Monetary Policy and Operating Procedures in New Zealand

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I. INTRODUCTION

The current structure of financial intermediation and monetary policy in New Zealand provides an interesting environment for examining some recent work by Fama (1980, 1983) concerning unregulated financial systems and price level determinacy. In New Zealand, banks are not subject to interest rate regulations or reserve requirements. Currency is also supplied elastically, and yet monetary policy has been able to exert control over prices and to reduce inflation substantially. These attributes of New Zealand's financial system seemingly are at odds with Fama's analysis since in the absence of currency control he emphasizes the use of noninterest-bearing required reserves as a means of establishing a well-defined real value of a medium of exchange.

A closer look at the operations of the Reserve Bank of New Zealand, however, reveals an important legal restriction governing the settlement of accounts between a bank and the Reserve Bank. This restriction, together with the operating procedures used by the Reserve Bank, creates a well-defined demand for an asset whose nominal supply is under the direct control of the central bank. This asset, called exchange settlement funds or cash, pays a below-market rate of interest. Thus the general thrust of Fama's work on price level determinacy holds.

It is also interesting to study the procedures of the Reserve Bank of New Zealand from a monetarist perspective. The Reserve Bank of New Zealand currently uses a quantity-based procedure rather than an interest rate instrument in conducting monetary policy. Like most central banks, however, the Reserve Bank is averse to directly controlling the stock of currency. Given the absence of reserve requirements the only other remaining quantity to target is excess reserves. The level of this target is extremely low compared to the size of the banking system and implies that monetary policy is implemented through its influence on a very small percentage of the monetary base. Also, as mentioned these excess reserves or settlement funds pay interest. Thus the operating procedures of the Reserve Bank of New Zealand impose a very small cost on the banking system compared to the costs imposed by most other institutional frameworks for monetary policy. New Zealand's arrangements, therefore, appear to be a relatively efficient means of anchoring the monetary system.

This paper outlines the major aspects of monetary procedures in New Zealand and examines how these procedures affect the price level. Section II briefly examines the setting for Reserve Bank operating procedures. Although New Zealand does not conform to any of the specific examples stressed by Fama that allow for price level determinacy, the monetary system does meet his general requirements. Section III presents a model of bank behavior based on a precautionary demand for exchange settlement or excess reserves. The model draws on past work on the precautionary demand for money, most notably Poole (1968). In Section IV the model's equilibrium and the determination of prices are discussed, while in Section V some extensions are examined. Section VI concludes the paper.

II. PRICE LEVEL DETERMINACY AND MONETARY POLICY IN NEW ZEALAND

Issues Concerning Price Level Determinacy

In some influential work Fama (1980, 1983) examines the behavior of economies with unregulated financial intermediation and analyzes the conditions under which a purely nominal commodity serves as a numeraire. Banks in his world provide two related services. They provide an accounting system of exchange that keeps track of exchanges of wealth

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between transactors. They also manage portfolios transforming one form of wealth (a particular portfolio) into another. This activity is related to banks' role in the exchange process because the recipient of a wealth transfer may wish to hold his wealth in a form that differs from that transferred by the initial holder. Since deposits are heterogeneous (every deposit may represent a claim to a different set of underlying assets), there is no sense in which a generic deposit can serve as a numeraire. Indeed, this unregulated world is not a monetary economy and has no object that resembles what is currently referred to as money.

To introduce a nominal commodity that serves as a medium of exchange into this abstract environment, Fama analyzes a number of monetary arrangements. The first relies on the introduction of a noninterest-bearing currency, which enjoys a relative advantage in certain types of transactions. The government monopolizes the printing of currency and sells a given quantity to banks for assets. Banks hold the currency for customers who may wish to exchange assets for currency. To get a well-defined price level, or real value for currency, there must be a well-defined demand and supply of currency, and currency must earn a below-market rate of return (see Patinkin). Because currency is valued for its transaction services there is a real demand for it, and the government is able to fix its nominal supply. As Wallace (1983) stresses, the government must prohibit privately issued competing transactions instruments (e.g., small denomination interest-bearing securities) for government currency to have value.[1]

Alternatively, the government could define a nominal unit of account through reserve requirements on bank deposits. Requiring banks to hold some fraction of deposits as noninterest-bearing reserves creates a well-defined real demand for reserves. The government can control the nominal supply of reserves and, as in the case of currency, produce a well-defined unit of account. Under this system nominal reserves are controlled and currency could be issued passively (i.e., on demand).

