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## Implementing monetary policy in a deregulated financial system: a study of the Australian official short-term money market

Jeffrey Carmichael Bond University

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## BOND UNIVERSITY School of Business

# DISCUSSION PAPERS

"Implementing Monetary Policy in a Deregulated Financial System: A Study of the Australian Official Short-Term Money Market"

Jeffrey Carmichael
School of Business
Bond University
and
Ian R. Harper
University of Melbourne

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Gold Coast,QLD,4229

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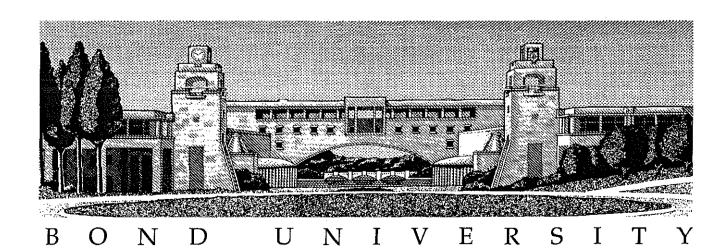
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## IMPLEMENTING MONETARY POLICY IN A DEREGULATED FINANCIAL SYSTEM: A STUDY OF THE AUSTRALIAN OFFICIAL SHORT-TERM MONEY MARKET

BY

JEFFREY CARMICHAEL BOND UNIVERSITY AND

IAN R. HARPER UNIVERSITY OF MELBOURNE

#### Abstract:

Deregulation of the Australian financial system in the 1980s necessitated a change of operating procedures for the implementation of monetary policy by the Australian central bank. This paper describes the new procedures, and attempts to model the process whereby changes in the official stance of monetary policy are translated into movements of the market-determined official or 'cash' interest rate. The model is estimated using daily data on the flow of funds through the official short term money market and receives qualified empirical support.

JEL Classification Codes:

E43; E52; E58; G28.

Keywords: Monetary policy; cash market; cash interest rate; Reserve Bank of Australia.

## IMPLEMENTING MONETARY POLICY IN A DEREGULATED FINANCIAL SYSTEM: A STUDY OF THE AUSTRALIAN OFFICIAL SHORT-TERM MONEY MARKET

#### I. INTRODUCTION

Prior to the deregulation of Australia's financial markets in the early 1980s, monetary policy was conducted primarily through direct controls imposed on banks. The progressive abolition of these controls through deregulation obliged the Reserve Bank of Australia (RBA) to use alternative means of administering monetary policy. Under the new arrangements, the RBA deals in the official short-term money market (or 'cash market') in order to influence the interest rate on overnight loans (the 'cash interest rate'). Through the network of financial market linkages, the cash interest rate influences the level and pattern of interest rates on securities of longer maturity, both official and non-official.

To understand how the RBA manipulates the cash interest rate requires an appreciation of the factors governing the demand for and supply of cash. This, in turn, requires a detailed understanding of the institutional arrangements under which the RBA exchanges securities with the banks and with the authorised short-term money market dealers as part of its open market operations. Despite the centrality of this process in the implementation of monetary policy, there is no published attempt to estimate a formal economic model of the cash market or the link between the cash interest rate and the remainder of the yield curve<sup>1</sup>. This paper is addressed to the first of these concerns.

<sup>\*</sup>The authors wish to acknowledge financial support from the Australian Research Council under the Small Grants Scheme (#SG7900060) and the provision of data and advice by the Reserve Bank of Australia. They also acknowledge valuable research assistance (at different times) from Phillip Leslie, Harold Freeman and Stephen Goodridge, and technical advice from Vance Martin, Graham Woodbridge and Adrian Pagan.

<sup>&</sup>lt;sup>1</sup> A number of descriptive accounts of the operation of the cash market have been published including: Morris (1988), Harper, (1988), Grenville (1990) and Battellino (1990). Rankin (1992) develops a formal algebraic model of the cash market but does not proceed to statistical estimation. A longer-term theoretical model is contained in Dotsey (1991).

#### II. IMPLEMENTING MONETARY POLICY IN AUSTRALIA<sup>2</sup>

#### Regulation vs Market Operations

Central banks throughout the world influence financial activity through two main channels. The first is their delegated authority to regulate financial institutions within their jurisdictions. This authority varies from country to country according to specific legislation. In general, it provides central banks with the power to set institutional interest rates, to impose lending guidelines with respect to the allocation and growth of credit, to impose balance sheet ratios and to levy sanctions on institutions which violate these regulations. The second channel of influence over the financial system is the central bank's transactions in financial markets on its own account. By buying and selling assets and issuing liabilities, the central bank can manipulate financial prices (and, ultimately, the general price level).

Historically, central banks have relied heavily on the regulatory mechanism for monetary control. As financial systems have grown in sophistication and depth, financial institutions have become increasingly adept at circumventing direct regulations. Not only has this undermined the effectiveness of the regulations for monetary policy purposes, it has also highlighted their inefficiency. These pressures resulted in the widespread financial deregulation of the 1980s. In Australia, as in most developed economies, deregulation has shifted the balance of emphasis in implementing monetary policy away from direct regulation and towards reliance on the RBA's market operations.

