PROFITABILITY OF RESERVE BANK FOREIGN EXCHANGE OPERATIONS: TWENTY YEARS AFTER THE FLOAT

Chris Becker and Michael Sinclair

Abstract

Since the float of the Australian dollar in December 1983, the Reserve Bank of Australia (RBA) has retained the discretion to intervene in the foreign exchange markets in order to avoid what it perceives to be large overshooting in the currency. In this paper we invoke the 'profit test' first advocated by Friedman to assess whether the RBA's foreign exchange operations have had a stabilising influence on the exchange rate. We do this over the entire post-float period, as well as for each of the three distinct cycles in the exchange rate during that period. The premise underlying the profit test is that if the central bank has made a profit from intervention in its currency, it must have 'bought low and sold high', which would work towards stabilising the exchange rate. Since the float, the RBA has made a profit of A\$5.2 billion on its intervention operations, with profits made in each of the three cycles. The paper concludes that the profitability of intervention suggests that the RBA's operations have had a stabilising influence on the exchange rate.

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1. Introduction

When the Australian dollar was floated over 20 years ago, the Australian Government and the Reserve Bank of Australia (RBA) gave up the determination of the exchange rate to market forces. However, while allowing the exchange rate to move freely in a wide range, the RBA retained the discretion to intervene in the foreign exchange market from time to time if conditions warranted.

Have the RBA's efforts to stabilise the exchange rate through intervention achieved the desired outcome?

As the counterfactual exchange rate path in the absence of intervention is unobservable, we invoke an indirect test of the effectiveness of intervention. The basic thesis postulated is that intervention aimed at stabilising the exchange rate will require the central bank to buy the currency when the exchange rate is relatively low and to sell it when the exchange rate is high. Such a policy, if pursued successfully, will generate a trading profit as a by-product. Applying this logic in reverse, it follows that if a central bank has generated profits from its intervention, it must have bought low and sold high, which would work to stabilise the exchange rate. This approach, first applied to Australia by Andrew and Broadbent (1994) derives from the work of Milton Friedman who, in his 1953 book, argued that currency speculators would, on balance, be stabilising as they would not survive if they did not buy low and sell high.

We find that the RBA has made a profit of A$5.2 billion from intervention since the float. We identify three distinct cycles in the exchange rate and in the intervention activities of the RBA, and find that intervention has been profitable, not only over the entire post-float period, but also in each of the three cycles. We conclude from these findings that the RBA's transactions have helped to stabilise the currency.

The paper is organised in the following sequence. Section 2 gives a brief account of why the RBA retains the discretion to intervene in the foreign exchange market. Section 3 gives a technical account of how intervention is conducted. Section 4 details how intervention has evolved since the time of the float. Section 5 lays out the calculation of profits from intervention. The final section offers some concluding remarks. The Appendix provides a survey of studies of Australian intervention.

2.   Why the Reserve Bank Intervenes

The decision to float the Australian dollar allowed market forces to determine the value of the currency. Since the float, the exchange rate has moved freely in a wide range around an average of US70½ cents, peaking at US96½ cents in March 1984 and reaching a low of just under US48 cents in April 2001. The adoption of a floating exchange rate regime, however, did not mean that the RBA had become indifferent to either the level of, or movement in, the exchange rate, since these can have a powerful influence on important aspects of the economy, particularly economic growth and inflation. As such, the RBA has from time to time intervened in the foreign exchange market.

This approach had its roots in the findings of the Campbell Committee which concluded that an absolutely 'clean' float was unrealistic and acknowledged that the authorities might wish to deal in the market from time to time, while at the same time cautioning against exchange rate targeting. There was also a widespread expectation in financial markets that the RBA would intervene, as suggested by an *Australian Financial Review* (AFR) headline on the first trading day of the float entitled, 'The question now is when and how to intervene' (12 December 1983, p 5).

It is interesting to note that the academic literature over the past couple of decades has come to acknowledge that financial markets can overshoot. There is extensive literature, for example, on speculative bubbles, herding, fads and other behaviour which can drive market prices away from their equilibrium values, even in a market which is deep and liquid. When such overshooting occurs, intervention may help in limiting the move or returning the exchange rate towards its equilibrium

level, thus obviating the need for costly adjustment by the real economy to the incorrect signals which the exchange rate would otherwise give.

The RBA's approach to intervention has evolved over the past 20 years. The various phases in its approach to intervention are outlined below, but in broad terms there has been a shift away from concern about short-term volatility in the early days following the float to a focus on episodes where the exchange rate has 'overshot' – i.e. moved to a level that does not seem reasonable in the context of a range of economic and financial developments. Broadly, this change in emphasis has resulted in intervention strategy moving from small daily interventions with frequent changes in direction (often described as 'testing and smoothing') to less frequent but larger scale intervention once the exchange rate had moved a long way.

Of course, the important issue is to identify in practice when the exchange rate has in fact overshot. Typically, the RBA has come to regard overshooting as unlikely to be occurring unless the exchange rate has moved a long way and, as noted, the move does not appear to be supported by economic and financial factors. This approach effectively means that the bulk of the RBA's intervention takes place around the cyclical highs and lows in the exchange rate.

In addition to circumstances where there appears to be misalignment, the RBA will also consider intervening in the market when conditions threaten to become disorderly. Persistent volatility, a sharp widening in bid-ask spreads or erratic movements of the exchange rate (especially at times of uncertainty about macroeconomic policy) may result in intervention to help restore order. Having said this, the RBA has become more comfortable with the ability of the market to cope with shocks of various types, so episodes when intervention is motivated by the desire to avoid disorderly conditions have become much less frequent.

Neither of the two reasons for intervention discussed above suggests that intervention could be used as an effective instrument of policy for achieving a particular level for the exchange rate. Nor does it imply the use of intervention to correct a monetary policy imbalance or to resist changes in the exchange rate which are in line with broader economic or financial developments.

In addition to intervention (i.e. transactions aimed purely at influencing the exchange rate) the RBA also undertakes more routine operations in the foreign exchange market, such as covering Government foreign exchange needs and rebuilding reserve holdings after periods of intervention. These give the RBA a fairly regular presence in the foreign exchange market.

3. How the Reserve Bank Intervenes

When the RBA intervenes, it buys or sells Australian dollars against another currency, almost always the US dollar.[1] To support the exchange rate at a time when it is depreciating, the RBA would sell foreign exchange and buy Australian dollars. If the RBA wanted to resist an appreciating exchange rate, it would buy foreign exchange and sell Australian dollars. The RBA has the capacity to deal in Australian dollars around the world, 24 hours a day.

