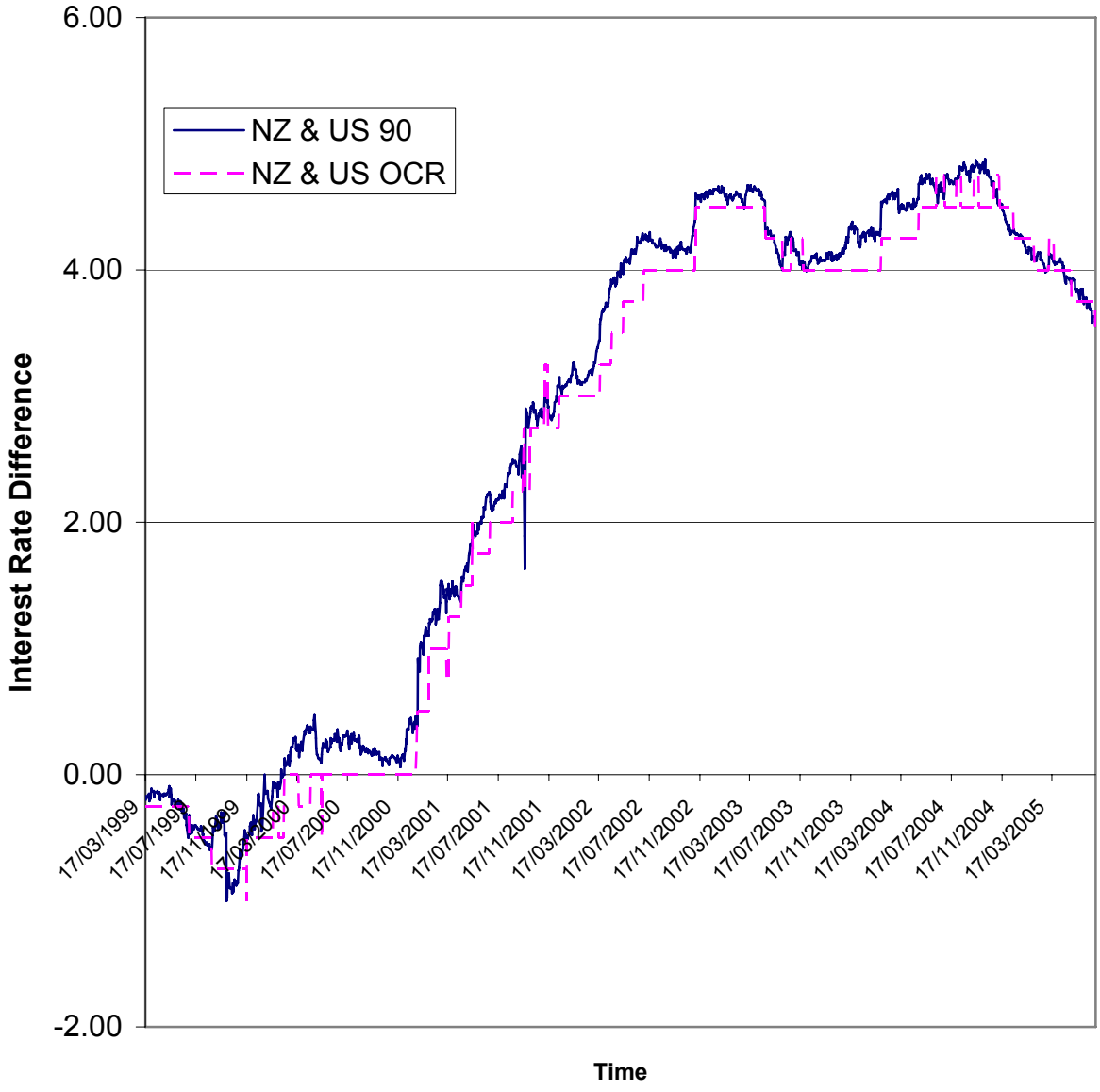
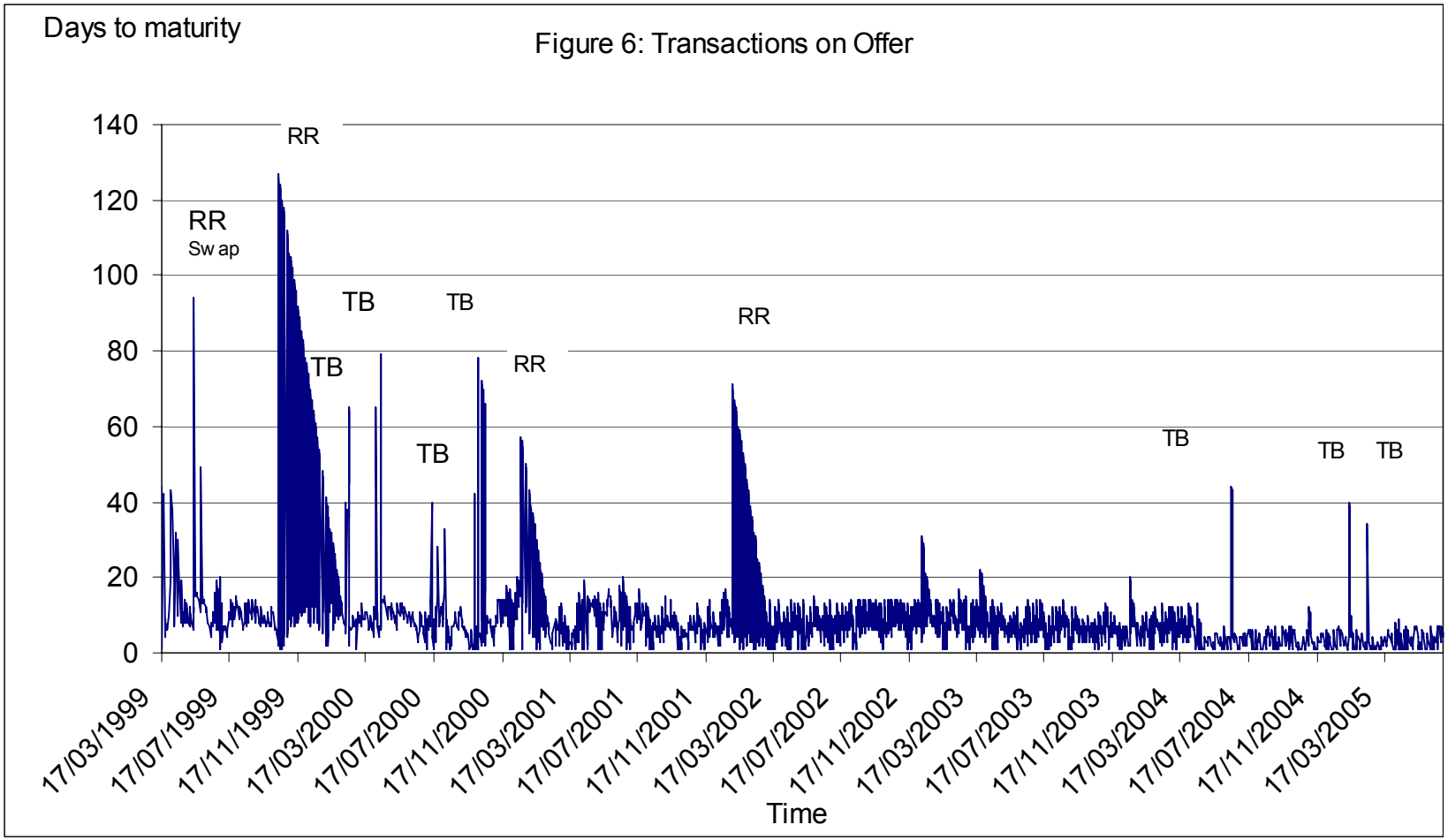