The shift of emphasis is more than cosmetic. As a business operation, the RBA, like other central banks, is small relative to commercial banks and other corporations. In the absence of any special feature to distinguish its market activity, the RBA's transactions would have little impact on the financial system. The distinguishing feature which turns these transactions into a potent weapon for conducting monetary policy is the RBA's monopoly of the market for cash.

<sup>&</sup>lt;sup>2</sup> A less detailed version of this discussion appears in Harper (1992).

#### The Money Multiplier Model

The banking literature focuses on the linkages between central bank "base" money and the supply of bank liabilities or, alternatively, bank credit. These linkages work through two quite distinct mechanisms. The first arises from the central bank's requirement that commercial banks hold a prescribed minimum ratio of their assets in the form of central bank liabilities. The second arises from the requirement that all debts between the banking system and the central bank be settled in central bank liabilities. The distinction is subtle but of fundamental importance to a proper understanding of how monetary policy works.

The simple money-multiplier model of the textbooks focuses entirely on the first mechanism. In this model, banks are required by the central bank to hold a legal minimum ratio of required reserves in the form of deposits with the central bank (that is, in the form of base money). In the simplest version of the model, these reserves pay no interest and are therefore kept at the legal minimum at all times. Under the assumption that the central bank controls the supply of its own liabilities, the central bank expands or contracts bank credit mechanically by expanding or contracting the monetary base.

The role played by money in this simple model has nothing to do with its status as a medium of exchange. The central bank's control of bank credit stems entirely from its legal restriction on minimum reserves combined with its monopoly of the supply of reserves. This much can be established by considering how the same system would operate if the central bank replaced the base money reserve system with one based on encyclopedias. If the central bank required that a fixed minimum ratio of bank assets be held in the form of encyclopedias and, importantly, the central bank controlled the supply of encyclopedias, it could regulate the growth of bank credit by expanding or contracting the supply of encyclopedias. This system of credit control would be just as effective as money base control under the simple money multiplier model.

In practice, while this first mechanism of monetary control has never been especially important, its role has been further eroded by deregulation. In the first place, deregulation has

greatly reduced the interest-elasticity of private sector loan demand. As a result, the transmission of changes in the money base to changes in credit expansion or contraction are much less predictable. Secondly, the RBA (and a number of other central banks around the world) has all but eliminated required reserves for commercial banks<sup>3</sup>. Yet few would argue that monetary policy has become impotent.

In short, the simple money-multiplier model is inappropriate as a description of the way in which the Australian financial system works. The RBA's leverage over the financial system derives much more from the second mechanism: namely, the legal requirement that all debts between the banking system and the central bank be settled in central bank liabilities or, to use the term familiar to the market, "cash".

More sophisticated money multiplier models incorporate this second mechanism based on money's role as a medium of exchange. The essence of these models is that banks hold reserves in excess of the legal minimum because they need central bank liabilities to settle debts with the central bank. In settling these debts, only central bank liabilities are legally acceptable. This second mechanism linking monetary policy to the level of banking activity works through the impact of changes in either the quantity or cost of central bank liabilities on the willingness of banks to hold excess reserves. The level of excess reserves held is a function of the opportunity cost of holding assets in this form and of the cost of being caught short of reserves. These, in turn, depend importantly on the institutional framework of the financial system.

In some countries, the central bank permits commercial banks to borrow reserves from it in order to meet its debts. In others, banks hold excess reserves on balance sheet. In Australia, the banks are not permitted to borrow from the RBA, although they are permitted to hold a form of reserves with the authorised short-term money market dealers. The remainder of this section provides details of Australian institutional arrangements and shows how the

<sup>&</sup>lt;sup>3</sup> In 1988, the RBA began phasing out the Statutory Reserve Deposit requirement (which had stood at 7% of the deposit liabilities of trading banks for a number of years) and replaced it with a much less onerous non-callable deposit requirement (set at 1% of the total liabilities of all banks).

legal restriction that only RBA liabilities are acceptable as ultimate means of payment forms the basis of the RBA's monetary control.

#### Cash

The importance of the term "ultimate" in the definition of cash as the ultimate means of settlement bears emphasis. Transactions between non-financial institutions and individuals can be settled in various ways, including bank cheques, currency and payment orders drawn on non-bank financial intermediaries. In transactions involving the liabilities of private sector institutions, however, the institutions are simply acting as agents for the payer and payee. Ultimately, the transactions are settled by an exchange of value between the agents. These ultimate settlements, by law, can only be carried out through an exchange of cash.

Legally, cash is any asset deemed to be cash by the central bank. In practice, the RBA bestows cash status on certain of its own liabilities, specifically, currency and balances in exchange settlement accounts (ESAs) held with itself. Each authorised bank and official short-term money market dealer is obliged to keep an exchange settlement account with the RBA which it must use to clear debts arising through the payments system. Exchange settlement accounts may be overdrawn during the business day but must be in credit by the close of each business day. No interest is payable on balances held overnight in ESAs.