As well as decisions about whether, and by how much, to intervene, the RBA also has discretion to vary the way the intervention is conducted and therefore the impact a given amount of intervention will have on the market. The most low-key form of intervention is to use an agent bank, so that the market as a whole is not aware of the RBA's presence. This type of transaction is also typically used when the RBA is replenishing reserves after a period of intervention, as the aim is to rebuild reserve holdings without having a significant impact on the market. In these operations, the RBA leaves orders with commercial banks and acts as a price taker rather than trying directly to push the exchange rate one way or another.

A second type of intervention involves the RBA entering the broker market directly, either through voice brokers or, in recent years, the electronic broker market. Within this broad strategy, the RBA can vary the intensity of its operations by either dealing on other banks' bids or offers or, if it wants to be more aggressive, bidding or offering directly. Because the broker market is the main mechanism used by interbank market participants to trade among themselves,

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[1] It will usually subsequently re-balance the various currencies it holds in order to restore the proportions in line with its foreign currency benchmark. For example, a sale of US dollars for Australian dollars will require a subsequent round of transactions to sell some euros and yen (the two other foreign currencies held) and buy US dollars so that the proportions of each currency held are restored to benchmark.

knowledge of the RBA's presence in the market is immediately available to all active interbank players. They typically also inform their clients very quickly. This 'announcement effect' can itself have a significant impact on the exchange rate.

A third form of intervention is to bypass the broker market and deal directly with banks. Such operations involve the RBA phoning banks quoting in the Australian dollar market for two-way prices in the exchange rate. If the RBA deals on a bank's bid or offer, that bank would be left with an open position which it would need to cover. This is risky for the bank concerned, as the RBA will be dealing on other banks' bids or offers, so a number of banks may be faced with the same position which they need to cover. To try to limit their potential exposures, banks receiving a call from the RBA will shift their exchange rate quotes to make them financially less attractive to the RBA, but in the process pushing the exchange rate in the direction the RBA desires for policy reasons. For example, during a period of exchange rate weakness, when the RBA is buying Australian dollars, a bank quoting a rate to the RBA would increase its offer price, thus causing the exchange rate to rise.

If the RBA deals on the offer, the bank selling would need to enter the interbank market to buy Australian dollars in order to cover its short position. This sets in train a second round of upward pressure on the exchange rate. The process of churning in the interbank market continues until the exchange rate has risen to a point that it entices a new seller of Australian dollars to enter the market. This form of intervention tends to have the largest impact on the exchange rate for any given transaction size. The RBA can of course use several different types of intervention simultaneously, say, asking banks for prices while bidding in the electronic broker market.

As well as undertaking transactions directly with the market, the RBA can use its transactions with the Australian Government to have an impact on the exchange rate. Normally, the RBA covers foreign exchange sold to the Government by buying in the market, so there is no net effect on its reserve holdings, apart from possible short-term timing mismatches. However, if the exchange rate is relatively low, the RBA may choose to meet the Government's foreign exchange needs directly from its reserve holdings. In effect, selling reserves to the Government can be thought of as a form of intervention in that it has a similar effect on the

exchange rate as intervention done in a low-key way in the market using agents. Normally, as the exchange rate is falling the RBA would stop buying foreign exchange in the market to cover Government transactions well before any direct intervention operations.

On rare occasions, such as in September 1998, the RBA has broadened its intervention to include buying call options on the Australian dollar. The buying of call options gives the RBA an additional element of flexibility in its intervention strategy, allowing it to stimulate significant demand for Australian dollars for a given outlay in options premiums. This demand is, of course, limited to the term of the option, but can still be useful in maintaining foreign exchange market stability during short-lived turbulence.

3.1   Sterilisation of Intervention

Intervention operations have implications for domestic liquidity. When the RBA buys Australian dollars, for example, there is a fall in the banking system's holdings of Australian dollars, thereby draining cash from the domestic money market. If the RBA took no further action, the market would be short of cash and domestic money market interest rates would tend to rise. This would be an example of unsterilised intervention. In effect, it would be a tightening of monetary policy since it leads to a rise in the cash rate.

The RBA can, of course, act in the domestic money market to replenish the banking system's liquidity by buying securities. This cancels, or 'sterilises', the liquidity effect of the intervention and leaves domestic interest rates unchanged. This is called sterilised intervention, and is the routine practice for central banks, unless they specifically set out to achieve a change in monetary policy. By using its domestic operations to keep cash rates around a target level, the RBA offsets excess demand for, or supply of, cash in the banking system whether it arises from intervention or from any other source.

At times of heavy intervention, this has the potential to cause substantial changes in the RBA's balance sheet as, for example, it sells US dollars in the foreign exchange market and sterilises this by buying domestic securities. To avoid the costs that can arise from this, the RBA has moved in recent years to greater use of

foreign exchange swaps as the main vehicle for sterilising its intervention. In a situation where the RBA has bought Australian dollars and sold US dollars in its intervention operations, it subsequently undertakes a swap in which it lends Australian dollars and borrows US dollars. The settlement flows from the first leg of the swap offset those arising from the intervention transaction, and therefore remove the need for further operations to control liquidity. As each swap consists of a spot with an offsetting forward transaction, it does not alter the net balance of demand and supply for Australian dollars in the foreign exchange market, and therefore does not cancel out the effect on the exchange rate of the original intervention.

4.   Intervention Since the Float

Over the post-float period, there have been three broad cycles of foreign exchange intervention reflecting the three cycles in the exchange rate: one in the second half of the 1980s; one in the first half of the 1990s; and one since 1997 (Figure 1). Each cycle began with the Australian dollar falling and the RBA selling foreign exchange, with the position reversed during the second phase of the cycle as the exchange rate rose.

The timing of each cycle shown in the graph is defined in terms of the major turning points in the RBA's cumulative foreign exchange position resulting from intervention.[2] For instance, the initial phase of the first cycle extended from December 1983 to September 1986 during which the RBA was a net seller of foreign exchange with cumulative net sales peaking at US$6.0 billion in September 1986. From there through to September 1991, the RBA was a net buyer. Total purchases over that period amounted to US$11.7 billion, so that the cumulative position since the float moved from a net short position of US$6.0 billion in September 1986 to a net long position of US$5.7 billion in September 1991. The subsequent cycle saw net sales of foreign exchange between October 1991 and

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[2] Changes in the RBA's net foreign exchange position are measured as the net of transactions with the market, the Government, and all other counterparties. Foreign currency received as earnings on foreign assets has been included as a 'purchase' of foreign exchange. The RBA takes into account such earnings in calculating how much foreign exchange to buy in the market to cover sales to the Government. Earnings therefore influence the discretionary actions of the RBA.