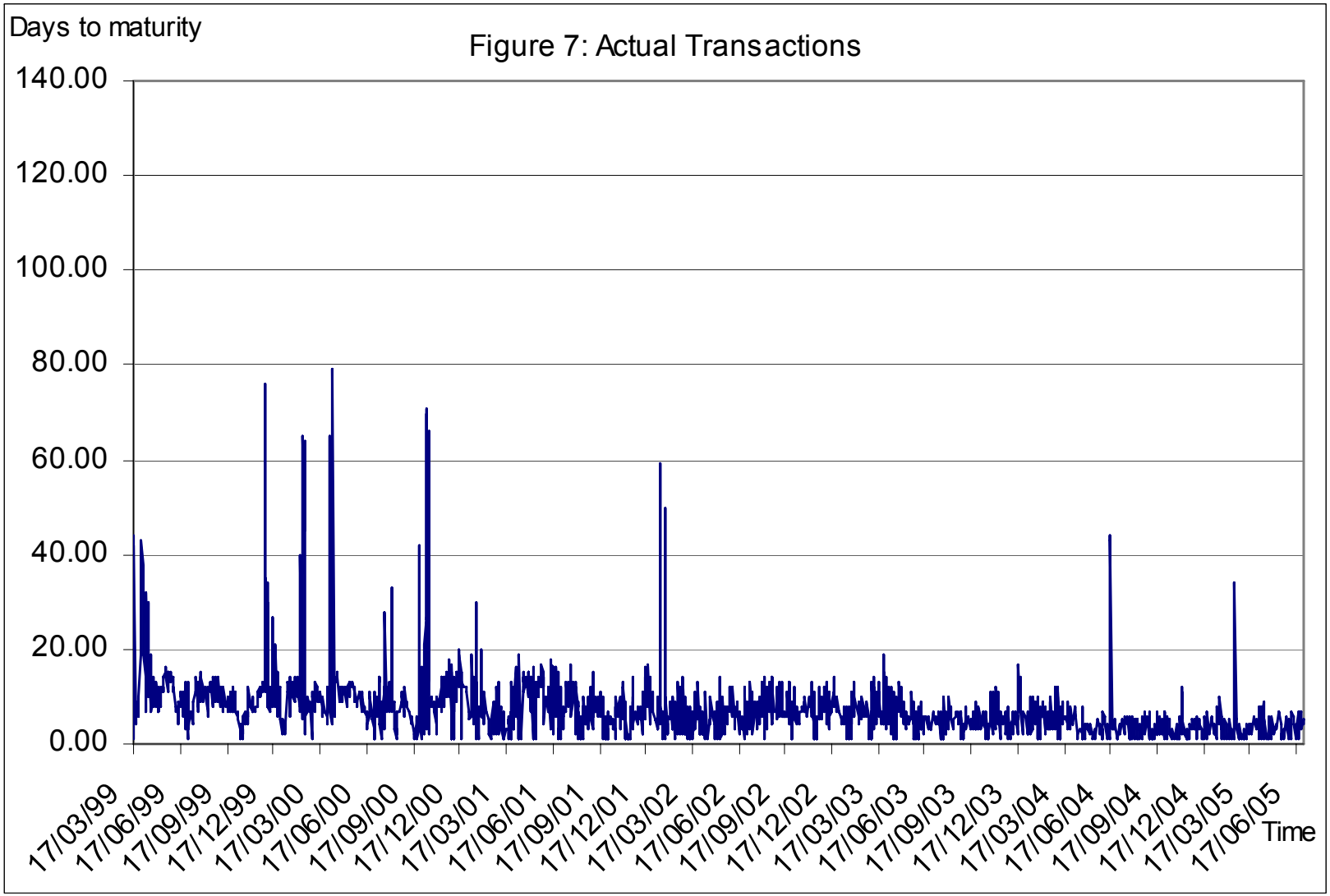
Figure 3: Correlation between change in USFFR vs change in US90
ρ
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3 -4 -5 -6 -7 -8 -9 -10 -11 -12
Days before (-) and after (+) policy change

