



**FINANCIAL DEREGULATION AND THE MONETARY
TRANSMISSION MECHANISM OF THE
AUSTRALIAN ECONOMY**

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To my wife and children

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ABSTRACT

The purpose of this thesis is to evaluate the changes that have occurred to the Australian monetary transmission mechanism as a result of deregulation of the financial sector. This thesis provides new insight into three main areas.

First, an asset market model, in which the supply of assets is endogenous, is specified and estimated for the Australian financial sector. The estimation of this model provides an assessment of how the process of financial deregulation has changed the relationships within financial markets in which the Reserve Bank is primarily reacting to asset market conditions, implying that the supply of money is endogenous. In this model, as well as being affected by demand and supply in the markets for financial assets, the exchange rate is affected by fundamentals such as relative expected secular inflation and unexpected changes in the trade balance. This treatment of the expectations mechanism in the foreign exchange market allows for exchange rate overshooting as observed in flexible exchange rate regimes.

Second, we evaluate the responses of the model to the banking sector's choices of the combination of assets and liabilities in the post-deregulation period, using a portfolio-loan approach to monetary changes. This approach embodies *a)* the post-Keynesian view of the implications of asset substitutability for the money supply, and *b)* the new Keynesian view of the banking system's response to the increased riskiness of credit, regarding credit rationing in the underwriting process for new risky assets, equities. In the portfolio-loan approach, the model of the monetary transmission mechanism is viewed in the spirit of a variant of the textbook IS-LM model, which incorporates the credit rationing hypothesis in the interest rate-GNP relationship. In this model bank controls on the loan rate under credit rationing is analysed by some rules under which loan rate controls depend on some specific historical data. Further, disequilibrium modelling of the demand and supply of loans provides estimation of the amount of credit rationing. In the model under discussion variation in the quantity of loans caused by changes in bank reserves makes monetary policy more expansionary than in the standard IS-LM model.

Another important aspect of this analysis is the implication of credit rationing for portfolio investors' preferences for securities with different terms to maturity. In this analysis portfolio investors' incentives to borrow from the banking sector play a pivotal role in the linkages between the bank loan market and the financial markets for securities of different maturities. The loan rate in a rationed credit market reflects banks' proxies for the expected rate of return and default risk of the average projects. If there is no regulation in financial markets, it is more likely that the proxies conform to the actual rate of return on the average projects. In this thesis we evaluate the relevance of the credit rationing approach in a model of the term structure of interest rates in which credit rationing provides portfolio investors with the ability to adjust to the actual rate of return on their portfolios. This requires that portfolio investors expectations in financial markets should be model consistent, or rational.

Third, in a reduced-form equation we evaluate the relevance of the credit rationing hypothesis by examining its tightening impact on real output, implying that in the credit-rationed state the effects on output of higher levels of aggregate demand relative to its trend values are depressed. We also examine the difference to the contribution of monetary shocks to output fluctuations when the economy's credit constraint is binding.

The Australian post-deregulation experience provides strong support for the credit rationing hypothesis, and the proposition that the output effects of credit rationing is of macroeconomic importance. The results show that Australian banks act, in the aggregate, as though they ration credit by non-price means. Also, there is evidence that credit rationing in the post-deregulation period provides portfolio investors with economic information concerning the actual rate of return on the average portfolio in the Australian market for short-term securities. In addition the output effects of credit rationing are shown to be significant, and the contribution of monetary shocks to output fluctuations is significant when a tightening of monetary policy is associated with the credit-rationed state.

DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by any other person, except where due references has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

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Chapter 1

INTRODUCTION

The transmission of monetary fluctuations to real output is a topic that has dominated traditional macroeconomic models for the past three decades. The common theme in modelling macroeconomic relations is that changes in monetary forces bring about changes in aggregate demand which are followed by changes in prices and output. While the long-run price changes are seen as the ultimate impact of monetary changes on aggregate demand, the short-run interactions between monetary variables and real output have remained at the core of the debates on the monetary policy transmission mechanism.

The focus of attention on the transmission mechanism of monetary fluctuations is in response to the policy makers' need to understand both how and how much monetary policy affects aggregate demand. For this reason, the linkages from financial markets to the real sector of the economy have attracted the attention of builders of empirical macroeconomic models. Models in the Keynesian IS-LM tradition¹ are assumed to be suitable for the study of those linkages.

However, in the IS-LM framework, the transmission mechanism of variations in monetary aggregates and interest rates has been *oversimplified* by the following assumptions: 1) that the money supply is exogenously determined; 2) that the demand for money function, which is assumed to be central to the modelling of the monetary transmission mechanism, is stable in the long run; 3) that the short-term bond rate, specified in a two asset model consisting of money and bonds, is taken as the only

¹ . Challen and Hagger (1983) identified the following features of the macro-econometric systems: 1) there exists a balance between aggregate desired expenditure and supply of goods; 2) the models relations are formulated in discrete time; 3) the relations are treated in dynamic fashion, 4) the relations are non-linear, 5) the models relations are stochastic.

short rate used in the term structure of interest rates, and hence in providing a proxy for the *ex ante* rate of return on fixed capital; and, 4) that the money channel, acting through changes in liquid assets (money and bonds) and interest rates, affects the availability of bank credit and, via changes in the investment demand, affects aggregate economic activity.

The specification of the monetary transmission mechanism in the AEM (1992) and TRYM (1993) macro models of the Australian economy², which are developed in the IS-LM tradition, has been carried out under the simplifying assumptions outlined above. The monetary transmission mechanisms in two Australian models are based on a similar theoretical model of the financial sector, which is explained in a simple two asset model consisting of money and bonds. The models differ in the specification of the interactions between the financial and real sectors, as well as the degree to which agents' optimizing behaviour is incorporated. The microeconomic foundations in the two models provide some links from agents' expectations of changes in asset prices and the exchange rate to the monetary and real sectors, but the analysis of the monetary policy transmission mechanism generates results that are consistent with the standard IS-LM framework. Murphy (1988) and Simes (1991) argued that such results can be treated as consistent with the structural change that has taken place in the Australian financial system over the past decades

The enormous changes in financial markets, which have been witnessed in the late 1970s and early 1980s, have compromised the simplifying assumptions 1-4, underlying the TRYM and AEM models. Research on these 4 issues is required to assess how the process of financial innovations and deregulation has impinged upon the relationships within financial markets which determine monetary variables such as the money supply, credit, interest rates and the exchange rate. Research on the monetary transmission mechanism also requires an assessment of how these monetary

² . The major macro models referred to in this thesis are the Access Economic Murphy (AEM) model and the Treasury Macroeconomic (TRYM) model. These are two models which outline the earlier comprehensive efforts undertaken at universities, the Reserve Bank, the Treasury and the Australian Bureau of Statistics in the 1970s and 1980s.

variables, through the mechanisms in deregulated financial markets, influence aggregate demand and output. An understanding of how bank credit affects aggregate economic activity can be derived from the models in which *a)* credit is an imperfect substitute for other assets in the portfolio-balance condition, and/or *b)* some markets clear by non-price means.

The major changes in the 1980s that have taken place in the financial system resulted in: 1) the removal of controls on interest rates and the exchange rate, and controls on bank credit aggregates; 2) increased integration with overseas capital markets; and, 3) changes in the mechanisms for implementing monetary policy. The first feature implies that financial market deregulation brought about an increased role for asset prices, notably interest rates, in helping markets to clear. The increased flexibility of interest rates in deregulated financial markets has, however, probably increased uncertainty for asset holders, which has consequently focused attention on such phenomena as the demand for money under conditions of uncertainty and imperfect asset substitutability. Also, credit rationing, which arose from regulations or Reserve Bank actions in the pre-deregulation period, can still occur post-deregulation as a result of the private initiatives of banks. The rationing behaviour of banks may also affect the process of money stock creation, which is no longer treated as a process entirely under the control of the monetary authorities.

The deregulation of the asset and foreign exchange markets and internationally mobile capital imply that Australia attracts capital for assets of similar maturity if the interest payments to investors in Australian capital markets are higher than the interest payments in overseas countries. This in turn implies that capital flows, as a result of increased integration with overseas capital markets, are influenced by the interest rate differential and investors' expectations of changes in the spot exchange rate. These changes can be treated as dependent on fundamentals such as relative expected secular inflation and adjustment in the long-run equilibrium real exchange rate. This treatment of the expectations mechanism in the foreign exchange market allows for exchange rate overshooting as observed in flexible exchange rate regimes.

Financial deregulation and the increased integration of capital markets with overseas countries have impinged upon the operational conduct of monetary policy. In deregulated financial markets, monetary authorities rely on open market operations to a greater extent than on instruments with more direct impact on financial aggregates such as the money supply and credit. In this treatment of monetary policy attention has been focused on the market oriented approach to the implementation of monetary policy, and the analysis of a range of policy reaction functions which have the ability to stabilize the monetary transmission mechanism. In particular from the 1980s the Reserve Bank has not sought to influence bank credit and reserves through qualitative or quantitative controls, nor to use SRD or LGS ratios actively³. In the liberalized financial system a market-clearing cash market is the primary means through which the Reserve Bank influences short-term interest rates and thereby the exchange rate. The use of other policy instruments, such as changes in the Reserve Bank holdings of domestic and foreign securities, may still be necessary in order to prevent the effects of large fluctuations of financial aggregates flowing onto asset prices and the exchange rate.

It is also widely accepted that the basic money demand equation, which relates the money stock to the price level, income and the interest rate on competing assets, becomes unstable when the sample period is extended into the 1980s. The reliability of macroeconomic models will be seriously impaired if such a key equation in the monetary transmission mechanism remains in an unstable state. This requires that the money demand equation, as well as the other key equations in the transmission mechanism, should be modified to overcome the instability encountered in the 1980s.

There are still more features of the Australian financial deregulation which could be considered for a detailed analysis of the operation of relationships within financial markets. However, the AEM and TRYM models allow for the implications of financial liberalization by simply leaving out some pre-deregulation control variables,

³ . Also, the process by which government securities are issued has changed with the move to the bond tendering system in 1982.

such as interest rate ceilings and credit controls. The basic features of the financial sector, outlined above, can be treated as central to the rest of a macroeconomic model, and can be analyzed adequately despite some other difficulties in producing a complete picture of the transmission mechanism.

The theoretical basis for these features can be elaborated with an asset market model which removes the simplifying assumptions of the standard IS-LM framework from the monetary transmission mechanism. While this is a useful starting point, it is increasingly clear that a complete picture of the transmission mechanism in macroeconomic models of the Australian economy involves many more elements. This thesis evaluates some of the major changes that have occurred to the Australian monetary transmission mechanism as a result of deregulation of the financial sector. In particular, in this thesis we evaluate the implications of financial deregulation for the following issues: 1) the interest effects of monetary changes on capital flows and the exchange rate, and the expectations mechanism in exchange rate determination; 2) the implications of monetary policy reaction functions post-deregulation, with regard to the mechanisms through which the Reserve Bank influences short-term interest rates; 3) the effects of the private initiatives of banks on the process of money stock creation; 4) the imperfect substitutability between bank loans and other assets in the private sector portfolio, and the links between the bank loan market and the asset markets under credit rationing; and, 5) the links between the loan market and the financial markets for securities of different maturities, with reference to the expectations theory of the term structure of interest rates. The thesis provides new insight into three main areas.

First, an asset market model, in which the supply of assets is endogenous, has been specified for Australia in the period 1978-1993. The estimation of this model provides an assessment of how the process of financial innovations and deregulation has changed the relationships within financial markets in which the Reserve Bank is primarily reacting to asset market conditions post-deregulation, implying that the money stock is endogenously determined. In the financial sector the responses of

capital flows and the exchange rate to *monetary changes*, and hence to changes in interest rates, are reflected in changes in the private sector's holdings of net foreign assets. The analysis of the interest effects of *monetary changes* on the assets in financial markets, without regard to the links between the bank loan market and the asset markets, are inconsistent with the ability of the banking system to underwrite the stock of assets post-deregulation. The different implications of the banking sector's choice of assets and liabilities are introduced by way of the post-Keynesian analysis of the money supply process and the new Keynesian approach to credit rationing.

Second, we evaluate the relevance of the post-Keynesian view of the money supply process and the new Keynesian approach to credit rationing by examining *a)* the contribution of bank lending to monetary and output fluctuations in a simple model which is a variant of the textbook IS-LM model, *b)* the credit rationing mechanism in this model. The significant difference from the standard IS-LM model is the inclusion of the effects of bank lending on the money supply and on aggregate economic activity. Such effects in a simple graphical representation like the IS-LM model are analysed by the inclusion of the loan rate in the interest rate-GNP relationship. This model permits us to incorporate the implications of bank lending into the monetary transmission mechanism.

In this thesis we evaluate the relevance of the credit rationing approach to bank lending, using a disequilibrium model of the loan market. In this model, loan rate controls, rather than imperfect adjustment to market-equilibrating loan rate, are treated as the major source of disequilibrium. Jaffee and Stiglitz (1990) argue that the theory of disequilibrium estimation can be used to obtain estimates of the demand and supply curves, and therefore of the amount of credit rationing. In the disequilibrium estimation of credit rationing, bank controls on the loan rate are analyzed by some rules under which loan rate controls depend on some specific historical data. Maddala (1983) argues that, given only the determinants of the price (loan rate) controls and observations on quantities and prices, we can estimate the disequilibrium model for a rationed (loan) market. In this analysis an implicit relationship between the amount of

credit rationing and the loan rate allows for a more general treatment of loan rate determination than the Jaffee and Stiglitz (1990) treatment of the exogeneity of the loan rate under credit rationing. More importantly, that relationship provides us with the ability to examine the interest rate-GNP relationship under credit rationing.

Another important aspect of this analysis is the implication of credit rationing for portfolio investors' preferences for securities with different terms to maturity. Juttner's (1990) discussion on the yield to maturity of securities is suggestive of the importance of portfolio investors' incentives to borrow from the banking sector, and hence the loan rate, in the term structure of interest rates. The loan rate in a rationed loan market reflects banks' proxies for the expected rate of return and default risk of the average projects in the economy. If there is no regulation in financial markets, it is more likely that the proxies conform to the actual rate of return on the average projects. In this thesis we evaluate the credit rationing approach in a model of the term structure of interest rates, in which there is no substitute for bank loans, and credit rationing provides portfolio investors with the ability to adjust to the actual rate of return on their portfolios. This requires that portfolio investors' expectations in financial markets should be model consistent, or rational. Tease's (1988) test of the expectations theory of the term structure of interest rates provides support for the rational expectations hypothesis in the Australian short-term security markets. However, Tease's model abstracts from the economic information available to portfolio investors under credit rationing. Also, most previous empirical macro models disregard the implications of portfolio investors borrowing from the banking sector for the term structure of interest rates.

Third, in a reduced-form equation we examine the implications of the credit-rationing mechanism over the post-deregulation period. This equation is used to examine the relationship between asset prices and aggregate demand, implied by three interest rate channels, namely, through their impact on private investment and expenditures on consumer durables; through their impact on the valuation of wealth; and through their impact on the exchange rate. In the reduced-form equation the

explanatory variables for these channels are those which account for the interest rate effects of monetary changes in the asset market model. This provides the reduced-form equation with the ability to incorporate the implications of financial deregulation into output fluctuations. In this section we evaluate the implications of credit rationing by examining its restrictive impact on real output, implying that in the credit-rationed state the effects on output of higher levels of aggregate demand relative to its trend values are depressed. We also examine the difference to the contribution of monetary shocks to output fluctuations when the economy's credit constraint is binding.

More precisely in this thesis we evaluate the relevance of the credit rationing approach by examining: 1) whether Australian banks in the post-deregulation period act, in the aggregate, as though they ration credit; 2) whether the rationing behaviour of Australian banks has any significant effect on real output; and, 3) whether a tightening of monetary policy in the credit-rationed state has strong effect on aggregate economic activity. Also, we evaluate the implication of credit rationing for portfolio investors' preferences for securities with different terms to maturity by examining: 4) whether the cost of bank lending under credit rationing provides portfolio investors with rationally formed expectations in the Australian short-term (two-period) security markets. As another important avenue of research, in this thesis we evaluate the buffer stock hypothesis by examining: 5) whether the interest rate effects of monetary changes on real output are less severe as a result of holding money as a buffer asset for disequilibria in asset markets.

The Australian post-deregulation experience provides strong support for the credit rationing hypothesis and the proposition that the output effects of credit rationing are of macroeconomic importance. Also, there is evidence that in the credit-rationed state the output effect of a monetary shock, which results from a tightening of monetary policy, is strong. In addition, we present evidence that the implication of credit rationing in deregulated financial markets is consistent with portfolio investors' rational expectations in the Australian short-term security markets. The evidence on the buffer stock role of money provides support for the hypothesis that in the absence

of a significant effect of the interest rate on real output, unexpected changes in the money supply makes a significant contribution to output fluctuations.

The outline of the thesis is as follows. Chapter two presents an overview of the theoretical issues in the monetary transmission mechanism of Australian macroeconomic models. Chapter three examines the theoretical issues of an asset market model which is modified from a basic LM curve, and presents the implications of Australian financial liberalization for the monetary transmission mechanism. Chapter four evaluates the modified model by examining the role of capital flows and fundamentals such as relative expected secular inflation and adjustments in the long-run equilibrium exchange rate in the determination of the spot exchange rate. The relationships in this model determine variables such as the money supply, foreign borrowings, interest rates, the exchange rate, and policy variables such as the Reserve Bank's holdings of domestic and foreign assets. The response of the model to the process of financial deregulation is reflected in the underlying relationships for each of these variables. Chapter five elaborates the theoretical basis for the links between the bank loan market and the asset markets, and between the loan market and the financial markets for securities of different maturities. In this chapter the implication of loan rate controls for the monetary transmission mechanism is represented by a simple model which is a variant of the textbook IS-LM model.

Chapter six evaluates the relevance of the credit rationing approach by examining: 1) the structurally endogenous nature of money and loans in Australian financial markets; 2) the links between the bank loan market and asset markets via the banking sector's response to shifts in the riskiness of assets⁴; and, 3) the rationing behaviour of banks in disequilibrium models, and loan rate controls under some rules which are consistent with predominantly excess demand for loans. Also in this chapter we evaluate the links from the loan market to the financial markets for securities of

⁴ . The links from asset markets to the credit market can be described by the underlying sources of uncertainty in the capital-asset-pricing model. In particular, the capital asset pricing model can be applicable to credit markets which provide loans for portfolio investors, interested in both risky and risk-free securities.

different maturities, and the relevance of the credit rationing approach in the term structure of interest rates by examining: 4) the importance of rational expectations in Australian short-term security markets, where portfolio investors contemplate raising funds by borrowing from banks.