October 1993, and net purchases from November 1993 to September 1997, while the final cycle saw net sales from October 1997 to February 2002 and net purchases from March 2002 onwards.[3]

Figure 1: RBA Foreign Exchange Operations
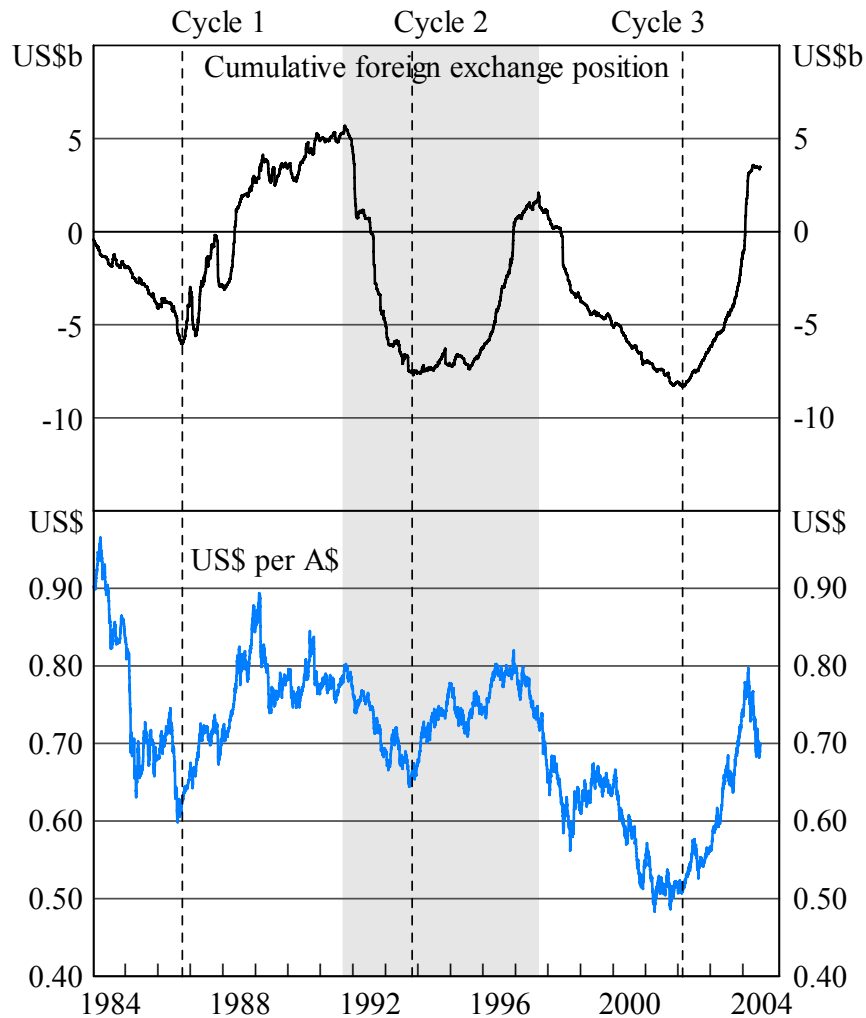
Sources: RBA; Reuters

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[3] The exact dates of the cycles are as follows: Cycle 1 – sales from 12 December 1983 to 25 September 1986 and purchases from 26 September 1986 to 23 September 1991; Cycle 2 – sales from 24 September 1991 to 27 October 1993 and purchases from 28 October 1993 to 2 September 1997; Cycle 3 – sales from 3 September 1997 to 7 February 2002 and purchases from 8 February 2002 to 30 June 2004.

As noted, the RBA's approach to intervention has evolved over the past 20 years. In the early post-float period, the approach was characterised by the phrase 'testing and smoothing' and, reflecting this, transaction values were typically small and relatively frequent. This pattern of intervention continued through to 1986, when the sharp fall in the exchange rate resulted in intervention volumes being lifted significantly; about A$2 billion of intervention was undertaken over July and August 1986, with the largest amount done on a single day – over A$200 million – several times the previous maximum daily amount.

From the early 1990s onwards, the RBA further changed its approach to intervention. There was no longer any semblance of 'testing and smoothing', but rather the focus was very clearly on attempting to limit large-scale overshooting of the exchange rate. As a result, there have been prolonged periods of no intervention, punctuated by short-lived episodes of heavy intervention when the exchange rate had moved to either very low or very high levels.

Table 1 provides some summary statistics on the RBA's foreign exchange transactions in the market, for the entire period since the float, and in each of the three cycles of intervention outlined earlier.

Overall, in the 20 years since the float of the Australian dollar, the RBA has transacted with the market on 40 per cent of trading days. A large proportion of these transactions represent cover for Government business and, reflecting this, the RBA has transacted to purchase foreign exchange on about three times as many days as it has to sell foreign exchange. For the same reason, the average size of purchases is around half the average size of sales. Because of the change in the style of intervention after the 1980s, the figures for the latter period are quite different from those in the earlier period:

- the proportion of days on which the RBA intervened in the market declined after the 1980s. In the episode between 1983 and 1986, as the exchange rate fell, the RBA intervened in the market to buy Australian dollars on 40 per cent of days. In the subsequent two episodes when the exchange rate fell, the RBA intervened in the market on only about 21 per cent and 4 per cent of days, respectively;

- the average transaction size increased. The size of average daily sales of foreign exchange to support the Australian dollar in the 1983 to 1986 episode was about A$20 million, but rose to around A$155 million in the subsequent two episodes; and

- the maximum size of daily intervention increased. For example, the largest daily sale of foreign exchange was equivalent to about A$250 million in the 1980s episode, but about A$1 200 million in each of the subsequent two cycles.[4]

Since the float in 1983, the net position resulting from sales and purchases of foreign exchange by the RBA (including transactions with the Australian Government) has fluctuated around zero. This provides an approximate indication that the RBA has not systematically tried to support or weaken the Australian dollar over the floating period as a whole.

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[4] Note from Table 1 that in the second part of the first cycle the appreciation in the exchange rate was temporarily disrupted by the October 1987 stock market crash, with an ensuing bout of intervention and a maximum daily sale of foreign exchange of A$1 025 million.

Table 1: RBA Foreign Exchange Market Transactions[a]

Purchases refer to the acquisition of foreign exchange and the sale of Australian dollars in the market

	Post-float period[b]		Cycle 1		Cycle 2		Cycle 3	
	Depreciation[c]	Appreciation[c]	Depreciation	Appreciation	Depreciation	Appreciation	Depreciation	Appreciation
Number of days in the period	2 433	2 930	729	1 302	547	1 004	1 157	624
Per cent of days with a transaction[d]	28	51	53	67	24	28	15	54
Per cent of days with purchases	12	48	21	60	3	28	10	54
Per cent of days with sales	19	4	40	9	21	0	4	0
Average purchase size (A$m)	20	52	10	56	37	39	31	54
Average sale size (A$m)	69	106	21	108	152	46	157	N/A
Largest daily purchase (A$m)	250	659	75	659	150	286	250	376
Largest daily sale (A$m)	1 256	1 025	251	1 025	1 256	90	1 189	N/A

Notes: Data reported in this table refers to the daily sum of purchases or sales of foreign exchange, not individual transactions *per se*.