Fama also indicates that a hybrid policy of controlling the sum of reserves and currency, but not caring about their mix, is sufficient for defining a price level. In New Zealand, none of the above policies are followed. There are no reserve requirements and currency is issued passively. What the Reserve Bank of New Zealand does is control the quantity of the transactions medium used to settle interbank balances between banks in the New Zealand Bankers Association and between these banks and the Reserve Bank. These settlement balances, referred to as cash, earn 65 percent of the seven-day Reserve Bank bill yield.[2]

The institutional structure of the interbank market and the rules for settlement set by the Reserve Bank generate a well-defined demand for cash. The Reserve Bank controls the nominal quantity of cash implying that the monetary system in New Zealand obeys Fama's necessary conditions for a determinate price level. In the United States an analogous policy would be controlling the supply of excess reserves.

The Operation of New Zealand's Monetary Policy

At the beginning of each new banking day the net position of each bank from business conducted on the previous day is calculated. Banks must then settle among themselves and with the Reserve Bank. There is a net flow of funds between the banking system and the Reserve Bank because the Reserve Bank serves as the government's banker. Also, the Reserve Bank does not permit overdrafts on settlement accounts. Any bank that has a net debit position must either borrow settlement cash from another bank or rediscount Reserve Bank bills of less than 28 days to maturity. These bills are issued with a maturity of 91 days and are the only instrument rediscounted by the Reserve Bank at a penalty of 150 percent above the market rate on seven-day certificates of deposit. The discount rate penalty, therefore, depends on the term to maturity of the bill. To avoid these penalties, banks hold an inventory of cash as well as an inventory of Reserve Bank bills. The rediscount feature of these bills implies that their supply affects the liquidity of the banking system and that their quantity, along with the quantity of exchange settlement, directly influences the price level.

A crucial feature of the New Zealand system is the uncertainty involving movements in the government's accounts. These movements must occasionally cause the banking system as a whole to have a net debit position with respect to the Reserve Bank. Banks can borrow and lend cash to satisfy net interbank

[1] Wallace's legal restrictions argument is somewhat severe. Privately issued bearer notes would be consistent with price level determinacy if the government auctioned off rights to print a fixed value of notes and required a below-market yield on these notes.

[2] The policy of paying interest on cash would be analogous to a policy of paying interest on excess reserves in the United States.

positions, implying that in the absence of stochastic cash flows with the government, the banking system as a whole need not hold cash. All settlement could be done through credit arrangements. Negative cash flows with the government require payment with exchange settlement or the rediscounting of Reserve Bank bills. Since rediscounting involves a penalty the optimal response by the banking system is to hold an inventory of cash for clearing purposes.

The primary instruments of monetary policy are, therefore, the supply of cash and the supply of Reserve Bank bills. The supply of cash is largely controlled through open market operations which are conducted in an attempt to hit a specific cash target, currently 30 million $NZ. Whether the end-of-day cash balance equals the target will depend on how well the Reserve Bank forecasts the net flow of government transactions. The Reserve Bank cannot afford to forecast or offset government flows too exactly or there will never be a need for rediscounting by the banking system as a whole. Without periodic rediscounting there would be no demand for cash, since an inventory of cash is only held to avoid rediscounting.

The Reserve Bank can also affect the demand for cash through its second instrument, namely the supply of Reserve Bank bills. These bills affect the liquidity of the banking system. A decrease in their supply would imply a greater likelihood that any individual bank would not have a sufficient amount of bills for rediscounting and would have to incur the additional transactions costs of obtaining such bills if the need should arise. Also, with a smaller supply of bills, a bank caught short of cash would have to rediscount bills of a greater average maturity, incurring a larger rediscount penalty. To avoid these added penalties, banks increase their demand for cash. By influencing the demand for cash the supply of Reserve Bank bills affects the price level and serves as an additional instrument of monetary policy.