If all transactions in the financial system took place exclusively between private sector participants, the net cash position of the banks taken as a group would necessarily sum to zero. In a closed system such as this, banks could settle their clearinghouse debts by buying and selling surplus balances. In reality, however, the system is not closed. Exchange settlement balances are also required by banks to settle transactions between themselves and the RBA or its customers.

By far the largest of the RBA's customers is the Australian government. When the government spends, it writes cheques on its account with the RBA. This injects funds into the banks' exchange settlement accounts after the cheques are presented and cleared through the Australian Clearing House. In similar fashion, payments to the government (including taxes)

withdraw funds from the exchange settlement accounts of banks. Table 1 provides a reasonably comprehensive list of transactions that either inject or withdraw cash from the financial system.

#### TABLE 1

#### Inject Cash

RBA purchases of foreign exchange RBA purchases of government securities RBA purchases of repurchase agreements Government spending Payment of interest on government securities

#### Withdraw Cash

RBA sales of foreign exchange RBA sales of government securities RBA sales of repurchase agreements Government revenue gathering Deposits by banks of reserves required to be held with the RBA

Over the course of a year or so, the balance of these flows constitutes an addition to or subtraction from the stock of cash (or 'base money') in the system. The net change in this stock over time is relatively minor compared with daily fluctuations arising from the sources and uses of cash listed in Table 1.

At the beginning of each business day, banks find the balances in their ESAs altered as a result of transactions which have occurred over the preceding few days. If the government has been spending in excess of its receipts, banks as a group will tend to accumulate surplus balances as cheques written by the government are cleared. If the RBA has been particularly active in selling assets, banks as a group will find the balances in their exchange settlement accounts declining.

In this respect, exchange settlement accounts are similar to current accounts operated by businesses for working capital purposes. Unlike many working capital accounts, however, exchange settlement accounts cannot remain in deficit. If, as a result of transactions cleared overnight, a bank loses more cash from its account than its closing balance on the previous day, it must restore its account to balance before the close of business<sup>4</sup>. This restoration can only be achieved by depositing cash with the RBA. One bank in deficit can clear its position by "buying" excess exchange settlement balances from another bank. When the banks as a group find their exchange settlement accounts in deficit, they must find an alternative source of cash with which to balance their accounts.

In principle, banks could hold large positive balances in their exchange settlement accounts to provide some insurance against having to search for alternative sources of cash. In practice, banks in Australia do not hold exchange settlement balances of any magnitude. Since the RBA pays no interest on these accounts, there is no incentive for banks to carry large balances from day to day provided there are other sources of cash with a lower opportunity cost. Banks finding themselves with positive balances at the beginning of the day typically seek to invest those funds so as to earn a positive return overnight. Thus deficit balances tend to occur regularly, thereby generating a demand for cash for immediate settlement.

The main alternatives to exchange settlement balances as sources of cash include: currency held by the banks and by the non-bank public, the Treasury Note rediscount facility offered by the RBA, certain RBA transactions and the Official Short-Term Money Market. The RBA's control of the supply of alternative sources of exchange settlement funds provides it with a degree of leverage over the entire financial system.

While fluctuations in the stock of currency have a large impact on the banks' exchange settlement account balances, they are not normally regarded as a ready source of cash with which to settle debts to the RBA. To access currency from the non-bank public, banks would

<sup>&</sup>lt;sup>4</sup> The Australian practice of prohibiting banks from overdrawing their exchange settlement accounts is not universal. Indeed, some central banks conduct monetary policy through the extension of credit directly to the banking system.

need to raise interest rates sufficiently to attract deposits of currency. It is unlikely that the public's demand for currency is sufficiently interest-elastic to provide banks with a reliable response to what could be an expensive exercise.

Under the rediscount facility, the RBA undertakes to repurchase Treasury Notes (within 90 days of maturity) from the market at an agreed interest rate (the rediscount rate). This facility is available to all holders of Treasury Notes and can be exercised at the holder's discretion. Importantly, the RBA agrees to give the market immediate value (i.e., cash) for rediscounted securities. In the case of a bank, this immediate value is credited to its exchange settlement account and can be used to settle debts on the same day. While rediscountable securities are not themselves cash, they are "cashable" in the sense that they can be quickly turned into cash. Since the RBA is, in effect, making cash available perfectly elastically through the rediscount facility, it sets the rediscount rate at a penalty to the market. Thus the rediscount facility is a "safety valve" designed to relieve market pressure when other sources of cash become too expensive.

Unlike the rediscounting of Treasury Notes, other RBA transactions do not generate cash on the same day. Purchases and sales of foreign exchange by the RBA, for example, do not normally affect the exchange settlement accounts of banks until two days after the transaction. Similarly, transactions in government securities between the RBA and banks are cleared the day following the transaction. Thus banks cannot use transactions in foreign exchange or government securities (other than rediscounts) to clear their debts either with each other or with the Reserve Bank.