Figure 5: Difference Between NZ and Australian Interest Rates

Figure 4: Difference Between NZ and American Interest Rates




Days to maturity
Figure 6: Transactions on Offer
140
120
100
80
60
40
20
0
RR
RR
Swap
TB
TB
TB
TB
RR
RR
TB
TB
TB
17/03/1999
17/07/1999
17/11/1999
17/03/2000
17/07/2000
17/11/2000
17/03/2001
17/07/2001
17/11/2001
17/03/2002
17/07/2002
17/11/2002
17/03/2003
17/07/2003
17/11/2003
17/03/2004
17/07/2004
17/11/2004
17/03/2005
Time


Days to maturity
Figure 7: Actual Transactions
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
17/03/99
17/06/99
17/09/99
17/12/99
17/03/00
17/06/00
17/09/00
17/12/00
17/03/01
17/06/01
17/09/01
17/12/01
17/03/02
17/06/02
17/09/02
17/12/02
17/03/03
17/06/03
17/09/03
17/12/03
17/03/04
17/06/04
17/09/04
17/12/04
17/03/05
17/06/05
Time

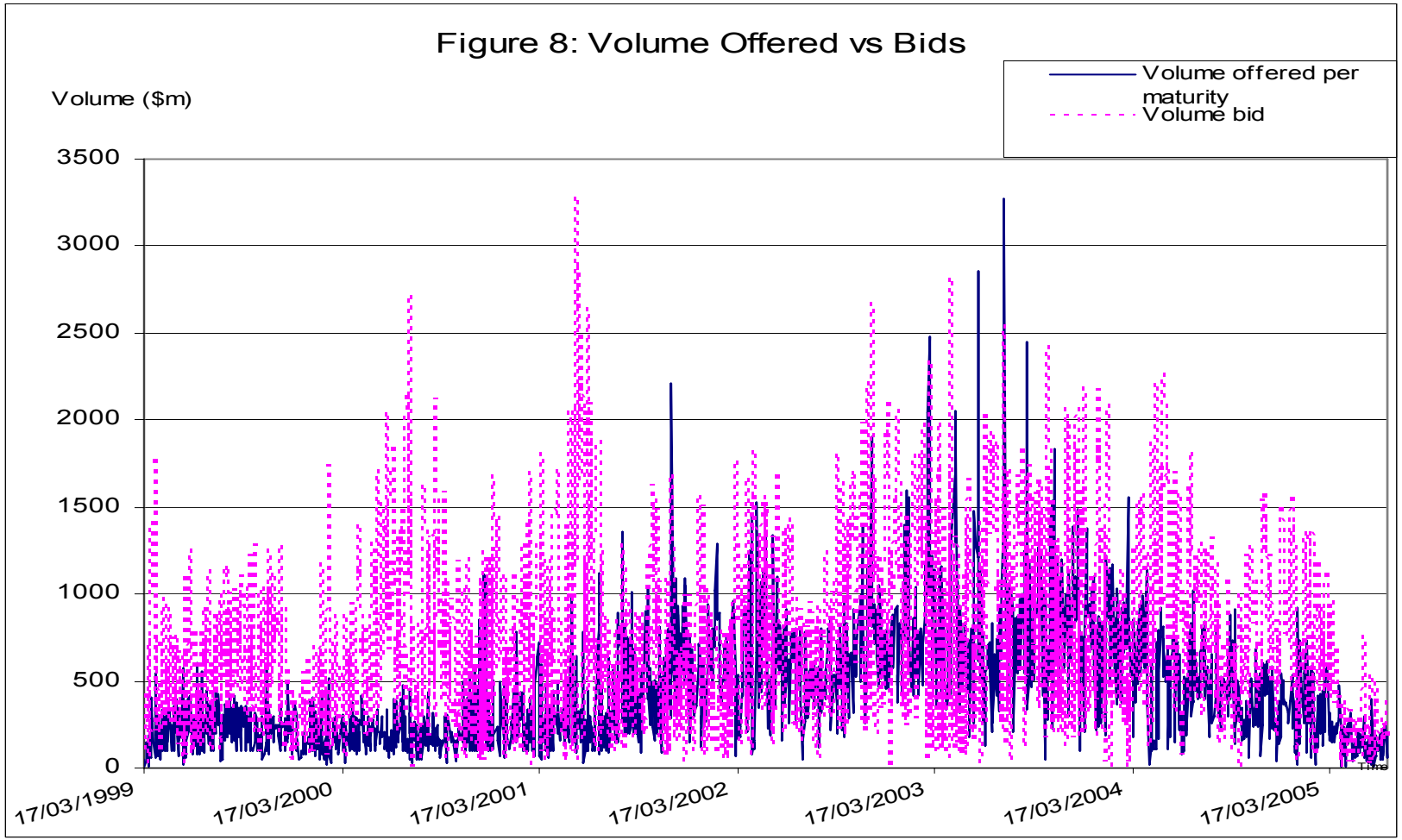


Figure 8: Volume Offered vs Bids
Volume ($m)
Volume offered per maturity
Volume bid
3500
3000
2500
2000
1500
1000
500
0
17/03/1999
17/03/2000
17/03/2001
17/03/2002
17/03/2003
17/03/2004
17/03/2005
Time

Figure 9**:** The Allotment Ratio over the Sample Period.