In chapter seven we examine the reduced-form relation between bank loans and aggregate economic activity. This reduced-form relation presents the basic channels through which monetary shocks impact on real output. In this reduced-form equation the buffer stock mechanism reflects the fact that in the absence of a significant effect of the interest rate on real output the monetary disequilibria makes a significant contribution to output fluctuations. In the reduced-form relation we evaluate the relevance of the credit rationing approach by examining: 1) the role played by credit in the monetary transmission mechanism, when there is a non-monotonic relationship between the loan rate and the expected return to banks; and more precisely, 2) the tightening impact of credit rationing on real output when a higher level of aggregate demand relative to its trend value is associated with the credit-rationed state; and, 3) the predictive content of a tightening of monetary policy when the economy is credit constrained.

Chapter 2

The Monetary Transmission Mechanism in Australian Macro-econometric Models: Overview of Theoretical Issues

2.1 Introduction

The AEM (1992) and TRYM (1993) models are two macro-econometric models which are referred to in this thesis as the models outlining the earlier comprehensive efforts on macro-econometric modelling of the Australian economy. The models also reflect structural changes in the Australian economy in the 1980s, and some theoretical developments in the past two decades. Both models are specified in the Keynesian tradition, in which exogenous changes in the money stock bring about changes in the short-term interest rate, and hence changes in aggregate demand and real output.

In keeping with the Keynesian IS-LM framework, the transmission mechanism in the AEM and TRYM models is specified under the simplifying assumptions: 1) that the money supply is exogenously determined; 2) that the demand for money function, which is assumed to be central to the transmission mechanism, is stable in the long run; 3) that the short-term bond rate, specified in a two asset model consisting of money and bonds, is the only short rate used in the determination of the *ex ante* rate of return on fixed capital; and, 4) that the money channel, acting through changes in liquid assets and interest rates, affects aggregate credit and, via changes in the investment demand, affects aggregate demand. In the AEM model, it is also assumed that agents' expectations in markets for long-term securities, and in the foreign exchange market are formed rationally. The TRYM model allows for the latter assumption in the modelling of agents' expectations in the foreign exchange market.

Having briefly reviewed the theoretical issues of the simplifying assumptions, we examine a general treatment of the transmission mechanism which is consistent with structural changes in the Australian financial system in the 1980s.

2.2 The exogenously determined money supply and the money supply equation

The money supply in a highly simplified version of Keynesian economics is assumed to be exogenous. In accordance with this textbook treatment, the AEM and TRYM models rely on exogenous changes in the money supply in the modelling of the monetary transmission mechanism.

The traditional view of the exogenously determined money supply was outlined by Friedman (1969), and Meltzer (1982). Using the exogenously determined money supply hypothesis, Friedman advocated a policy rule of a fixed growth rate for the money supply. The money supply equation in Friedman's view is specified by a simple money multiplier model as

$$M = m \cdot H \quad (2.1)$$

$$m = \frac{(D/R) \cdot (1+D/C)}{(D/R) + (D/C)} \quad (2.1a)$$

where

M = the stock of money,

H = the stock of high-powered money,

m = the money multiplier,

(D/R) = the ratio of deposits owned by the public, (D), to the total reserves of banks, (R),

(D/C) = the ratio of deposits owned by the public to the public's holdings of currency, (C).

In equations (2.1) and (2.1a) high-powered money, or the money base, and the money multiplier are both regarded as exogenous. Since central banks have failed to implement that policy rule (and many claim that it cannot be implemented, Goodhart

(1994)), it can be claimed that the money supply is endogenously determined, (Moore, 1988; Wray, 1992).

The money multiplier models in different versions have been specified by Friedman and Schwartz (1963), Brunner and Meltzer (1964), Jordan (1969), Rasche (1972), Rasche and Johannes (1987), and the theoretical evaluation of this type of model is represented by the research initiated by the Federal Reserve Bank of St. Louis. The characteristics of the simplest version of this model, which is represented by equation (2.2), reflects certain fixed ratios, describing the portfolio preferences of the public and banks, and monetary authorities' ability to provide a particular quantity of the money base for a target level of money supply.

$$M = \frac{1+k}{r(1+t+g)+k} \cdot H \quad (2.2)$$

where

$$m = \frac{1+k}{r(1+t+g)+k}$$

k = the ratio of currency to demand deposits, C/D ,

t = the ratio of time deposits to demand deposits, T/D ,

g = the ratio of government deposits to demand deposits, G/D ,

r = a weighted average reserve ratio against all deposits in banks, $R/(D+T+G)$.

Papademos and Modigliani (1990) pointed out that the public and banks' portfolio preferences in equation (2.2) cannot be assumed to be invariant to the changes in the rates of return and income, and hence that the portfolio ratios are not stable and predictable. In their explanation, the money base, (H), remains exogenous, which implies that a policy rule requiring a fixed money base could be used to implement monetary policy. The money multiplier in their explanation for a narrow monetary aggregate is represented by

$$m = m \begin{matrix} + & + & - \\ (i, & i_D, & i_T, \dots, r, Y) \end{matrix} \quad (2.3)$$

where

i = the market rate on government securities,

i_D = the interest rate on demand deposit, D,

i_T = the interest rate on time deposit, T,

r = required reserve ratio for demand and time deposits, D+T,

Y = real income.

Signs above the interest rates represent the signs of partial derivatives.

In equation (2.3) the elasticity of the money multiplier with respect to the money market rate of interest, (i) , is expected to be positive, which gives rise to the positively sloped money supply function, given that the money base is exogenous. The exogeneity of the money base implies that the monetary authorities can still rely on exogenous changes in the money supply, and the direction of causation runs from either the money base or the money supply towards other financial aggregates and interest rates.

The use of the money base as the monetary policy instrument, in the elaborations made by Barro, (1974) and Sargent and Wallace (1981), is considered to be restricted by the balance of payments and the government budget constraint. Furthermore, in Jackson's (1990) explanation, it was shown that the relationship between the government budget constraint and the money base or the money supply can be represented within either the flow-of-funds framework or the IS-LM framework; and the linkages between the money supply and aggregate demand may theoretically be explained by the financial flows or the interest rate effects of monetizing government deficit. In the recent literature the debate has focused on the exogeneity of the base, or on the central bank ability to control its liabilities.

In the analysis of central banks' monetary policy, the exogeneity of the money base was considered to be problematic by Moore (1979, 1983, 1988a) and Kaldor (1982, 1985). Both Kaldor and Moore disagreed with the view that central banks can increase or decrease the money base, since the base consists of the central banks liabilities. In Moore's (1988b) view the money multiplier models are only descriptive identities which have no implications for the process of money creation. Moore also argued that the empirical studies in the US economy imply that the money base cannot

be treated as an exogenously determined policy variable. Moore's analysis of the monetary process implies that there is an asymmetry in central banks ability to manipulate the stock of money. The asymmetry arises from the constraint on the central bank's ability to initiate a reduction in the money stock, since the supply of money is demand determined. In the Kaldor-Moore view the money supply process is initiated by the creation of bank loans. In Kaldor-Moore's analysis loans make deposits, the opposite of the money multiplier analysis where deposits are needed to make loans.

Moore (1988b, 1989), Rousseas (1985) and other post-Keynesians insist on the role of bank lending in the process of money creation, and the demand determined characteristics of the money stock, as well as the money base. Lavoie (1984) in a survey of the post-Keynesian analysis of the money supply, explained that in post-Keynesians' monetary theory the money stock results from the expansion of credit. He concluded that the central bank in defensive operations accommodates the money base to the stock of money which is demand determined. The money base is then dependent upon the money stock in an inverse money multiplier equation or "*credit divisor*" model¹, and hence dependent upon the demand for money. Lavoie's specification of the "credit divisor" model can be represented by

$$H = (1/m).M \tag{2.4}$$

where the partial derivatives of the money multiplier, (m), and the money stock, (M), with respect to the interest rate (i) are positive and negative, respectively.

If the supply of the money base is demand determined, [*i.e.* it is determined by the demand for currency, (C^d), and reserves, R=r.(D^d+T^d)], inverse relationships between the interest rate, (i), and either of (C^d) and (D^d+T^d) require that the relationship between the interest rate and the supply of the base should be negative. In the post-Keynesian view this implies that the total effects of (i) on the money base in equation (2.4) should also be negative.

¹. Lavoie (1984) argued that the inverse money multiplier model is implied by a large segment of the post-Keynesian monetary literature.

Pollin (1991) pointed out that the various approaches to the endogeneity of the money supply in the post-Keynesian tradition share similar characteristics which may be summarized as 1) a demand determined money supply, and 2) the effects of the banking sector on the process of money creation. In Pollin's explanation, post-Keynesians' accommodative theory of the endogeneity of money supply inverts the traditional causality of deposits-reserves-loans and replace it with the relationship loan-deposit-reserves², *i.e.* loans make deposits and the central bank provides the reserves. This direction of causation implies that central banks have an obligation to accommodate the demand for reserves through open market operations or the discount window. In the accommodative version of the endogeneity hypothesis, the supply schedule is horizontal at a given rate of interest, *i.e.* the relationship between the interest rate and the money stock is determined solely by the demand schedule. However, Wray (1992) pointed out that the horizontal approach to the money supply schedule results from excluding the role played by liquidity preference in the causality relationship.

Palley (1987, 1994) presents models which introduce a distinctive channel for loan accommodation. Palley's (1994) model embodies the post-Keynesian view of endogenous money whereby the private initiatives of the banking sector matter for the determination of the money supply. The significant feature of Palley's model is the modelling of bank choices regarding the composition of banks assets and liabilities. In the post-Keynesian accommodative theory such choices are irrelevant and the ability of the banking system to accommodate loan demand depends exclusively on the rate stance of the monetary authority. The assumption of the banks' asset liability management in Palley's model can be represented by the following equations.

$$L^s + S + R^d = D^d + T^d \quad (2.5)$$

$$L^s = L^d \quad (2.6)$$

². It is argued in Lavoie (1984) that commercial banks are ready to provide all loans demanded and central banks are ready to provide all reserves or advances which are demanded at existing rate; and loans make deposits and deposits make reserves.

$$R^d = r_D \cdot D^d(\cdot) + r_T \cdot T^d(\cdot) \quad (2.7)$$

$$H = C^d + R^d \quad (2.8)$$

$$MR_L = MR_B = MR_F = MC_F = MC_D = MC_T \quad (2.9)$$

where

L^S = supply of loans,

L^d = demand for loans,

S = secondary reserves of banks,

R^d = demand for require reserves,

D^d = demand for demand deposits, and $D^d(\cdot)$ represents the demand for demand deposit function,

T^d = demand for time deposits, and $T^d(\cdot)$ represents the demand for time deposit function,

r_D = required reserve ratio for demand deposits,

r_T = required reserve ratio for time deposits,

C^d = demand for currency,

MR_L = marginal revenue on loans,

MR_B = marginal revenue on bonds,

MR_F = marginal revenue on non-borrowed reserves, the money base, equal to the federal funds rate, i_F ,

MC_F = marginal cost of borrowed reserves, equal to i_F ,

MC_D = marginal cost of demand deposits,

MC_T = marginal cost of time deposits.

Equation (2.5) represents the banking sector balance sheet identity. In this equation holdings of secondary assets, (S), is referred to as the banks holdings of bonds. These reserves are assumed to be used as a buffer to offset variations in loan demand and demand for deposits. Equations (2.6) and (2.8) represent the equilibrium conditions in the loan and money markets. The latter equation is treated as the definition for reserves in the post-Keynesian accommodative theory of endogenous

money. Equation (2.7) determines the required reserves held by banks. Equation (2.9) represents the first order condition for bank's decisions on holding assets and liabilities.

The role of secondary reserves as a buffer in disequilibrium in the banks balance sheet identity implies that: if there are unexpected withdrawals of deposits into currency, individual banks sell secondary reserves to fund the outflow; and, if there is an increase in loan demand individual banks sell secondary reserves to fund additional lending. The modelling of banks asset and liability choice via equations (2.5) and (2.9), provides banks with an incentive to seek the cheapest sources of financing. Such incentives are absent in the post-Keynesian accommodative theory. In this theory accommodation depends exclusively on the rate of interest set by monetary authorities. This is because the money supply curve is described to be horizontal, and monetary policy is represented by a given rate of interest implying that the amount of money in existence is demand determined. In Palley's model, banks finance loans through sales of secondary reserves, bonds, and transformations of checkable deposits into time deposits. In this model increased lending causes liability transformations that increase the money multiplier, and through the process of 'loans creating deposits' increase the money supply.

While the monetarists and post-Keynesians focus on different implications of the money supply process, an incorporated treatment of the channels through which reserves create loans and loans create deposits may improve our understanding of variation in the money supply. In this treatment of the money supply process we can evaluate the relevance of the two approaches by examining the causal link between variations in bank lending and variations in the components of the money supply, *i.e.* the money base and the money multiplier. The significant difference from the money multiplier models is the structurally endogenous nature of money, and the significant difference from the post-Keynesian accommodative theory can be identified in terms of bank choice of the composition of assets and liabilities, and hence the process by which the money supply rises in response to the private initiatives of banks. In the incorporated treatment of the money supply process we may also examine the

implication of bank choice of the composition of assets and liabilities in a model of bank's optimizing behaviour which allows the bank to maximize its expected return on loans. In Palley's post-Keynesian approach such an optimization is irrelevant, and the process of 'loans creating deposits' depends on the ability of the banking system in accommodating increases in loan demand. The optimizing behaviour of banks provides banks with the ability to finance loans on the open market, and to increase loans to maximize their expected return. In this approach a different result arises from banks response to uncertainty concerning the risk of borrowers default. This is a necessary condition for credit rationing which will be examined in section 2.5.

2.3 The stability of the demand for money and the transmission mechanism

The demand for money equations in the Australian macro-econometric models are assumed to be central to the modelling of the interactions between financial and real sectors. These equations are assumed additionally to be in a functional form in the Keynesian tradition. The simplest logarithmic form of the demand for money equation can be represented by

$$\ln M_t^d = b_{01} + b_{11} \cdot \ln Y_t + b_{12} \cdot \ln i_t + b_{13} \cdot \ln P_t + u_{1t} \quad (2.10)$$

where

$\ln M_t^d$ = the logarithm of the demand for money,

$\ln Y_t$ = the logarithm of real income,

$\ln i_t$ = the logarithm of the interest rate,

$\ln P_t$ = the logarithm of the price index.

The traditional Keynesian approach to the demand for money equation has exhibited shortcomings in the form of substantial instability over the past two decades. While the demand for money equation is treated as a key equation in the modelling of the monetary transmission mechanism, the instability problem in this equation has raised the question of whether the equation is really needed in macro models (Simes, 1991). If a stable relationship between the demand for money and the interest rate on

competing asset(s) is important in the modelling of the transmission mechanism, it is necessary to introduce modifications to the demand equation. The modifications are concerned with the sources of instability and the appropriate definition for monetary aggregates which together ensure a stable interest elasticity for the demand for money.

Hall *et al.* (1989) emphasized that in the 1970s the demand for money equation was considered to be unstable for broad money and the pace of financial deregulation has led to increasing doubt about the stability of narrow money. Artis and Lewis (1990) pointed out that the problem of instability in equation (2.10) can be seen by the errors in prediction which became evident in the empirical studies of the 1970s and 1980s. Goodhart (1989) and Goldfeld and Sichel (1990) drew attention to the fact that the key shortcomings have resulted from misspecification of the traditional equation for the demand for money. In Artis and Lewis' view, changes in the nature of the demand for money, which have occurred in response to the increased variability of the interest rate, give rise to the need to amend the demand for money equation in one or both of the following ways: 1) the inclusion of the lagged dependent variable, such as $(\ln M_{t-1})$; 2) the inclusion of some other variables (quantitative or qualitative) which previously were ignored (correctly) in the demand for money equation.

Atkinson and Chourqui (1987), and Friedman (1988) proposed an approach which explains instability in terms of movements of the arguments within the traditional demand for money function, rather than by shifts in the function. In this approach, the arguments in the function are assumed to be affected by uncertainty about future inflation, nominal interest rates and the exchange rate. The empirical results, in accordance with this hypothesis, showed that the expectations of rising and unstable inflation in the early 1970s brought about increasing velocity in that period, and disinflation in the early 1980s resulted in a fall in the velocity and a rise in the demand for money.

Judd and Scadding (1982) and Goodhart (1989) argued that the empirical problems associated with attempts to find a stable specification for the demand for money with post-war data are largely attributed to the effects of innovations and

deregulation in the financial system, *e.g.* removal of interest rate ceilings and exchange rate controls. Cuthbertson and Taylor (1990) pointed out that innovations and deregulation in the financial markets have considerably stimulated research in the field of applied econometrics to provide reasonable explanations for the behaviour of the demand for money in the deregulated financial markets.

A particularly noteworthy avenue of research is concerned with the partial adjustment mechanism of monetary changes and the buffer stock role of money for disequilibrium in asset markets. In this approach holdings of money may differ from their desired level as a result of money acting as a buffer for disequilibria in other markets. The best known of the Buffer-stock models is that of Carr and Darby (1981) who made the distinction between expected and unexpected changes in money balances. In their model money is the buffer asset in a portfolio, because asset holders permit money balances to fluctuate in response to any unexpected or transitory changes in the overall size of the portfolio, resulting from exogenous changes in the money supply. The Carr-Darby model of the demand for money in logarithmic form can be represented by

$$\ln m_t = b_{21} \cdot x_t + b_{22} \cdot (\ln M - \ln M^a) + u_{2t} \quad (2.11)$$

where

$\ln m_t = (\ln M_t - \ln P_t)$, real money balances,

x_t = a vector representing the arguments of the demand for money function, and

M^a = the anticipated part of the money stock. So $(\ln M - \ln M^a)$ represents the unanticipated part of the money stock.

This model has been examined by a number of researchers with different assumptions made about the exogeneity and the endogeneity of the money supply and about the formation of expectations for changes in the money supply. The buffer stock approach to monetary changes has an important policy implication. If the buffer stock hypothesis is valid, then the interest rate effects of an increase in the money supply is less severe since most of the increase will be absorbed as transitory balances in the short

run. In the long run price adjustments are then able to restore equilibrium in the money market.

The other approach in empirical work emphasizes an error correction model for analysing the stability of at least narrow money functions. Hendry (1980) applied the error correction mechanism to the money demand equation in the UK. The major assumption in this approach, described by Taylor (1987), is that the supply of money will always adjust to the short-run demand for money. A typical example of these models can be represented by

$$\begin{aligned} \Delta \ln M_t = & b_{31} \cdot \Delta \ln Y_t + b_{32} \cdot \Delta \ln i_t + b_{33} \cdot \{ \ln M_{t-1} - c_0 \\ & + c_1 \cdot \ln Y_t + c_2 \cdot \ln i_t \} + u_{3t} \end{aligned} \quad (2.12)$$

In equation (2.12) the term $\{ \ln M_{t-1} - \dots \}$ represents last period's error or deviation of money from its long-run relationships with (Y_t) and (i_t) .