#### The Official Short-Term Money Market

The major alternative source of cash in the Australian system is the official short-term money market. Under arrangements put in place in the early 1950s, the Authorised Short-Term Money Market Dealers (henceforth referred to simply as "dealers") also have exchange settlement accounts (technically known as 'clearing accounts') with the RBA. The dealers act as a buffer between the RBA and the financial system, as well as making a market in

Commonwealth Government securities. As part of this buffering process, the RBA treats the dealers in a unique way: it confers "same day" value on all their transactions. Thus, when a dealer deposits a bank cheque into its exchange settlement account, the RBA credits it for immediate value even though the cheque is not cleared until the following day. This convention plays an important role in the functioning of the Australian short-term money market.

Since dealers have exchange settlement accounts, banks can settle their debts with the RBA by drawing cheques on call deposits held with dealers. Thus banks tend to keep their surplus liquid balances as call deposits with dealers (earning a market rate of interest) rather than as non-interest bearing deposits in ESAs with the RBA<sup>5</sup>.

When the banks as a group find themselves with excess exchange settlement balances, they simply deposit them with the dealers. When they find themselves with deficit balances, they run down their deposits with dealers. This transfers the balancing process and the need for cash from the banks to the dealers. As is the case with banks, dealers can generate cash by rediscounting Treasury Notes. Unlike banks, however, dealers have a number of additional channels through which to generate cash. Since the RBA gives all dealer transactions "same day" value, any transaction that generates a credit to a dealer's ESA suffices to clear an initial imbalance.

The operation of this cash-generating mechanism is illustrated in the following example. Suppose that, on 1 July 1994, the banking system as a whole is in balance. During the day, corporate taxpayers write cheques to the government totalling \$1billion. These are received through the mail on 2 July and banked into the government's account with the RBA. The cheques clear though the Australian Clearing House overnight on 2 July. On 3 July, the banking system begins the day with a deficit balance of \$1billion in exchange settlement accounts at the RBA. This is settled immediately by banks drawing on their deposits with dealers. Any further transactions between the banks and the RBA, or between the banks and

<sup>&</sup>lt;sup>5</sup> The dealers in the Australian system act, in effect, as subsidiaries of the RBA. Bank deposits with dealers perform the same role in the Australian system as non-borrowed reserves in the US system.

their customers, on 3 July do not affect their exchange settlement accounts until the following day at the earliest.

Following the banks' withdrawal, the dealers find themselves with the same deficit that initially faced the banks, viz., \$1billion. In the absence of any action by the RBA, the dealers can generate the \$1billion by bidding for overnight deposits to replace those called by banks. These deposits must be raised from the non-bank sector<sup>6</sup>. When dealers attract deposits from non-banks, the RBA credits their ESAs immediately. The cheques written by the non-banks for deposit with the dealers do not clear (i.e., result in a debit to the issuing bank's ESA) until the following day, however. Thus, by raising deposits from the non-bank sector, dealers are able to "borrow" cash from the next day. This is known as "playing the float".

Once a non-bank writes a cheque on its account with a bank and lodges it with a dealer, the bank ceases to pay interest to the non-bank. The non-bank earns interest instead from the dealer. But the bank still has the funds overnight. In fact, the bank could have the funds deposited overnight with the very same dealer who, as a result, pays *twice* for the same overnight deposit of funds. To rectify this outcome, the bank must pay to the dealer a rate of interest to reflect the fact that the funds deposited by the non-bank with the dealer are effectively lent to the bank overnight on account of the one-day delay in clearing the cheque. This rate of interest is known as the *float rate* and is paid by those who benefit to those who lose as a result of the one-day delay in cheque clearance through the clearing house.

The level of the float rate is determined by convention and is set by the Reserve Bank every Thursday. It is calculated as the weighted average of the cash interest rates applying at the close of each business day since the previous Thursday, with Friday receiving a weight of 3 (to reflect the weekend) and the day before a mid-week public holiday a weight of 2. The float rate is fixed for seven days and can therefore differ markedly from the cash interest rate on any particular day. Thus, even though a bank must pay the float rate to a dealer who benefits from the transfer of funds by a non-bank, the bank may still be ahead if the cash interest rate

<sup>&</sup>lt;sup>6</sup> The deposits must come from the non-bank sector because any deposits raised from banks would immediately put the banks' exchange settlement accounts back into deficit, thereby restarting the entire process.

exceeds the float rate by a substantial margin. Of course, the bank would lose if the float rate exceeded the cash interest rate but, in this case, the cash interest rate would most likely be falling and dealers would not be bidding aggressively to attract non-bank deposits from banks.