(a) Includes within spot and forward market transactions.

(b) Sample – 12 December 1983 to 30 June 2004.

(c) As discussed earlier, each cycle is characterised by a phase of exchange rate depreciation when the RBA typically sold foreign exchange to purchase Australian dollars, followed by a period of appreciation and reserve rebuilding.

(d) Since purchases and sales may occur on the same day, the number of days with a transaction may be smaller than the sum of the days with purchases and sales.
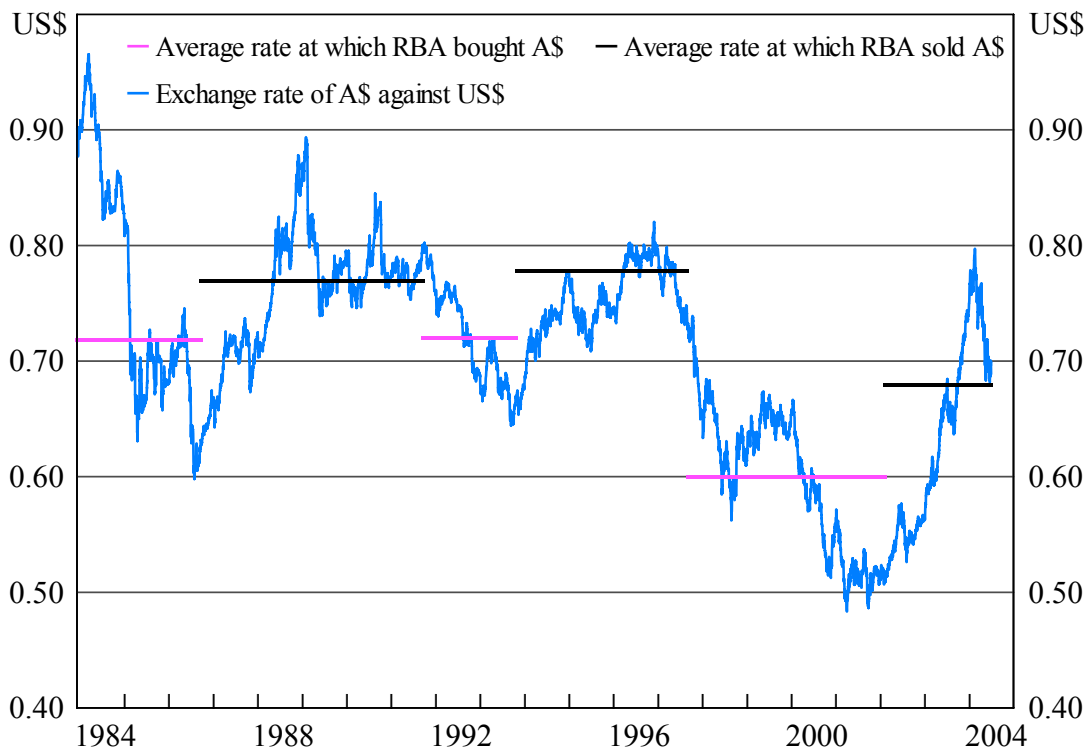
5.   Profits from Intervention

Formal evaluations of the efficacy of intervention are difficult to perform because it cannot be known how the exchange rate would have behaved in the absence of intervention. Furthermore, there is an endogeneity problem when estimating contemporaneous effects of intervention, since intervention is mostly triggered by exchange rate movements (Kearns and Rigobon 2003).

Researchers have come up with indirect measures to evaluate whether intervention has exerted a stabilising influence on the exchange rate. One such measure is the 'profits test' (Friedman 1953). The application of the profits test relies on the central bank acting as a stabilising long-term speculator. If the objective of the central bank is to limit the fluctuations in the exchange rate, this will tend to involve the purchase of the local currency (sale of foreign exchange) when the exchange rate is relatively low, and the sale of the local currency (purchase of foreign exchange) when the exchange rate is high. If the central bank is successful in buying low and selling high, its intervention should yield a profit. It follows from this that if a central bank has been profitable in its intervention, it must have bought low and sold high, therefore contributing to the stabilisation of the exchange rate.

While we consider the behaviour of the RBA and the Australian dollar over the post-float period to be well suited to the application of the profit test, this does not imply that the approach will necessarily always be the most relevant in the evaluation of intervention. For example, one possible limitation in using trading profitability to gauge the effectiveness of intervention may arise when the exchange rate exhibits a persistent trend. In such cases the central bank may not have the opportunity to rebuild reserves at a higher exchange rate. Nonetheless, intervention may still have exerted a stabilising influence despite being unprofitable in a trading sense (although this is not the case for Australia over the post-float period).

As can be seen in Figure 2, the RBA has been successful in buying low and selling high in its interventions. The horizontal lines on the graph mark the average exchange rates at which total net transactions took place in each episode. These rates reflect the average exchange rate at which the RBA added to or subtracted from its overall foreign currency position by entering into deals in the market or with its clients. In the first cycle, the RBA bought Australian dollars (sold foreign exchange) at an average rate of US71.8 cents and subsequently sold Australian dollars (bought foreign exchange) at an average exchange rate of US76.9 cents. The respective figures in the second cycle were US72.0 cents and US77.8 cents; and in the third cycle they were US59.9 cents and US67.9 cents. Since in each cycle the RBA bought Australian dollars at a lower exchange rate than it subsequently sold them, the figures indicate that each cycle of intervention, and therefore intervention over the post-float period as a whole, has been profitable.

Figure 2: Australian dollar and Average RBA Transaction Rates

Daily

Sources: RBA; Reuters

In this study, we measure the profitability of intervention in the period from the float on 12 December 1983 to 30 June 2004. The profitability of the RBA's operations in relation to its total foreign exchange position can be broken up into three main components as described below.[5]

5.1 Realised Trading Profits

Realised trading profits are those that accrue from trades that act to close out part of an existing open position.[6] Realised gains or losses are measured by comparing the rate applicable to a transaction with the average rate at which the position was established. The calculation can be written as:

$$\Pi_t^{rp} = \sum_{i=1}^{t} m_i \left[e_i - s_i \right] \tag{1}$$

where:

Π^{rp} denotes realised trading profits;

m is the reduction in an existing foreign currency position, with $m>0$ for sales of foreign currency in a long position, and $m<0$ for purchases of foreign currency in a short position;

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[5] These three components of profitability were also identified in Andrew and Broadbent (1994), who found that over the period between 1983 and 1994, the RBA's foreign exchange operations had been profitable and were thus judged to have exerted a stabilising influence on the exchange rate.