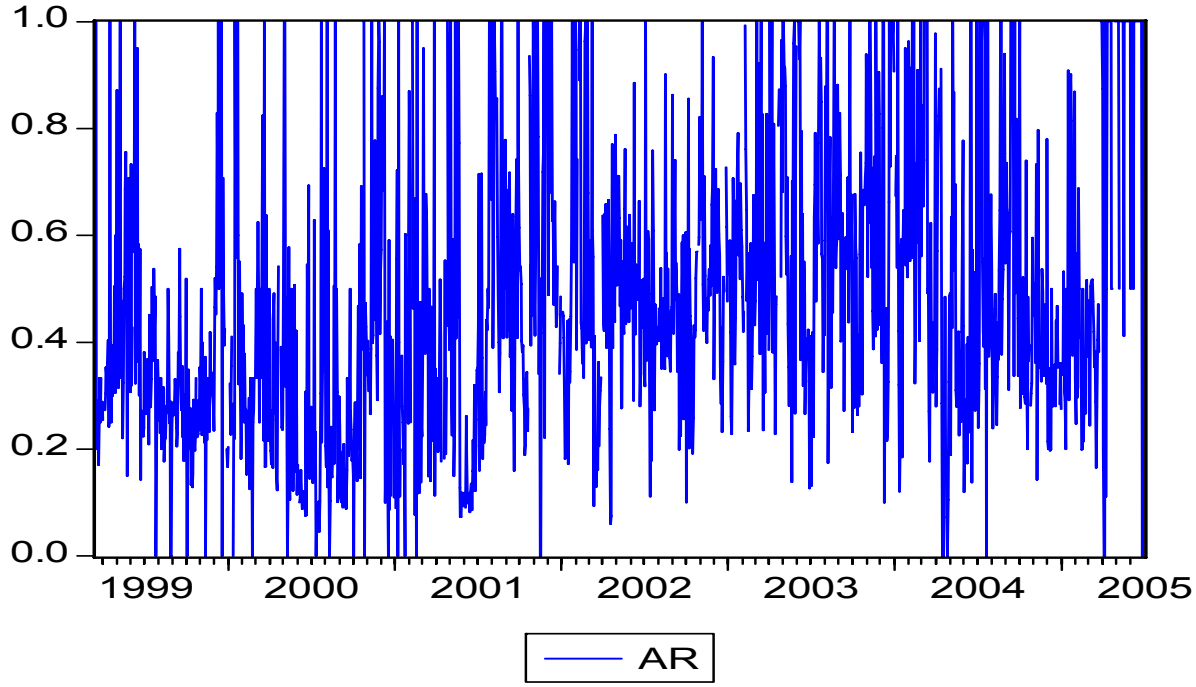


Figure 10**:** The MS Ratio over the Sample Period

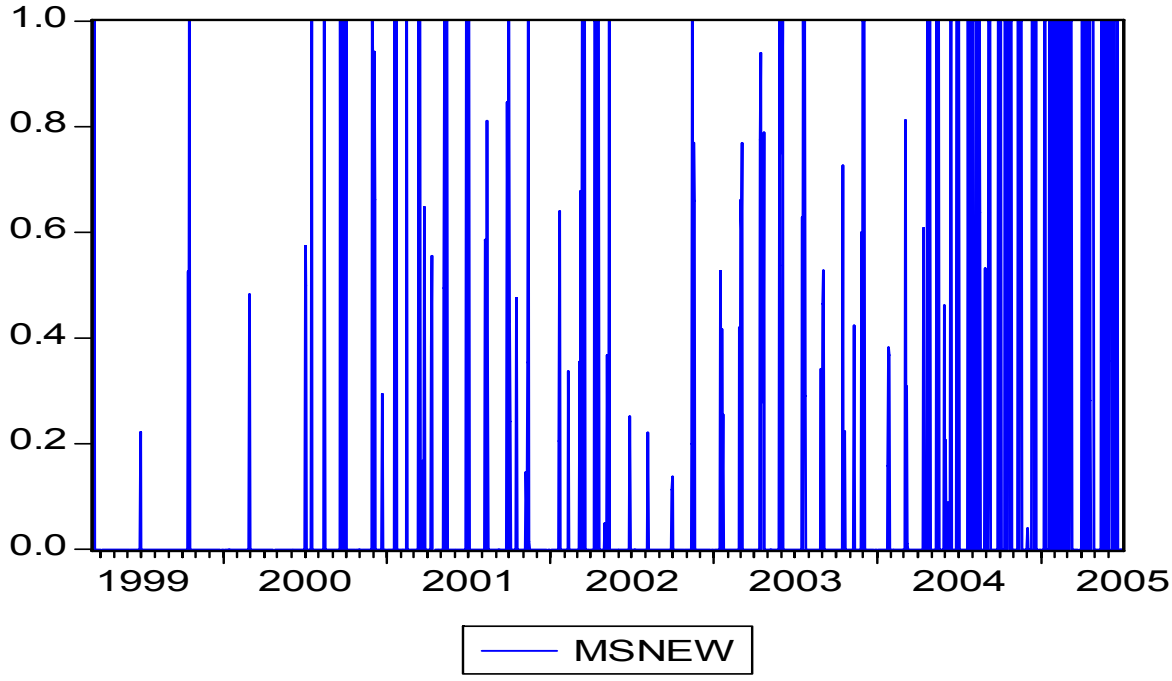


Table 1: An Overview of Monetary Policy Settings and Changes

New Zealand

Date of change	Target value	Target Change	Day of week	Duration in trading days	Duration in calendar days	Change in 90-day bank bill rate	Δ90-day / ΔOCR
17/Mar/1999	4.50	na	Wednesday	175	245		
17/Nov/1999	5.00	0.5	Wednesday	45	63	-0.01	-
19/Jan/2000	5.25	0.25	Wednesday	19	27	0.05	+
15/Feb/2000	5.75	0.5	Tuesday	46	64	0.02	+
19/Apr/2000	6.00	0.25	Wednesday	20	28	0.05	+
17/May/2000	6.50	0.5	Wednesday	215	301	0.05	+
14/Mar/2001	6.25	-0.25	Wednesday	26	36	-0.11	+
19/Apr/2001	6.00	-0.25	Thursday	19	27	-0.23	+
16/May/2001	5.75	-0.25	Wednesday	90	126	-0.08	+
19/Sep/2001	5.25	-0.5	Wednesday	40	56	-0.27	+
14/Nov/2001	4.75	-0.5	Wednesday	90	126	-0.04	+
20/Mar/2002	5.00	0.25	Wednesday	20	28	0.14	+
17/Apr/2002	5.25	0.25	Wednesday	20	28	-0.03	-
15/May/2002	5.50	0.25	Wednesday	35	49	-0.04	-
3/Jul/2002	5.75	0.25	Wednesday	211	295	-0.03	-
24/Apr/2003	5.50	-0.25	Thursday	30	42	-0.24	+
5/Jun/2003	5.25	-0.25	Thursday	35	49	0.05	-
24/Jul/2003	5.00	-0.25	Thursday	135	189	-0.01	+
29/Jan/2004	5.25	0.25	Thursday	65	91	0.22	+