This process is summarised in the following illustrative balance-sheet changes:

Stage 1: 9:30 am; opening cash position shows a deficit of \$1billion

Banks - owe RBA \$1billion to pay for bank cheques used to pay government for taxes

Dealers - are in balance

RBA - is owed \$1billion by banks to fund rise in the government's deposit account as a result of tax receipts

#### **CUMULATIVE BALANCE SHEET CHANGES**

Commercial Banks		Authorised Dealers		Reserve Bank	
Non bank deposits -\$1 B	ESAs with RBA -\$1 B	0	0	Govt A/C +\$1 B Banks' ESAs -\$1 B	0

Stage 2: Mid-morning; banks draw \$1billion from their deposits with dealers and use this amount to clear their debt to the RBA

Banks - square with RBA but have a reduction in their collective balance sheets of \$1billion

Dealers - have a reduction in their deposit liabilities of \$1billion and find themselves owing the RBA \$1billion as the banks deposit \$1billion with the RBA

RBA - now square with respect to the banks but require \$1billion from the dealers

#### **CUMULATIVE BALANCE SHEET CHANGES**

Commercial Banks		Authorised Dealers		Reserve Bank	
Non bank deposits -\$1 B	ESAs with RBA 0 Deps with Dealers -\$1 B	Deps from Banks -\$1 B	ESAs with RBA -\$1 B	Govt A/C +\$1 B Banks' ESAs 0 Dealers' ESAs -\$1 B	
	l			<del></del>	0

Stage 3: Following bank withdrawals, dealers bid for \$1billion of deposits from non-bank clients who draw the money (in bank cheque form) from their deposits with banks.

Dealers deposit these funds in their RBA exchange settlement accounts to square up with the RBA. RBA gives dealers immediate value for the deposits.

Banks - still in balance

Dealers - now in balance with same size of balance sheets but with \$1billion of non-bank deposits substituted for \$1billion of bank deposits

RBA - in balance but with balance sheet \$1 billion larger. By crediting the dealers with immediate value for the bank cheque funds while not debiting the banks until the cheques clear on the following day, the RBA effectively lends the dealers \$1 billion overnight.

#### **CUMULATIVE BALANCE SHEET CHANGES**

Commercial Banks		Authorised Dealers		Reserve Bank	
Non bank deposits -\$1 B -\$1 B	ESAs with RBA 0 Deps with Dealers -\$1 B	Deps from Banks -\$1 B  Deps from non banks +\$1 B	ESAs with RBA 0	Govt A/C +\$1 B Banks' ESAs 0 Dealers' ESAs 0	Implicit Loan to Dealers +\$1 B
•	•			+\$1 B	+\$1 B

This use of the "float" to borrow cash from the next day is only temporary. In the above example, in the absence of any other transactions, the banks would find themselves on the following day (4 July) facing another opening deficit of \$1billion. The process can be delayed indefinitely, however. On the morning of 4 July, the overnight deposits lodged by non-banks with dealers mature and would generally be returned to banks. Since the maturing overnight deposits are repaid by dealers with cheques drawn on their ESAs, when they are lodged once again with banks, they provide same-day funds for banks to deposit into their own exchange settlement accounts. Thus the opening deficit of \$1billion in the banks' ESAs is immediately cleared by an offsetting deposit of same-day funds.

As the non-bank deposits flow back to the banks, however, the dealers once again find themselves owing the RBA \$1billion. By bidding these deposits away from banks for a second time, the process of an implicit loan from the RBA is repeated and the \$1billion deficit is rolled forward from one day to the next.

The process is brought to a halt only by complete removal of the cash shortage. This may occur either when other funds come into the system (for example, as a result of government payments to welfare recipients or direct provision of the cash by the RBA through its market operations) or via use of the rediscount facility. Since rediscounts remove securities from circulation, they remove the deficit permanently.

The more dealers are forced to bid deposits away from banks, the more pressure will be exerted on the "cash interest rate" (the interest rate on overnight funds in the official money market). As the price of overnight funds from the non-bank sector approaches the rediscount rate, dealers will consider substituting rediscounts for use of the float.

#### Reserve Bank Intervention

Since reliance on the float is likely to involve large swings in the cash interest rate, the RBA usually intervenes with its own transactions to smooth imbalances in the market for cash. Anticipating the shortage of cash in the above example, the RBA would typically announce its willingness to buy assets from the dealers. These could be in the form of outright purchases of Treasury Notes or repurchase agreements<sup>8</sup>. In both cases, the RBA makes cash available to the system through the dealers.

The extent to which the Reserve Bank is willing to accommodate the cash needs of the system depends upon the stance of monetary policy. Lesser accommodation of deficits and heavier accommodation of surpluses (i.e., RBA sales of securities or reverse repurchase agreements) would be consistent with a tightening of monetary policy.

#### III. A MODEL OF THE OFFICIAL SHORT-TERM MONEY MARKET

On any given day, the excess demand for cash consists of several components. The first arises from the opening balance of the exchange settlement accounts of banks. This is announced to the public each day by the RBA and is known as the "system cash position". Whenever the system is in deficit, the initial impact on the market is an excess demand for cash. This base demand is perfectly inelastic since the banks have a legal obligation to clear

<sup>&</sup>lt;sup>7</sup> The decision to substitute a rediscount for use of the float involves more than a simple comparison of rates, since potentially large differences in maturity are involved. Nonetheless, the rediscount rate tends to put a ceiling on the price of cash from other sources.