[6] Realised trading profits are calculated on the basis of *economic gain* in these examples. For *financial reporting* purposes the RBA accumulates foreign exchange on the basis of 'average stock cost' and accounts for gains and losses only when it sells this foreign exchange out of stock. There are two main differences between the concepts. Firstly, because for the purpose of this paper we are only concerned with events over the post-float period, gains arising from the average stock cost of foreign exchange reserves that had been acquired prior to the float of the Australian dollar are ignored. Secondly, the economic gain method used in the example implies that gains over the most recent episode have already been realised, whereas for financial reporting purposes they will not be realised until the RBA sells the foreign exchange acquired when replenishing reserves.

e is the exchange rate at which a transaction is made in terms of the number of Australian dollars per unit of foreign currency; and

s is the weighted-average exchange rate at which the position is acquired.

5.2 Unrealised Trading Profits

As the name suggests, unrealised trading profits represent the gain or loss from marking any remaining open position to market at time *t*. The implied gains or losses result from comparing the prevailing market rate to the average rate of establishing the existing open position, and can be written as:

$$\Pi_t^{up} = \sum_{i=1}^{t} \left(v_i - m_i\right)\left(e_t - s_t\right) \tag{2}$$

where:

all notation is as previously explained;

Π^{up} denotes unrealised trading profits; and

v is the addition to an existing foreign currency position, with *v*>0 for purchases of foreign currency in a long position, and *v*<0 for sales of foreign currency in a short position.

5.3 Net Interest Earnings

The net interest earnings component of the profit calculation represents an attempt to capture the gain or loss in terms of interest income from switching between domestic and foreign assets which results from the central bank's operations in the foreign exchange market. The impact on interest income arises because domestic and foreign interest rates are not normally the same.

This component of profitability is particularly important if the exchange rate exhibits a longer-term trend that dominates the cycle. In this case the realised and unrealised trading profits alone may not be a reliable gauge in assessing the

effectiveness of intervention. For example, if the exchange rate were to exhibit trend depreciation this may prohibit the rebuilding of reserves at an exchange rate higher than at which they were spent. However, intervention may have contributed to the stabilisation of the exchange rate around the broader trend and could therefore be judged to have been successful, albeit unprofitable. The inclusion of net interest earnings in this example would add to profitability as long as there is a long term tendency toward uncovered interest parity, which would imply that interest rates in the economy whose exchange rate is depreciating are on average higher than abroad.[7]

The addition to profits from net interest earnings can be written as:

$$\Pi_t^{ni} = \sum_{i=1}^{t} e_i \left[\left(r_i^* - r_i \right) \sum_{j=1}^{i} \left(v_j - m_j \right) \right] \qquad (3)$$

where:

all notation is as previously explained;

Π^{ni} denotes net interest earnings; and

r and r^* are the short-term interest rates on Australian dollar and foreign currency assets, respectively.

5.4   Methodologies of calculating profits

The majority of foreign exchange reserves until the early 1990s were held in US dollars. With the shift to a diversified reserves portfolio in mid 1991, while intervention was still exclusively conducted in Australian dollars against the US dollar, it has been followed by transactions in the European euro (previously the Deutschemark) and the Japanese yen against the US dollar to rebalance the reserve

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[7] For a more in-depth discussion of the rationale behind including net interest earnings in the calculation of profits, see Andrew and Broadbent (1994).

portfolio.[8] As such, sales or purchases of Australian dollars were in effect conducted against the three major world currencies, not just the US dollar. One could therefore argue that the measure of profitability of intervention should take into account not only the exchange rate between the Australian dollar and the US dollar, but also that between the Australian dollar and other currencies in official reserves. Although it is important to note that explicit intervention transactions against the US dollar are quite distinct in the timing of their execution to the subsequent reserve rebalancing transactions.

In the estimates below, we present two profit calculations: one which is based purely on the first leg of intervention – i.e. transactions in the Australian dollar against the US dollar which we refer to as the 'US dollar Intervention' method; and one which also takes into account the related rebalancing transactions which we call the 'Reserve Impact' method.[9]

5.4.1   US dollar Intervention Method (UIM)

To calculate profits using the UIM, all transactions are treated as having occurred in US dollars against the Australian dollar. While this is the case for the bulk of transactions in the market and with clients, some transactions are conducted against a third currency, and for these the appropriate cross-rate is applied. Similarly, earnings on reserves are all converted into US dollar terms despite having also been earned in euro and yen.

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[8]   Prior to the formal adoption of a diversified portfolio, the RBA held its foreign exchange reserves mainly in US dollars. While there were always assets denominated in other currencies, there was no systematic rebalancing. In the middle of 1991 the policy of managing reserves changed to formally hold 40 per cent of reserves in US dollars and 30 per cent each in Deutschemark (later euro) and Japanese yen. Rebalancing transactions took place from time to time to approximate these weights. However, active management of reserves meant that there were prolonged periods during which the actual portfolio composition departed from the prescribed weightings. In early 2000 the RBA adopted a more passive management policy where rebalancing transactions were conducted on a daily basis with a tolerance for a 1 per cent deviation from the allocation. A further change occurred in early 2002 when the RBA modified the benchmark weights to 45 per cent US dollars, 45 per cent euro, and 10 per cent yen.

[9]   Andrew and Broadbent (1994) presented profit estimates based only on the 'US dollar Intervention' method as for most of the period they covered in their study, reserves were held primarily in US dollars.

Total profits are simply the sum of realised and unrealised trading profits plus net interest earnings over the period, that arise from changes in the overall foreign currency position as a result of transactions and earnings as described above. Table 2 details the composition of profits over the post-float period as a whole and during the three cycles explained earlier.

Table 2 shows that the RBA's foreign exchange market transactions have been profitable over the 20 years since the float, with realised profits of $3.7 billion, unrealised profits of $0.5 billion, and additional interest earnings of $1.6 billion. Note also that each cycle has been profitable regardless of whether net interest earnings are taken into consideration. This may be interpreted as intervention having exerted a stabilising influence on the exchange rate.

Table 2: Profits From Intervention (UIM)

A$ million

	Realised	Unrealised	Interest	Total
Since the float[a]	3 707	510	1 634	5 851
Cycle 1[b]	405	−122	354	637
Cycle 2[c]	1 146	−82	1 345	2 410
Cycle 3[d]	1 831	182	1 087	3 101

Notes: (a) 12 December 1983 to 30 June 2004. The sum of profits in each of the cycles is not the same as profits over the entire post-float period as each cycle is treated independently. This requires that the cumulative foreign exchange position be reset to zero at the beginning of each cycle, irrespective of the remaining open position that is the result of operations from the preceding cycle. The average exchange rate of transactions within each cycle is therefore entirely determined by operations undertaken within that cycle.
(b) 12 December 1983 to 23 September 1991.
(c) 24 September 1991 to 2 September 1997.
(d) 3 September 1997 to 30 June 2004.

