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**THE EFFECTIVENESS OF RESERVE  
BANK OF AUSTRALIA FOREIGN  
EXCHANGE INTERVENTION**

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# **The Effectiveness of Reserve Bank of Australia Foreign Exchange Intervention**

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## **Abstract**

Despite the absence of substantial evidence to support the claim that sterilised foreign exchange intervention does systematically affect exchange rates, Central Banks continue to employ this practice. Recent overseas studies strongly support the notion that intervention is effective in the short-term. This paper evaluates the effectiveness of foreign exchange intervention performed by the Reserve Bank of Australia and studies which factors enhance intervention, using an event-study methodology. The period considered includes 1991 – 1998. Evidence is found of the RBA being able to cause reversals in the exchange rate trend and effect the direction of the exchange rate. A number of factors were found to consistently contribute to successful intervention episodes. Intervention effectiveness was enhanced when the actual exchange rate was closer to its fundamental value and the absence of on-going intervention appeared to aid exchange rate smoothing. Evidence is also found in support of the hypothesis that the mechanism involved is that of signalling.

**JEL Classification:** E44 G14 G15

**Keywords:** Foreign exchange intervention Central banks Exchange rate smoothing Exchange rate volatility

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## **1. Introduction**

This paper examines the response of the AUD/USD exchange rate to foreign exchange intervention undertaken by the Reserve Bank of Australia (RBA). The effects on intervention effectiveness of major economic variable announcements and deviations from the fundamental value of the exchange rate (both of which appear to be unexplored in the literature), will also be assessed.

Foreign exchange intervention involves buying (selling) foreign reserves held by the Bank, in an attempt to decrease (increase) the value of the Australian dollar. The RBA generally undertakes sterilised intervention, meaning that purchases (sales) of foreign currencies are offset with sales (purchases) of domestic securities, leaving the domestic monetary base unchanged. Intervention is sterilised to ensure that foreign exchange operations do not directly affect domestic monetary policy. In Australia, the value of the dollar is commonly measured against the USD, hence this paper focuses on the AUD/USD exchange rate.

Generally, Central Banks intervene in the Foreign Exchange market (inter alia) in order to smooth disorderly markets<sup>1</sup> and to bring the exchange rate back to within an equilibrium band.<sup>2</sup> These two reasons are regularly cited in RBA publications as the rationale for intervention.<sup>3</sup> Hence, in this paper, the effectiveness of intervention is appraised in terms of the RBA's ability to affect the direction and volatility of the Australian dollar in light of the two reasons for intervention just mentioned.

## **2. The Empirical Literature**

Generalised floating exchange rates were first introduced around the world in 1973. In the ensuing decade, disagreement grew between the European monetary authorities

and the Reagan administration on managing the floating currencies (Schwartz 2000). This culminated in a G-7 Summit in Versailles in 1982 where studies were commissioned on the effectiveness of foreign exchange intervention, which later formed the *Jurgenson Report* (1983). This report concluded that although intervention was effective in the short-run, sterilised intervention had no long-run effect unless supported by appropriate changes in domestic monetary policy. Theory suggests that where intervention by a Central Bank is effective, it may be due to either the 'portfolio balance' or 'signalling' channel. We will look at each in turn.

The portfolio balance channel may be approached through the portfolio balance model of exchange rate determination (Sarno and Taylor 2001). This model proposes that investors balance their portfolio among the assets of various countries on the basis of their relative expected returns. Following sterilised intervention there is little or no change to interest rates as the domestic monetary base is unchanged. However, the composition of portfolios will change following the Central Bank's purchase or sale of domestic assets. Hence, agents will attempt to rebalance their portfolios by purchasing or selling foreign assets. The changing of the relative supplies and prices of the assets prompts the exchange rate to shift.<sup>4</sup> This theory has little intuitive appeal as the amount of intervention relative to daily turnover in the foreign exchange markets is insignificant. As such, one would expect that there would be limited ability for a Central Bank to effect relative supplies and prices, and consequently the exchange rate. Furthermore, foreign and domestic assets may be close substitutes. Hence, there would be little or no need to rebalance portfolios following intervention.

Empirical research regarding the portfolio effect is limited due to the many difficulties in performing empirical work on the portfolio balance model of exchange rate determination. The two fundamental problems are the difficulties which arise in

the selection of non-monetary assets for use in the model and the absence of bilateral data.<sup>5</sup> Despite this, two general tests of the portfolio balance model have emerged; direct demand and inverted demand. Inverted demand testing involves determining the risk premium from the portfolio balance model and testing whether bonds denominated in different currencies are perfect substitutes. During the 1970's and 1980's some credence was given to the portfolio balance effect, although many found that the effects were small.<sup>6</sup> More recently, Dominguez and Frankel (1993) found intervention was able to assist in determining the risk premium, thereby providing significant support for portfolio balance theory. They also found that co-ordinated intervention, in particular, assisted in causing intervention to be effective.

Signalling channel theory proposes that Central Banks have superior information to other market participants, hence, any intervention performed should signal new information. Being a forward-looking variable, the exchange rate will be affected immediately by any changes in expectations regarding variables which are seen to affect the exchange rate. Under this theory, Central Bank intervention in foreign exchange markets should alter exchange rate expectations, as market participants will be prompted into changing their expectations of future actions of the monetary authorities or because they change their view of the impact of certain monetary authority actions (Sarno and Taylor 2001). Informational efficiency is implicitly assumed.

There is a significant body of work which supports signalling theory.<sup>7</sup> Dominguez (1987) found significant support for the signalling effect in regressing intervention on pre-announced money supply forecasts which are publicly available. It was found that intervention had a signalling effect, demonstrated by positive and significant coefficients in periods of 'high reputation' of the Central Bank and heavy

sterilised intervention. Almekinders (1994) presents significant and supportive findings regarding signalling theory, via the use of game theory. In particular, he suggests that information symmetry between the market and the Central Bank would render sterilised intervention ineffective. Hence, the secrecy demonstrated by Central Banks around the world may be extremely important, as it yields the Central Bank a foreign exchange policy tool which is independent of monetary policy. Not only is intervention designed to be independent of monetary policy, but there is little empirical evidence supporting a relationship between intervention and monetary growth rates. Hence, it can be argued that sterilised intervention is effective as it signals a target for the exchange rate. Eijffinger and Verhagen (1997) also support this notion. They suggest that traders in the foreign exchange market are focused on short-term profits, hence knowledge of the exchange rate being determined by fundamentals in the long run is of no relevance to them. Instead, they will concentrate on non-fundamental analysis.<sup>8</sup> This suggests that Central Bank intervention can affect the market via the signal of a desirable exchange rate, unlike a change in monetary policy, which reflects a change in the fundamentals of the economy.