The above approaches concentrate on the instability problem by examining the stability criterion in empirical studies. They also propose some specific changes in the traditional specification by the inclusion of a term reflecting adjustments in the demand for money in equation (2.12).

Goldfeld and Sichel (1990) in a re-examination of the traditional specification argued that it is useful to consider the measurement and specification issues in a variable-by-variable review. In their view the first criterion is the selection of a measure for money with the property of small variations in periods of financial development. The other issues are: finding the scaling variables to reflect appropriately the measure of transactions as well as portfolio motives in holding money; the appropriate measuring of the opportunity cost of money in terms of money's own rate of interest and the rate of return on other assets which are alternative to money; and the inclusion of the transaction technology variable which reveals improvements in business and cash management techniques. They suggested that other simple devices such as slope and intercept dummy variables may also help to restore stability in the demand for money equation.

While it is well understood that the stability of the demand for money equation may result from a different functional form than the traditional equation (2.10), the modifications emphasized by Goldfeld and Sichel (1990) include the main factors needed for stability in the traditional equation. Also a limited sample period, as employed by Australian macro models, reduces the instability problem in the monetary transmission mechanism.

The Australian models, the AEM and TRYM models, allow for the simplest version of these modifications which are the use of a narrow definition for money, or only the currency held by the public, and the use of intercept dummies in the demand for money equation. These modifications exclude some other sources of instability which arise from exchange rate flexibility, and from buffer variations in the demand for money. The latter implies that when there is a rise in uncertainty in the earning asset markets, agents reduce their holdings of earning assets to provide enough money balances in their portfolio. These sources of instability in the demand for money are due to financial liberalization, and need to be taken into account.

This thesis allows for implications of financial liberalization in links between money, interest rates and income, and hence faces the instability problem in the modelling of the demand for money equation to a greater extent than the two Australian models. This requires that the modifications described by Goldfeld and Sichel (1990) should be incorporated into the Australian demand for money equation.

It is also worth noting that sources of instability in the demand for money equation give rise to instability in the other equations in the monetary transmission mechanism. To model the transmission mechanism with the required stability, it is also necessary to consider the stability criterion in the other equations of the Australian macro models.

2.4 The monetary transmission mechanism and disaggregated asset markets

The monetary transmission mechanism in the traditional IS-LM framework is oversimplified by the assumption that the model contains only two assets: money and bonds. In that tradition the bond rate is viewed as the rate of interest on the competing asset in the demand for money equation (2.10). Through this equation the bond rate, as the interest rate in an integrated asset market, provides a link for monetary policy into the real sector. Departure from that traditional simplification may allow for the role of other financial assets in the modelling of the monetary transmission mechanism. Such a treatment of the interactions between financial markets and the real sector was explained by Brainard and Tobin's (1968) modelling of the financial sector with a range of assets in a diversified portfolio held by the public, and Tobin's (1969, 1982) general equilibrium approach to monetary theory in the modelling of the transmission mechanism. In these models, the adjustment process in financial markets is based on the assumption of imperfect asset substitutability, which results in differing rates of interest in equilibrium. Also Tobin's (1958) portfolio approach provides further insight into the asset adjustment process necessary for the modelling of the monetary transmission mechanism by introducing uncertainty, and hence the variability of asset prices, in the demand for money.

Tobin's (1982) approach to the monetary transmission mechanism is consistent with a principal feature of Australian financial liberalization, which can be characterized by the increased variability of interest rates and a number of differing rates of interest in equilibrium. This feature allows for market determined rates of interest in a liberalized financial system, and for the public's well-behaved preferences over a range of assets in financial markets.

In the post-deregulation period there has been increased integration with overseas capital markets, and controls on the exchange rate has been relaxed. In the post-float period capital flows can be treated as important determinants of the exchange rate. Capital flows are affected by the interest rate differential and investors'

expectations of changes in the spot exchange rate. The letter is responsive to 'fundamentals' such as relative expected secular inflation, and adjustments in the long-run equilibrium real exchange rate. Capital flows are also affected by demand and supply in financial markets via changes in domestic interest rates. Therefore, the explanatory variables in the foreign exchange market can be represented by the models in which the exchange rate is affected by financial variables in the demand for net foreign borrowings and by the 'fundamentals' also.

Financial deregulation has also impinged upon operational conduct of monetary policy. Monetary authorities today rely on open market operations to a greater extent than other controlled variables such as interest rate ceilings and direct controls on bank lending and on money supply. The transmission mechanism in the liberalized financial system is characterized by the policy rules which comply with the short-run interactions between financial and real sectors, and hence affect the market determined rates of interest and the exchange rate.

To describe another feature of the Australian financial liberalization, the two Australian macro models allow for agents' expectations of future spot exchange rates and long-term interest rates. The expectations mechanism in the foreign exchange market in both models is specified by the assumption of model consistent or rational expectations. The AEM model also allows for this assumption in the modelling of the term structure of interest rates. While the expectations mechanisms in the two models provides links from the disaggregated domestic and foreign asset markets to the rest of the models, the lack of evidence on the rational expectations hypothesis in the assets and foreign exchange markets casts doubt upon the validity of the role of expectations in the linkages between financial markets and the real sector, (Juttner 1990; Blundell-Wignall *et al* 1993).

Having suggested that the treatment of disaggregated asset markets produces a better understanding of the transmission mechanism in the Australian economy, we outline the short-run interactions between financial markets and the real sector, and

examine the policy rules which are feasible in a liberalized financial system. We also examine the mechanisms of capital flows in Australian asset markets, and highlight the expectations mechanism for the exchange rate and long-term interest rate in the modelling of the monetary transmission mechanism.

2.4.1 The transmission mechanism as an asset adjustment process in financial markets

The asset adjustment process for a wide range of assets in the IS-LM paradigm was developed in Brainard and Tobin's (1968) approach to the financial sector and Tobin's (1969) general equilibrium approach to monetary theory. In these approaches, the public's portfolio consists of money, bonds and domestic capital assets, and claims on the foreign sector. In these approaches, it was assumed that assets in the individuals' portfolio are imperfect substitutes. In Tobin's (1969) approach it was assumed additionally that the ratio of the market value of equities to the replacement cost of capital, or Tobin's (q), measures the *ex ante* return on fixed capital. In Tobin's (1978) explanation, the monetary transmission mechanism is captured by the link between two rates in the (q) ratio: 1) the marginal efficiency of capital, (r); and, 2) the required rate of return on fixed capital³, (i_e). The resulting identity in this approach is

$$q_t = \frac{\sum_{j=0}^n \{(C_{t+j})/(1+i_e)^j\}}{\sum_{j=0}^n \{(C_{t+j})/(1+r)^j\}} \quad (2.13)$$

where C_{t+j} refers to the expected return on fixed capital in ($t+j$). The numerator represents the market value (present value) of equities and the denominator represents the replacement cost of capital.

³. In the standard IS-LM framework it is assumed that the relevant rate of interest for a firm's investment decision is the rate of interest on bonds, given that bonds and equities are perfect substitutes. So, the similar link of the transmission mechanism in the Keynesian model results from the comparison between the rate of interest on bonds and the marginal efficiency of capital.

The properties of the (q) ratio were elaborated by Tobin's (1982) discussion on the macroeconomic process, in which the deviation of the (q) ratio from unity, within a growth context, determines the incentive for investment in the short run⁴.

In the traditional IS-LM framework it is postulated that investment would take place if the cost of capital (*i.e.* the bond rate, i_b) was below the marginal efficiency of capital, (r), given that bonds and equities are perfect substitutes. In equation (2.13) Tobin differentiates between the two rates (i_e) and (i_b). The Australian models allow for Tobin's (q), determined by equation (2.13), but with a different assumption which takes account of the long-term bond rate, (i_b), as the required rate of interest in providing a proxy for the cost of capital. This treatment of the (q) ratio complies with the assumption of perfect substitutability between bonds and other interest-bearing assets.

While the Australian macro models use Tobin's approach in the modelling of the transmission mechanism, the assumption of perfect asset substitutability in those models disregards the other aspect of Tobin's approach which allows for a wide range of assets in the private sector portfolio, and for differing rates of interest on those assets in equilibrium. The assumption of perfect asset substitutability in the Australian models results in the modelling of the asset adjustment process in the financial sector without regard to: 1) different rates of interest in the earning asset markets, and hence their impacts on private investment; and, 2) the effects of changes in these rates on the valuation of the total outstanding stock of assets in the private sector portfolio, and hence on expenditures on consumer durables.

The effects of total net worth on financial aggregates complicate the adjustment process in asset markets with further effects resulting from uncertainty, as implied by Tobin's portfolio approach (1956). In this approach the value of total wealth is used as a scaling variable in the demand for money (and in the demand for other financial

⁴. Tobin argued that in the long run the value of equities equals the replacement cost, *i.e.* (q) equals one, and no new investment takes place. In the short run, the larger the value of (q), *i.e.* for (q)>1, the greater the incentives for investment.

assets) equation(s). This scaling variable reflects the effects of changes in the nominal values of financial assets on the public's holdings of money.

In the real sector the monetary transmission mechanism reflects the other aspect of Tobin's (q) in which changes in the money stock cause wealth holders to reallocate their holdings of the financial assets. In Tobin's (1982) approach the reallocation of assets influences the required rates of return on earning assets, and hence influences the (q) ratio, and via new net investments increases the equity proportions in total net worth. Assuming that assets are imperfect substitutes, an increase in the equities brings about an increase in total net worth, and to a lesser extent, will eventually raise consumption. This provides another source of change in aggregate demand which results from changes in the (q) ratio.

Tobin (1978) emphasized that in his specification of the transmission mechanism the (q) ratio is as important as (M) for the monetarists transmission mechanism. In the monetarists view a direct link between the public holdings of money (M) and their holdings of all other assets⁵ and/or a direct link between (M) and the public spending are regarded as the basis for the monetary transmission mechanism. Friedman's (1956) restatement of the quantity theory set the demand for money within the theory of wealth, and Friedman's (1957) formulation of the permanent income hypothesis emphasized that there is a direct link between the stock of money and aggregate expenditure. In the empirical studies represented by Friedman and Schwartz (1963, 1982) monetary changes were highlighted as a major determinant of movements in nominal income⁶. Plosser (1990) argued that the monetarists view reflects little confidence in alternative transmission mechanisms.

The comparison between the two alternative mechanisms of monetary changes, which are specified by the (q) ratio and (M), is clarified by Balden-Hovel *et al.* (1982).

⁵ . In this view the alternative assets to money are assumed to be both the financial assets (bonds and equities as the claims on capital assets) and the real assets.

⁶ . In the new quantity theory, it is assumed that at an aggregate level income and expenditure are equal.

They argued that the term indicating total net worth in the consumption function can be measured in terms of the stock of liquid assets (the liquidity models) or alternatively in terms of the volume of total accumulated savings (the wealth models). In their explanation, the two models differ mainly in the policy implication of an increase in the money stock. In the liquidity models an increase in the money stock (similar to monetarists model) brings about an increase in consumption. In the wealth models some of the changes in the money stock or government bonds (similar to Tobin's model) may be offset by imperfect substitutability between assets. Also, changes in Tobin's (q) may result in an increase in the percentage of equity in total net worth, as a result of new net investments, and the resulting increase in the total net worth raises consumption in the same way as implied by Tobin's (q) theory.

While the wealth arguments in the two Australian macro models are specified in terms of total accumulated savings of asset holders, the assumption of perfect asset substitutability for earning assets means that the models take no account of changes in the valuation of equities, and hence of total net worth, in modelling wealth effects. In other words the two models disregard capital gains and losses on total net worth, and assume a given value for bonds and equities in the net worth in each period which is based on initial saving decisions of asset holders. Another assumption in the models, implied by imperfect asset substitutability between money and earning assets, provides a result for monetary changes which is similar to Tobin's approach.

2.4.2 Short-run interactions between financial markets and the real sector, and monetary policy rules

The adjustment process for the demand for money (and other assets) in the Australian models is assumed to be in real terms, and embodies a slow price adjustment mechanism within a growth context. The rationale for the transmission of monetary changes into the real sector is the same as a simple Keynesian IS-LM model and is based on the assumption of short-run sticky prices. So, in the Australian models, changes in the nominal money stock, and the subsequent changes in the interest rates,

bring about real changes in the desired holdings of assets and new net investment, since prices are sticky in the short run.

While some models which deal with sticky prices (mainly equilibrium rational expectations models) provide little scope for policy makers (Plosser 1991, Hoover 1989), the assumption of sticky prices in the short run can be employed reliably to allow for some policy rules which are feasible in the monetary policy transmission mechanism (Goodhart, 1989).

On the other hand, in disaggregated asset markets, the transmission mechanism for new net investment and changes in total net worth, as implied by Tobin's (q) ratio, is consistent with both the monetary policy rules of a fixed money supply and a fixed interest rate, (i_e). These policy rules in the Keynesian IS-LM framework are characterized by changes in the money supply and its subsequent effects on interest rates and on holdings of other assets. Gowland (1985) argued that these effects in empirical studies are shown to be slow and/or unpredictable. In this approach the money supply is assumed to be exogenously determined, and changes in the interest rate are followed by changes in capital accumulation. Macfarlane and Stevens (1989) argued that as a result of the indirect transmission mechanism, when the nominal money supply is used as a nominal anchor, the interest-rate setting behaviour of monetary authorities may make the financial system unstable and leaves the price level indeterminate in the long run. Barro (1989) emphasized that in the face of shortcomings of the indirect transmission mechanism, reliance should be placed solely upon the interest rate whose variations can be followed directly and observed more rapidly.

While the IS-LM framework provides economists with the analysis of monetary policy in terms of either interest rates or the nominal money supply, in the AEM and TRYM models the transmission mechanism relies basically on the monetary policy in terms of money supply. In the models the policy reaction functions provide a link for monetary changes into interest rates, prices and income. In a liberalized financial system monetary authorities may rely on open market operations to impinge on interest

rates more directly and leave the money supply to fluctuate with the demand for money. This complies with the bond tendering system, founded in 1982, and a market-clearing cash market which are the primary means through which optimal bids in the bond market and Reserve Bank activities impact upon interest rates.

To model a direct link between monetary policy and the interest rates which allows for the market oriented approach to policy implementation, the monetary transmission mechanism in the short run should be patterned upon policy rules whose targets consists of nominal interest rates and the exchange rate. In this thesis we allow for such policy rules in the modelling of monetary policy reaction functions.

2.4.3 Capital flows and the models of exchange rate determination

Liberalization of the Australian financial system also increased integration of Australian capital markets with overseas countries. Deregulated financial markets and international capital mobility imply that capital moves to areas of highest return. Thus Australia may attract capital for assets of similar maturity if the interest payments to investors in Australian capital markets are higher than the interest payments in overseas country. This implies that the capital flows into the Australian economy is dependent upon the domestic interest rate, (i), relative to the world rate, (i_f).

Cuthbertson and Taylor (1987) argued that in the *flow* theory of the capital account a step increase in (i) above (i_f) leads to a permanent inflow of capital; and in the *portfolio* theory when this occurs in the short run, the new asset stock equilibrium returns inflows to zero. A restrictive assumption in the flow theory is that it ignores the effects of expected changes in the exchange rate on capital flows. In the portfolio balance model, (PBM), such effects are explained by the impact of uncovered interest differential, $[(1+i)-(E^e/E).(1+i_f)]$, on foreign assets, where (E) is the exchange rate and (E^e) represents the expected spot exchange rate. Such effects in the portfolio balance model is elaborated by Branson and Henderson (1985). In this model the level of exchange rate is determined by demand and supply in the markets for financial assets, and by wealth effects of a current account deficit or surplus.

The interest rate differential, $i - i_f$, in the sticky price models of exchange rate determination, such as Dornbusch (1976), Frankel (1979) and Hooper and Morton (1982), is an explanatory variable which is used to explain the effects of capital market gains on the exchange rate. These models explain the fact that the initial rise in domestic interest rates leads to a step appreciation of the exchange rate after which a slow depreciation is expected in order to satisfy uncovered interest parity (Dornbusch, 1990; Macdonald and Taylor, 1991). Therefore, in these models the increased attention has been given to exchange rate overshooting, and hence a distinction between the short-run and long-run determinants of the exchange rate. A better understanding of exchange rate behaviour in the post-float period can be produced by models of exchange rate determination which allow for both the overshooting phenomenon and the determinants of the demand and supply for assets in financial markets.

2.4.4 The expectations mechanism in the exchange rate and term structure equations

The other mechanism through which financial markets impinge upon the real sector, in the AEM and TRYM models, is specified by the expectations mechanism in the exchange rate and term structure equations. The expectations mechanism for the exchange rate in the two models was introduced by the effects of expected rate of return on foreign assets, $\{(E^e/E), i_f\}$, on the real sector.

The expectations mechanism for the exchange rate in both models is patterned upon the uncovered interest parity condition. The exchange rate equation in the models can be represented by the following equation for uncovered interest parity:

$$(i_{f,t} - i_t) = {}_{t+1}E_t^e - E_t \quad (2.14)$$

where

$${}_{t+1}E_t^e = E_{t+1} + \omega_t$$

$({}_{t+1}E_t^e)$ represents the expected exchange rate for next period's value of (E_t) , and (ω_t) represents a zero mean random error.

The assumption of rational expectations in equation (2.14) implies that the expected spot exchange rate, $({}_{t+1}E^e_t)$, is equal to the exchange rate realized in the next period, (E_{t+1}) , plus a random error, (ω_t) , whose average value is zero.

Equation (2.14) in the two Australian models is estimated by the assumption of model consistent expectations in which all exogenous variables can influence the exchange rate, although no equation is directly estimated and tested. This sort of estimation of the exchange rate equation in the Australian models brings about results which share the main feature of Dornbusch's (1976) model of exchange rate overshooting in an open economy. Cuthbertson and Taylor (1987) pointed out that Dornbusch's model can be viewed as a partly rational expectations model, in which the foreign asset market is modelled with the rational expectations hypothesis and other markets are treated as not conforming to that hypothesis. Blundel-Wignall *et al.* (1993) showed that the test for the above modelling of the exchange rate equation (2.14), for the Australian data rejects the hypothesis of uncovered interest parity with rational expectations. They pointed out that such a result is commonplace in the literature on testing for uncovered interest parity.

The Australian models as partly rational models also allow for the expectations theory of the term structure of interest rates which complies with Fair's (1979, 1983) specification of that theory in macro models. The theory introduces the relationship between the long-term rate of interest, (i_L) , and expected short-term rate of interest, (i^e_t) , in the asset adjustment process. According to the expectations theory of the term structure of interest rates, the above relationship can be represented by

$$i_{L,t} = (1/n) \cdot \sum_{j=0}^{n-1} {}_{t+j}i^e_t \quad (2.15)$$

where $({}_{t+j}i^e_t)$ represents short-term interest rate for j quarters into future.