29/Apr/2004	5.50	0.25	Thursday	30	42	0.12	+
10/Jun/2004	5.75	0.25	Thursday	35	49	0.05	+
29/Jul/2004	6.00	0.25	Thursday	30	42	0.04	+
9/Sep/2004	6.25	0.25	Thursday	35	49	0.05	+
28/Oct/2004	6.50	0.25	Thursday	95	133	-0.03	-
10/Mar/2005	6.75	0.25	Thursday			0.12	+
			Average	**65.04**	**91.04**		

Australia

Date of Change	Target Value	Target Change	Day of week	Duration in trading days	Duration in calendar days	Change in the 90-day bank bill rate	Δ90-day / ΔOCR
02/Dec/1998	4.75	-0.25	Wednesday	240	336		
03/Nov/1999	5	0.25	Wednesday	65	91	-0.04	-
02/Feb/2000	5.5	0.5	Wednesday	45	63	0.09	+
05/Apr/2000	5.75	0.25	Wednesday	20	28	-0.01	-
03/May/2000	6	0.25	Wednesday	65	91	0.03	+
02/Aug/2000	6.25	0.25	Wednesday	135	189	0.09	+
07/Feb/2001	5.75	-0.5	Wednesday	20	28	-0.31	+
07/Mar/2001	5.5	-0.25	Wednesday	20	28	0.00	+
04/Apr/2001	5	-0.5	Wednesday	110	154	-0.12	+
05/Sep/2001	4.75	-0.25	Wednesday	20	28	0.02	-
03/Oct/2001	4.5	-0.25	Wednesday	45	63	0.13	-
05/Dec/2001	4.25	-0.25	Wednesday	110	154	0.09	-
08/May/2002	4.5	0.25	Wednesday	20	28	0.07	+
05/Jun/2002	4.75	0.25	Wednesday	370	518	-0.04	-
05/Nov/2003	5	0.25	Wednesday	20	28	0.16	+
03/Dec/2003	5.25	0.25	Wednesday	325	455	-0.01	-
02/Mar/2005	5.5	0.25	Wednesday			0.00	+
			Average	**101.88**	**142.63**		