III. A MODEL

The following model attempts to capture the major aspects of monetary operations in New Zealand and examines how these operations affect the price level. The most important aspect is the precautionary nature of the banking system's demand for cash and the role that unanticipated flows in the Crown's accounts have in generating that demand. Throughout it is assumed that there exists a perfectly competitive interbank market. In this respect the model is similar to that of Poole (1968) and also is related to much of the literature on the precautionary demand for money.

The major characteristic of the model is the simple and direct way it relates nominal magnitudes to Reserve Bank policy. The cost of doing this requires the assumption that the real and monetary sectors of the economy are exogenous. But this assumption is to some extent justified by treating New Zealand as a small open economy with perfectly flexible prices and a flexible exchange rate. Under such treatment, the real rate of interest and the real exchange rate are taken parametrically and are unaffected by domestic monetary policy. Also, for simplicity, currency, being elastically supplied and so having no essential effects on any other variables, is omitted from the model. Adding a currency demand function would only serve to determine the nominal supply of currency without affecting the main channels through which monetary policy affects nominal magnitudes.

The Real Economy

The real rate of interest, ρ_t, and the real exchange rate, ϵ_t (expressed as the number of world goods per New Zealand good), are taken as given. Thus,

$$(1) \quad i_t = (1+\pi_t^e)(1+\rho_t)$$

and

$$(2) \quad e_t = \frac{P_t^*}{P_t}\epsilon_t$$

where i_t is the nominal rate of interest, π_t^e is expected inflation, e_t is the nominal exchange rate (the number of New Zealand dollars per unit of world currency), P_t^* is the rest of the world's price level, and P_t is the price level in New Zealand.

Banks

The banking system is assumed to be competitive and provides transactions accounts called demand deposits to individuals. Funds flow between banks for two reasons. One is that individuals transact among themselves creating interbank flows. The net of these flows for the banking system as a whole is zero, and it is assumed that an interbank credit market exists to handle short-term imbalances. Individuals also transact with the government, creating a net flow of funds between the banking system and the Reserve Bank of New Zealand. The Reserve Bank does not permit overdrafts requiring banks to maintain a nonnegative balance of settlement funds at the end of the day. A bank that has a net negative position with the Reserve Bank is required to pay a penalty by rediscounting Reserve Bank bills at a penalty rate, r^P. These bills are auctioned regularly by the Reserve Bank and constitute the only rediscountable security it accepts. The absence of overdraft privileges, plus the penalty on rediscounting, creates a precautionary motive for holding a settlement account at the Reserve Bank and a corresponding motive for holding Reserve Bank bills. In the presence of an interbank market it is the net expenditure flows with the government, as well as the rediscounting policy of the Reserve Bank, that creates a well-defined precautionary demand for exchange settlement funds or cash.

A simplified representation of a bank's balance sheet is depicted in Figure 1.

Figure 1

Assets	Liabilities
C	D
RB	
L	

A representative bank supplies demand deposits D at a constant marginal cost α and pays a nominal interest rate of r^D on the account. Banks hold at the Reserve Bank cash or clearing balances C which yield a below-market rate of r^C. They also purchase Reserve Bank bills, RB, that yield a rate r and make loans, L, that earn a risk-adjusted nominal interest rate of i. A further assumption is that if a bank does not have the necessary amount of Reserve Bank bills for rediscounting, it must buy some in the market and incur a proportional transactions cost of ϕ. Further, since rediscounting is at a penalty rate, it is easiest to think of each dollar of Reserve Bank bills rediscounted as incurring a net proportional cost of δ. Because Reserve Bank bills have the added feature of being rediscountable they will never trade at a rate greater than i in equilibrium.

Before describing the simple model that depicts the major features of a bank's decision in this environment, it may be useful to highlight some of the operating characteristics of the interbank model. In doing so I focus on movements in the overnight interbank interest rate that occur under various realizations of stochastic cash flows between the banking system and the government. First, when cash is plentiful and all banks' exchange settlement accounts have a positive balance at the end of the day, the interbank rate should equal the rate paid on cash. If the interbank rate fell below the rate paid on cash, a bank would find it profitable to borrow cash and deposit it at the Reserve Bank. Also, from the standpoint of the lending bank it would be better to deposit the money at the Reserve Bank than lend the cash at a lower rate. If the banking system on the whole is short of cash, then the interbank rate should rise to the level of the penalty rate on the shortest available maturing Reserve Bank bill.[3] If the rate were to exceed the penalty rate, banks could earn profits by rediscounting a bill and lending the cash. The interbank rate will, therefore, be bounded by the rate paid on cash and the penalty rate for rediscounting.