Whilst some uncertainty exists regarding the reason(s) why intervention is effective in the short run, even greater uncertainty is found with respect to exchange rate determination. Such theories have found very little support, particularly short run models. Meese and Rogoff (1983) found little empirical evidence in support of a short run exchange rate model, whilst many theoretical arguments have been developed as to why short run models are difficult to estimate. In particular, it is argued that non-fundamental factors dominate fundamental factors in the short run, making it extremely difficult to model the exchange rate (Goodhart 1998). Many of

the techniques used for testing the portfolio balance channel and signalling channel effects involve estimating a model of the exchange rate. As there is no consensus on how to model the exchange rate, particularly in the short run, these techniques are questionable. In recognition of this problem, researchers have recently been using other statistical and econometric techniques which avoid the need to estimate the exchange rate. These techniques include logit analysis, conditional probability testing, matched sample testing and non-parametric means testing (Humpage 1996 and Fatum 2000). Furthermore, as Central Banks around the world are releasing higher frequency data, the use of event studies to capture any systematic effect of exchange rate intervention is becoming increasingly popular. The recognition that regressions of intervention on the exchange rate are unlikely or unable to capture any systematic effect<sup>9</sup> has also popularised the event study methodologies.

Fatum (2000) used techniques of non-parametric sign testing, matched sample testing and logit analysis, to determine whether sterilised intervention was able to systematically affect the exchange rate and to identify those what factors which might increase the likelihood of an effective intervention in Bundesbank and Federal Reserve operations. Effectiveness was evaluated using 'direction', 'smoothing' and 'reversal' criteria (these terms are explained below). Fatum found strong evidence of the Central Banks being able to systematically affect the exchange rate using non-parametric tests. The matched sample tests he performed indicated that intervention has a statistically significant smoothing effect on exchange rates. Furthermore, a dummy variable capturing the first day of intervention was found to improve the likelihood of an effective intervention, in his logit analysis. This implies that intervention does have a signalling effect. It is somewhat surprising that the first day of intervention effect was found to enhance exchange rate smoothing, as increased

volatility is often a by-product of intervention.<sup>10</sup> Variables capturing changes in monetary policy and public announcements of intervention were not found to influence the effectiveness of intervention. In his paper, Fatum did not include a variable capturing announcement effects of CPI, National Accounts and Labour Force statistics. Such announcements can affect exchange rate movements in addition to intervention. It follows that spurious results may be obtained if there are periods where the relevant announcements coincide with intervention and announcements are not controlled for in the regression. Hence, as an important improvement on Fatum (2000), an announcement variable will be included in the logit estimation to be undertaken in this paper.

Research on Australian foreign exchange intervention has been quite limited in both depth and breadth. The earliest study was performed by Andrew and Broadbent (1994), who found that intervention operations were profitable after accounting for net interest earnings, and thus suggested that they were stabilising. The period evaluated in their research commenced after the float of the Australian Dollar on 12 December 1983 and concluded at 30 June 1994. However, in this period, and particularly in the first few years following the float, the Bank's specific objective for each intervention episode was unclear. For example, intervention operations were often undertaken on both sides of the market, for similar transaction amounts on successive days. Thus, while the general objective of providing a stabilising influence on the currency remained, it was difficult to determine exactly what the Bank's objective was and, as a result, it was difficult to determine how effective the operations were. Furthermore, the sample period covers a significant structural change - the use of monetary policy to target inflation since 1990.

The main technique used by Andrew and Broadbent to appraise intervention effectiveness was 'Friedman's profits test'. Friedman proposed that a central bank is somewhat like a speculator, in that it will purchase an asset when it is perceived to be undervalued and sell the asset when it overvalued. He argued that such profitable speculation should reduce the variability of the exchange rate, as depreciations and appreciations will be limited. Friedman's profitability test is of limited value, as the criterion of success is simply whether or not the agency makes or loses money. Whilst intervention operations may be profitable, they may in reality have little impact on currency stability. Furthermore, the degree of effectiveness cannot be quantified. This test is also highly sensitive to changes in the sample period. It should also be considered that intervention may be profitable, but not stabilising. For example, when a central bank attempts to stabilise the currency on a consistent downward trend, it is likely to purchase currency at a higher rate than the rate at which it will sell. Thus, given Friedman's criteria, intervention operations in this example are ineffective, as they are unprofitable. Andrew and Broadbent also evaluated intervention using other criteria and found further evidence that intervention tended to be stabilising. These tests were performed on the premise that intervention is stabilising when the variance of movements around the exchange rate equilibrium are reduced. No regard is given to objective other than a reduction of volatility, nor the possibility that increased volatility in the short-run may simply be a consequence of intervention aimed at a different goal, such as to reach a longer-run equilibrium. In this paper we are able to take account of the passage of time to include events since 1994. Another difference between this paper and that of Andrews and Broadbent is that we are able to supplement our event studies with a logit analysis of intervention so as to examine the determinants of the probability of successful intervention.

Kim, Kortian and Sheen (2000) examine RBA intervention operations in five distinct periods during 1983 - 1997. Using EGARCH time series modelling, evidence was found of the RBA being successful in terms of influencing the direction and the (time varying) logarithm of the conditional variance of the exchange rate with 'sustained and large' interventions. Inspection of coefficients on various dummy variables concerned with intervention suggests that "the RBA's interventions did have trend dampening effects on the Exchange rate movements" (ibid p 14). With respect to (conditional) volatility, they conclude that intervention is "market calming" (ibid, p 15). Rogers and Siklos (2001) explored the impact of intervention operations on the higher moments of the distribution of FOREX returns and specifically, implied volatility (proxied by the implied volatility of foreign currency futures options) and the uncertainty of extreme outcomes in the exchange rate (proxied by kurtosis of implied risk-neutral probability density functions) in Australia and Canada. The sample period ranged from 1989 to 1998. They used Ordinary Least Squares (OLS) with the dependent variable being the logarithmic change in implied volatility and the logarithmic change in Kurtosis. It was found that RBA interventions reduced implied volatilities of foreign currency futures options but had no impact on kurtosis.

In this paper, an approach similar to that of Fatum (2000) described above has been followed. As a result this paper differs from Kim, Kortian and Sheen (2000) and Rogers and Siklos (2001) in that we analyse 12 events, as opposed to 5 and 4 events respectively and use three rather than two criteria to appraise intervention effectiveness. We also utilise both 'event studies' and logit analysis, as opposed to EGARCH and OLS techniques. Volatility is modelled using a direct measure, unlike the indirect measure used by Kim, Kortian and Sheen. Also, unlike Rogers and Siklos, we are interested in attempting to distinguish between various explanations of

successful intervention. Since one motivation for this paper was the desire to attempt to test the signalling channel hypothesis, the relationship between the deviations from the fundamental value of the exchange rate and the foreign exchange operations, which appears to be unexplored in the literature, will be examined. As will be seen, a significant relationship would give credence to signalling channel theory.

The remainder of the paper is organised as follows: Section 3 provides a description of the event-study methodology and demonstrates the application of the methodology. The historical context of each intervention episode is also given. Section 4 provides a description of the non-parametric sign test, the Wilcoxon Matched-Pairs Sign-Ranked Test, the Logit Model, and the respective data sets. Section 5 presents the results from the testing. The final section summarises the findings.

### **3. Event-study Methodology**

In this paper we look at 'events' which occurred in the period 6 June 1991 through 2 September 1998. An event study allows us to test hypotheses about Central Bank intervention without relying on a structural model of exchange rate determination. As models of exchange rates are generally unable to 'explain or predict exchange rate movements' (Schwartz 2000, p 4), such an approach is greatly advantageous. The relevant hypothesis is that exchange rate intervention is successful, given direction, smoothing and reversal criteria. This approach enables the effects of the various episodes of intervention to be isolated, thereby enabling an accurate and relatively objective assessment of the Bank's performance.