5.4.2 Reserve Impact Method (RIM)

Under this methodology, a decision to intervene is effectively treated as a decision to intervene in the Australian dollar against all three reserve currencies simultaneously (i.e. US dollar, European euro, and Japanese yen). Daily transactions are split into the three reserve currencies according to their respective

portfolio weightings.[10] Apart from this, the methodology is the same as that used in the UIM above.[11]

Table 3 shows the profitability of intervention under the RIM method.

Table 3: Profits From Intervention (RIM)
A$million

	Realised	Unrealised	Interest	Total
Since the float[a]	2 515	318	2 385	5 218
Cycle 1[b]	405	−122	354	637
Cycle 2[c]	680	195	1 612	2 487
Cycle 3[d]	761	96	1 776	2 634

Notes: (a) 12 December 1983 to 30 June 2004. Profits over the cycles will not add to profits since the float.
(b) 12 December 1983 to 23 September 1991; USD 100 per cent, DEM 0 per cent, JPY 0 per cent.
(c) 24 September 1991 to 2 September 1997; USD 40 per cent, DEM 30 per cent, JPY 30 per cent.
(d) 3 September 1997 to 30 June 2004; before February 2002 USD 40 per cent, DEM (EUR) 30 per cent, JPY 30 per cent; from February 2002 USD 45 per cent, EUR 45 per cent, JPY 10 per cent.

On this method, total profits from intervention over the floating period to 30 June 2004 are slightly smaller than on the UIM method, at A$5.2 billion. This comprised A$2.5 billion in realised profits, A$0.3 billion in unrealised profits, and A$2.4 billion in interest earnings. Again, intervention in each of the three cycles in the exchange rate has also been profitable. Taking portfolio rebalancing

[10] Transactions with clients in the Australian dollar that are not directly dealt against the US dollar are initially converted into US dollar terms at the appropriate exchange rate before the portfolio weightings are applied. Once the daily sum of transactions is split into three parts, each part is then converted into reserve currency terms using the daily 4pm AEST exchange rate.

[11] Realised profits are calculated from any trade that acts in the direction of closing out the RBA's position in any one of the three foreign currencies. Unrealised profits are calculated from the RBA's open position, using the average exchange rate of obtaining each position and the currently prevailing exchange rate of the Australian dollar against the US dollar, euro, and yen. Interest earned or foregone by the RBA as a result of shifting between domestic and foreign assets reflects the differential between domestic and overseas interest rates. The net interest earnings for the US portfolio are calculated on the interest differential between Australian 13-week Treasury notes and the 3-month US Treasury bill. Net interest earnings for Japan (Europe) are calculated by applying the interest differential against the Japanese 3-month government bill (3-month Euribor) to the RBA's net open yen (euro/Deutschemark) position.

transactions into consideration when calculating profitability, therefore does not materially impact on the interpretation of the results.

Figure 3 shows the pattern of profits through each of the three cycles, using the RIM. As can be seen, intervention is initially unprofitable as the RBA starts to intervene before the trough in the exchange rate has been reached, consistent with its objective of trying to stabilise the exchange rate. It also indicates that early rounds of intervention do not produce a permanent change in the path of the exchange rate.

We interpret the overall findings from this study as evidence that intervention over the post-float period has, on balance, worked to stabilise the exchange rate. The results are also in line with similar studies in other major countries. Other methods used to assess the effectiveness of foreign exchange intervention have relied on event studies and even surveys of foreign exchange dealers. Appendix A provides a literature survey of the main findings of these studies.

Figure 3: Cumulative Profits From Intervention
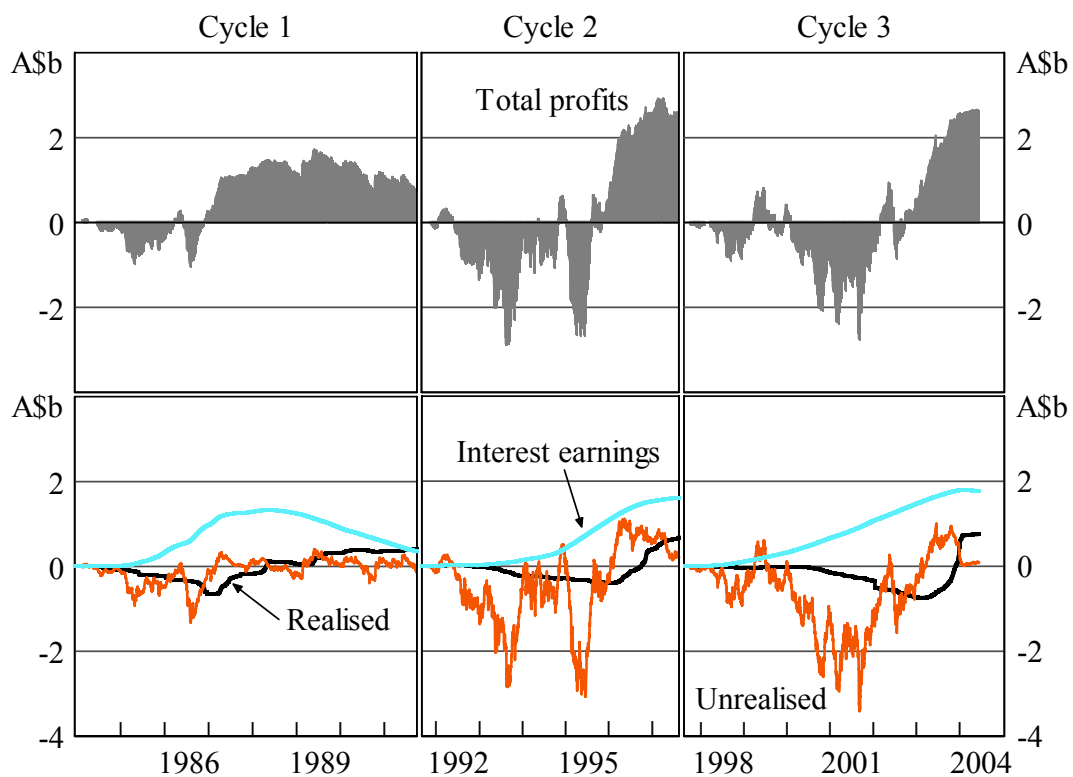
Source: RBA

6. Conclusion

The exchange rate regime in place in Australia over the past two decades can be best characterised as an independent float with occasional intervention by the RBA. Our study has found that the RBA has earned significant profits from its intervention over the past two decades, indicating that its foreign exchange operations have been to purchase the local currency when it is low and sell it when it is high, thereby exerting a stabilising influence. This conclusion is strengthened by the finding that the RBA's foreign exchange operations have also been profitable in each of the three identifiable cycles in the exchange rate.

Appendix A: Effectiveness of Australian Intervention – A Survey

Many authors have attempted to measure the effectiveness of foreign exchange intervention by central banks. Edison (1993) conducts a thorough survey of the early international literature. Sarno and Taylor (2001) discuss the progress made over the 1990s in international studies of the efficacy of intervention.