Given the Reserve Bank's operating procedures, banks will decide on an optimal level of both C and RB. These levels will be based on the penalties associated with rediscounting, the opportunity cost of holding cash and Reserve Bank bills, transaction costs, and the stochastic processes governing flows between each bank and the government. I will discuss in detail the simplest case in which there are no interbank flows and where each bank realizes the same stochastic cash flow with the government. In this case a representative bank can serve as a stand-in for the banking system as a whole. I make this simplifying assumption to concentrate on aggregate disturbances to the cash position of the banking system as a whole. It is these disturbances and the resulting precautionary demand for cash that are crucial for understanding nominal determinacy in New Zealand. In particular, let deposits held at a bank be $\hat{D} = D + pg$, where D is expected deposits, p is the price level, and g is a mean zero random variable with a density function f(g) that takes on positive values over the interval $[-\bar{g}, \bar{g}]$. Deposits are decomposed into these two components because banks in this model are only able to choose an ex ante expected level of deposits. Actual deposits will equal expected deposits plus any stochastic deposit flows. A representative bank maximizes its expected profits, Q, subject to the balance sheet constraint $C + RB + L = D$. Formally, a bank solves the optimization problem seen in the accompanying box.

[3] Note the yield on Reserve Bank bills should not change significantly for temporary cash shortages since their yield is governed by intertemporal considerations. That is, their demand is a function of expected future cash shortages as well.

$$
\begin{aligned}
(3)\quad \max_{C,RB,D,L} Q = {} & (i+\delta+\phi)\int_{-\bar{g}}^{\frac{-(C+RB)}{P}} (C+RB+pg)f(g)dg \;-\; \delta\int_{-\bar{g}}^{\frac{-(C+RB)}{P}} RBf(g)dg \\
& + \delta\int_{\frac{-(C+RB)}{P}}^{\frac{-C}{P}} (C+pg)f(g)dg \;+\; r\int_{\frac{-(C+RP)}{P}}^{\frac{-C}{P}} (RB+C+pg)f(g)dg \\
& + r^C\int_{\frac{-C}{P}}^{\bar{g}} (C+pg)f(g)dg \;+\; r\int_{\frac{-C}{P}}^{\bar{g}} RBf(g)dg \\
& + iL \;-\; (r^D+\alpha)\int_{-\bar{g}}^{\bar{g}} (D+pg)f(g)dg
\end{aligned}
$$

subject to $C+RB+L = D$.

The first two terms in (3) represent the case where there is a large transfer of funds to the government. For such a large negative value of g the bank is short of Reserve Bank bills. It must borrow and pay a brokerage fee to obtain the bills and then rediscount them at a proportional loss of δ.[4] The expression inside the first integral is, therefore, negative and represents a cost. Furthermore, in this case the bank must rediscount its entire stock of bills and this cost is given by the second integral. When g is not so negative as to force all of the bank's bills to be rediscounted, the bank rediscounts a portion at a cost δ (the third term) and earns r on the rest (the fourth term). When the outflow of funds to the government is not less than the bank's inventory of cash (i.e., $g > -C/P$), the bank earns r^C on its cash balances and r on all its bills. This realization is given by the fifth and sixth terms in (3). Finally, banks earn i on loans and incur a cost of $r^D+\alpha$ on each dollar deposited.

The first-order conditions for the bank's profit maximization are:

$$(4a)\quad \phi F\left(\frac{-C-RB}{P}\right) + r\left[1-F\left(\frac{-C-RB}{P}\right)\right] = i\left[1-F\left(\frac{-C-RB}{P}\right)\right]$$

$$(4b)\quad (\phi-r)F\left(\frac{-C-RB}{P}\right) + (r+\delta-r^C)F\left(\frac{-C}{P}\right) + r^C = i\left[1-F\left(\frac{-C-RB}{P}\right)\right]$$

$$(4c)\quad r^D+\alpha = i$$

Since banks produce deposits at a constant marginal cost the equilibrium value of deposits will be demand determined. The bank's balance sheet constraint can be used to calculate L once p, i, r^D, C, and RB are determined. Given i, r^D is obtained from (4c). Using (1), (4a), (4b), and the equilibrium conditions

$$(5a)\quad C = C^S,$$

$$(5b)\quad RB = RB^S,$$

where C^S and RB^S are cash and Reserve Bank bills supplied, one can calculate i, p, C, RB, and r.