Equation (2.15) in the AEM model is represented by the same assumption as implied by the "model consistent expectations". In the TRYM model the above equation is estimated by the assumption of backward-looking expectations.

While the Australian models deal with some of the complications arising from agents' expectations of future exchange rates and long-term interest rates, the assumptions of rational expectations in those models may give rise to misspecification of equations (2.14) and (2.15), and hence of the monetary transmission mechanism. This is because in a large number of cases tests on the rational expectations hypothesis reject this hypothesis in equations (2.14) and (2.15). Also the AEM and TRYM models disregard the role of interest rates on assets other than government bonds, and hence the rate of interest of loans, in the information set, used for the determination of the expected values of the short-term interest rates, $({}_{t+j}i_t^e)$.

The next section examines the role played by loans in the process of asset adjustment, and hence in the modelling of the transmission mechanism of the Australian economy.

2.5. The credit channel of the transmission mechanism

In the IS-LM framework the monetary transmission mechanism is represented traditionally by the money channel through the money market rate of interest. In this tradition, 1) bank loans are viewed as perfect substitutes for bonds and other earning assets⁷; and, 2) the financial markets clear only by prices. A distinct role for credit arises from relaxing either of these assumptions.

Abandonment of the first assumption has been emphasized by the models in which the credit channel in the transmission mechanism is subject to the equilibrium conditions in both the assets and loan markets. These models ignore credit rationing. The above distinction between the two channels is reflected in Tobin's (1969, 1982) general equilibrium approach, and is embedded in the IS-LM framework in the model presented by Bernanke and Blinder (1988, 1992). Tobin's approach allows for the overall role played by movements in credit, nominal money balances and interest rates in the transmission mechanism.

⁷. The perfect substitutability assumption implies that the rates of return on loans and assets in the private sector portfolio move together and differ only by a constant spread.

Removal of the second assumption has been emphasized by the models in which credit rationing provides a link from loan markets into the rest of the model. Stiglitz and Weiss (1981), Blinder and Stiglitz (1983), and Blinder (1987), explain credit rationing as a special feature of the credit market in which borrowers and lenders have differential access to information concerning a project's risk. In this approach asymmetrical information is a particular important issue which is reflected in banks response to uncertainty and in the extent of banks' risk aversion. Blinder (1985) introduces credit rationing along with some major characteristics of the loan market in the US economy. Jaffee and Stiglitz (1990) explained credit markets with imperfect information in which the origins of credit rationing are integrated parts of their model. In this model, while the money supply and credit are likely to be highly collinear, credit transacted in the loan market does not change monotonically with changes in the loan rate. This implies that, in contrast with the standard IS-LM model, the availability of credit, rather than changes in the equilibrium interest rates, may determine the extent of borrowing.

Either of the two treatments of the credit channel can be observed in liberalized financial markets in which: 1) there is no role for credit control in the transmission mechanism; and, 2) the private initiatives of banks allow for the effects of credit on the monetary process, and hence on the assets in the private sector portfolio. The second feature of a liberalized financial system complies with the assumption that credit and earning assets in the public's portfolio are imperfect substitutes. Alternatively, the private initiatives of banks can be considered with non-monotonic changes in the rates of interest when the extent of loans is determined by credit rationing with imperfect information.

While the AEM and TRYM models leave out the role of credit controls in the modelling of the transmission mechanism, the exclusion of the second feature of a liberalized financial system led them to exclude bank lending from the transmission mechanism. In both models the money channel reflects the assumption of perfect substitutability between credit and earning assets, which gives rise to their joint effects

in an integrated market for credit and earning assets. The inclusion of the second feature of financial liberalization in the two Australian model requires a modification which allows for a distinct role for credit in the modelling of the transmission mechanism.

Moreover, both treatments of the credit channel can be represented by simple models which can be viewed as variants to the textbook IS-LM framework. Bernanke and Blinder (1988) presented a simple model for the first treatment of the credit channel. To model the second approach in a similar way, it is necessary: 1) to view both the availability of credit and the credit rate of interest as variant to the monetary preferences of the public and banks; and, 2) to specify the excess demand for credit in the rationing state. Both models represent modifications to the IS-LM framework, but each gives a different treatment of the credit channel.

Complying with the Bernanke and Blinder (1988) model, the incorporation of the credit channel into the modelling of the transmission mechanism in the Australian economy requires that: 1) earning assets and loans in the public's portfolio should be treated as imperfect substitutes; and, 2) the financial sector should be modelled by modifying the basic IS-LM framework. Additionally, by assuming some rules for loan rate controls in rationing periods, we may allow for loan rate variations in the modelling of the equilibrium credit rationing in the modification of the basic IS-LM framework.

To specify the monetary policy transmission mechanism in the modified model, it is essential to take account of differences between sources of credit rationing in the Australian financial system pre- and post-deregulation. Prior to deregulation restrictions imposed on interest rates reduced the ability of the banking system to compete for funds when outflow or slowed inflow of deposits occurred. This in turn caused banks, in tight periods, to face a shortage in loanable funds which led them to ration credit in order to reduce uncertainty in acquiring enough funds to lend. In addition, quantitative controls on bank lending forced banks to adjust loans and advances in a non-price setting. The decreasing role of these forms of credit rationing

in the post-deregulation period was explained by Swamy and Tavalis (1989), Battellino and McMillan (1989), and Grenville (1991). In deregulated financial markets private initiatives of banks, and not the control imposed by the Reserve Bank, may comply with either of the above treatment of the credit channel.

In this chapter we examined the transmission mechanisms between the financial and real sectors other than those in the standard IS-LM framework. The enormous changes in the Australian financial system, which have been witnessed over the 1980s, have changed financial operations and the mechanisms for implementing monetary policy⁸. These changes require a reassessment of the simplifying assumptions by which the monetary transmission mechanism is specified in the Australian macro models, the AEM and TRYM models. One important aspect of this analysis is that the reliability of the models will be seriously impaired if key relationships in the monetary transmission mechanism are in an unstable state in the period covering both pre- and post-deregulation.

2.6 Summary and Conclusion

The purpose of this thesis is to evaluate the changes that have occurred to the Australian monetary transmission mechanism as a result of deregulation of the financial sector. The analysis of the monetary transmission mechanism of the Australian economy is carried out within a model which is modified from a basic IS-LM framework. In the modified model the simplifying assumptions in the standard IS-LM framework are no longer valid. The modified model will be characterized by key relationships within financial markets which determine variables such as the money supply, the amount of credit rationing, interest rates and the exchange rate. The relationships are used to evaluate the relevance of the following issues in the monetary transmission mechanism of the Australian economy: 1) the analysis of the exchange rate in the post-float period, using the determinants of capital flows and fundamentals

⁸. Fahrer and Rohling (1992)

such as expected secular inflation and adjustments in the long-run equilibrium real exchange rate; 2) the mechanisms through which the Reserve Bank influences short-term interest rates, in the analysis of monetary policy reaction functions post-deregulation; 3) the endogeneity of the money supply, implying that the private initiatives of the banking sector play an important role in the process of money creation; 4) the links between the bank loan market and the asset markets; and, 5) the links between the loan market and the financial markets for securities of different maturities. This thesis evaluates the issues outlined above, regarding two approaches to asset market behaviour.

First, an asset market model, in which the supply of assets is endogenous, is specified and estimated for the Australian financial sector. This model is in the spirit of Tobin's (1969) model in which assets are imperfectly substitutable and the focus is on changes in asset prices. As is implied by Bradley and Jansen (1986) an interest rate operating instrument in this model is consistent with an endogenously determined money supply. The estimation of the asset market model provides an assessment of how the process of financial deregulation has changed the relationships within financial markets in which the Reserve Bank is primarily reacting to asset market conditions, implying that the supply of money is endogenous. In the financial sector the responses of capital flows and the exchange rate to monetary changes, and hence to changes in interest rates, are reflected in the private sector's holdings of net foreign assets.

Second, we evaluate the relevance of the banking sector choice of assets and liabilities in the post-deregulation period in a portfolio-loan model which embodies *a*) the post-Keynesian view of endogenous money, and the structurally endogenous nature of loans, and *b*) the new Keynesian approach to credit rationing. The significant differences from the asset market model are the inclusion of the effects of bank lending on the money supply, and the disequilibrium modelling of the bank loan market. In the portfolio-loan model we examine the money supply implications of imperfect substitutability between auction market credit, bonds, and customer market credit, loans, and the banking system's response to the increased riskiness of credit.

The model of the transmission mechanism in this thesis is viewed in the spirit of a variant of the textbook IS-LM model, which incorporates bank lending into the linkages between the financial and real sectors. In this model the different implications of the lending channel arise from the banking system's response to the probability of borrowers default. Such a response in the credit rationing approach is specified by a non-monotonic relationship between the loan rate and the expected return to banks, and/or by banks control on loan rates. In a rationed credit market the controlled loan rate can be specified by some rules under which loan rate controls depend on some specific historical data.

In this thesis, we evaluate the relevance of the credit rationing approach by examining: 1) whether Australian banks, in the aggregate, ration credit by non-price means; 2) whether the rationing behaviour of Australian banks has any predictive content for aggregate economic activity post-deregulation; and, 3) whether credit rationing makes a significant difference to the contribution of monetary shocks, stemming from a tightening of monetary policy, to output fluctuations. In the transmission mechanism between the financial and real sectors we also evaluate the buffer stock hypothesis by examining, 4) whether the interest rate effects of monetary changes on real output are less severe as a result of money acting as a buffer for disequilibria in other markets.

Also, in this thesis we examine the implication of credit rationing for portfolio investors' preferences for securities with different terms to maturity. Juttner's (1990) elaboration of the yield to maturity of securities is suggestive of the importance of the loan rate in the term structure of interest rates. In a model of the expectations theory of the term structure of interest rates we evaluate the relevance of the credit rationing approach by examining: 5) whether the cost of bank lending provides portfolio investors in short-term security markets with rationally formed expectations. This treatment is based on the principle feature of a rationed credit market in which the loan rate reflects banks' proxies for the expected rate of return and risk of default of the average projects in the economy. In completely deregulated financial markets these

proxies conform to the actual rate of return on the average projects. Also, if there is no substitute for bank loans, portfolio investors allow for, on average, the same rate of return on their portfolio investment as implied by the banks' proxies. Therefore, in completely deregulated financial markets, when there is no substitute for bank lending, credit rationing provides portfolio investors with economic information, concerning the actual rate of return on their portfolios. This requires that portfolio investors' expectations in financial markets should be model consistent, or rational.

Chapter 3

Asset Market Behaviour in Macroeconomic Models

3.1 Introduction

Australian macro-econometric models such as the Access Economic Murphy (AEM) Model (1992) and the Treasury Macroeconomic (TRYM) Model (1993) have similar theoretical structures and model the financial sector and the monetary transmission mechanism in essentially the same way. In these models the specification of asset market behaviour is based on the assumption that assets other than money are perfect substitutes, and hence they are considered in an integrated earning asset market. This assumption abstracts from default risk, differing rates of interest in equilibrium and the private sector's portfolio decisions.

Both models disregard the wealth effects of a current account deficit or surplus on the exchange rate, and assume that the domestic and foreign assets are perfectly substitutable. There is also no distinction between short-run and long-run determinants of the exchange rate, although this distinction may be regarded as crucial in a flexible exchange rate regime. Additionally, the models make no reference to the effects of bank lending on the private sector's portfolio decisions, and assume that auction-market credit (bonds and other earning assets) is a perfect substitute for customer-market credit (loans), and financial markets clear only by price. These are two simplifying assumptions which exclude the role played by loans in the monetary transmission mechanism. Also, in both models the effects of the loan rate (or the cost of borrowing from the credit market) on the *ex ante* rate of return on fixed capital are assumed negligible. Such effects can be described by the expectations theory of the term structure of interest rates. Both models rely on a standard IS-LM framework, which oversimplifies financial and monetary policy operations when used with the

other restrictive assumptions such as *a*) the exogeneity of the money supply, and *b*) the model consistent expectations of the long-term rate of interest and the exchange rate.

As will be discussed in this chapter, the main features of the Australian financial system can be presented by the following issues: 1) uncertainty in earning asset markets and imperfect asset substitutability across a wide range of assets; 2) the effects of a current account deficit/surplus on the exchange rate, and the distinction between the short- and long-run determinants of the exchange rate; 3) the endogeneity of the money supply; and, 4) an explicit role for bank loans in the monetary transmission mechanism. Another of the principal characteristics of the Australian financial sector, arising from financial liberalization, can be presented by an appropriate specification of financial operations and of monetary policy reaction functions in deregulated financial markets.

In order to take into account the issues outlined above, we specify an analysis for asset market behaviour for the Australian economy which abandons the restrictive assumptions in the standard IS-LM framework and provides modifications for the theoretical structure of the AEM and TRYM models. The analysis will be based upon the main features of asset market behaviour in Tobin's (1958, 1963) portfolio approach and Tobin's (1969, 1982) general equilibrium approach to monetary theory. These approaches take account of money as an asset in a diversified portfolio, and hence allow for imperfect asset substitutability across a wide range of assets, as well as the demand for money under conditions of uncertainty. The analysis also takes into account the wealth effects of a current account deficit or surplus with particular reference to the principles viewed by the portfolio balance model (PBM)¹, and the Dornbusch-Frankel model of exchange rate determination². These models are viewed

¹. A thorough consideration for asset market behaviour in open economies was introduced by Bryant (1975) and recently by Branson and Henderson (1985), Cuthbertson and Taylor (1987), and Argy (1992).

². Dornbusch (1976) introduced a sticky-price monetarist model of exchange rate determination. Frankel (1979) provided an extension for the Dornbusch model in the so-called real interest differential model. More recently Macdonald (1988), and Macdonald and Taylor (1989) presented a summary of empirical studies and test results on the Frankel model. Macdonald and Taylor (1991) extended a discussion on the extant empirical evidence on the PBM and Dornbusch-Frankel Models.

as extensions to Tobin's general equilibrium approach, as the financial sector is patterned upon a small open economy model.

In addition, the analysis presents concerns about the endogeneity of the money supply as explained in the post-Keynesian literature³, with special reference to the Reserve Bank's meeting on monetary issues in 1985 in which a general agreement was reached on the endogeneity of the money base⁴. Consideration is then given to the models which allow for the role of bank loans in the private sector's portfolio allocation. The analysis takes into account the effects of a loan expansion/contraction on asset market behaviour, and also of the loan rate in the term structure of interest rates, based on the theoretical considerations concerning the risk of default for bank loans, and hence credit rationing, in the monetary transmission mechanism⁵.

To proceed with the modified model we start with a brief review of the specification of asset market equations in the AEM and TRYM models. Then, along with outlining the important relationships in a model of asset market behaviour, we examine the principle features of those relationships in a model which is modified from a basic IS-LM framework. To examine whether such a modification aids prediction of asset market behaviour post-deregulation, we analyse the major characteristics of Australian financial liberalization and its implication for the monetary policy transmission mechanism.

³. The recent literature on the endogeneity of the money supply, from a post-Keynesian perspective, is surveyed by Moore (1988b), and Pollin (1991).

⁴. Reserve Bank of Australia Bulletin, December 1985.

⁵. Friedman (1983) and Bernanke (1986) examined the role of loans in the monetary transmission mechanism. Bernanke and Blinder (1988, 1992) introduced a model of a non-rationed loan market with a distinct role for loans in an IS-LM framework. Blinder (1987) proposed a model in which there is rationing and no substitute for loans. Blinder and Stiglitz (1983), Stiglitz (1988) and Blinder (1989) stressed the importance of loans in a rationing system in the economic activity.

3.2 The specification of asset market equations in the AEM and TRYM models

In the AEM (1992) and TRYM (1993) models the financial and monetary policy operations are modelled in terms of three key equations which are: 1) the demand for money equation; 2) the term structure equation; and, 3) the uncovered interest parity equation. In addition, in keeping with the assumption of an integrated market for earning assets, as it is presented in the textbook IS-LM framework, the models rely on competitive forces in that market which give rise to equal rates of return on government bonds, equities and foreign assets.

On the above specification of asset market behaviour, the portfolio-balance condition is presented in a two-asset model, comprising money and earning assets. In this context, the equilibrium condition for earning assets is suppressed by Walras' law, and the demand for money equation is regarded as the monetary policy reaction function, given that the supply of money is exogenously determined. In this simplified version of financial and monetary policy operations, the models allow for a *conventional specification of the demand for money equation* which is given as

$$M/P = M(Y, i) \quad (3.1)$$

where

M = money supply,

P = price level,

Y = income,

i = short-term interest rate.

Equation (3.1), which relates the stock of money to the price level, income and the rate of interest on competing assets, is viewed as central to the modelling of the monetary transmission mechanism. As discussed in the previous chapter, the *stability* of the demand for money equation (3.1) should be considered pivotal in providing stability for the monetary transmission mechanism in these models.

To explain the behaviour of the yield to maturity as the term to maturity for earning assets increases, the models take into account *the term structure of interest rates*, which is considered in terms of a simplified equation as⁶

$$i_{L,t} = (1/n) \cdot \sum_{j=0}^{n-1} {}_t i^e_{t+j} \quad (3.2)$$

where

$i_{L,t}$ = the long-term (10-year) interest rate,

i_t = the short-term (one-quarter) interest rate, and

${}_t i^e_{t+j}$ refers to this quarter's expectations for i_t , j quarters into the future, and from this it follows trivially ${}_t i^e_t = i_t$.

Using the expectations theory of the term structure of interest rates, it is assumed that long-term securities are perfect substitutes for short-term securities. This implies that in the term structure equation, long-term securities yield the same rate of return as short-term (one-period) securities yield over the long run.

To explain the relationship between the yield on a short-term domestic security and the expected yield on a short-term foreign security, the models employ the *uncovered interest parity equation*, given as

⁶. According to the expectations theory of the term structure, the rate of interest on a long-term (n -period) security equals the expected rate of interest from holding a series of short-term (*one-period*) securities over the long-term period. This specification implies that:

$$(1+i_{n,t})^n = (1+{}_t i^e_t) \cdot (1+{}_t i^e_{t+1}) \dots (1+{}_t i^e_{t+n-1}) \quad (3.2a)$$

or

$$i_{n,t} = [(1+{}_t i^e_t) \cdot (1+{}_t i^e_{t+1}) \dots (1+{}_t i^e_{t+n-1})]^{1/n} - 1 \quad (3.2b)$$

where

$i_{n,t}$ = the yield to maturity in period t on an n -period security,

${}_t i^e_t$ = the expected one period rate of interest in the first period, equal to i_t ,

${}_t i^e_{t+j}$ = the expected one period rate of interest in period $t+j$.

In this equation the values for ${}_t i^e_{t+j}$ are unobserved, hence, some assumption about how expectations are formed must be made to model the expectations theory of term structure.