### *3.1 Defining the events*

Each event involves the Bank's foreign exchange intervention. An 'event' is therefore a period over which the Bank continues to buy/sell foreign currency with the primary intention of affecting the direction and/or volatility of the exchange rate. The Bank may have multiple reasons for buying (selling) foreign exchange; meeting the requirements of the Commonwealth Government, restocking (depleting) reserves<sup>11</sup> and intervention per se.<sup>12</sup> RBA Annual Reports and consultation with staff in the Bank's International Department were used to determine the Bank's intentions regarding each intervention episode. Events may include a number of days where no intervention occurred.<sup>13</sup> Fatum (2000) found that a maximum of 15 days of non-intervention between days of Bundesbank – Federal Reserve intervention within the one event was optimal when defining an event. Shorter periods create too many overlaps between events, whilst longer periods are intuitively unappealing, as it is likely that after a hiatus within the event period, the following intervention is likely to constitute a separate event.

Twelve events were identified using the aforementioned definition (refer to section 3.4 and to Table 1 below for details). The maximum number of days of no intervention within an event was six, which is intuitively appealing given Fatum's findings.

### *3.2 Defining the pre-event and post-event window*

The event window, being the time span over which the exchange rate is examined, consists of the pre-event window, intra-event or intervention window and post-event window. Pre- and post-event windows should be set long enough to capture a 'normal no-intervention' performance of the exchange rate, but not too long, as this prompts

significant overlaps between pre- and post-event windows of different events. Fatum (2000) found that there were no substantial differences between the lengths of two, five, ten, fifteen and thirty days for pre- and post-event windows when subjecting each of these event definitions to the various success criteria - a result which is supported by this study. However, the use of two and five-day windows were preferred as longer windows experienced at least five overlaps between events.

[TABLE 1 NEAR HERE]

### *3.3 Definitions of Success*

Three criteria are used to assess the effectiveness of intervention; direction, smoothing and reversal.<sup>14</sup>

The *direction criterion* refers to whether the movement of the exchange rate is in the intended direction. That is, if the RBA purchases (sells) foreign exchange for Australian dollars, the intended direction of the exchange rate is downward (upward). More formally, a success is defined as follows;

$$\{I_t > 0 \text{ and } \Delta S_{t+} > 0\} \text{ or } \{I_t < 0 \text{ and } \Delta S_{t+} < 0\}$$

where:  $I_t$  is foreign exchange intervention at time  $t$ . A positive (negative) number reflects sales (purchases) of foreign exchange

$\Delta S_{t+}$  is the change in the exchange rate over the post-event window

The *smoothing criterion* refers to the reduction in volatility, measured as a daily percentage change of the exchange rate. An event is a success according to the

smoothing criteria if exchange rate volatility is greater in the pre-event window, relative to the volatility in the post-event window. This is formally expressed as;

{the event is a success according to the direction criterion}

or

$\{I_t > 0 \text{ and } \Delta S_{t+} > \Delta S_t\}$  or  $\{I_t < 0 \text{ and } \Delta S_{t+} < \Delta S_t\}$

The *reversal criterion* is applied when the RBA is pursuing a 'leaning against the wind' policy. That is, the RBA attempts to reverse an ongoing trend in the exchange rate. Events are classified as 'leaning for and against' the wind by observing the directional change in the pre-event window and the subsequent policy of intervention. An event is a success according to the reversal criteria when a change in the direction of the exchange is observed, given the RBA is pursuing a 'leaning against the wind' policy.

### *3.4 Historical Context of Intervention*

#### *Event 1: 6 June 1991 – 10 June 1991*

In this period the RBA had a brief bout of intervention to bring 'stability and orderliness' (RBA Annual Report 1991, p 26) to the market and support the dollar, as uncertainty over the change in Treasurer generated strong selling pressure.

#### *Event 2: 6 December 1991 – 5 February 1992*

In December 1991, the Bank undertook an intense bout of intervention to support the dollar in the face of strong selling pressure. The threat of easier monetary policy and uncertainty over political leadership in Australia prompted the dollar to fall below what was perceived to be justified, given the economic fundamentals, and thus posed a threat to inflation. The Bank continued to support the dollar in early 1992, as

the foreign exchange market became unsettled due to rumours suggesting the Government favoured a lower exchange rate and fiscal expansion, in the lead-up to the Government Economic Statement release.

*Event 3: 26 June 1992 – 13 July 1992*

The dollar weakened in June 1992 based on expectations of further monetary policy easings. Though the 2.8 per cent decline in the exchange rate was significant, it occurred in an orderly fashion, hence the Bank only undertook light intervention, to support the dollar (RBA Bulletin July 1992, p 6,7).

*Event 4, 5, 6: 4 August 1992 – 22 January 1993*

The Bank undertook heavy intervention during August 1992, as the exchange rate had depreciated by 15 per cent over the previous year and a further depreciation was thought likely to threaten 'both price stability and confidence in policy more generally' (RBA Annual Report 1993, p 19). The Bank intended to reduce the tendency for overshooting by steadying the markets, thereby ensuring that exchange rate adjustments took place in a calmer environment (ibid). Such intervention continued between October 1992 and January 1993, but with reduced intensity. Smoothing of exchange rate movements was the primary intention of the RBA during this period.

*Event 7, 8: 28 April 1993 – 30 June 1993*

Similar downward pressures re-emerged throughout April and June 1993. This was met with a reduced magnitude of intervention relative to August 1992 as the fall in the value of the currency, measured by the TWI, resulted from the Japanese Yen falling against many Asian-Pacific currencies, with which the Australian dollar was associated, as opposed to a fundamental weakness in the Australian economy (RBA Annual Report 1993, p 19).

*Event 9: 17 August 1993 – 14 September 1993*

The RBA undertook a concentrated intervention operation between August and September 1993. The dollar was under intense selling pressure, reaching an historical low in TWI terms, whilst great uncertainty surrounded the Budget's passage through the Senate. The Bank intervened to support the dollar, as the weakening dollar was perceived as a threat to inflation and confidence in economic policy.

*Event 10: 15 May 1998 – 21 May 1998*

The RBA abstained from any significant intervention during the 'Asian currency crisis,' having 'accepted that a significant depreciation of the dollar in 1997/1998 was appropriate' (RBA Monetary and Financial Statements 1998, p 38). However, in May of 1998, the RBA performed a brief intervention operation of a small magnitude to assist in eliminating speculative selling undertaken by large international fund managers.

*Event 11: 9 June 1998 – 10 June 1998*

The RBA intended to eliminate speculative selling of the dollar and thus reduce volatility, by purchasing the Australian dollar. Approximately AUD 2.6 billion was purchased in June as the exchange rate hovered around US 60 cents. This was in the midst of the Asian financial crisis. The RBA intended its presence to act 'as a counterweight to hedge funds and restore a normal two-way flow of business' (RBA Bulletin July 1998, p 8).

*Event 12: 28 August 1998 – 2 September 1998*

Following the Russian's declaration of a moratorium on foreign debt and the associated turmoil created in financial markets and also with the dollar having fallen 25% against the USD since the commencement of the Asian crisis, the RBA was prompted into intervening with AUD 665 million in late August/early September

1998. The exchange rate was perceived to be overshooting, hence the RBA's intention was to reverse the trend and reduce volatility of exchange rate movements.