IV. Equilibrium

The simple model of Section III is now used to analyze the equilibrium determination of prices and interest rates. One case involves the situation where the supply of Reserve Bank bills is such that, in equilibrium, $(C+RB)/p \geq \bar{g}$. In this case equation (4a) implies that $r=i$ and (4b) implies

[4] It is easiest to think of rediscounting as a collateralized loan at the rate r^P. In the area of the distribution where $g < (-C-RB)/P$, the bank essentially must swap a loan or Treasury bill for a Reserve Bank bill at a cost of ϕ per dollar of transaction and then take out the equivalent of a penalty loan from the Reserve Bank. The bank must also use its stock of Reserve Bank bills to secure a penalty loan at a net cost of r^P-r. Alternatively one could look upon rediscounting as involving a proportional loss of δ per dollar of bills rediscounted (i.e., $\delta = r^P-r$). In the case where a bank is out of cash and must borrow Reserve Bank bills, the bank must first borrow the money (sell off a loan at rate i) to get a Reserve Bank bill that earns r, pay a proportional transactions cost ϕ', and rediscount at r^P earning a proportional loss of δ. Thus $\delta+i+\phi' = r^P+\phi$ in the paper.

that $(\delta + r - r^C)F(\frac{-C}{P}) = i - r_C$. Here the supply of Reserve Bank bills is so abundant that the marginal bill supplies no liquidity services and hence the yield on bills is driven to i. When that happens the price level is directly proportional to C because a proportional change in cash and the price level still solves equation (4b). Also if $\phi = 0$ then (4a) once again implies $r = i$, and (4b) yields a solution in which prices are proportional to cash. With no transaction costs in acquiring Reserve Bank bills, Reserve Bank bills and loans become perfect substitutes from an individual bank's standpoint and hence bills provide no added liquidity benefits. In these cases, marginal changes in Reserve Bank bills have no effect on the real demand for settlement cash. Hence the price level is proportional to the supply of cash.

Since Reserve Bank bills typically yield less than other financial instruments (i.e., $r < i$), one must conclude that $(C + RB)/p < \bar{g}$. For the simple model with independently distributed flows among banks this implies that at times banks may not have enough Reserve Bank bills for rediscounting. The transaction cost ϕ could then be interpreted as an additional penalty imposed by the Reserve Bank. In these circumstances the price level would no longer be directly proportional to cash since equations (4a) and (4b) would no longer be satisfied if cash and the price level were changed proportionately from their equilibrium values. These equations would still be satisfied, however, if cash, Reserve Bank bills, and prices changed proportionately. Hence the price level is sensitive to the supply of Reserve Bank bills even though these bills pay a competitive rate of interest. The sensitivity of the price level to a financial instrument paying a competitive rate occurs because in this case the supply of Reserve Bank bills influences the real demand for settlement cash. With the possibility that a bank may incur an additional cost of ϕ, the real demand for cash decreases as the supply of Reserve Bank bills is increased.

In reality, each bank does not hold enough cash and Reserve Bank bills to cover all stochastic realizations of flows with the government. Yet the banking system as a whole does. This happens because the flow of funds between banks and the government is not independent across banks. Although removing the assumption of independence and analyzing idiosyncratic as well as aggregate movements in cash greatly complicates the analytics of the model, it should not change the basic result that the price level is a function of both the supply of cash and Reserve Bank bills. Neglecting independence, one could think of each bank receiving a stochastic cash flow composed of a common term g and an idiosyncratic term u, where the sum of the idiosyncratic terms across banks is zero and these terms take on values over the interval $[-\bar{u}, \bar{u}]$. Hence, any one bank could be in the position of $\bar{g} < (C + RB)/p < \bar{g} + \bar{u}$, in which case the banking system as a whole would have enough Reserve Bank bills but the individual bank experiencing the large cash drain would have to purchase bills and incur the transaction cost ϕ. If the penalty for being unable to cover stochastic outflows through rediscounting were severe enough (say closing the bank), then the first-order conditions would guarantee that each bank would hold enough liquid assets $(C + RB)$ so that in equilibrium the banking system would not be short of Reserve Bank bills.