Edison, Cashin and Liang (2003, p 12) note a 'general consensus in the literature' that intervention via influencing market participants' portfolio decisions is ineffective, but that there is some evidence that intervention via the signalling channel is effective. Sarno and Taylor (2001) view the evidence from the 1990s as supportive of the effectiveness of intervention via both channels. Sarno and Taylor also suggest a third channel of intervention that may be relevant; the coordination channel.[12]

A considerable literature has developed that studies the effectiveness of the intervention activities of the RBA. This survey outlines the methods used and empirical results found in this literature.[13]

A1. Evaluating the Effectiveness of Intervention

Measuring the effectiveness of intervention is difficult for two reasons. Mainly this is because the counterfactual is unknown. That is to say, it cannot be reliably estimated how the exchange rate would have behaved in the absence of intervention.[14] In addition, there is endogeneity between intervention and exchange rate movements; intervention will affect the exchange rate *and* the exchange rate is also an input into any decision to intervene. It is difficult to control for this, and in

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[12] The authors suggest that the central bank has a role to remedy coordination failures in the foreign exchange market when the exchange rate is overvalued or experiencing a bubble, but where traders are unwilling to be the first to break the trend. The central bank could use publicly announced intervention operations to coordinate 'smart money' traders to enter the market together and break the bubble (Sarno and Taylor 2001, p 863).

[13] For background information on the RBA's foreign exchange operations, refer also to Fraser (1992), Macfarlane (1993, 1998) and Rankin (1998).

[14] Sarno and Taylor (2001) refer to studies by Dominguez and Frankel in which exchange rate expectations are used to proxy for the counterfactual. However, to our knowledge no studies of this sort have been carried out in the Australian context.

attempts to mitigate the problem, some studies have excluded the contemporaneous effect of intervention on the exchange rate, leading to possibly biased results. Many attempts to evaluate the effectiveness of intervention that have failed to capture the endogeneity have been unsuccessful.

Nonetheless, five main methods have been used in the literature in attempts to measure the effectiveness of intervention. These are:

- event studies;

- time series studies;

- measuring the profits from intervention;

- Generalised Methods of Moments (GMM); and

- survey methods.

A1.1 Event Studies

Event studies identify distinct intervention episodes and examine the effectiveness of intervention within the intervention window. Intervention is judged to be effective if it 'has been successful at stopping or delaying any given trend in the exchange rate' (Edison *et al* 2003, p 12). Fatum (2000) observes that 'standard time-series techniques may not be well suited when dealing with the analysis of intervention vis-à-vis the behaviour of exchange rates', whereas the event study method 'seems to fit well' given that 'a cluster of intervention operations constitutes a natural candidate for identification as a single event' (Fatum 2000, pp 5–6). In addition, examining intervention windows can also allow the use of intraday data on exchange rates if these data are available.

Edison *et al* (2003) undertook an event study of the RBA's intervention in the Australian dollar. The authors found 18 episodes of intervention between 1984 and December 2001 with 12 out of 18 episodes classified as successful. They conclude that there is some evidence that the 'RBA has been effectively "leaning against the

wind" in changing the trend movement in the Australian dollar exchange rate' (Edison *et al* 2003, p 17).

The method of classification employed in event studies is often somewhat inflexible. An episode of intervention is classified as successful if the intervention immediately reverses the trend observed in the exchange rate prior to the intervention, or if it achieves a continued reversal of the trend, or both. However, the method does not take account of the purpose of the intervention.

In Edison *et al's* study, this inflexibility leads to two possible misclassifications of intervention episodes. Intervention in December 2000 is classified as a failure because it does not reverse the direction of the trend in the exchange rate. The authors note that it could also be classified as leaning *with* the wind: the RBA purchased Australian dollars at a time when the Australian dollar was appreciating (from a low level) and that appreciation continued following the intervention. That is, the RBA leaned with the wind successfully. Intervention in January 2001 is a second possible misclassification. Here, the RBA again purchased Australian dollars at a time when the Australian dollar was appreciating, a possible attempt to lean with the wind, but the currency depreciated over the intervention window and following the intervention. Because the exchange rate firstly appreciated and then depreciated, the intervention was classified as successful. However, as the RBA aimed to support the currency and this was not the result, using this methodology the episode should not be classified as a success.[15]

A1.2 Time Series Studies

Various time series studies have also been conducted to evaluate intervention. Many of these have failed to find strong evidence to suggest that intervention is effective. This is most often due to the fact that these models do not capture the endogeneity between intervention and the exchange rate, or have excluded the problem of endogeneity by excluding contemporaneous intervention preventing 'measurement of the immediate impact [of intervention]' (Kearns and Rigobon 2003, p 5).

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[15] These reclassifications would not have altered the conclusions of the study as 12 out of 18 intervention episodes would still be classified as successful.

Consequently, the results produced in these models are likely to suffer from a negative bias which results in small and insignificant or incorrectly signed estimates for the impact of intervention. That is, the models predict that a purchase of the domestic currency has little effect on the currency or even depreciates the currency. Other coefficient estimates may also be biased due to the omitted variables. Kearns and Rigobon (2003) discuss the effects of the exclusions and provide an empirical example of the effect of ignoring the contemporaneous effects of central bank intervention.

Despite the difficulties faced, time series studies have been undertaken to address the important question of the efficacy of foreign exchange intervention. Various methods have been used and some of those employed in the Australian context are considered here.

A1.2.1   Results from GARCH time series modelling

Many of the time series studies use models of the exchange rate with GARCH or EGARCH (exponential generalised autoregressive conditionally heteroskedastic) error structures. These models 'allow the empirical testing of the effectiveness of intervention to be carried out simultaneously on both the mean and conditional volatility of exchange rate returns' (Kim, Kortian and Sheen 1999, p 10). Testing the effects of intervention on the conditional mean of the exchange rate is one way to test if the intervention has had the effect of reversing or dampening a trend in the exchange rate.

Kim *et al* (1999) employ an EGARCH model to explain the percentage change in the A$/US$ exchange rate with intervention included as one of the explanatory variables. They use daily data from December 1983 to December 1997 and break the sample up into smaller sub-periods according to variations in the intervention style employed by the RBA. The authors find that the estimated contemporaneous effects of intervention were destabilising. However, the authors note that this is likely the result of the simultaneity of intervention and the exchange rate. When the slope dummy variables are examined they find 'evidence of a stabilising influence on the $A/$US exchange rate process' due to the RBA's intervention and that 'a worse outcome on [the day of intervention] may have occurred if the Reserve Bank had not intervened' (p 16).