#### **4. Testing whether Intervention is Systematically Successful**

##### *4.1 Data Set*

The twelve events described above span the period from June 6, 1991 to September 2, 1998. Data prior to 1989 was excluded, primarily because the objectives of the Bank in the first few years following the float were generally unclear, hence the effectiveness of intervention episodes were not appraisable. Furthermore, following 1990, the RBA underwent a regime shift in monetary policy.

##### *4.2 Characteristics of Data*

Figure 1 displays the daily net purchases of foreign currency over the aforementioned period. From this figure the sporadic and clustered nature of intervention is clear. Furthermore, it can be ascertained that the magnitude of daily interventions is generally quite small, given that the size of average daily intervention as a percentage of average daily turnover was 0.13% in 1990, for example (source of all data is the International Department at the RBA). Figure 2 denotes the AUD/USD exchange rate over the relevant period. Over this period the exchange rate had fallen from 0.7578 to 0.5827. This series was found to be non-stationary under Phillips-Peron and the Augmented Dickey-Fuller (ADF) test at the 1% significance level.<sup>15</sup> Daily volatility expressed by daily percentage changes in the exchange rate is depicted in Figure 3. From this figure it can be seen that the exchange rate appears to be reasonably volatile. This series was determined to be stationary by the ADF and Phillips-Peron test at the 1% significance level.<sup>16</sup> However, the exchange rate volatility series was

not normally distributed.<sup>17</sup> Given the statistical characteristics of the relevant series, the non-parametric sign and matched-pairs signed-rank tests were performed.

[FIGURES 1 – 3 NEAR HERE]

#### *4.3 Data Set for the Non-Parametric Sign Test and Wilcoxon Matched-Pairs Signed-Rank Test*

Daily exchange rates and daily measures of net purchases of foreign currency in the foreign exchange market<sup>18</sup> over June 6, 1991 to September 2, 1998 are used to perform the analyses.<sup>19</sup> 'Net purchases of foreign exchange' includes customer (Government) transactions. The inclusion of customer transactions is not considered a limitation as the episodes chosen target more 'active' intervention.<sup>20</sup> Moreover, Neely (1998) found that the inclusion of customer transaction data does not significantly affect the statistical properties of the intervention data. Also, it must be noted that a central bank's roles of transacting large amounts of foreign exchange on behalf of clients and pursuing exchange rate objectives can often overlap. For example, a central bank might schedule previously agreed upon customer transactions to coincide with and thus support, intervention operations.

#### *4.5 Non-parametric Sign Test*

This test is used to determine whether the success of an intervention operation, is random or systematic. The non-parametric sign test is applicable to any continuous distribution. This property is desirable, as both the exchange rate series and the percentage change in the exchange rate were not normally distributed, which prevents

the valid application of numerous other statistical tests, such as F-tests. The null and alternate hypotheses for the various success criteria are:

$$H_0 : \text{Median} = 0$$

$$H_1 : \text{Median} > 0$$

A rejection of the null would suggest that intervention operations are systematically successful with respect to the criterion tested. The proportion of successful intervention events,  $p$ , with regard to all criteria, was 0.5.<sup>21</sup> This value was chosen in light of the assumption of the exchange rate following a martingale process, hence an upward or downward movement is equally likely. The number of sample observations,  $n$ , differed for the different criteria over the different window lengths used,<sup>22</sup> whilst the number of successful events were determined given the aforementioned definitions and assumed to have a binomial distribution.

The results of the non-parametric sign tests are given in Table 2.<sup>23</sup> An inspection of the second column of the table shows that the results were not particularly robust with regard to the direction criterion. The only statistically significant variable was found to occur over the 5-day event windows. However, this was only significant at the 10% level and did not remain significant when  $p = 0.6$ .

[TABLE 2 NEAR HERE]

The results in the third column of the table suggest that the RBA is able to systematically reduce the volatility of the exchange rate in the post-event period relative to the pre-event period. This finding is significant at the 5% and 10% level for 5-day and 2-day pre- and post-event windows respectively. The finding for the 5-

day pre- and post-event window is particularly robust, as it remained significant at the 10% level when  $p = 0.6$ .

Turning to the last column of Table 2, we see that there is strong evidence that the RBA is able to systematically reverse the exchange rate. Statistically significant results were found at the 5% level for both event window lengths, when success was assumed to be random. Furthermore, when the probability of success was raised to 0.6, the results remained significant, albeit at a reduced significance level over the two-day period.

Overall, the results from the non-parametric means testing are largely consistent with Fatum's findings which were summarised in Section 2 above. The only major difference was the absence of a finding that the RBA is able to effect the direction of the exchange rate. This may have been the result of the test statistics being sensitive to the sample tested.<sup>24</sup> However, as the RBA appeared to be able to affect reversals in the exchange rate, one might suggest that the RBA is more successful when pursuing 'leaning against the wind' exchange rate policy.<sup>25</sup> There is no contradiction involved in finding that the RBA is able to affect the direction of the exchange rate but at the same time to find that the RBA appeared to be able to affect reversals in the exchange rate. The reason is that 'direction' is a simple measure of whether intervention is effective, whilst 'reversal' considers what is happening to the exchange rate before the intervention occurs, that is, it considers when the Bank pursues a particular policy – that of 'leaning against the wind'. As the simple non-parametric sign test can only give a weak indication of whether intervention success is random or otherwise, a matched-pairs signed-rank test was performed.

#### *4.6 Wilcoxon Matched-Pairs Signed-Rank Test*

The matched sample testing employed by Fatum has not been pursued here as this test assumes that the series tested are normally distributed, whilst it was found that the relevant series in the Australian data set were not normally distributed using a Jarque-Bera test. Instead, the matched-pairs signed-rank test is used to determine whether matched pairs from the pre- and post-event windows differ in size. It is more powerful than a standard sign test, as the magnitudes of differences are ranked. This test is suited to small samples where the distribution is unknown, hence, it may be appropriately applied to the event-study. The null hypothesis proposes that the difference between each matched-pair has a median value of zero. Under the null hypothesis, the distribution of each pair's members is from an identical distribution and the difference between the pairs is symmetrical.

This test was performed on the five-day pre- and post-event windows for each event,<sup>26</sup> pertaining to the relevant criterion.<sup>27</sup> The first-day observation in the pre-event is matched with the first-day observation in the post-event, and so on for the remaining four pairs. Hence, there are five pairs in each test. The absolute difference of each pair is calculated and then ranked in terms of magnitude. Pairs where the difference is equal to zero are excluded and pairs where the absolute difference is equal receive the same rank. The sign attached to the difference is then reassigned to enable the summing of all the positive rankings (W+) and the negative rankings (W-) of the differences. The p-value is then determined by this summation of (W+) and (W-), adjusted for sample size. The results are reported in Table 3.