For example, with a banking system composed of two identical banks A and B, bank A would invoke the penalty of being closed down if

$$(C_A + RB_A)/p < 2\bar{g} - \frac{C_B + RB_B}{P}.$$

If the penalty of being closed is sufficiently negative, then the first-order conditions for bank A would not be met unless the preceding inequality were reversed. Since each bank is identical, the system as a whole could meet its liquidity needs. However, a solution with $(C_A + RB_A)/p < \bar{g} + \bar{u}$ is entirely possible and r would be less than i as long as there is a transaction cost for purchasing additional Reserve Bank bills. Also, the price level would be sensitive to the supply of bills.

One should also note that the first-order conditions (4a) and (4b) depend on the form of the distribution function F. The distribution of net cash flows between the Reserve Bank and the banking system is also under the control of the Reserve Bank. Specifically, the Reserve Bank can to some extent control the variability of these flows and thus influence the demand for cash. Hence different choices of F can lead to different equilibrium outcomes. The Reserve Bank can also choose r^C and δ, and can achieve the same equilibrium for a variety of choices regarding F, r^C, and δ. Different combinations of these instruments will generally alter the overall tax on the banking system associated with the Reserve Bank's monetary policy. For example, making cash flows less variable would require costly additional monitoring of government transactions. There are, therefore, tradeoffs between costs to the banking system and costs to the Reserve Bank in obtaining any equilibrium price level (or price level path). A quantitative assessment of these costs would be interesting.

V. Extensions

While extending the model to incorporate some stochastic dependence among banks may not qualitatively affect price level determination, it would provide a framework for examining fluctuations in the interbank interest rate. Interbank lending is an ex post decision with respect to cash flows and this rate would be a function of given realizations of g. In a setting where profits from cash management do not affect economic activity, and where the price level and other market rates are not influenced by these unexpected flows, the interbank rate will vary with realizations of g. When all banks are flush with cash, the interbank rate, under a quantity target, should fall to the rate paid on cash. When, on the other hand, banks are rediscounting, the interbank rate should rise to the rediscount rate. One could then investigate how various institutional changes (e.g., with respect to rediscounting) would affect the volatility of the interbank interest rate.

One could also extend the analysis to consider a banking system under imperfect competition. Comparing operating procedures that use an interest rate instrument as opposed to a quantity target would have different implications for bank behavior.

VI. Summary

This article provides an analytical framework for investigating the nominal implications of targeting interbank balances in New Zealand. The institutional structure of the interbank market is such that banks demand clearing balances for precautionary reasons. The Reserve Bank through its supply of cash and Reserve Bank bills is able to affect the price level and nominal interest rates. Of particular interest is the result that the supply of Reserve Bank bills influences the price level even though these bills pay a competitive rate of interest. These bills do so because they provide an additional form of liquidity and, therefore, affect the demand for exchange settlement funds.

Further, one observes that the Reserve Bank of New Zealand conducts monetary policy through a reserve instrument, namely exchange settlement funds. Except in the case of an optimal deflation, the operation of any monetary system that produces nominal determinacy must do so through some sort of efficiency loss. One part of the efficiency loss arises because the monetary instrument must by necessity earn less than the market determined nominal rate. Holding this instrument, therefore, incurs an opportunity cost [for a more detailed discussion of efficiency losses see Wallace (1983)]. While all central banks prohibit interest on currency, New Zealand's system seems to impose a smaller tax on its banking system than most other monetary systems. There are no reserve requirements. Moreover, excess reserves, which constitute a small fraction of bank assets, do earn some interest. The full cost borne by New Zealand banks also involves any interest differential between Treasury bills and Reserve Bank bills as well as any costs incurred through rediscounting. These costs still appear relatively small so it may well be that New Zealand's monetary policy will be a precursor for other central banks.

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