The expression on the right-hand side of (3.2b) can be recognized as a *geometric average* of the n -period compounding factors. The geometric mean of the compounding factors minus one can be approximated by a simple arithmetic average, so

$$i_{n,t} = (1/n) \sum_{j=0}^{n-1} {}_t i^e_{t+j}$$

$${}_t i^e_{t+j} = i_t \quad \text{for } j=0$$

$$(i_{f,t} - i_t) = {}_tE^e_{t+1} - E_t \quad (3.3)$$

where

$i_{f,t}$ = the rate of interest on foreign assets,

E_t = the exchange rate, and

${}_tE^e_{t+1}$ refers to this quarter's expectations for next quarter's value of E_t , and the trivial result that ${}_tE^e_t = E_t$.

Using the above specification of *the uncovered interest parity equation*, the models implicitly assume that the interest rate differential between foreign and domestic assets with the same maturity is equal to the expected appreciation/depreciation of the domestic currency over the period to the assets' maturity. This is an assumption which implies that agents in the foreign exchange market are risk neutral, and hence do not demand a premium on the foreign assets' return.

Equation (3.3) in the TRYM model and equations (3.2) and (3.3) in the AEM model are expressed with forward-looking expectations. These expectations were assumed to be formed rationally, and hence, model consistent estimations were employed to ensure that this assumption was borne out in the equations. However, as we have noted in the previous chapter, the rational expectations assumption in the financial markets with securities of different maturities and in the foreign exchange market may give rise to misspecification in equations (3.2) and (3.3), and hence in the modelling of the monetary transmission mechanism. This is because the results achieved by many researchers with Australian data rejected the rational expectations hypothesis in these equation⁷.

In the TRYM model the term structure of interest rates, equation (3.3), is specified by a backward-looking expectations assumption which holds the variability of the long-term interest rate consistent with the expectations theory of the term structure

⁷ The hypothesis of uncovered interest parity, UIP, with the assumption of rational expectations was examined by Blundel-Wignall *et al.* (1993). The result, which is commonplace in the literature on testing for uncovered interest parity, rejected the UIP hypothesis. Also, Juttner (1990) pointed out that the validity of the rational expectations hypothesis in the term structure of interest rates, with exception for Tease's (1988) findings, has been rejected by many researches, using Australian data.

of interest rates. However, such a specification of the expectations theory of term structure should not be confused with the assumption of rational expectations in this theory⁸.

Additionally, in the AEM and TRYM models *the portfolio-balance condition* is based upon a consolidated balance sheet of the non-bank private and banking sectors. This implies that the portfolio-balance condition in the models abstracts from the public and banks' mutual claims, and hence from bank loans, in the modelling of asset market behaviour. To describe this feature of the models more clearly, it is useful to derive the consolidated balance sheet of the non-bank private and banking sectors from separate identities as

$$W = C_p + DD + TD + B_p + EQ + FA - L \quad (3.4)$$

$$L = DD + TD - (C_b + B_b + R) \quad (3.5)$$

where

W = the money value of the total outstanding stock of assets in the private non-bank sector (public's) portfolio,

C_p = the public's holdings of currency,

DD = the public's demand deposits in commercial banks,

TD = the public's term deposits in commercial and saving banks,

B_p = the public's holdings of bonds,

EQ = the public's holdings of equities,

FA = the public's holdings of net foreign assets, denominated in domestic currency,

L = the public's loan liabilities, owed to banks,

R = non-borrowed reserves of banks.

C_b = currency held by banks,

B_b = bonds owned by banks.

⁸. In the expectations theory of the term structure under the rational expectations assumption, it is presumed that the future values of the short-term interest rates equal the markets' expectations of the corresponding spot rates.

Identity (3.4) represents the balance sheet of the non-bank private sector, and identity (3.5) represents the balance sheet of banks. Summing up identities (3.4) and (3.5), the consolidated balance sheet of the non-bank private and banking sectors can be represented by the following identity.

$$W = (C_p + C_b) + (B_p + B_b) + EQ + FA + R \quad (3.6)$$

As is clear from identity (3.6), the consolidated balance sheet of the non-bank private and banking sectors excludes deposits and loans from the public's portfolio⁹. Also, an integrated earning asset market, consisting of bonds, equities, and net foreign assets represented by $(B_p+B_b)+EQ+FA$, implies that after invoking Walras' law, and dropping the demand equation for $(B_p+B_b)+EQ+FA$, the equation of the demand for the money base, defined as $(C_p+C_b)+R$, can be considered to be central in the specification of the monetary transmission mechanism.

As a consequence, the AEM and TRYM models exclude the loan effect from the modelling of the transmission mechanism, since there is no consideration of such an effect in their specification of the portfolio-balance condition, defined by identity (3.6)¹⁰.

In general, both models disregard the approaches to imperfect asset substitutability, and to bank lending in modelling the private sector's portfolio decisions. Also, the model consistent expectations in the AEM and TRYM models cannot be treated as a reliable expectations assumption since the models do not provide any evidence for the rational expectations hypothesis in equations (3.2) and (3.3). In these models a money demand equation provides the central relationship between an

⁹. The AEM and TRYM models also disregard the effects of banks reserves, (R), in the banks balance sheet identity, and hence in identity (3.6). The TRYM model additionally excludes (DD) from identity (3.5) which results in the inclusion of (DD) in identity (3.6). This can be shown by identity (3.6a).

$$W = ((C_p + C_b) + DD) + ((B_p + B_b) + EQ + FA) \quad (3.6a)$$

¹⁰. Bank loans in the banks' balance sheet identity is an asset of the banks and a liability of the non-bank private sector. There is an inverse consideration for bank loans in the non-bank private sector's balance sheet identity. Hence, a consolidated balance sheet of the private non-bank and banking sectors excludes the effect of bank loans on asset market behaviour. For this reason the loan effect in the monetary transmission mechanism must be viewed via a distinct consideration of the bank lending in asset market behaviour.

exogenously determined monetary aggregate and a key interest rate; and a range of private sector's portfolio decisions is assumed to be influenced by only this rate of interest. As a result of financial liberalization, controls on financial markets have been relaxed, and it has become clear that a better understanding of the transmission mechanism involves many more elements than those considered in the AEM and TRYM models. In this thesis attention has been given to such phenomena as: 1) well-behaved preferences of the private sector over a wide range of assets in disaggregated asset markets; 2) bank loans in the process of money supply creation; 3) exchange rate determination under conditions implied by the increased integration with overseas capital markets post-deregulation; 4) the private initiatives of banks in the determination of the volume of loans; and, 5) the term structure of interest rates, regarding portfolio investors' interest in borrowing from the banking sector.

The issues outlined above provide a basis for modeling asset market behaviour, and are referred to as modification in the standard IS-LM framework. The theoretical basis for such modifications will be presented in the following discussion.

3.3 Asset market behaviour

The model of asset market behaviour to be evaluated in this thesis is modified from a basic IS-LM framework, and takes into account agents' well-behaved preferences over a range of assets in the private sector portfolio. This modification also places more emphasis upon the loan effects in the private sector's asset allocation decisions, and also on the rate of return on financial assets regarding the yield to maturity of securities. The latter takes into account both the money market interest rate and the loan rate in the determination of the long-term interest rate, and hence in the determination of the *ex ante* rate of return on fixed capital.

In order to provide a basis for that modification this section summarizes the theoretical issues of an asset market model which are relevant to the monetary transmission mechanism. In particular, attention has been given to such phenomena as the private sector's portfolio decisions in disaggregated asset markets, the endogeneity

of the money supply, exchange rate determination, the availability of credit, and the links between the bank loan market and asset markets, and between the loan market and the financial markets for securities of different maturities. The implications of asset market disaggregation in Tobin's (1969, 1982) general equilibrium approach to monetary theory is taken as a useful starting point for the modifications required by the phenomena outlined above.

3.3.1 Asset market disaggregation as a modification to the traditional monetary transmission mechanism

Tobin's (1969, 1982) general equilibrium approach to monetary theory focuses on a wide range of assets in the portfolio-balance condition. Brainard and Tobin's (1968) proposition on modelling the financial sector in a general equilibrium framework has a similar focus. This focus is the basis of identity (3.4). In Tobin's (1969) approach money is viewed as one asset in the menu of assets available to the private sector, and the Keynesian IS-LM model is modified to allow for the implications of asset market disaggregation and the private sector portfolio allocation for the monetary transmission mechanism. In Tobin's approach the specification of disaggregated asset markets is carried out in a general framework in which all assets in the portfolio are imperfect substitutes, and asset markets clear by prices¹¹. In this approach, also, imperfect asset substitutability gives rise to differing rates of interest in equilibrium¹².

Tobin's (1958, 1963) portfolio approach incorporates uncertainty, or the default risk of earning assets, into the private sector's optimal holdings of money. Under conditions of uncertainty, the private sector finds it optimal to hold transaction balances since the variance of money's pecuniary rate of return is zero even though

¹¹. The model also implicitly allows for Walras' law to eliminate one of the market-clearing conditions as redundant.

¹². In Tobin's approach the rates of interest on bonds and equities are viewed as the opportunity costs of holding transaction balances, and the asset adjustment process determines the rates of interest on these assets.

money offers (zero or) a lower average rate of return than interest-bearing assets. This approach implies that money is a direct portfolio substitute for interest-bearing assets.

In this approach the money value of the total outstanding stock of assets in the private sector portfolio, (W), is treated as a scaling variable in the demand for money equation. In Tobin's (1969, 1982) general equilibrium framework, a system of demand equations of the following form is postulated for each asset in the private sector portfolio.

$$A_k = f(i_j, W, X) \quad k, j = 1, 2, \dots, N \quad (3.7)$$

where

A_k = the desired holdings of the "k"th asset,

i_j = a vector of interest rates,

X = other factors influencing the desired portfolio.

In the system of equations (3.7), imperfect asset substitutability implies that the demand for each asset is affected by the rates of interest on other earning assets, represented by differing rates of interest in equilibrium, i_j . The imperfect asset substitutability in Tobin's approach is based on the assumption that, given that the public have well-behaved preferences over a wide range assets in their portfolio, the assets offer differing rates of interest in equilibrium.

Tobin (1961) argued that the simple Keynesian LM curve can be treated as a special case of a three asset model, consisting of money, bonds and equities, in which the restrictive assumption is that bonds and equities are perfect substitutes. This assumption abstracts from default risk and the risk of dividend variability, and allows for an integrated earning asset market for bonds and equities. In this treatment the rate of interest on bonds is the rate at which the cost of fixed capital is measured. The AEM and TRYM models follow this Keynesian approach along with a simple amendment which implies that the rate of interest on equities is the rate of interest on bonds, but with a constant spread representing equities' risk premium¹³.

¹³. The spread is taken to be constant to allow the treatment of variations in the bond rate as variations in the rate of interest of equities. In the AEM and TRYM models the constant spread is implicitly estimated as a part of the constant term in the demand for money equation.

It is worth noting that a more important role for equities arises from treating the spread as variable, and hence the equity rate as the rate which is different from the bond rate. In this treatment, a model of asset market behaviour is based on the assumptions of imperfect asset substitutability and differing rates of interest in equilibrium, as explained in Tobin's general equilibrium approach. In keeping with these assumptions, a simplification can only be made by expressing the rate of interest on equities in an implicit functional form, which is obtained from the equilibrium condition in the equity market, and by including that functional form in the simplified model¹⁴. While this simplification excludes the rate of interest on equities from the money and bond market equilibrium conditions, the inclusion of the implicit function for the equity rate in the model makes the model consistent with Tobin's approach which allows for the role played by equities in disaggregated earning asset markets.

The other requirement of Tobin's approach to asset market disaggregation requires that the total outstanding stock of assets, (W), functions as a constraint, and hence as a scaling variable, on the equations for the demand for money and other assets¹⁵. On the other hand, as implied by Juttner (1990), a non-restrictive assumption

¹⁴. This assumption allows for a generalization in which a constant spread on the bond rate can be interpreted as a special case of the simplified model. That is, given that in equilibrium the demand for and supply of equities are equal and there are only two rates of interest in the model, an implicit function for equities can be written as

$$i_e = f(i_b)$$

where

i_e = the rate of interest of equities,

i_b = the rate of interest of bonds.

A linear functional form of the above equation can be written as

$$i_e = a_0 + a_1 \cdot i_b$$

Substituting the implicit function $f(i_b)$ for i_e into the money and bond market equilibrium conditions, we obtain equations in terms of i_b and $(a_0 + a_1 \cdot i_b)$. These equations, implicitly, take account of the variations of the rate of interest on bonds as well as equities.

As a special case in which ($a_1=1$) the two rates differ only by constant spread equal to a_0 .

¹⁵. The market value of earning assets will vary inversely with their rate of return. However, changes in nominal asset values will affect the total wealth of asset holders, and may in turn be expected to have repercussions in the allocation of portfolios (Stevenson, 1988; Juttner, 1990). To allow for such factors, the wealth constraint can be written as

$$W = M + A/r_A$$

where

W = the nominal value of total wealth,

M = the outstanding stock of transaction balances,

A = the outstanding stock of earning assets,

r_A = the rate of interest on earning assets,

A/r_A = the nominal value of earning assets.

for the effects of the money value of the total portfolio in the asset demand equations implies that: in each period asset holders may allow for the terminal value of the portfolio in their portfolio decisions by taking into account returns earned during the period. Otherwise, the asset holders are only allowed to maximize the terminal portfolio while they are not able to take into account returns earned during the period in their portfolio decisions. This constitutes a contradiction in the sense that we exclude sources of increase in the money value of the terminal portfolio. The non-restrictive assumption additionally implies that the expected portfolio may affect holdings of each asset by classifying them into normal or inferior assets¹⁶.

3.3.2 The Portfolio Balance Model of exchange rates (PBM) and exchange rate determination

In the context of a small open economy¹⁷, the extension of Tobin's general equilibrium approach can be explained by the assumptions that: 1) domestic and foreign assets are imperfect substitutes, and 2) a current account deficit (surplus), via changes in the total outstanding stock of assets in the private sector portfolio, affects the demand for foreign assets. The portfolio balance model of exchange rates takes account of these assumptions in a model which is specified in a manner consistent with Tobin's approach in equations (3.7).

In the PBM the exchange rate is determined by the equilibrium conditions in disaggregated asset markets. As implied by the portfolio balance theory, a current account deficit (surplus) represents a fall (rise) in the domestic holdings of net foreign assets, and hence in the private sector portfolio, (W), and affects the level of demand for domestic assets, which in turn affects domestic rates of interest and the exchange

However, such revaluation effects complicate the analysis of asset market behaviour and require a simultaneous system of equations to generate a solution.

¹⁶. Juttner (1990), pp. 251-262.

¹⁷. In a small open economy, it is assumed that changes in the domestic economy have no feedback effects on the world economy.

rate. Changes in the exchange rate bring about changes in the demand for net foreign assets, denominated in domestic currency.

In Branson and Henderson's (1985) elaboration of the portfolio balance theory, the demand equation for net foreign assets, as well as other demand equations, allows for the effects of the *uncovered interest rate differential* which is concerned with uncovered arbitrage in asset markets. The uncovered interest differential, which is described by the following expression, is included in the vector of rates of interest in the system of equations (3.7).

$$(1+i) - (E^e/E).(1+i_f) \quad (3.8)$$

where, (E^e) is the expected spot exchange rate.

The expectations mechanism in this model, represented by expression (3.8), is different from the *uncovered interest parity condition* for equilibrium in the capital account monetary models, represented by equation (3.3). Due to international as well as Australian evidence that rejects the equalization of expected returns on domestic and foreign assets¹⁸, it seems reasonable to take account of the Branson-Henderson specification of the uncovered interest differential in the demand equation for net foreign assets.

Changes in net foreign assets may also arise from foreign competitiveness which, via changes in the trade balance, provides further effects on the current account balance. More effects on net foreign assets may also emerge from changes in the real interest rate differential and relative prices in the long run. We may view these factors as the determinants of the supply of foreign assets denominated in domestic currency. Given that the supply of foreign assets denominated in foreign currency is demand determined, these factors can be regarded as influential in the determination of the exchange rate which is used to convert these assets into the domestic-currency-denominated assets.

¹⁸. Tease (1988), Froot and Frankel (1989), and Blundell-Wignall *et. al.* (1993).

To consider the above determinants of the supply of foreign assets, denominated in domestic currency, changes in the exchange rate are examined with the aid of Dornbusch's (1976) model of the exchange rate and the modifications on this model, presented by Frankel (1979), and Hooper and Morton (1982). The former modification adds a term reflecting relative expected secular inflation, $\pi - \pi_f$, into the Dornbusch expectations equation for the exchange rate, and the latter introduces the effects of shifts in the long-run equilibrium real exchange rate (q'), through unexpected changes in the long-run equilibrium current account, in the so called Dornbusch-Frankel model. The expectations equation for the exchange rate in the Dornbusch-Frankel model can be represented by

$$(s' - s) = (1/\theta) \cdot [(i - \pi) - (i_f - \pi_f)] \quad (3.9)$$

or

$$s = s' - (1/\theta) \cdot [(i - \pi) - (i_f - \pi_f)] \quad (3.10)$$

where

s = log of nominal exchange rate (in terms of domestic currency per unit of foreign currency),

s' = log of long-run nominal equilibrium exchange rate,

θ = adjustment coefficient,

i = log of domestic interest rate,

i_f = log of foreign interest rate,

π = log of domestic inflation rate,

π_f = log of foreign inflation rate.

Equation (3.10) introduces a term reflecting the expected inflation differential, $(\pi - \pi_f)$, into the Dornbusch expectations equation¹⁹. The long-run nominal equilibrium

¹⁹. Dornbusch' expectations equation for the exchange rate can be represented by:

$$(s^e - s) = \theta \cdot (s' - s)$$

where s^e represents log of expected exchange rate. The adjustment coefficient, (θ) , indicates that the short-run (s) can differ from its long-run value.

The modification made by Frankel can be shown by:

$$(s^e - s) = \theta \cdot (s' - s) + (\pi - \pi_f)$$

The assumption of uncovered interest parity in the long run implies that

$$(s^e - s) = i - i_f$$

Combining these two equations in the Frankel model yields,

exchange rate, (s'), in this equation reflects the purchasing power parity condition, given as

$$s' = P' - P'_f \quad (3.11)$$

where

P' = log of long-run equilibrium domestic price index,

P'_f = log of long-run equilibrium foreign price index.