[TABLE 3 NEAR HERE]

The results suggest that there is strong evidence of the RBA being able to systematically affect the direction of the AUD, with ten of the twelve events yielding a rejection of the null hypothesis at the 10% level. Similarly, there is strong evidence that the RBA was able to affect a reversal in nine of the ten events. However, little evidence was found that intervention was able to systematically reduce exchange rate volatility. Only one of the twelve identified events was found to exhibit a different level of volatility between the pre- and post-event windows, at the 10% level of significance. Reference to the raw data reveals that the difference is positive, that is, there was reduction in volatility. Such weak results with regard to the smoothing criteria are to be expected, given the high daily volatility of the exchange rate, and that only a short-period, five days either end of the intervention period was examined.<sup>28</sup> Furthermore, increased volatility is likely a by-product of intervention, thus one would be less likely to expect a reduction in volatility immediately following an intervention.<sup>29</sup> One may also argue that this is consistent with both the portfolio balance and the signalling theories. Under portfolio balance theory, one would expect to see increased volatility in the intervention period and perhaps in the subsequent days following intervention, relative to the pre-event period, as investors re-adjust their portfolios. Under signalling theory, one would expect increased volatility in the intra-event period, relative to the pre-event period, as market participants receive and disseminate the signal provided by intervention, and subsequently take a new position in the market. Hence, the matched-pairs signed-rank test findings with regard to the smoothing criteria are consistent with both theories of intervention.

Having established that intervention success is not random, with respect to the direction and reversal criteria, we turn to examine those characteristics of intervention and other factors that may enhance the likelihood of success.

## 5. A Logit Model of the Determination of Factors which Enhance Intervention Effectiveness

In this section of the paper we report the results of employing a Logit model to determine which factors increase the likelihood of a successful intervention.<sup>30</sup> The Logit model states that the log of the odds ratio is a function of explanatory variables. The odds ratio regarding the success of intervention is denoted as follows:

$$\frac{P(y_i = 1 | X_i)}{1 - P(y_i = 1 | X_i)} \quad (1)$$

where: P refers to the estimated probability of observing success

$y_i$  refers to the dependent variable

$X_i$  is a vector of variables that affect the probability of observing a successful intervention operation

The success criteria of direction, smoothing and reversal, each form the dependent variable in the logit estimations. The actual series for each variable is binary (consisting of 1's for the successful events and 0's for the unsuccessful events) and determined by the definitions given previously.

Taking the log of the odds ratio yields the logit model:

$$L_i = LN \left( \frac{P(y_i = 1 | X_i)}{1 - P(y_i = 1 | X_i)} \right) = b' X_i + u_i \quad (2)$$

where;  $L_i$  (the logit function) is estimated using maximum likelihood techniques

$P_i$  is the estimated probability of observing a success

$b$  is a vector of the estimated parameters

$u$  is a vector of the error terms

When the variable is continuous, the slope coefficient is interpreted as the change in the log of the odds ratio per unit change in the explanatory variable, *ceteris paribus*. If the variable is a dummy, the coefficient is interpreted as the change in the log of the odds ratio when the dummy is 'switched on', *ceteris paribus*.

Three magnitude variables were included on the RHS of the fitted equation. One continuous variable, *MAGN*, was included to capture the actual magnitude and sign of the intervention.<sup>31</sup> The remaining magnitude variables, *Small* and *Large*, are dummy variables. *Small* is 'switched on' when the size of the intervention was no larger than AUD 100 million, whilst *Large* is 'switched on' when the intervention was at least AUD 500 million. The magnitude of intervention is considered to be an important aspect of exchange rate policy under both theories of intervention. Dominguez (1990) found a signaling effect from sterilized intervention, only when intervention was 'heavy'. Whilst under the portfolio balance theory, one would expect that an increased magnitude of intervention will prompt greater adjustments in investor's portfolios, as the changes in relative supplies and prices are enhanced, and thus, a greater impact on the exchange rate.

Two dummy variables regarding the pattern of intervention operations were also included in the Logit equation. The variable *FDE* was 'turned on' when the first day on an intervention occurred. This variable was intended to test whether there was an expectations effect on the first day of intervention. Given that the RBA uses intervention to signal its beliefs regarding the fundamental value of the exchange rate, such information should be revealed on the first day of intervention, as opposed to subsequent days in the episode. Hence, a significant *FDE* variable would give credence to the signalling hypothesis. The 'back-to-back' variable, *B2B* was intended to capture any cumulative effect of intervention. As such, the variable was 'turned

on' when intervention had occurred on the preceding day. This also tests signalling theory, as one would not expect a cumulative intervention effect, given that the relevant information was signalled on the first day of the intervention episode.

Monetary policy can significantly affect the effectiveness of foreign exchange intervention operations. Given that intervention is sterilised, changes in monetary policy can improve intervention if the changes are consistent with the intervention operation. Hence, *Dunoff*, a continuous variable, denoting the change in the Australian unofficial cash rate, was included to account for any monetary policy changes.

As previously mentioned, Fatum (2000) failed to include an announcements variable in his study. This is a major shortcoming because announcements of economic data can have a significant influence on both the direction and volatility of exchange rate markets. Thus, they can affect the possibility of an intervention being successful. Hence, in this study, a dummy variable, *ANCMNTS*, has been included. It is 'switched on' when announcements of changes in monetary policy are made and when National Accounts, Labour Force and the Consumer Price Index data is released by the Australian Bureau of Statistics.<sup>32</sup>

Another innovation made in this study is the inclusion of a continuous variable, *DEV*, which captures deviations in the actual exchange rate from the estimated fundamental exchange rate. Following Froot and Rogoff (1995), the fundamental exchange rate was modelled as a four-year moving-average. Froot and Rogoff found that 'consensus estimates put the half-life of deviation from purchasing power parity at about four years, among major industrialised countries.' (Froot and Rogoff 1995, p 1648). An improved estimation of the fundamental exchange rate would be obtained from a moving-average of six or seven years, for example, as

opposed to four years, given Froot and Rogoff's findings. However, data limitations prevented the implementation of a longer period moving average estimation of the fundamental exchange rate. Deviations of the actual exchange rate from the fundamental exchange rate were then calculated in percentage terms. It is hypothesised that, as the exchange rate moves further away from its fundamental value, the tendency to overshoot increases. As such, the greater the deviation from the calculated fundamental value, the less likely the intervention would be a success, with respect to all criteria. Alternatively, one could argue that as the exchange rate deviates from its fundamental value, market participants generate a wide range of expectations. Given the diversity of beliefs, a signal from the RBA's intervention may unify market expectations and thus cause the operation to be effective.

In addition to daily exchange rates and measures of net purchases of foreign currency, estimation of the Logit model requires a series for the changes in the unofficial cash rate was required. Unlike Fatum (2000), co-ordination variables were not used, as Australia does not explicitly undertake intervention in co-ordination with any other country. Also, variables regarding the publicity of intervention in newspapers and market perceptions of intervention were omitted, as no objective measure of these variables is available for Australia over the relevant time period. This is unfortunate as the latter series, in particular, would have contributed to determining the presence of signalling effects from intervention. Various measurements of returns on assets and the official target cash rate were omitted due to differing institutional arrangements, particularly with respect to Germany, and econometric limitations respectively. Changes in the official interest rate were often zero and as such were frequently highly correlated with various dummy variables, causing estimation to be inefficient. The RBA did not make any public

announcement of intervention over the relevant period; hence, this variable was excluded.

All twelve events were subjected to the logit model. Data sets of both the 2-day and 5-day, pre- and post-event windows are analysed to determine the robustness of the results obtained. The variables *Large* and *MAGN*, were found to be highly correlated over each of the data sets.<sup>33</sup> Hence, to improve estimation, one of the variables, *Large*,<sup>34</sup> was omitted from the model. This approach was marginally favoured over the use of interactive dummy variables, via reference to the classification tables and to the significance of the variables. The results are reported in Table 4. There were no significant differences in the results from the two data sets used. The only exception, in terms of the statistical significance of variables, was that of *FDE* and *B2B* are significant over the 2-day window data set but are insignificant over the 5-day window data set.