<sup>&</sup>lt;sup>8</sup> A repurchase agreement or "repo" is effectively a secured loan in which title to the collateral is actually transferred. When the RBA "buys" a repurchase agreement, it buys a Treasury Note from a dealer for immediate value and simultaneously agrees to sell the Note back to the dealer at a future date at an agreed price.

these deficit balances regardless of the price. When the system opens in surplus, the initial impact on the market is an excess supply of cash. As with a deficit, this base supply is perfectly inelastic since the banks have no incentive to hold positive balances overnight provided the overnight interest rate offered by dealers is positive.

The second component is the RBA's accommodation of the opening position. To the extent that this is provided to the market early in the trading day, it too can be treated as exogenous and therefore inelastic with respect to movements in the cash interest rate during the day. In the model sketched in Figure 1, the RBA's transactions are subtracted from the opening cash position to derive a base excess demand or supply to the market. This is shown as OD' in both Figures 1 and 2.

The third component arises from the tender system for Treasury Notes and Commonwealth Bonds. Each Wednesday, the RBA offers Treasury Notes for auction; it offers Commonwealth Bonds at less regular intervals. Successful bidders (mostly banks and dealers) have one week in which to settle their lots. The decision to settle is heavily influenced by the overnight money market rate, since this rate represents the funding cost of taking the securities up before the end of the week. The only settlement transactions that affect the cash market on the day are settlements by dealers (all other Treasury Note settlements affect banks' exchange settlement accounts the following day). Thus, once the cash interest rate falls below the yield on securities won by dealers at the most recent tender, the dealers will demand cash to settle. This amount varies from day to day according to the stock of unsettled securities available to dealers. It is shown as the rightward kink EF in the base excess demand schedules in Figures 1 and 2.

The market supply of cash is dictated by the supply of non-bank deposits to dealers. This is shown as an increasing function of the cash interest rate (AA' in Figures 1 and 2) given that interest rates on alternative investments remain given. However, once the cash interest rate rises above the rediscount rate on Treasury Notes, the supply of cash becomes highly elastic, provided dealers hold an adequate stock of Treasury Notes (or are able to purchase them in the open market). The equilibrium cash interest rate in both figures is i\*. As can be seen from

Figures 1 and 2, the impact of the rediscount facility is to put an effective ceiling on the daily cash interest rate at i<sub>rediscount</sub>, whereas the unsettled Treasury Notes tend to put something of a floor under the rate at i<sub>tender</sub>.

#### IV. EMPIRICAL RESULTS

To test this formulation of the official short term money market in Australia, the following simple simultaneous linear equation system was estimated using daily data on the cash interest rate and the various exogenous variables suggested by the theoretical model:

$$i_c = \alpha_0 + \alpha_1 Q + \alpha_2 i_u \tag{1}$$

$$Q = OB + \beta_I U \tag{2}$$

where:

 $i_c$  = official cash interest rate

 $i_u$  = unofficial cash interest rate

Q = demand for (supply of) cash

OB = opening cash market position net of RBA transactions

U = outstanding stock of unsettled Treasury securities

Equation (1) is the equation of the supply curve in Figures 1 and 2. The expected sign of  $\alpha_1$  is therefore positive. In order to avoid problems of identification, an additional exogenous variable is required on the right-hand-side of equation (1). The interest rate offered on overnight deposits of cash by institutions *other than* official short term money market dealers (the so-called "unofficial" cash interest rate) is chosen for these purposes. Such deposits are offered by banks and money market corporations, the essential difference being that such deposits do not enjoy the "same day" or cash status that deposits with the official dealers enjoy. In this way, unofficial cash represents all alternative investments. The kink in the supply curve, as depicted in Figures 1 and 2, is ignored for the purposes of estimation.

Since the position of the supply curve is fixed for a given value of  $i_u$ , the model explains changes in the official cash rate which have not yet been transmitted to the unofficial cash market and beyond. The model aims to explain how the official cash interest rate is determined and, for such purposes, it is appropriate to assume that the unofficial cash rate is exogenous. In a more complete model of interest rate determination, one would wish to explain how the unofficial cash interest rate, and other interest rates further out along the yield curve, were influenced by policy-induced changes in the official cash rate. This is an important issue but one which is not addressed within the more limited purview of the current model.

Equation (2) is the demand curve in Figures (1) and (2). It is independent of the cash interest rate and would appear as a vertical line in Figures (1) and (2). The kink in the demand curve as depicted in the figures has been ignored for the purposes of estimation. Thus the position of the demand curve on a given day depends upon the volume of Treasury securities settled on that day, which is in turn (unrealistically) assumed to be independent of cash market conditions on the day.