The crucial element in the Dornbusch-Frankel model, equation (3.10), is the distinction between the short-run and long-run determinants of the exchange rate (Cuthbertson and Taylor, 1987). In this model the long run is characterized by the purchasing power parity condition, represented by equation (3.11). In the short run (s) differs from (s') because of the expectations are formed, as represented by equation (3.10). The crucial element in the Hooper and Morton (1982) modification is the treatment of the equilibrium real exchange rate as the rate that maintains current account equilibrium in the long run. In the Hooper and Morton modification the long-run determinants of the exchange rate is represented by the following equations for the long-run equilibrium nominal and real exchange rates.

$$s' = (P' - P'_f) + q' \quad (3.12)$$

$$q'_t = q'_0 - \tau \cdot \Sigma [C_t - (1-\lambda) \cdot C_{t-1}] + (\tau \cdot \lambda \cdot C'_t) \cdot t \quad (3.13)$$

where

q' = log of long-run equilibrium real exchange rate,

C = current account balance,

C' = long-run equilibrium current account,

t = time trend,

λ = a constant fraction of the gap between the actual and equilibrium current account,

τ = estimated parameter obtained from a predetermined value for (λ).

The Hooper and Morton model allows for unexpected changes in the current account, represented by the right hand side of equation (3.13), as the other long-run

$(s' - s) = (1/\theta) \cdot [(i - \pi) - (i_f - \pi_f)]$
 which is the same as equation (3.9) in the body of this section.

determinant of the nominal exchange rate, represented by equation (3.10). In this model the short-run nominal exchange rate can differ from its long run value by the same mechanism as implied by the Dornbusch-Frankel model. In the long run both the purchasing power parity condition, $(P^i - P^f)$, and shifts in the equilibrium real exchange rate, (q^i) , which is required to maintain current account equilibrium in the long run, are viewed as crucial in the determination of the nominal exchange rate, (s) , in equation (3.10). The determinants of (q^i) allow additionally for the effects of foreign competitiveness on the nominal exchange rate, (s) , via changes in the trade balance, and hence changes in the current account balance in equation (3.13).

All these effects can be regarded as the determinants of the exchange rate, and thus of the supply of net foreign assets denominated in domestic currency, given that the supply of these assets denominated in foreign currency is demand determined. The demand equation for foreign assets denominated in foreign currency complies with the specification implied by the PBM and the system of equations (3.7).

3.3.3 The endogeneity of the money supply

The money market equilibrium condition in the AEM and TRYM models, in accordance with the textbook LM curve, is specified by an exogenously determined money supply and a money demand equation in the conventional form as

$$\ln M_t^d = b_0 + b_1 \ln i_{m,t} + b_2 \ln W_t + b_3 \ln Y_t + u_{1t} \quad (3.14)$$

where

$(\ln M_t^d)$ = log of real money balances,

$(\ln i_{m,t})$ = log of the money market interest rate,

$(\ln W_t)$ = log of the outstanding stock of assets in the private sector portfolio,

$(\ln Y_t)$ = log of real money income.

Equation (3.14) represents the conventional demand for money equation in the context specified by the system of demand equations (3.7). The last two terms in equation (3.14) stand for the other factors denoted by (X) in equation (3.7).

In equation (3.14), government transactions are considered to be the only source of changes in the stock of money, and the demand for money function behaves as the monetary policy reaction function. In this treatment of the demand for money equation the government budget constraint and Reserve Bank transactions on government bonds provide a direct control over the size of the money stock. On the Reserve Bank control over the money stock, monetary theory over the last two decades has placed reasonable doubt. Specifically, recent literature in monetary theory emphasizes that the models of money supply determination should account for variations in the monetary preferences of the public and banks, and for the direction of causality²⁰ in the process of money creation.

In a simple money multiplier model²¹ central banks can control the size of the money stock since it is presumed that: 1) banks maintain cash reserves equal to a fixed proportion of deposits, as demanded by the regulatory requirement and by their internally determined liquidity constraint; 2) the public's demand for transaction balances and term deposits are constant proportions of demand deposits; and, 3) the supply of the money base (or central bank liabilities) is exogenously determined by the monetary authorities or central bank transactions. As explained by Papademos and Modigliani (1990), an improvement in the monetarists' model can be achieved by treating *the public and banks' portfolio ratios* in the money multiplier as functions of the rates of interest in asset markets. In their view only the third assumption can be regarded as reliable in the modelling of the money supply process.

In the model represented by Papademos and Modigliani, the money supply function, rather than being vertical in the money-interest rate space, is upward sloping,

²⁰. As noted in the previous chapter, Moore (1988b) emphasized that a descriptive identity in the money multiplier model has no implication for causality and does not explain the process of money creation (pp 83-86).

²¹. A simple version of the money multiplier model can be represented by:

$$M^S = m \cdot H$$

where

m = the money multiplier,

H = the monetary base.

In this model (m) includes the public and banks' portfolio ratios. In models which assume the money supply is exogenously determined, the ratios in the money multiplier, (m) are taken to be fixed.

and the slope is determined by *the public and banks' portfolio ratios* in the money multiplier function. In that specification, the function can still be shifted exogenously as the central bank changes the supply of the money base at its discretion²².

The different implication of the money multiplier model is explained by Lavoie (1984). Lavoie' model is represented by an inverse functional form as *a credit divisor* equation for the money base²³. In this equation the money base, consistent with the post-Keynesian view, is assumed to be accommodative to the public and banks' portfolio preferences (or the ratios) in the money multiplier and the determinants of the money stock²⁴.

In the post-Keynesian literature, presented by Rousseas (1985) Moore (1988b, 1989) and Pollin (1991), the accommodative endogeneity of the money base is explained, along with an endogenous money supply schedule which is also accommodative to *the public and banks' monetary preferences*. In the post-Keynesian tradition it is also implied that the causality in the process of money supply creation accommodates the money supply to the monetary preferences which are described by the non-bank private sector's demand for transaction balances and deposits, as well as by bank's demand for reserves.

When the money supply is taken to be accommodative to the demand for money, the money supply schedule can be represented by a '*horizontal* supply curve' which displays the stock of money at a given rate of interest, *i.e.* 'the supply of money is horizontal at every going short-term interest rate and the quantity of money is demand determined' (Kaldor, 1982). The implication of the *horizontal* money supply

²². Moore (1988b) argued that the empirical studies of US money supply imply that the money base cannot be treated as an exogenously determined policy variable.

²³. Lavoie summarized the post Keynesian view in a credit divisor equation as

$$H=(1/m).M$$

where $(1/m)$ is defined as the credit divisor.

He explained that this equation is only implicit in the post Keynesian literature. The difference between the monetarist equation and the credit divisor equation is that in the latter the causality is running from the banks and public's monetary preferences to the stock of the money base.

²⁴. In the descriptive identity for the money base, the public and bank's preferences on currency are determined by the rates of interest on substitute assets as the opportunity cost of holding currency, and banks' reserve preferences are determined by *banks' operational costs and returns*.

schedule is that the initial impact of a monetary policy can be perceived by changes in the money market rate of interest. In this view, the money stock is not a control variable and is not dependent upon a discretionary rule for changes in the money base as implied by the money multiplier models.

A more general treatment of the endogeneity of the money supply, consistent with the endogenous nature of assets in Tobin's (1969) general equilibrium model, is presented by Bradley and Jansen (1986). In this approach an inverse money supply schedule allows for a demand determined money supply and an interest rate operating instrument for monetary policy. Bradley and Jansen's specification of a simple money supply function can be represented by

$$\ln i_m = \delta_0 + \delta_1 \ln i_a + \delta_2 \ln M_t + u_{2t} \quad (3.15)$$

where $(\ln i_a)$ is the exogenously determined rate of interest, set by the monetary authority, and (u_{2t}) represents changes in the supply equation and stands for the effects of the determinants of money multiplier on the money supply. In equation (3.15) it is assumed that the stock of nominal money balances $(\ln M_t)$ is determined by a demand equation.

In this equation, modelling the demand determined supply equation has a different implication from that of a fixed money supply²⁵. The money supply function (3.15) enables us to model the transmission mechanism along with the effects of changes in demand for money, the monetary policy interest rate instrument, (i_a) , and the other interest rates in the system of demand equations (3.7).

The process of money supply creation in the post-Keynesian view can be represented by a distinct channel for loan accommodation. Palley's (1994) model represents this lending channel in the context of the post-Keynesian analysis of endogenous money, whereby 1) bank lending does matter for the determination of the

²⁵ One difficulty in the specification of the money supply is that we may not be able to estimate a supply function if the parameters affecting supply also affect demand. In this case the observed data reflect the joint influence of both, and it may not be possible to estimate a supply function. We shall solve this problem by assuming that the demand for money is a demand for real money balances, but the money stock in the supply function is the supply of nominal balances.

money supply; 2) banks holdings of bonds is treated as a buffer to offset variations in loan demand and demand for deposits; and, 3) the banks asset and liability choice is represented by equality between marginal revenue and marginal cost of assets and liabilities in the banks balance sheet identity. The equations in Palley's model can be represented by

$$L^s + B_b + r.(DD^d+TD^d) = (DD^d+TD^d) \quad (3.16)$$

$$L^s = L^d \quad (3.17)$$

$$H^d = C^d + r.(DD^d+TD^d) \quad (3.18)$$

$$H^d = H^s \quad (3.19)$$

$$MR_L = MR_B = MC_{DD} = MC_{TD} = MC_R \quad (3.20)$$

where

L^s = the supply of loans,

L^d = the demand for loans,

B_b = banks holdings of bonds,

DD^d+TD^d = the public's demand for deposits,

C^d = the demand for currency,

H^d = the demand for the money base,

H^s = the supply of the money base,

r = the reserve ratio on deposits,

$r.(DD^d+TD^d)$ = banks reserves, (R),

and (MR)s and (MC)s represent the marginal revenue and marginal cost associated with banks assets and liabilities in the banks balance identity.

Equation (3.16) represents the banks balance sheet identity. Equation (3.17) represents the equilibrium condition for bank loans. Equation (3.18) represents the demand for reserves, and equation (3.19) is the monetary base equilibrium condition. Equation (3.20) represents the first order condition for competitive banks. (DD^d+TD^d) , (C^d) and (L^d) are specified in functional forms, complying with the specification represented by the system of demand equations (3.7). The banks holding of secondary assets, bonds, are treated as a buffer for disequilibrium in identity (3.16).

Palley's model is suggestive of *a*) the importance of the private initiatives of banks for loan accommodation, and *b*) the structurally endogenous nature of money and loans. The causality relations between bank lending and money are given by a consistent solution for equations (3.16)-(3.20) and the equations of demand for (DD^d+TD^d) , (C^d) and (L^d) . Such a solution is assumed to be consistent with the process 'loans creating reserves' postulated by the post-Keynesian view of endogenous money, and by the money multiplier models in which an increase in the total stock of reserves makes banks increase loans. In the post-Keynesian approach, the money supply rises in response to an increase in bank lending. By contrast, in the money multiplier models, it is changes in the money multiplier or the money base which cause changes in bank lending.

The key innovations in Palley's model are: 1) the introducing of the banks holdings of secondary assets, bonds, acting as a buffer for disequilibrium in the banks balance sheet identity; and 2) the explicit modelling of banks asset and liability choice via equation (3.20). The modelling of bank asset and liability choice provides bank with an incentive to seek the cheapest sources of financing. Such a specification of the lending channel requires that the banks balance sheet identity should be included explicitly in the model, and that banks asset and liability choices should be considered with a consistent solution for the system of equations (3.7) and equations (3.16)-(3.20). In this model the banks holdings of secondary assets, bonds, are determined by the banks balance sheet identity.

3.3.4 The loan effect

In Tobin's (1982) general equilibrium approach to monetary theory a distinctive lending channel is modelled, using the assumptions that: 1) in the portfolio-balance condition, identity (3.4), loans are imperfect substitutes for other assets; and, 2) financial markets clear by asset prices. Based on these assumptions, Bernanke and Blinder (1988) developed the principal characteristics of the lending channel in which the loan rate is determined at the level required by the market-equilibrating interest rate

and the equality between the demand for and supply of loans. In terms of this approach the lending channel can be represented by the system of equations (3.7), for the desired holdings of assets and loans in the private sector portfolio, and by a supply equation for loans, and the loan market equilibrium condition (3.17).

In the other approach regarding a distinct role for loans in the modelling of the transmission mechanism, Blinder (1987), and Stiglitz (1988) take account of bank loans in a rationed credit market in which there is no substitute for loans and the loan rate does not adjust to clear the market²⁶. In this approach, when rationing arises, the loan rate is determined by the maximization condition for the expected returns to the banks, and the extent of bank lending is determined by the availability of loans. In both the treatments of loan market behaviour, the lending channel requires an explicit inclusion of the banks balance sheet identity in the model, given that the model allows for separate equations for the demand for and supply of loans.

In the latter approach equation (3.17), the loan market equilibrium condition, is replaced by

$$\begin{cases} L^e = L^s & \text{if } L^s < L^d & \text{or,} & i^e_d > i_d \\ L^e = L^s = L^d & \text{otherwise} & & \end{cases} \quad (3.21)$$

where

L^e = the transacted quantity of loans,

i^e_d = the market-equilibrating loan rate,

i_d = the quoted loan rate.

Under the credit rationing hypothesis, the expected return received by banks does not increase monotonically with the rate of interest charged. In the sense of Stiglitz and Weiss (1981), there are two basic reasons for the non-monotonic relationship between the loan rate and the expected receipts of banks: adverse selection

²⁶ Blinder and Stiglitz in their explanation of the importance of credit emphasized that the credit market should not be viewed as an auction market; and when the required credit in the asset markets is unavailable, there may be a failure of effective supply in which firms fail to produce their desired amount of goods. They assume that banks normally ration credit, and the theories based on imperfect information provide an appropriate explanation for the origins of credit market imperfections and the subsequent credit rationing.

effects and adverse incentive effects. The adverse selection effects imply that as the interest rate charged on loans increases, the mix of applicants change adversely, *i.e.* safe potential borrowers drop out of the market. The adverse incentive effects imply that as the interest rate increases, applicants undertake riskier projects. In the equilibrium rationing hypothesis, changes in the availability of credit, not changes in the loan rate, may determine the extent of borrowing. This can be regarded as the case in which bank controls on the loan rate give rise to disequilibrium in the loan market.

In the loan market with possibilities of loan rationing, the actual loan rate can be viewed as *a)* a market equilibrating rate of interest, when a rise in the supply of loans increases the expected return to banks, or as *b)* a rate conditioned by disequilibrium in the loan market, which maximizes the expected return to banks, given that raising the loan rate reduces the expected return to the banks. Both the situations for the determination of the loan rate can be considered in rationing models in which: 1) the loan rate is specified by a non-monotonic function of the expected return to banks; and, 2) the transacted quantity of loans, (L^e), is specified by

$$L^e \leq L^d \quad (3.22)$$

Condition (3.22) is concerned with the modelling of the lending channel with imperfect information, and complies with the same specification as implied by condition (3.21), regarding loan rate controls as the sources of disequilibrium in the loan market.

The other possibility is that loan market imperfections give rise to disequilibrium in non-rationing situations. In this respect, imperfect adjustment of the loan rate, and not loan rate controls, are the source of loan market imperfections. In disequilibrium models the transacted quantity of loans can be determined solely by the following minimum condition,

$$L^e = \min \{L^s, L^d\} \quad (3.23)$$

The rationing and disequilibrium conditions, represented respectively by equations (3.22) and (3.23), stand in contrast to the equilibrium condition in the loan market, specified by equation (3.17). The former two equations allow for special

characteristics of the loan market, regarding loan rate controls and imperfect adjustment of loan rates as two sources of disequilibrium in the loan market. In the banks balance sheet identity (3.16) the supply of loans can be replaced by (L^e) , obtained from condition (3.22) or (3.23). The resultant identity can be represented by

$$L^e + B_b + r.(DD^d+TD^d) = (DD^d+TD^d) \quad (3.16a)$$

In equation (3.16a) the banks holdings of secondary assets, (B_b) , can still be treated as a buffer for disequilibrium in the banks balance sheet identity. The buffer stock role of secondary assets, bonds, in the banks balance sheet identity implies that: if there are unexpected withdrawals of deposits, banks sell bonds to fund the outflow; and, if there is an increase in the supply of loans, banks sell reserves to fund additional lending. In these circumstances the transacted quantity of loans is determined by loan market imperfection, or under credit rationing by the private initiatives of the banking sector. Such a treatment of the buffer stock role of bonds in the banks balance sheet identity is absent in Palley' (1994) model of the lending channel.

In the credit rationing approach limits on the loan rate are treated as exogenous. Maddala (1983) suggested that in rationing models, based on the disequilibrium condition (3.21), there are many situations in practice in which the limits are not exactly fixed. What we have are some rules. The exact level at which loan rate controls are imposed depends on some specific historical data. In view of this, it is more meaningful to assume that the loan rate limits in rationing models are stochastic. Therefore, we may add the following equation, regarding some rules for loan rate controls in the context of the equilibrium rationing hypothesis²⁷, which is also consistent with the model specified by the demand and supply equations of loans and the disequilibrium condition (3.21).

$$i_d = i_d((L^d-L^s), \Theta) \quad (3.24)$$

where

²⁷. Note that this does not mean that loan rate variation is always strong enough to clear the loan market. The existence of uncertainty in the loan market and what determines the access of banks to loanable funds are the reasons for stating that the loan market may operate a rationing system.

$(L^d - L^s)$ = excess demand for loans,

Θ = a vector variables representing some specific historical data for limits on the loan rate.

In equation (3.24), under the equilibrium rationing hypothesis, we may assume that the loan rate adjusts in response to only excess supply in the loan market. That is, in equation (3.24), $(L^d - L^s) \leq 0$. This assumption implies that when there is excess demand, the loan rate is not responsive to the disequilibrium condition in the loan market, and there are some other variables, represented by (Θ) , which may have a systematic influence on the loan rate.

The implications of loan rate adjustment, in either the equilibrium or disequilibrium models, for *the expectations theory of the term structure of interest rates* can be presented by the linkages between the loan market and the financial markets for securities of different maturities²⁸. The following discussion introduces such links, using a combination of the money market and the loan market interest rates to provide a proxy for the expected rate of interest on short-term securities.

3.3.5 *The expectations theory of the term structure of interest rates*

In an asset market model the rates of interest on *the assets in the non-bank private sector portfolio* and on *bank loans* can be treated as the short-term rates of interest. The incorporated rates of interest on these assets can be viewed as a proxy for the rate of interest on short-term securities ($i_{SR,t}$). The expectations theory of the term structure of interest rates can be used to specify the required relationship between the

²⁸. It is worth noting that in the conventional specification of the credit rationing hypothesis, in the context explained by Stiglitz and Weiss (1981) and Jaffee and Stiglitz (1990), it is argued that the loan rate is set exogenously by banks at a level which maximizes the expected return to banks. This approach implies that the adjustment of the loan rate, which is central to the modelling of the term structure equation with the money and loan rates, loses its effects on the determination of loans, and hence the loan rate cannot be used as a variable which may determine the extent of borrowing.