Table 1 Continued

United States

Date of Change	Target Value	Target Change	Day of week	Duration in trading days	Duration in calendar days	Change in 90-day com. paper rate	Δ90-day CB/ ΔFFR
17/Nov/1998	4.75	0.25	Tuesday	161	225		
30/Jun/1999	5	0.25	Wednesday	39	55	-0.17	-
24/Aug/1999	5.25	0.25	Tuesday	60	84	0.01	+
16/Nov/1999	5.5	0.25	Tuesday	56	78	0.01	+
02/Feb/2000	5.75	0.25	Wednesday	34	48	0.03	+
21/Mar/2000	6	0.25	Tuesday	40	56	0.02	+
16/May/2000	6.5	0.5	Tuesday	166	232	0.02	+
03/Jan/2001	6	-0.5	Wednesday	20	28	0.05	-
31/Jan/2001	5.5	-0.5	Wednesday	34	48	-0.12	+
20/Mar/2001	5	-0.5	Tuesday	21	29	0.06	-
18/Apr/2001	4.5	-0.5	Wednesday	19	27	0.01	-
15/May/2001	4	-0.5	Tuesday	31	43	-0.10	+
27/Jun/2001	3.75	-0.25	Wednesday	39	55	0.03	-
21/Aug/2001	3.5	-0.25	Tuesday	19	27	-0.03	+
17/Sep/2001	3	-0.5	Monday	11	15	0.00	-
02/Oct/2001	2.5	-0.5	Tuesday	25	35	-0.06	+
06/Nov/2001	2	-0.5	Tuesday	25	35	-0.12	+
11/Dec/2001	1.75	-0.25	Tuesday	236	330	-0.06	+
06/Nov/2002	1.25	-0.5	Wednesday	165	231	-0.21	+
25/Jun/2003	1	-0.25	Wednesday	265	371	0.10	-
30/Jun/2004	1.25	0.25	Wednesday	29	41	0.00	+
10/Aug/2004	1.5	0.25	Tuesday	30	42	0.03	+
21/Sep/2004	1.75	0.25	Tuesday	36	50	0.00	+
10/Nov/2004	2	0.25	Wednesday	24	34	0.00	+
14/Dec/2004	2.25	0.25	Tuesday	36	50	0.01	+
02/Feb/2005	2.5	0.25	Wednesday	34	48	0.02	+
22/Mar/2005	2.75	0.25	Tuesday	30	42	0.00	+
03/May/2005	3	0.25	Tuesday	42	58	0.01	+
30/Jun/2005	3.25	0.25	Thursday			0.02	+
			Average	**61.68**	**86.32**		

Note: The sample period extends from 17 March 1999, the day the Reserve Bank of New Zealand changed its operating procedure, to 30 June 2005. The first (last) data entry for Australia and the US corresponds to the first (last) change in the target rate after (before) 17 March 1999 (30 June 2005).

Table 2: Changes in the Policy Instrument and the Impact Effect on the Market Interest Rate: 17 March 1999 – 30 June 2005.

	New Zealand	**Australia**	**United States**
Total number of changes in the policy instrument	24	16	28
25 basis points *decreases*	6	4	4
25 basis points *increases*	13	9	14
50 basis points *decreases*	2	2	9
50 basis points *increases*	3	1	1
Range of Policy Instrument	4.5-6.75	4.5-6.25	1-6.5
Target Rate at Beginning	4.5	4.75	4.75
Target Rate at End	6.75	5.5	3.25
Average Duration of Policy Stance in Trading Days	65.04	101.88	61.68
Average Duration of Policy Stance in Calendar Days	91.04	142.63	86.32
Same day effect of policy change on 90-day bill rate			
$\geq \lvert 20 \rvert$	4	1	1
$\geq \lvert 10 \rvert$ *but* $< \lvert 20 \rvert$	4	3	5
$\geq \lvert 5 \rvert$ *but* $< \lvert 10 \rvert$	7	4	4
$> \lvert 0 \rvert$ *but* $< \lvert 5 \rvert$	9	6	13
0	0	2	5
Monetary easing resulting in *x* basis point *decrease* in 90-day bill rate			
≥ 20	3	1	1
$10 \leq x < 20$	1	1	3
$5 \leq x < 10$	1	0	1
$0 \leq x < 5$	2	0	1
$x = 0$	0	1	1
Monetary tightening resulting in *x* basis point *increase* in 90-day bill rate			
≥ 20	1	0	0
$10 \leq x < 20$	3	1	0
$5 \leq x < 10$	5	3	0
$0 \leq x < 5$	2	1	10
$x = 0$	0	1	4