A total of 999 daily observations of the various cash market variables were obtained from the Reserve Bank of Australia covering the period 1 January 1986 to 31 December 1991. The two-equation system was estimated by applying Ordinary Least Squares regression techniques to each equation separately using the TSP software package. Since the system is only trivially simultaneous, there being only one endogenous variable, the application of simultaneous equation methods was judged unnecessary. Estimation of the model using 3SLS confirmed this judgement, the results being virtually identical.

The results of OLS estimation of equations (1) and (2) are as follows:

$$i_c = 0.2558 + 0.00036Q + 0.9497i_u$$
  $R^2 = 0.94$   $DW = 0.34$   $Q = OB + 0.0749U$   $R^2 = 0.64$   $DW = 1.92$ 

The parameters of all of the exogenous variables are statistically significant and their signs are as expected. While the levels of the unofficial and official cash rates are clearly

highly correlated, the model is able to explain how the official rate can be made to depart from the unofficial rate as a result of policy actions undertaken by the RBA.

The least attractive aspect of the estimation results is the autocorrelation evident in the supply equation. In order to determine the source of this problem, the data on the official cash rate were graphed as shown in Figure 3. This reveals two distinct eras within the data set, one prior to the end of 1989 when the cash interest rate appears to be highly variable, and the other subsequent to that time when the cash rate appears to follow an almost step-like pattern. Closer inquiry indicated a subtle change in RBA announcement policy with the assumption of office of the current Governor of the RBA, Mr Bernie Fraser. The new policy involved announcement of the cash interest rate which the RBA expected the market to achieve. Needless to say, given the monopoly position of the RBA in the official cash market, the actual market rate subsequently tracked the announced rate with great accuracy.

When the model predictions were fitted over the actual data, the latter period displayed consistent underprediction as shown in Figure 4. On these grounds, it was decided to split the initial data set into two parts around the date of the change in RBA governorship on 6 December 1989. The results of estimation over the two sub-periods separately are as follows:

1 January 1986 - 6 December 1989

$$i_c = -0.1927 + 0.000877Q + 0.9683i_u$$
  $R^2 = 0.92$   $DW = 0.40$   $Q = OB + 0.1145U$   $R^2 = 0.73$   $DW = 1.81$ 

7 December 1989 - 31 December 1991

$$i_c = -0.04 - 0.0000085Q + 0.9952i_u$$
  $R^2 = 0.99$   $DW = 0.75$   $Q = OB + 0.0418U$   $R^2 = 0.59$   $DW = 0.89$   $DW = 0.89$ 

While partitioning the data set in this fashion does not remove the autocorrelation evident in the regression estimates, it does reveal a significant change in the operation of the cash market since the end of 1989. With the advent of explicit announcements of its cash market intentions by the RBA, the market now behaves as if the supply curve were horizontal (i.e., the coefficient on Q in the supply equation is statistically insignificantly different from zero)<sup>9</sup>. In other words, the official cash interest rate is seemingly determined independently of the supply of or demand for cash; the cash rate is what the RBA says it will be.

Of course, the rate must be determined by the forces of supply and demand in an ultimate sense. But the RBA's ability to supply cash on demand so as to achieve its desired cash interest rate brings the market into equilibrium at that rate almost instantaneously. This is distinct from the more drawn-out equilibration process which took place before the onset of the announcement policy, and which gives rise to the detectable influence of supply and demand in the regression results for the pre-December-1989 period.

Presumably, granted access to intra-day trading data, it might be possible to fit the pre-December-1989 model to the later period so as to detect the influence of the RBA's supplying and demanding cash on the process of realising the announced cash rate. Daily data are too coarse for this purpose. As a result, the impression is gained from regression results such as those reported above that supply and demand for cash no longer matter for the determination of the cash interest rate.

#### V. CONCLUSION

Empirical analysis provides qualified support for the theoretical model of cash interest rate determination developed in this paper. The key to understanding the official cash market on this view is recognising the monopoly power wielded by the RBA in the market for its own liabilities. At least prior to the assumption of policy announcement by the current governor, the results show a significant positive relationship between the demand for cash, subsequently supplied by the RBA, and the level of the cash interest rate. Since the advent of policy announcement, it is no longer possible to detect the process of supply-demand equilibration in

<sup>&</sup>lt;sup>9</sup> We are grateful to Adrian Pagan for pointing out that in the model we are using, the autocorrelation is largely irrelevant, given the small size of the errors and the large size of the t-statistics.

the cash market using daily data. Policy announcement does not change the operation of the cash market in principle but makes the process of equilibration more difficult to detect.