[TABLE 4 NEAR HERE]

The variable, *ANCMNTS*, was never found to be of statistical significance. This intimates that public announcements of the National Accounts, Labour Force, Consumer Price Index and changes in monetary policy have no discernable impact on the effectiveness of intervention. The insignificance of this variable may be explained by the presence of few announcements of the intervention periods identified. Furthermore, many other announcements, or 'news' will be present in a given day, hence, the effect of the single announcement may not be captured as daily, as opposed to intra-daily data, is being tested.

The cumulative effect of intervention was found to have no impact on the likelihood of a successful intervention, given the reversal and direction criteria. This lends support to signaling theory as, given that the RBA is signaling its beliefs as to the fundamental value of the exchange rate, this information should have been received by market participants on the first day of intervention and thus no cumulative effect should be observed. However, *B2B*, was found to be significant when the smoothing criterion formed the dependent variable. The coefficient was negative, suggesting that accumulated intervention reduces the likelihood of a successful intervention. Specifically, in the 2-day window data set, if there was intervention on the previous day, the likelihood of a successful intervention was reduced by a factor of approximately 0.24, *ceteris paribus*. It should be noted that the model from which this statistic was computed is one of best-fitted models of all tested, as indicated by the McFadden statistic and the classification tables. This supports the claim that increased volatility is a by-product of intervention.

Deviations from the fundamental value of the exchange rate were found to consistently affect the probability of a successful intervention. Of all the models estimated, *DEV*, was always statistically significant at the 5% level, and of a negative sign. This suggests that when the exchange rate has a 1% deviation from the fundamental exchange rate, the probability of a successful intervention is reduced, by a varying factor, depending on the success criterion applied. The probability of intervention being successful is reduced the most when the smoothing criteria forms the dependent variable. These findings suggest that a larger actual and fundamental exchange rate differential will result in a reduced probability of a successful intervention.

The change in unofficial interest rates was not found to affect the probability of the RBA's intervention operations. There was only a change in official interest rates during two events, hence, it is not surprising that no relationship was found. Furthermore, foreign exchange operations over the period of time examined were conducted independently of monetary policy. Thus, one would not expect a relationship between the changes in interest rates and the success of intervention.

There was further evidence of the signaling effect, demonstrated by *FDE* being significant at the 5% and 10% level with regard to the direction and reversal success criteria respectively over the two-day window data set. However, these results cannot be considered robust as *FDE* was never significant in the estimations made over the five-day data set. However, over the two-day data set, it was found that on the first day of intervention the probability of success was increased by a factor of 0.83 with regard to the direction criterion, *ceteris paribus*, a finding which is similar to Fatum (2000). The probability of success was increased by a factor 0.85, *ceteris paribus*, with regard to the reversal criteria. The logit analysis yielded a similar finding to the matched-pairs signed-rank test, namely that the RBA was more likely to be successful when pursuing a 'leaning against the wind' policy. The logit finding implies that the market is receiving a signal from the RBA's intervention and behaving accordingly, thereby causing the exchange rate to move in the desired direction. It is notable that *FDE* is not statistically significant in the logit when the smoothing criterion forms the dependent variable. One would expect this result because, as the market receives and interprets the signal and takes a position on that information, volatility would be expected to increase, especially, on the first day of intervention, when the signal is supposedly received.

Finally, there was no evidence of the magnitude of intervention affecting the success of intervention with regard to all criteria. One would have expected that a greater magnitude would send a stronger signal of the desired level of the exchange rate to the market, as the intervention would be easier to observe by market participants as the size increases. This argument is given some credence by the statistical insignificance of the variable, *SMALL*, in each estimation. However, one may argue that the markets are extremely sensitive to any perceived intervention performed, due to the informational asymmetries between market participants and the RBA and as such, do not place a great weighting on the magnitude of the intervention.

## 6. Conclusions

The RBA's foreign exchange intervention operations appear to be successful in the short-run. In general, intervention was slightly more effective when the RBA pursued a 'leaning against the wind' policy. Strong evidence was found supporting the Bank's ability to systematically influence the direction of the exchange rate and generate reversals of the exchange rate using matched-pair signed-rank tests. However, the RBA seemed unable to reduce the volatility of the exchange rate. Furthermore, there was evidence of intervention generating increased volatility over the time horizons examined, which would be consistent with the signalling hypothesis.

Numerous factors were found to increase the probability of an effective exchange rate policy implementation, in terms of the direction, reversal and smoothing criteria, via use of the logit model. Success was more likely to be achieved with regard to the direction criteria when the exchange rate was closer to its fundamental value and on the first day of intervention. The absence of on-going intervention and the lesser the deviation from the fundamental value of the exchange

rate, the greater the probability of success, given the smoothing criterion. These findings suggest that increased volatility is a by-product of intervention, and that when the exchange rate is close to its equilibrium, its volatility is diminished. The RBA was also more likely to prompt a reversal in the exchange rate on the first day of intervention and when the exchange rate is closer to its fundamental value.

Significant evidence was found in support of the signalling hypothesis in the logit analysis. In particular, accumulated intervention was not found to improve intervention performance, whilst, first day of intervention signalling effects were found, with regard to both the direction and reversal criteria.

## Endnotes

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<sup>1</sup> A market which experiences large daily movements above and below the mean daily value of the asset

<sup>2</sup> A Central Bank may intervene in order to act in co-operation with another Central Bank (Fatum 2000 and Schwartz 2000). This does not seem to be relevant in the case of Australia.

<sup>3</sup> For example, 'There have been episodes...in which the Bank has taken action to influence the exchange rate, either because the market overshooting had pushed the exchange rate to levels which could have compounded problems of economic management, or because markets had become unsettled...' – Reserve Bank of Australia, *Annual Report 1997*, p. 18.

<sup>4</sup> Assuming foreign and domestic assets are not perfect substitutes.

<sup>5</sup> See Taylor (1995) for a rigorous discussion of the econometric difficulties surrounding the PBM.

<sup>6</sup> See Edison (1993) for a review of 1980's portfolio balance empirical testing.

<sup>7</sup> Signalling theory has also been tested by inverted portfolio balance equations where the risk premium is the dependent variable whilst intervention is the explanatory variable. See Dominguez (1990) for an example.

<sup>8</sup> The fact that short-term capital movements dwarf long-term foreign direct investment, should indicate the focus on the short term within foreign exchange markets.

<sup>9</sup> This is due to the highly volatile nature of the exchange rate on a daily basis and the clustered and sporadic nature of intervention.

<sup>10</sup> The magnitude of intervention was also found to enhance intervention effectiveness, yet dummy variables capturing small and large interventions were insignificant.

<sup>11</sup> If the dollar is soft, the Bank may defer replenishing the FOREX reserves as the exercise would be very expensive. Instead, the Bank may wait for the dollar to strengthen and then purchase FOREX to rebalance the portfolio.

<sup>12</sup> These objectives may overlap.

<sup>13</sup> Hence a degree of discretion is created, as one may determine a number of non-intervention days as being part of the one event, or consider them to be part of the next event. To limit the subjectivity in determining the windows, the RBA Annual Reports and International Department were consulted.