Table 3: How the Conditional Mean and Variance Respond to Interest Rate Spreads and the Structure of Open Market Operations

Mean Equation		
	Coefficient	Std. Error
c	0.0023[#]	0.0013
Δr_{t-5}	0.0587[**]	0.0241
$r_{t-1} - r_{t-1}^{AUS}$	-0.0039[**]	0.0011
$r_{t-1} - r_{t-1}^{US}$	0.0003	0.0003
AR_t	-0.0005	0.0022
MS_t	0.0052[**]	0.0016
D1	0.0489[**]	0.0069
D2	-0.0974[**]	0.0092
D3	0.1346[**]	0.0041
Variance Equation		
c	0.00002[**]	0.000007
v_{t-1}^2	0.1093[**]	0.010
h_{t-1}	0.8054[**]	0.0122
$r_{t-1} - r_{t-1}^{AUS}$	-0.0000003	0.000004
$r_{t-1} - r_{t-1}^{US}$	-0.000009[**]	0.000001
AR_t	0.00008[**]	0.000001
MS_t	0.00002[#]	0.000001
D1	0.0013[**]	0.0002
D2	0.0020[**]	0.0003
D3	-0.0003[**]	0.000005
Adj. R^2	0.144	
S.E of regression	0.026	
F-statistic	15.71	
No of obs.	1567	

****** denotes statistical significance at 1 percent level
[#] denotes statistical significance at 10 percent level.

Specification of Mean Equation:

$$\Delta r_t^{NZ} = \alpha_0 + \sum_{j=1}^{n} \alpha_j \Delta r_{t-j}^{NZ} + \beta_1 (r_{t-1}^{NZ} - r_{t-1}^{AUS}) + \beta_2 (r_{t-1}^{NZ} - r_{t-1}^{US}) + \beta_3 AR_t + \beta_4 MS_t + \beta_5 D1_t + \beta_6 D2_t + \beta_7 D3_t + v_t$$

Specification of Conditional Variance Equation:

$$h_t = c_0 + c_1 v_{t-1}^2 + c_2 h_{t-1} + c_3 (r_{t-1}^{NZ} - r_{t-1}^{AUS}) + c_4 (r_{t-1}^{NZ} - r_{t-1}^{US}) + c_5 AR_t + c_6 MS_t + c_7 D1_t + c_8 D2_t + c_9 D3_t$$

Appendix:

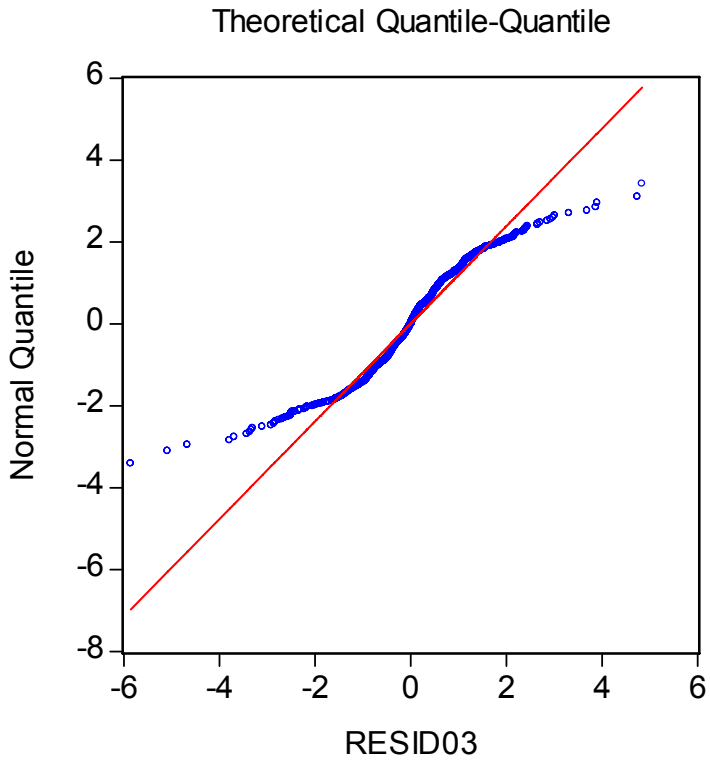
The data used in this paper were downloaded from the website of the Reserve Bank of New Zealand: http://www.rbnz.govt.nz/. The Australian 90-day bank bill rate and the US 90-day commercial paper rate were taken from Datastream.

Table A1: Correlations Between Changes in Policy Instrument and Changes in Leads and Lags of the 90-Day Bill (Paper) Rate.