As is implied by equation (3.24), the specification of disequilibrium models under the assumption of loan rate controls, which is consistent with the credit rationing hypothesis, may still allow for the endogeneity of the loan rate in the sense that it is determined by some rules under which loan rate controls depend on some specific historical data. This specification of loan rate adjustment in disequilibrium models holds the term structure of interest rates consistent with the treatment of the loan rate as a measure of the extent of suppressed excess demand pressure under the equilibrium rationing hypothesis.

short-term interest rate, $(i_{SR,t})$, and the long-term interest rate, $(i_{L,t})$ ²⁹. In this treatment of the expectations theory of the term structure the expected value of the short-term interest in equation (3.2) should be replaced by a combination of the money market interest rate and the loan rate as follows

$$i_{L,t} = (1/n) \cdot \sum_{j=0}^{n-1} {}_t(i_{SR})^e_{t+j} \quad (3.25)$$

where, (i_{SR}) represents the rate of interest of short-term securities, proxied by a combination of the short rates, (i) and (i_d) , and ${}_t(i_{SR})^e_{t+j}$ refers to this quarter expectations for (i_{SR}) $t + j$ quarters into future, and ${}_t(i_{SR})^e_t = (i_{SR})_t$.

Juttner (1990) argued that a large number of interest rates, namely interest rates for borrowers, lenders and official rates, comprise the interest rates on *short- and long-term securities*. In this thesis, the term structure of interest rates examines the portfolio investor's incentives to borrow short-term funds from the banking sector. The rates of interest relevant to investors are the short term interest rates, comprising the loan rate and the money market interest rate, and the interest rate of longer term treasury bonds.

According to the expectations theory of the term structure of interest rates, the relationship between the short rates, $(i_{SR})^e_s$, and the long rate, $(i_{L,t})$ can be modelled on the assumption of *no arbitrage opportunities* in the financial markets for securities of different maturities. Therefore, the expectations theory implies that long-term securities are perfect substitutes for short-term securities. This assumption in an asset market model requires that each security should be considered in an integrated market. In such an integrated market, the short-term and long-term rates of interest are equated through arbitrage in the market³⁰.

²⁹. This discussion is based on the principal assumptions in the theory of the term structure of interest rates elaborated by Shiller and McCulloch (1990).

³⁰. Arbitrage eliminates any price differentials between short-term and long-term securities in each market, and makes one price dominant in the market, with no profit for arbitrageurs who take advantage of any price differentials.

The implication of arbitrage is that an investment on an n -period security must, at the end of the "n"th period, yield exactly the same rate of return as consecutive investments on "n" *one-period* securities, that is:

$$(1 + i_{L,t})^n = (1 + i_{SR,t}) \cdot (1 + {}_t i_{SR,t+1}) \dots (1 + {}_t i_{SR,t+n-1})$$

or

$$i_{L,t} = [(1 + i_{SR,t}) \cdot (1 + {}_t i_{SR,t+1}) \dots (1 + {}_t i_{SR,t+n-1})]^{1/n} - 1 \quad (3.26)$$

where

$i_{L,t}$ = the rate of interest in period t for an n -period security,

${}_t i_{SR,t+j}$ = the rate of interest in period t for a *one-period* security at the period $t+j$.

As long as interest rates are small relative to unity, then the right hand side of equation (3.26) can be well approximated by a simple arithmetic average as³¹

$$i_{L,t} = (1/n) \sum_{j=0}^{n-1} {}_t i_{SR,t+j} \quad (3.27)$$

The expectations theory of term structure takes account of equation (3.27) with an annotation for the forward rates, (${}_t i_{SR,t+j}$)s, (Fair 1979, 1983). In this theory any spot rate on a security with " n " periods to maturity can be related to the *one-period* spot rate and $n-1$ period *implied forward* rates. The implied rate on a *one-period* security at $t+j$, i.e. (${}_t i_{SR,t+j}$), is assumed equal to the market expectations in period t of the corresponding spot rate, (${}_t i_{SR,t+j}^e$).

According to the expectations theory, the expected values of *one-period* rates of interest are conditional on information available at the beginning of each period. The values of *one-period* rates of interest can be determined by an asset market model. The current value of the *one-period* interest rate can also be treated as the expected value of the short-term interest rate in the first quarter. To specify the expected values of the short-term interest rates in the quarters in future, we construct an implicit function for the short-term rate of interest, ($i_{SR,t}$). The short-term rate of interest, ($i_{SR,t}$), can be

³¹. To see this, we may add 1 to both sides of equation (3.26), and take the logarithm of each side, provided ($i_{L,t}$) and ($i_{SR,t}$) are small compared with unity, then

$$\log [(1+i_{L,t})] = i_{L,t}$$

and $\log [(1+i_{SR,t})] = i_{SR,t}$

specified by explanatory variables such as: the rates of interest in the asset markets, (i, \dots) , the total outstanding stock of assets in the private sector portfolio, (W) , the stock of money, (M) , and other assets in the private sector portfolio, (V) , variables determined in the real sector, (R) , and inflation expectations, (inf^e) .

$$i_{SR,t} = f_t ((i, \dots), M, W, V, R, inf^e, \alpha) \quad (3.28)$$

where

α = the remaining factors which have not been explicitly included in the information set.

According to equation (3.28), the short-term interest rate is determined by the explanatory variables comprising the relevant factors in asset markets and those which are derived from the rest of the economy. The relationship is a contemporaneous one in which current values of the explanatory variables in period t determine the current level of $(i_{SR,t})$. As a consequence, it can be presumed that the expected value of the short-term interest rate in period $t+j$, $(i_{SR,t+j}^e)$, is determined by expected values of the explanatory variables in the same period, *i.e.*

$$i_{SR,t+j}^e = f_{SR,t+j}^e (i_M, \dots, W, V, R, inf^e, \alpha) \quad (3.29)$$

$$i_{SR,t+j}^e = E (i_{SR,t+j} | \Phi) \quad (3.30)$$

where, $E(i_{SR,t+j} | \Phi)$ denotes the subjective expectation of $(i_{SR,t+j})$ in period t , conditional on information set, Φ . In the model of asset market behaviour information set comprises the variables in the implicit function of $(i_{SR,t+j})$, equation (3.29).

Substituting the conditional expectations of $(i_{SR,t+j}^e)$ s for $(i_{SR,t+j})$ in term structure equation (3.27) yields

$$i_{L,t} = (1/n) \sum_{j=0}^{n-1} i_{SR,t+j}^e \quad (3.31)$$

In equation (3.31) *the rate of interest on bank loans*, as well as the other variables in the information set whose direct effects may be ignored in equation (3.29), *i.e.* the variables represented by (α) , should be included in the determination of the long-term

interest rate³², ($i_{L,t}$). This implies that in an asset market model, the variations of the rates of interest on the assets in the public's portfolio, as well as the rate of interest on bank loans lead to the variations of the long-term interest rate. This introduces a linkage from the loan market to the markets for securities of different maturities, and hence introduces a role for portfolio investors' incentives to borrow from the banking sector when modelling the term structure of interest rates.

The AEM and TRYM models take different information sets in modelling the values of the short-term interest rates expected in future periods. Such a difference in the specification of the information set results in different implications for the monetary transmission mechanism in the models. The discussion presented in the *appendix 3*, explores the different implications of the term structure equations in the AEM and TRYM models, which are comparable with the model explained in this analysis.

To summarize the discussion so far this chapter has examined the following issues in an asset market model which is modified from a basic IS-LM framework: 1) the endogeneity of money supply; 2) the wealth effects of a current account deficit or surplus on the exchange rate, and the importance of overshooting phenomenon in exchange rate determination; 3) the lending channel in modelling the linkages between financial markets and the real sector, and the importance of credit rationing in the transmission mechanism; and, 4) the portfolio investors' incentives to borrow from the banking sector in the term structure equation. In the next section we outline some further implications of a modified model of asset market behaviour which allow for some basic characteristics of Australian financial markets.

³² . The effect of the inflation expectations, inf^e , in the information set can be determined by another equation concerning the real value of the long-term interest rate.

3.4 Implications of Australian financial liberalization for the monetary transmission mechanism

The modifications to the asset market model, specified in the previous section, are dependent upon the complications arising from increasing the number of assets, and from modelling a complete picture of the transmission mechanism. The modifications can also be treated as consistent with the Australian financial system provided that the responses of the model to the process of financial deregulation are reflected in the operation of key relationships in the model. In the modified model these relationships determine the monetary variables such as the money supply, credit, interest rates and the exchange rate.

In what follows we outline the salient characteristics of the Australian financial liberalization, and the analytical implications of the liberalization for the monetary policy transmission mechanism. The implications can be incorporated into an asset market model, and hence into an empirical model of links between financial markets and the real sector, which produces a better understanding of the Australian monetary transmission mechanism post-deregulation.

3.4.1 Australian financial liberalization and the mechanisms for implementing monetary policy

Monetary policy in a liberalized financial system relies on the operations of the Reserve Bank in the short-term cash market and, to a lesser degree, in the foreign exchange market. The Reserve Bank conducts market operations by influencing short-term interest rates as well as the exchange rate in asset markets. Also, the Reserve Bank's purchase/sale of government securities and government issued bonds in the foreign asset market, which is undertaken in response to government budgetary actions, prevents the effects of large fluctuations in asset demand flowing onto asset prices and the exchange rate, and moderates uncertainty in asset markets.

Reserve Bank operations in the short-term cash market and foreign exchange market influence the rates of return of the domestic and foreign assets. These rates are

also expected to be affected by financial operations of the non-bank private and banking sectors. Such operations in deregulated financial markets place constraints on the operational conduct of monetary policy. In the modified model we evaluate the operational conduct of monetary policy in the post-deregulation period by examining the causes of change in the policy variables such as the Reserve Bank's holdings of domestic and foreign securities. In the following discussion we examine the principal characteristics of the liberalized financial system which are important in the determination of the appropriate stance of monetary policy.

1) Money market: Financial liberalization implies that the Reserve Bank implements monetary policy to bring about a particular interest rate outcome in the money market. When the monetary authorities use the interest rate as an intermediate objective of monetary policy, the monetary aggregate must be allowed to adjust in accordance with the money demand at the chosen rate of interest. That is, the money supply should be determined endogenously by the demand for money. This interpretation of policy actions conforms to the post-Keynesian view on the direction of causation in the process of money supply creation, whereby the money supply is accommodative to the monetary preferences of the public and banks³³. As a consequence, the monetary policy reaction function can be specified by an equation in which the money market interest rate is the dependent variable, and represents the effects of changes in the (demand determined) money supply and in the policy instrument such as the rate of interest in the short-term cash market.

2) Uncertainty and interest rate volatility in asset markets: The liberalized financial system can be characterized by increased intermediation of the non-bank

³³. In the Reserve Bank's "Meeting on Monetary Issues" (1985), it was generally agreed that the Reserve Bank always holds the money base at the level determined by the public demand for transaction balances and deposits in banks, *i.e.* the supply of base money should be viewed as a demand-determined stock, but at a price set in the money market. Hence, it is often argued that any strict attempt at controlling the money base would result in volatility in interest rates. Thus, it is appropriate for the monetary authorities to conduct market operations in a manner which secures appropriate outcomes for all the monetary aggregates (including the money base). The principle of this view remains valid even prior to deregulation.

Also Goodhart (1994) argued that, contrary to the beliefs of most monetary economists, central banks cannot systematically control the monetary base. The need to accommodate the day-to-day requirements of the banking system rules out monetary base controls for all practical purposes.

private and banking sectors in financial operations³⁴, and by market determined values for interest rates and the exchange rate. While the Reserve Bank's open market operations allow the Reserve Bank to effectively guarantee the safety of the nominal value of the income stream on government bonds, the prospect for holders of equities and net foreign assets are uncertain. Stock prices are highly volatile and dividend payments are not very predictable over extended periods of time. Also, a current account deficit/surplus and the floating of the exchange rate have increased uncertainty concerning the domestic-currency proceeds of foreign assets.

The different sources of uncertainty in asset markets requires that government bonds, equities and foreign assets in the private sector portfolio offer differing rates of interest in equilibrium. This in turn requires that, consistent with the process of financial deregulation, the equilibrium interest rates and the exchange rate should be determined by a model which takes into account the disaggregation of asset markets, and imperfect asset substitutability across a range of assets in the private sector portfolio.

3) Exchange rate floating and capital flows: In the post-float period capital flows are important determinants of the exchange rate. Capital flows are affected by interest rate differentials and the expected changes in the exchange rate. The latter are influenced by expectations mechanisms such as secular rates of inflation and unexpected changes in the current account balance. Capital flows via changes in domestic interest rates are also affected by the demand for and supply of other assets in financial markets. Therefore, as well as being affected by demand and supply in deregulated financial markets, the exchange rate is also affected by expectations mechanisms in the foreign exchange market. The former effects are implied by the portfolio balance models, and the latter by the sticky-price monetary models of exchange rate determination. The latter models also allow for exchange rate

³⁴ . It was also argued that the amount of intermediations of banks has increased at the expense of non-bank financial institutions. In this analysis, because of the similarity between operations undertaken by banks and non-bank financial institutions after financial deregulation, all banks and financial institutions are categorized as the banking system.

overshooting which complies with the facts of observations in flexible exchange rate regimes.

The characteristics of the exchange rate in the post-float period, which are outlined above, have placed restrictions on the use of monetary policy for external stabilization. In this period the effects of the monetary policy on capital flows and on the exchange rate are limited to the impact of the cash market interest rate on the domestic interest rates, and hence on the interest rate differential between Australia and overseas countries.

4) Credit rationing: Financial deregulation has changed sources of non-price adjustment in the credit market. In the pre-deregulation period restrictions on interest rates limited banks operations in the money market, and reduced banks ability to compete for funds. In this period, in times when outflow or slowed inflow of deposits occurred, banks could not competitively bid for funds, and hence, banks would face up to a shortage of loanable funds. Therefore, in tight periods banks rationed loans to reduce uncertainty in acquiring enough sources of loanable funds. In addition, the quantitative control on bank lending forced banks to adjust their loans and advances on a non-price setting.

Since removing the interest rate ceiling on bank deposits in December 1980, banks were allowed to move towards active management of liabilities (deposits). A significant feature of removing the interest rate ceiling on bank deposits was a reduction in the uncertainty of earning enough sources for loanable funds. The lifting of quantitative lending controls in June 1982 left adjustments in bank lending to the banks' initiatives. In this situation, banks could ration loans for other reasons, such as considerations of the likelihood of default on project outcomes and of borrowers' default risk. The rationing behaviour of banks post-deregulation resulted in imperfect adjustment of loan rates. A result not dissimilar from official interest rate ceilings pre-deregulation.

The deregulation of the Australian financial system resulted in diminishing controls of monetary authorities on the banking sector. Also, by deregulating the

operations of the banking system, banks and non-bank financial intermediaries were left under the same operational costs and returns. This means that the monetary authorities can now focus on efficient operations of the banking sector and on the private sector's portfolio decisions, which are totally responsive to the same rates of interest and the exchange rate.

3.4.2 The implications for monetary policy in an asset market model

In section 3.4 we examined a simple asset market model which allows for the operations of key relationships within financial markets. These relationships, which are modified from a basic IS-LM framework, determine financial variables such as the money supply, interest rates, the exchange rate, and credit, including the amount of credit rationing. To incorporate the principle characteristics of the Australian financial deregulation into the modified model, the model should provide insight into the following questions.

1) Whether changes in the public sector portfolio, such as the Reserve Bank's holdings of domestic and foreign securities, cause changes in asset prices, notably interest rates, and the exchange rate.

2) Whether investors' expected return between domestic and foreign assets and fundamental factors of exchange rate overshooting, such as relative expected secular inflation and adjustments in the equilibrium real exchange rate, have any predictive content for the exchange rate in the post-float period.

3) Whether Australian banks in the post-deregulation period act, in the aggregate, as though they ration credit.

On the first question, one possibility is that fluctuations in interest rates and the exchange rate are still subject to large scale intervention by the monetary authorities. The other possibility is that interest rates and the exchange rate in Australian asset markets, reflect market determined values, as the model takes account of enhanced intermediation of the private sector at the expense of intervention by the monetary authorities.

The second question refers to the responses of capital flows and the exchange rate to changes in asset prices, notably interest rates, in deregulated financial markets. A distinction between the short-run and long-run determinants of the exchange rate implies that the Reserve Bank may be able to influence the exchange rate in the short run through changes in the short-term interest rates, and hence through changes in the size of the interest rate differential. In the long run the real interest differential and the determinants of the equilibrium real exchange rate, such as the trade balance and the interest payments on net foreign borrowings, can be treated as the principle factors influencing the spot exchange rate. Therefore, whilst the Reserve Bank may influence the interest rate differential in the short run, it does not have any influence on the long-run determinants of the exchange rate, this effectively being determined in the foreign exchange market.

The third question examines the rationing behaviour of banks in deregulated financial markets. As we have already noted, in the post-deregulation period credit rationing arises from bank controls on loan rates, and from the non-monotonic relationship between expected return to banks and interest rate charged. The optimizing behaviour of banks under credit rationing implies that the loan market is sometimes in equilibrium and sometimes in disequilibrium, and that the loan market predominantly exhibits excess demand.

In the absence of rationing, imperfect adjustment of loan rates, rather than loan rate controls, is the source of disequilibrium in the loan market³⁵. In this circumstance loan market imperfections provide possibilities of both excess demand and excess supply. In disequilibrium models of loan market imperfections, if the periods of excess demand are considerably more than the periods of excess supply, the special feature of loan market imperfections can be characterized by credit rationing. The theory of disequilibrium estimation can be used to estimate the amount of credit rationing, and to provide prediction for the future behaviour of bank lending.

³⁵ . The difference between the two mechanisms was shown by the disequilibrium conditions (3.22) and (3.23).

When the loan market is characterized by credit rationing, bank controls on the loan rate can be specified by some rules under which loan rate controls depend on some specific historical data. These rules aid prediction of the loan rate in a rationed loan market, and hence of banks' expected rate of return and default risk of the average projects in the economy. If banks through loan rate controls aim to affect the risk of default on securities with different terms to maturities, there should be some links between the loan rate and the rates of interest in the financial markets for these securities. Such links require that the term structure of interest rates should depend on portfolio investors' incentives to borrow from the banking sector.

We evaluate the relevance of bank lending in portfolio investors' preferences for securities with different terms to maturity by examining whether the cost of borrowing from the banking sector affects the term structure of interest rates. Most previous empirical macro models, and also the AEM and TRYM models, abstract from the implications of portfolio investors' incentives to borrow from the banking sector for the linkages between short- and long-term rates of interest in financial markets.