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<sup>14</sup> Definitions for the criteria are those used by Fatum (2000)

<sup>15</sup> ADF (trend and intercept) statistic: -1.31 Critical Value (1%): -3.97 (equivalent results for PP).

<sup>16</sup> ADF statistic: -42.1 Critical Value (1%): -2.57 (equivalent results for PP),

<sup>17</sup> Percentage change in exchange rate: Jarque-Bera Statistic = 979.3, p-value = 0.00. Note: the Jarque-Bera test cannot be applied to the exchange rate series as it was found to be non-stationary.

<sup>18</sup> A negative value in this series represents a net sale of foreign currency.

<sup>19</sup> All data used in this paper has been provided by the RBA.

<sup>20</sup> That is, intervention where the primary goal of the RBA is to affect the level or volatility of the exchange rate.

<sup>21</sup> This assumption was preferred to out of sample testing, as much subjectivity is required for such testing. Furthermore, the direction series is non-stationary, thus no sample will be representative of the whole series.

<sup>22</sup> Two and five day window lengths were tested.

<sup>23</sup> Equivalent results were achieved when the TWI, as opposed to the AUD/USD exchange rate was subjected to the test.

<sup>24</sup> The 'reversal' data set is a subset of the 'direction' data set.

<sup>25</sup> Baillie and Osterberg (1997) also found that intervention was more likely to be effective when a 'leaning against the wind' policy was being pursued.

<sup>26</sup> The sample size of the 2-day windows was deemed too small to yield any meaningful results.

<sup>27</sup> Hence, only ten events were tested for the reversal criterion.

<sup>28</sup> Longer periods were avoided due to 'overlapping' intervention events.

<sup>29</sup> It would also appear that reductions in volatility were more likely to be significant over 15 and 30-day windows, as opposed to 2 and 5 day windows. Furthermore, it was found that the difference in average volatility between the pre- and post-event period relative to the intra- and post-event period, was less, which supports the notion that increased volatility is a by-product of intervention.

<sup>30</sup> A Probit model was also estimated, however, no significant differences were found between probit and logit estimations with regard to the classification tables and the significance of variables. The differences which did arise, usually favoured the use of the logit model. Hence, the results reported are those of the logit model.

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<sup>31</sup> A further improvement to a magnitude variable would be to capture the magnitude of intervention. relative to the size of the AUD/USD market on each day of intervention.

<sup>32</sup> Data regarding the announcements of the CPI, Labour Force, National Accounts and changes in monetary policy were obtained from the ABS.

<sup>33</sup> The correlation coefficient for each data set was greater than 0.88.

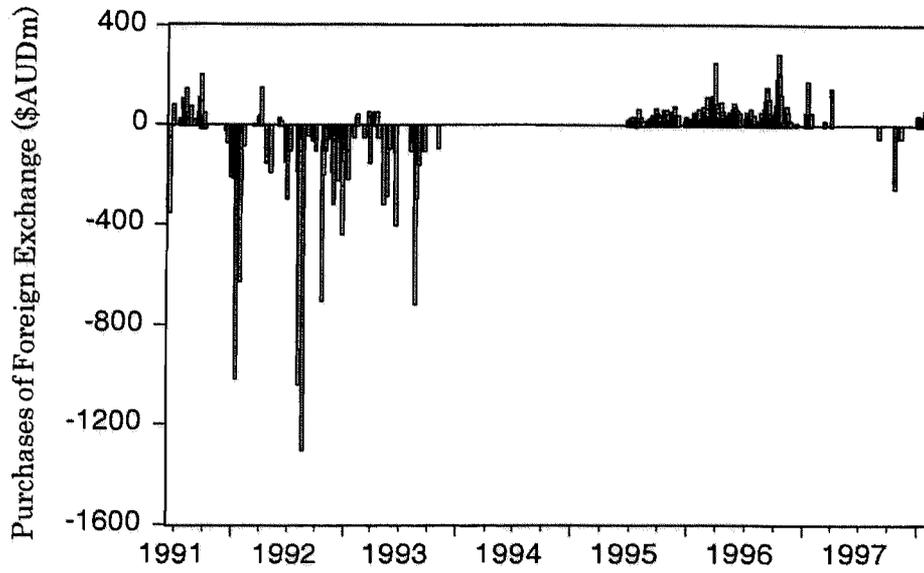
<sup>34</sup> *MAGN* was selected to remain in the model as it contained more information than *Large*.

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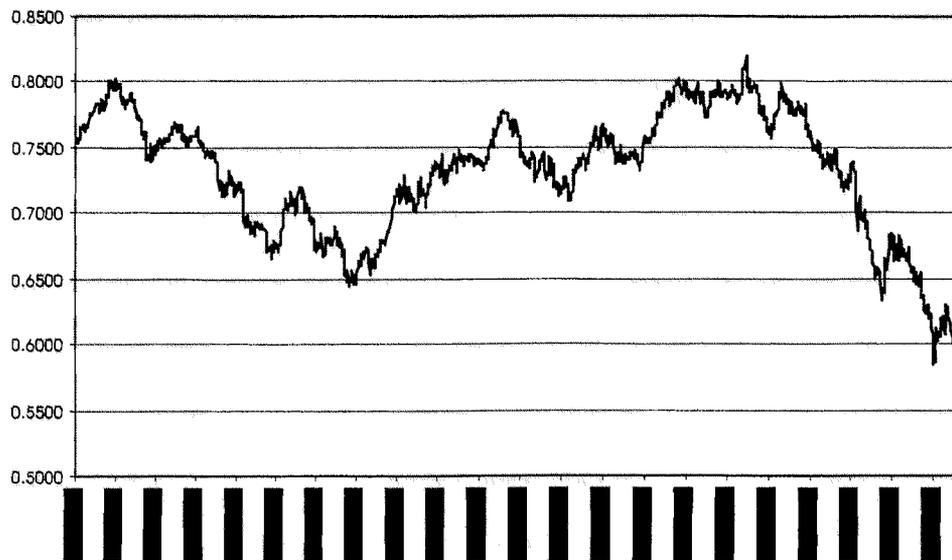
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**Figure 1. Foreign Exchange Market Intervention  
6 June 1991 – 2 September 1998**