#### AN OPENING DEFICIT FOR THE CASH MARKET

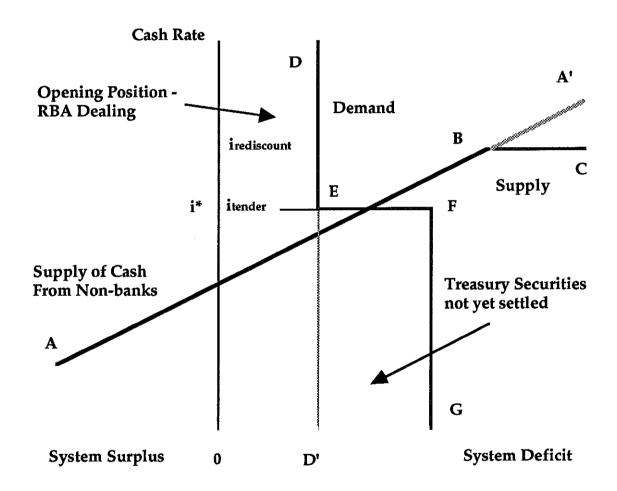


FIGURE 1

#### AN OPENING SURPLUS FOR THE CASH MARKET

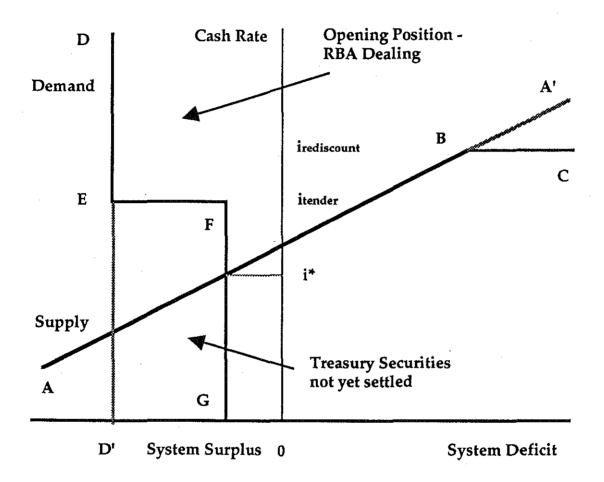


FIGURE 2

#### 23

#### Official Cash Rate

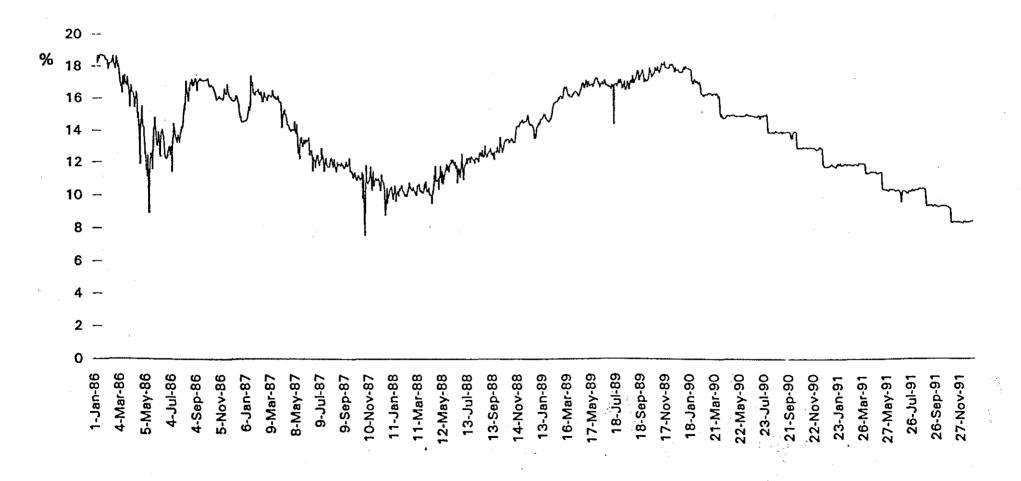


Figure 3

#### Official Cash Rate

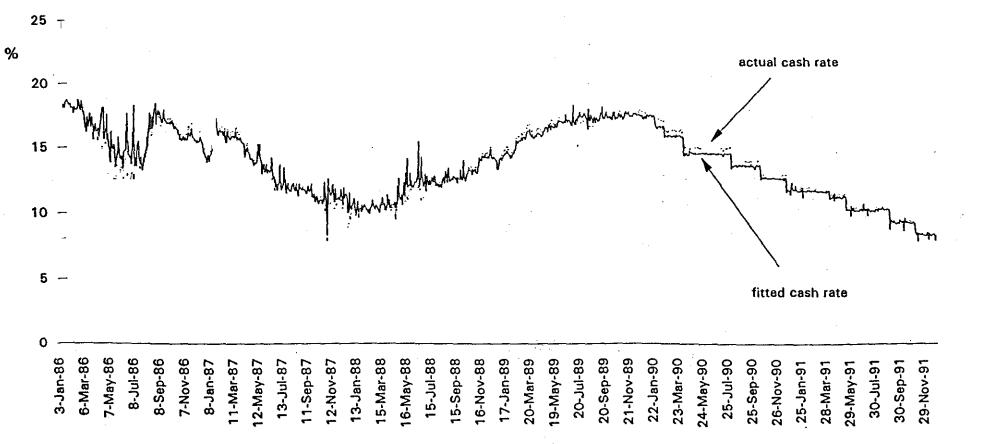


Figure 4

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