A1.2.2   Results from Central Bank Reaction Function Studies

Other time series studies (Rogers and Siklos 2003, McKenzie 2004 and Kim and Sheen 2002) use a central bank reaction function to investigate the conditions under which the central bank may intervene. Identifying what prompts a central bank to intervene can provide evidence as to whether the central bank is acting to 'lean against the wind'. These studies most often use a Probit model to predict the probability of intervention given movements and volatility in the exchange rate.

Rogers and Siklos (2003) study the intervention of the RBA using daily data for the period of January 1989 to September 1998. They find 'considerable evidence' of 'leaning against the wind' throughout the 1989–1997 period and intervention was 'quantitatively larger' in the 1989–1993 period.[16] In addition, as would be expected, the stabilising effects of intervention are greatest on the day of intervention and decrease gradually on the days following the intervention.

Kim and Sheen (2002) use data from December 1983 to December 1997 'to estimate Probit models for purchases and sales of foreign currency (in US$) separately' and also to 'estimate a friction model of intervention whereby the Reserve Bank chooses to buy/sell only beyond threshold limits' (p 627). The authors find in general 'that a moderate appreciation (depreciation) of the $A from its 150–day average leads to an intervention purchase (sale) of foreign currency designed to slow the rise (fall) of the value of the $A' (p 647). This form of intervention is 'in accordance with the stated short horizon aim of leaning against the wind'. In addition, the friction model reveals that 'intervention is strongly correlated with lagged intervention, which suggests that positive (negative) intervention was usually followed by positive (negative) intervention on the following day' (p 643). Kim and Sheen suggest that this persistence may imply that RBA intervention tends to be carried out over a few days and they propose that this may improve its effectiveness as their model gives a significant estimate for the stabilising effect of cumulative intervention.

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[16] Despite noting the possibility of simultaneity between their chosen estimation equations, due to the endogeneity of exchange rates and intervention, the authors estimate equations separately on the basis of Hausman specification tests. However, if simultaneity was in fact a problem, the estimates may be biased.

McKenzie (2004) conducts analysis using a Probit analysis of the reaction function; an '*ex post* government intervention decision against a measure of exchange rate volatility' (p 62). In addition, he proxies for exchange rate volatility using a GARCH model. McKenzie finds that the 'dynamics of the foreign exchange market are significantly different on the days' on which the RBA intervenes (p 72). He notes that it could be that RBA intervenes on these days because volatility in the market is high, or it may be that volatility is high because the RBA intervenes. However, distinguishing between these is not possible within his analysis due to the likely endogeneity of intervention and the exchange rate.

A1.2.3   Other time series approaches

Hopkins and Murphy (1997) undertake a case study using regression analysis to determine the effect of intervention on the market. They examine the 7.5 per cent depreciation of the Australian dollar during July to October 1993 and aim to identify the relative importance of information in the market at that time when 'uncertainty regarding the passage of the Federal Budget through the Senate was reflected in the foreign exchange market' (p 199). They find, for this period of uncertainty in the market, that 'intervention operations and associated statements by the RBA did provide some stability to the market' (p 217). However, their results should be interpreted with caution as only a small sample size is used due to the restricted time period studied, and as the authors include contemporaneous intervention but ignore the possible simultaneity issues that arise as a result.

Karunaratne (1996) employs multicointegration techniques to test the hypothesis that RBA intervention has been ineffective. The author breaks up the period from December 1983 to May 1993 into five sub-periods and models the rationale for RBA intervention using a quadratic loss function where the RBA aims to minimise 'losses due to target missing and losses because of exchange rate instability' (p 409). The results of the Johansen multicointegration tests are 'favourable to the proposition that RBA intervention was effective from a long-run perspective' (p 415). However, the methods used do not take account of the endogeneity of the exchange rate and intervention. Consequently, as Karunaratne notes, the long-run equilibrium relationships found between the nominal exchange rate, the foreign interest rate as a proxy for the unobservable target exchange rate target variable,

and the domestic interest rate (with net purchases of foreign currency included as a control variable), may 'have occurred even without intervention' (p 415).

A1.3 Profits from Intervention

The thinking underlying this line of research was outlined in the body of this paper. As noted, it is an adaptation of the argument put by Friedman (1953) that stabilising speculation should be profitable. Until now, Andrew and Broadbent (1994) had been the only Australian study to conduct an analysis of the profits from intervention. They find significant profits from intervention between December 1983 and June 1994 and conclude that RBA intervention had a stabilising influence on the Australian dollar exchange rate against the US dollar.

A1.4 Generalised Method of Moments (GMM) Studies

There has been a recent innovation in the study of intervention developed by Kearns and Rigobon (2003). The authors use simulated Generalised Method of Moments to evaluate the effectiveness of intervention while explicitly allowing for the endogeneity of the intervention and the exchange rate.

Kearns and Rigobon (2003, p 1) recognise that 'once a central bank has decided to intervene, the quantity of currency it buys or sells and the decision as to whether to engage in further intervention will typically depend on the response of the exchange rate to [the central bank's] trades'. The advantage of GMM is that the model allows estimation of a set of simultaneous equations and explicitly captures the interdependence of the exchange rate and the central bank's intervention and the contemporaneous impact of intervention.

Their results provide empirical econometric evidence to support the description of RBA intervention as 'leaning against the wind'. The results of the paper suggest that there is a strong positive effect of intervention (where Australian dollars are purchased and foreign exchange sold); particularly on the day it is conducted, with a smaller positive effect for a few days afterwards.[17] They find point estimates to

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[17] This result is consistent with the findings of other studies where significant effects are not found if the contemporaneous effects of the intervention are excluded as these studies only pick up the smaller effects on subsequent days.

suggest that RBA intervention has an economically and statistically significant contemporaneous effect on the exchange rate, such that a US$100 million purchase of Australian dollars will appreciate the Australian dollar by between 1.3 per cent and 1.8 per cent.

A1.5 Survey Methods

One other method that has been applied to gauge the effectiveness of RBA intervention is to survey market participants. Hutcheson (2003) surveyed foreign exchange dealers licensed by the RBA as at 12 July 1999.[18] The tabulated responses imply that the RBA's intervention transactions and their motivations are viewed as credible, with 86 per cent of respondents stating that intervention is usually conducted at the appropriate moment, 77 per cent saying that intervention achieves the desired goals and 73 per cent answering that intervention moves exchange rates towards their fundamental value. Fifty per cent of respondents thought that intervention increases exchange rate volatility. However, this result should be interpreted with caution. If the exchange rate falls intraday and intervention successfully reverses the depreciation, intraday volatility will have increased due to the intervention. Alternatively, as Hutcheson suggests, intraday volatility may increase if intervention is not well anticipated by dealers. In addition, this result is difficult to interpret as no time frame for volatility was stated in the survey question.

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[18] Fifty-nine surveys were sent to foreign exchange dealers and 39 of these were completed. The respondents were mostly senior employees in their institutions' treasury departments.

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