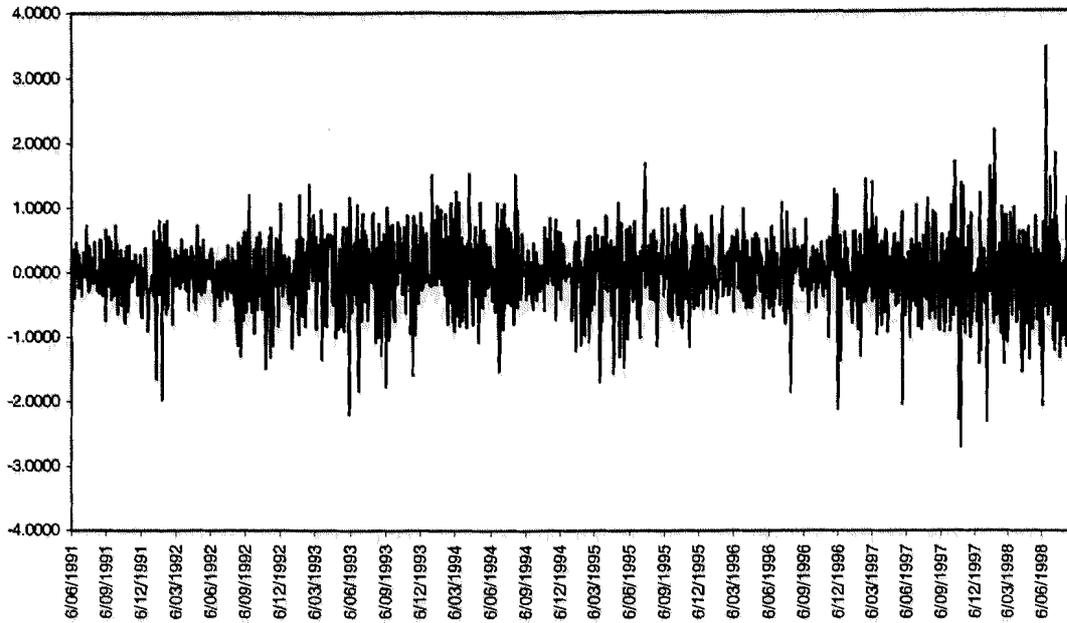


Source (for data displayed in all Figures): RBA

**Figure 2. Historical Data for the AUD/USD Exchange Rate  
6 June 1991 – 2 September 1998**



**Figure 3. Percentage Changes in AUD/USD Exchange Rate  
6 June 1991 – 2 September 1998**



**Table 1: Event Details**

<i>Event</i>	<i>Event Span</i>	<i>Total amount of Intervention (\$AUD million)<sup>a</sup></i>	<i>Number of days during event</i>	<i>Number of days of no intervention during the event<sup>b</sup></i>	<i>Maximum number of consecutive days of no intervention during the event</i>
1	6/6/91-10/6/91	-445	3	0	0
2	6/12/91-5/2/92	-5278	51	14	6
3	26/6/92-13/7/92	-1012	12	3	2
4	4/8/92-25/8/92	-3814	16	6	3
5	22/9/92-2/10/92	-334	9	3	2
6	27/10/92-22/1/93	-3781	61	30	5
7	28/4/93-1/6/93	-457	3	0	0
8	23/6/93-30-6-93	-632	6	2	1
9	17/8/93-14/9/93	-1589	21	10	3
10	15/5/98-21/5/98	-577	5	2	2
11	9/6/98-10/6/98	-2528	2	0	0
12	28/8/98-2/9/98	-665	4	0	0

- a. Negative values represent AUD purchases.  
b. Excluding weekends and public holidays.

**Table 2: Non-parametric Sign Test Results**

<i>Proportion(success)=0.5</i>	<i>DIRECTION</i>	<i>P-values</i>	
		<i>SMOOTHING</i>	<i>REVERSAL</i>
2-day	0.613	0.073*	0.020**
5-day	0.073*	0.019**	0.011**
<i>Proportion(success)=0.6</i>			
2-day	0.335	0.225	0.071*
5-day	0.225	0.083*	0.046**

- \*Significant at 10% level  
\*\*Significant at 5% level

**Table 3. Matched-Pairs Signed-Rank Test Results**

<i>Event</i>	<i>Direction</i>	<i>Smoothing</i>	<i>Reversal</i>
	<i>p-value</i>	<i>p-value</i>	<i>p-value</i>
1	0.0625*	0.3125	0.0625*
2	0.0625*	0.8125	0.0625*
3	0.0625*	0.6250	0.0625*
4	0.0625*	0.8125	0.0625*
5	0.0625*	0.6250	0.0625*
6	0.0625*	0.1875	0.0625*
7	0.0625*	0.6250	
8	0.1250	0.8125	
9	0.0625*	0.1875	0.0625*
10	0.0625*	0.6250	0.0625*
11	0.0625*	0.1875	0.0625*
12	0.1250	0.0625*	0.1250

\* Significant at the 10% level

Note: Events 7 and 8 were episodes of the Bank 'leaning with the wind' and because of this were not tested against the reversal criterion.

Table 4. Results from Logit Testing

5 DAY WINDOWS			2 DAY WINDOWS		
<i>DIRECTION as the dependent variable</i>			<i>DIRECTION as the dependent variable</i>		
<i>Variable</i>	<i>Coefficient</i>	<i>Prob.</i>	<i>Variable</i>	<i>Coefficient</i>	<i>Prob.</i>
ANCMNTS	0.363 (0.653)	0.579	ANCMNTS	0.125 (0.584)	0.831
B2B	-0.433 (0.575)	0.451	B2B	-0.058 (0.480)	0.904
C	1.138 (0.211)	0.000**	C	-2.046 (0.314)	0.000**
DEV	-0.150 (0.056)	0.008**	DEV	-0.382 (0.068)	0.000**
DUNOFF	0.173 (0.767)	0.821	DUNOFF	-0.247 (0.597)	0.679
FDE	-1.215 (0.844)	0.150	FDE	1.586 (0.790)	0.045**
MAGN	-0.002 (0.002)	0.202	MAGN	0.001 (0.001)	0.287
SMALL	0.845 (0.528)	0.110	SMALL	0.007 (0.420)	0.987
<i>SMOOTHING as the dependent variable</i>			<i>SMOOTHING as the dependent variable</i>		
<i>Variable</i>	<i>Coefficient</i>	<i>Prob.</i>	<i>Variable</i>	<i>Coefficient</i>	<i>Prob.</i>
ANCMNTS	-0.069 (0.374)	0.854	ANCMNTS	-0.021 (0.596)	0.972
B2B	-0.252 (0.346)	0.467	B2B	-1.133 (0.519)	0.029**
C	0.854 (0.133)	0.000**	C	-0.196 (0.274)	0.474
DEV	-0.243 (0.048)	0.000**	DEV	-0.713 (0.099)	0.000**
DUNOFF	0.240 (1.214)	0.843	DUNOFF	0.821 (2.539)	0.746
FDE	-0.389 (0.556)	0.484	FDE	0.429 (0.888)	0.629
MAGN	-0.001 (0.001)	0.367	MAGN	-0.000 (0.001)	0.767
SMALL	0.258 (0.316)	0.413	SMALL	0.724 (0.499)	0.147
<i>REVERSAL as the dependent variable</i>			<i>REVERSAL as the dependent variable</i>		
<i>Variable</i>	<i>Coefficient</i>	<i>Prob.</i>	<i>Variable</i>	<i>Coefficient</i>	<i>Prob.</i>
ANCMNTS	0.446 (0.786)	0.571	ANCMNTS	0.321 (0.602)	0.594
B2B	-0.367 (0.646)	0.569	B2B	-0.222 (0.502)	0.659
C	1.359 (0.234)	0.000**	C	-1.981 (0.337)	0.000**
DEV	-0.166 (0.064)	0.010**	DEV	-0.372 (0.071)	0.000**
DUNOFF	0.176 (0.892)	0.844	DUNOFF	-0.288 (0.607)	0.635
FDE	-1.104 (0.982)	0.261	FDE	1.706 (0.921)	0.064*
MAGN	-0.002 (0.002)	0.307	MAGN	0.001 (0.001)	0.336
SMALL	0.806 (0.603)	0.181	SMALL	-0.005 (0.434)	0.992

\* Significant at the 5% level

\*\* Significant at the 10% level

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