New Zealand			Australia			United States		
Lags/leads	ρ	Z	Lags/leads	ρ	Z	Lags/leads	ρ	Z
DNZ90(12)	0.040489	1.600073	DAUS90(11)	0.026398	1.042899	D(US90(12))	0.043041	1.701036
DNZ90(11)	0.036236	1.431853	DAUS90(12)	-0.00123	-0.048545	D(US90(11))	0.018774	0.741581
DNZ90(10)	0.016419	0.648547	DAUS90(10)	0.026392	1.042636	D(US90(10))	0.041094	1.624016
DNZ90(9)	0.040474	1.599461	DAUS90(9)	0.009007	0.355756	D(US90(9))	0.01556	0.614628
DNZ90(8)	-0.01612	-0.63658	DAUS90(8)	0.083657	3.311912	D(US90(8))	-0.00998	-0.394001
DNZ90(7)	0.003694	0.145891	DAUS90(7)	0.021272	0.840290	D(US90(7))	-0.01062	-0.419331
DNZ90(6)	0.002287	0.090317	DAUS90(6)	0.001839	0.072649	D(US90(6))	-0.00102	-0.040399
DNZ90(5)	0.027737	1.095804	DAUS90(5)	-0.00941	-0.371712	D(US90(5))	0.002147	0.084790
DNZ90(4)	0.026313	1.03953	DAUS90(4)	0.040779	1.611535	D(US90(4))	0.153666	6.117777
DNZ90(3)	0.041891	1.655541	DAUS90(3)	0.027486	1.085892	D(US90(3))	0.023239	0.918036
DNZ90(2)	0.043291	1.710911	DAUS90(2)	0.057234	2.263047	D(US90(2))	-0.00169	-0.066831
DNZ90(1)	0.031971	1.263174	DAUS90(1)	-0.01765	-0.697051	D(US90(1))	0.037939	1.499182
DNZ90	0.291029	11.83682	DAUS90	0.107498	4.262303	D(US90)	0.101849	4.036695
DNZ90(-1)	0.034839	1.37657	DAUS90(-1)	0.069546	2.751284	D(US90(-1))	0.039841	1.574439
DNZ90(-2)	0.03769	1.489336	DAUS90(-2)	0.017238	0.680918	D(US90(-2))	0.02322	0.917278
DNZ90(-3)	-0.00332	-0.13095	DAUS90(-3)	0.041854	1.654069	D(US90(-3))	0.059659	2.359148
DNZ90(-4)	0.051776	2.046812	DAUS90(-4)	0.022362	0.883376	D(US90(-4))	0.046863	1.852302
DNZ90(-5)	0.108336	4.2958	DAUS90(-5)	0.020313	0.802412	D(US90(-5))	-0.00878	-0.346637
DNZ90(-6)	0.013614	0.537734	DAUS90(-6)	0.000827	0.032657	D(US90(-6))	0.056455	2.232170
DNZ90(-7)	0.080048	3.168412	DAUS90(-7)	-0.02789	-1.102002	D(US90(-7))	0.183095	7.314140
DNZ90(-8)	-0.00048	-0.01915	DAUS90(-8)	0.021335	0.842783	D(US90(-8))	0.050075	1.979462
DNZ90(-9)	-0.00052	-0.02045	DAUS90(-9)	-0.02687	-1.061464	D(US90(-9))	0.038559	1.523705
DNZ90(-10)	0.037646	1.487607	DAUS90(-10)	0.046972	1.856616	D(US90(-10))	-0.04142	-1.636818
DNZ90(-11)	0.07586	3.002	DAUS90(-11)	0.005951	0.235036	D(US90(-11))	0.019367	0.765017
DNZ90(-12)	0.031964	1.262913	DAUS90(-12)	0.061331	2.425438	D(US90(-12))	-0.00687	-0.271195

Correlation coefficients that are statistically significant at the 5 percent level are highlighted.

Figure A1: Plot of Residuals



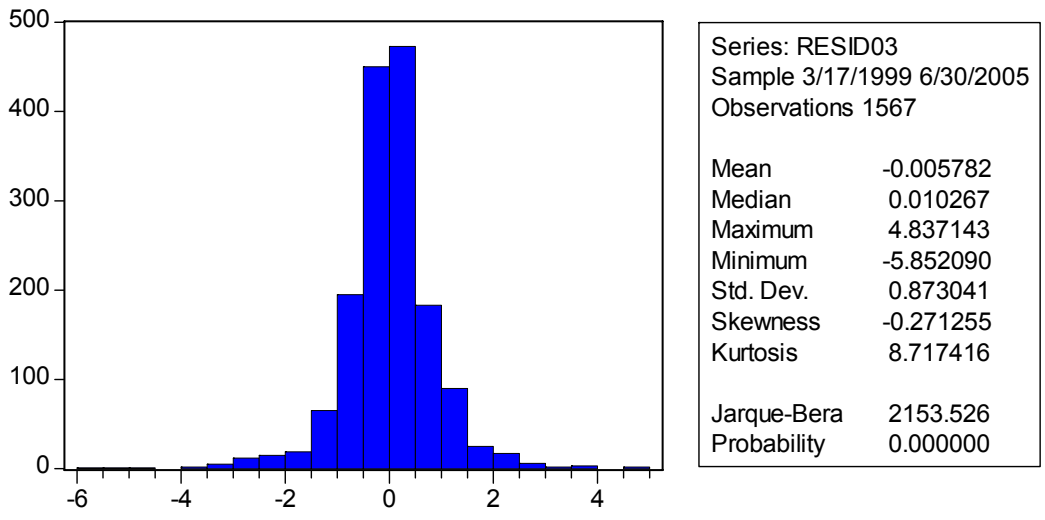


Figure A2: Distribution of the Residuals