3.5 Conclusion

This chapter analysed the principal modifications which can be employed in an asset market model, and examined the implications of: 1) capital flows and exchange rate determination in the post-float period; 2) monetary policy in terms of the Reserve Bank's holdings of domestic and foreign securities; and, 3) banks rationing behaviour, and the implications of the cost of borrowing from the banking sector in the financial markets for securities of different maturities. The next chapter evaluates the relevance of the two former issues by examining: 1) the portfolio balance approach to the exchange rate and fundamental factors of exchange rate overshooting; and, 2) the response of asset prices, including the exchange rate, to changes in policy variables such as the Reserve Bank's holdings of domestic and foreign securities. The credit rationing hypothesis and the implication of the cost of borrowing from the banking sector for the term structure of interest rates will be evaluated in chapters five and six.

Appendix 3

The implications of the expectations theory of the term structure of interest rates for the transmission mechanism in the AEM and TRYM models

The AEM model: In the AEM model the expectations theory of term structure is explained by the assumption of forward-looking expectations in the financial markets for securities of different maturities. The expectations are assumed to be rational *i.e.* model consistent. According to the rational expectations assumption, in the term-structure equation the predicted values of the long-term interest rate, ($i_{L,t}$) and of the conditional expectations of ($t i_{SR,t+j}^e$)s satisfy the following standard equations for the expectations theory of the term structure, and the rational expectations hypothesis.

$$i_{L,t} = [(1 + t i_{SR,t}^e) \cdot (1 + t i_{SR,t+1}^e) \dots (1 + t i_{SR,t+n-1}^e)]^{1/n} - 1 \quad (3.32)$$

$$t i_{SR,t+j}^e + e_{t+j} = t i_{SR,t+j} \quad (3.33)$$

where

$t i_{SR,t+j}^e$ = the expected value of the short rate in period $t+j$,

e_{t+j} = the prediction error which has the stochastic properties mentioned by John Muth³⁶, *i.e.* $E(e_{t+j})=0$, and e_{t+j} is uncorrelated with all the variables in the information set at the time the prediction is made.

In the AEM model the term structure equation is consistent with the rational expectations hypothesis in the sense that the predicted values for ($i_{L,t}$) and ($t i_{SR,t+j}^e$) satisfy the standard equation (3.32), and maintain the equality between the forward rates and the market's expectations of the corresponding spot rates³⁷, given by equation

³⁶ . John Muth, 1961.

³⁷ . In other words the AEM model takes account of future events in the information set. When future events are included in the information set, and hence in the security prices, it becomes necessary to specify how the expectations, pertaining to occurrence of such events, are formed. It is generally assumed that expectations are formed rationally. The rational expectations assumption in the security markets with different yields to maturity implies that future events are reflected appropriately in the information set. Obviously, such expectations do not ignore pertinent facts and are not biased or formed in an illogical way (Juttner, 1990).

(3.33). This implies that, in the AEM model, the term structure equation can be described by the same explanatory variables as implied by the information set in equation (3.29) in the body of this chapter. That is, equation (3.32) implicitly takes account of the effects of the loan rate and the total outstanding stock of assets in the private sector portfolio, as well as other variables whose values were excluded from the model. However, an explicit consideration of such variables in the modelling of the expectations theory of term structure requires that those variables should be included in the monetary transmission mechanism, implied by the linkages from financial markets to the real sector of the economy.

The TRYM model: In the TRYM model the expectations theory of the term structure is explained by backward-looking expectations in which each $({}_t i_{SR,t+j}^e)$ is a function of the lagged value of $(i_{L,t})$, current and lagged values of $(i_{SR,t})$, the inflation expectations (inf^e) , and of some other monetary variables³⁸. Hence, the explanatory variables in the term structure equation provide a fairly complicated specification for the conditional expectations of the short-term interest rates, $({}_t i_{SR,t+j}^e)$ s. In that model, the term structure equation is consistent with the expectations theory, in the sense that the functional form of the current and lagged values of the explanatory variables approximate the expected future values of $({}_t i_{SR,t+j}^e)$ s³⁹.

The effects of these variables can be viewed as consistent with the conditional expectations assumption as the expected values of $({}_t i_{SR,t+j}^e)$ s satisfy the following equation.

$${}_t i_{SR,t+j}^e = E({}_t i_{SR,t+j} | \Phi) \quad (3.34)$$

³⁸ . The term structure equation in the TRYM model is written as follows,

$$i_{n,t} = f(i_{n,t-1}, i_p, i_{t-1}, inf^e, inf^e_{t-1}, inf^e_{t-2}, \vartheta)$$

where

ϑ = current and lagged values of some other financial variables.

³⁹ . Fair (1979, 1983) pointed out that when such a specification for the expectations theory of the term structure is taken as a part of a macro model, the equation is not consistent with the expectations theory because in simulations of the model the predicted values of $(i_{L,t})$ and $({}_t i_{SR,t+j}^e)$ s in general do not satisfy the expectations theory as represented by equation (3.32).

where, $E(.|\Phi)$ denotes the subjective expectations of $(i_{SR,t+j})$, and Φ represents the explanatory variables in the equation which are the same as variables in the information set⁴⁰.

In this specification of the term structure equation, the TRYM model excludes the effects of the loan rate and the money value of the private sector portfolio from the monetary transmission mechanism, since the model disregards these variables in the information set.

⁴⁰ . In the TRYM model, it is assumed that the information set only includes current and past events which impinge on the short-term and long-term securities.

Chapter 4

A Simple Model of Asset Market Behaviour for the Australian Economy

4.1 Introduction

In this chapter recent theoretical developments and the analysis of asset market behaviour, discussed in the previous chapter, are used to examine a simple structural model for the Australian financial sector. More specifically, the model allows for the implications of: 1) imperfect asset substitutability and the demand for money under conditions of uncertainty; 2) the endogeneity of the money supply; and, 3) the portfolio balance theory and fundamentals of exchange rate overshooting in a modified Dornbusch-Frankel model. In this chapter the asset market model is specified by the portfolio-balance condition for the assets in the consolidated balance sheet of the non-bank private and banking sectors. A distinction between the money and lending channel will be elaborated in the next chapter, where we include the bank balance sheet identity in the asset market model.

Even in the absence of a clear specification of the lending channel, any model of the Australian financial sector should now reflect the implications of financial liberalization for monetary policy: 1) an interest rate operating instrument, such as a market-clearing cash market, requires that monetary aggregates should be allowed to adjust at a chosen rate of interest in financial markets; and, 2) as a result of the deregulation of financial markets and internationally mobile capital, capital flows are influenced by the interest rate differential, and investors' expectations of changes in the spot exchange rate.

In the model given in the next section, the former issue is represented by an endogenous treatment of the supply of money and other assets in financial markets.

The latter issue is represented by the implications of uncovered interest differential in the portfolio balance theory of exchange rates, and by fundamentals of exchange rate overshooting in a modified Dornbusch-Frankel model. Section three presents empirical results, and section four presents conclusions.

4.2 Specification of asset market behaviour in the Australian financial sector

Following the theoretical considerations of asset market disaggregation, the behavioural equations in the Australian financial sector are considered in a general equilibrium context allowing for equilibrium conditions in the markets for money, bonds, equities, and net foreign assets. In this model, it is assumed that the Reserve Bank is primarily reacting to money market conditions during the post-deregulation period, implying that the money base is structurally endogenous. This means that the money base is dependent on all the factors which determine the money stock and the level of money income. An interest rate equation (or an inverted money base function) reflects the fact that in this period the money market interest rate is market determined. In this equation the cash market interest rate is the variable controlled by the monetary authority. The supply and demand equations imply that an interest rate operating instrument will control the money base only if the Reserve Bank is able to adjust the interest rate regularly and significantly, and money demand is sufficiently responsive to the interest rate in the short-term cash market.

The model also allows for an endogenous treatment of the supply of net foreign assets, denominated in domestic currency. In this treatment, given that the supply of foreign assets denominated in foreign currency are demand determined, capital flows are influenced by investors' expectations of changes in the spot exchange rate. These changes, as a result of the deregulation of the assets and foreign exchange markets, are treated as dependent on fundamentals such as relative expected secular inflation and adjustments in the long-run equilibrium real exchange rate. This treatment of the

expectations mechanism in the foreign exchange market allows for exchange rate overshooting as observed in flexible exchange rate regimes.

In the asset market model the policy reaction functions reflect the fact that in the post-deregulation period the Reserve Bank's open market operations in the domestic and foreign asset markets are necessary in order to prevent the effects of large fluctuations in financial aggregates flowing onto asset prices. In this period a market-clearing cash market is treated as the primary means through which the Reserve Bank influences interest rates and the exchange rate.

In what follows we examine the operation of key relationships within financial markets which determine variables such as the money supply, net foreign borrowings, interest rates, and the exchange rate. Following Tobin's (1969, 1982) approach and the extensions provided by the portfolio balance theory for a small open economy, and Hooper and Morton's (1982) modification of the Dornbusch-Frankel model of exchange rates, a simple asset market model for the assets in the consolidated balance sheet of the non-bank private and banking sectors can be represented by the following equations.

Money market

$$C^d = C^d (\phi(i_b, i_e), i_f, Y, W) \quad (4.1)$$

$$DD^d = DD^d (\phi(i_b, i_e), i_f, Y, W) \quad (4.2)$$

$$H^d = H^d (\phi(i_b, i_e), i_f, Y, W) \quad (4.3)$$

$$M = C^d + DD^d \quad (4.4)$$

$$m = m (\phi(i_b, i_e), i_f, i_a) \quad (4.5)$$

$$H^s = m' \cdot M \quad (4.6)$$

$$H^d = H^s (= H) \quad (4.7)$$

where

C^d = the demand for currency,

DD^d = the demand for demand deposits,

H^d = the demand for the money base,

M = the supply of money, $M1$,

H^S = the supply of the money base,

i_b = the rate of interest on the short-term government bonds,

i_e = the rate of interest on equities,

$\phi(i_b, i_e)$ = the rate of interest on a competing asset in the money market, represented by a combination of two interest rates (i_b) and (i_e).

i_f = the short-term rate of interest on foreign assets¹,

Y = aggregate demand,

W = the private sector's holdings of the total outstanding stock of assets, or the private sector portfolio,

m = the money multiplier in a functional form, $m(\cdot)$,

m' = the inverse of money multiplier, or the credit divisor,

i_a = the rate of interest in the market for the short-term funds, determined by open market operations,

H = the equilibrium stock of the money base.

Bond market

$$B^d = B^d (\phi(i_b, i_e), i_b, i_e, i_f, Y, W) \quad (4.8)$$

$$B^s = B (i_b, i_e, i_f, GD) \quad (4.9)$$

$$B^d = B^s (= B) \quad (4.10)$$

where

B^d = the demand for bonds,

B^s = the supply of bonds,

GD = government deficit financed by changes in the government interest bearing debt,

B = the equilibrium stock of government securities in the private sector portfolio.

¹. In accordance with the portfolio balance theory, elaborated by Branson and Henderson (1985), the foreign rate of interest in the demand equations takes into account the expected rate of depreciation, $\xi (= E^e/E)$, (where E^e denotes the expected value of the exchange rate). In this theory (ξ, i_f) allows for the effects of foreign arbitrage on the demand for foreign assets.

Equity market

$$EQ^d = E^d (\phi(i_b, i_e), i_b, i_e, i_f, Y, W) \quad (4.11)$$

$$EQ^s = EQ (i_b, i_e, i_f, I) \quad (4.12)$$

$$EQ^d = EQ^s (= EQ) \quad (4.13)$$

where

EQ^d = the demand for equities (treated as the claims on real capital),

EQ^s = the supply of equities,

I = changes in the claims on real capital, or investment,

EQ = the equilibrium stock of equities.

Foreign asset market

$$(F^d.E) = F^d (\phi(i_b, i_e), i_b, i_e, i_f, Y, W) \quad (4.14)$$

$$E.F^s = F^s. E (\{P/P_f\}, \{ \phi(i_b, i_e) - \pi \} - \{ i_f - \pi_f \}, E' \{ \Sigma[CAB - \overline{CAB}_{LR}] \}) \quad (4.15)$$

$$F^d = F^s (= F) \quad (4.16)$$

where

F^d = the demand for net foreign assets denominated in foreign currency,

F^s = the supply of net foreign assets denominated in foreign currency,

E = the exchange rate, measured as the number of domestic currency units exchanged for one unit of foreign currency,

E' = the long-run equilibrium exchange rate, its functional form is denoted by $E'\{.\}$,

P = the domestic price index,

P_f = the foreign price index,

π = the domestic inflation rate,

π_f = the foreign inflation rate,

CAB = the current account of the balance of payments, and

$\Sigma[CAB - \overline{CAB}_{LR}]$ represents the deviation of the cumulative partial first difference of

the current account from a fraction of the cumulative equilibrium current account,
 F = the equilibrium stock of net foreign assets, denominated in foreign currency.

Portfolio-balance condition

$$W = H + B + EQ + (E.F) \quad (4.17)$$

Policy reaction functions

$$(RBS/BB) = RBS (\phi(i_b, i_e), \overline{GDP}/GDP, P) \quad (4.18)$$

$$RBF = RBF (F, E, P/P_f) \quad (4.19)$$

where

RBS = the Reserve Banks' holdings of government securities,

BB = the total government issued domestic securities,

RBF = the Reserve Banks' holdings of foreign assets,

\overline{GDP} = growth trend in real GDP, *i.e.* $\overline{GDP} = GDP_0 \cdot e^{\dot{Y}.t}$, and

\dot{Y} denotes the growth rate of GDP, t denotes time trend, and \overline{GDP}/GDP denotes cyclical variability of GDP.

The variables in equations (4.1)-(4.19) are characterized as follows:

Identity:

$$W = H + B + EQ - (E.F)$$

Endogenous variables:

$C^d, DD^d, M, H^d, H^s, m, B^d, B^s, EQ^d, EQ^s, F^d, F^s, E, W, (RBS/BB), RBF, i_b, i_e, \phi(i_b, i_e).$

Exogenous variables in the financial sector:

$i_a, i_f, CAB, \overline{CAB}_{LR}, P_f, \pi_f.$

Variables determined in the real sector:

$Y, GD, I, P, \pi, (\overline{GDP}/GDP).$

Equations (4.1), (4.2) and (4.3) represent the demand for currency, demand deposits and the money base. These equations have the conventional specification of the demand for money. Equations (4.5) and (4.6) represent a functional form of the money multiplier, and the supply of the money base. The supply of the money base is written in an inverse functional form, complying with the credit divisor approach to money multiplier models. Equation (4.4) is the definition of money and equation (4.7) represents the equilibrium condition in the money market. Equations (4.8), (4.9), (4.11) and (4.12) represent the demand for and supply of bonds and equities, and equations (4.10) and (4.13) represent the equilibrium conditions for these assets. Equation (4.14) represents the demand for net foreign assets denominated in domestic currency. Equation (4.15) is treated as the supply equation for net foreign assets, and equation (4.16) represents the equilibrium condition for these assets. Equation (4.17) represents the portfolio balance identity in the asset markets.

The policy reaction functions are represented by equations (4.18) and (4.19). These equations reflect government intervention in the domestic and foreign asset markets. Equation (4.18) specifies that the Reserve Bank manages domestic credit in response to changes in asset prices and its counter-cyclical and anti-inflationary goals. Equation (4.19) says that if the real exchange rate appreciates (that is, domestic economy becomes less competitive price-wise with its trading partners), the Reserve Bank would intervene to depreciate the nominal exchange rate (buy foreign exchange and sell domestic currency). In equation (4.18), the cyclical variability of GDP, can be represented, alternatively, by the cyclical variability of the average productivity of the labour force, and the cyclical variability of the employed labour force², which are

². To obtain the trend growth of the average labour-force productivity and total labour force, we specify GDP as the product of average labour-force productivity and total labour force.

$$\text{GDP} = (\text{GDP/LF}) \cdot \text{LF}$$

Taking logarithms of the above equation, and then differentiation with respect to time gives the growth rate equation as,

$$(\dot{Y} = \dot{Y}/\text{LF} + \dot{\text{LF}})$$

where,

\dot{Y} = the growth rate of GDP,

\dot{Y}/LF = the growth rate of productivity,

$\dot{\text{LF}}$ = the growth rate of labour force,

$$\overline{\text{GDP/LF}} = (\text{GDP/LF})_0 \cdot e^{(\dot{Y}/\text{LF}) \cdot t}$$

$\overline{\text{GDP/LF}}$ = trend growth in average labour-force productivity,

represented respectively by $(GDP/LF)/(\overline{GDP/LF})$, and (LF/LF) . The cyclical variability of the employed labour force in the Reserve Bank reaction function has an important role in Simes' (1988) model but there it relies on a different specification of the policy function.

The model also takes account of uncertainty and imperfect asset substitutability in the specification of the money demand equations (4.1)-(4.3), which complies with Tobin's (1969) approach to monetary theory, analysed in the previous chapter. The model presented in this section is assumed to be consistent with asset market behaviour post-deregulation. Further discussion of the policy reaction functions, uncertainty and imperfect asset substitutability, will be presented shortly in this section. In the following discussion we present a simplified version of the model which is represented by equations (4.1)-(4.17).

Before proceeding with a discussion on the simplification, it is useful to provide more elaboration for the supply of base money and net foreign assets, represented by equations (4.6) and (4.15), respectively.

4.2.1 The supply of the money base

The equation of the supply of base money is specified by an inverse functional form of the money multiplier model. The specification of the multiplier equation (4.5) for $m(.)$ embodies Papademos and Modigliani's (1990) approach to the money multiplier models. As we have noted in chapter 2, in this approach the functional form of the money multiplier allows for a number of interest rates which represent the rates of return on the assets in the private sector portfolio, and the assets and liabilities in the banks balance sheet identity. These rates in the money market can be represented by (i_b) , (i_e) , (i_f) , the short-term rate of interest on term deposits, (i_c) , and the loan rate, (i_d) . This function also includes the rate of interest in the short-term cash market, (i_a) ,

$$\overline{LF} = LF_0 \cdot e^{\overline{LF}.t}$$

\overline{LF} = trend growth in total labour force.

which is treated as a policy variable in the model. In addition, the inverse functional form of the money base equation complies with the post-Keynesian view elaborated by Lavoie (1984). Further elaboration of the supply of base money can be represented by the following equation.

$$H^S = m'(\phi(i_b, i_e), i_f, i_a, i_c, i_d) \cdot M \quad (4.6.1)$$

where

$\phi(i_b, i_e)$ denotes the short-term rate of interest on a competing asset in the money market. A simplification of the model, represented by equations (4.1)-(4.19), using a smaller number of interest rates as will be shown in the following discussion, results in substituting the money market rate of interest, (i_m) , for the short rate $\phi(i_b, i_e)$. This treatment of the money market interest rate implies that (i_m) is the market determined rate of interest on competing assets, bonds and equities, and allows for 1) the income stream on government bonds, guaranteed by the government, and 2) the risk premium on earning assets which is determined by the equilibrium conditions in asset markets, consisting of money, bonds and equity markets.

Substituting (i_m) for $\phi(i_b, i_e)$, equation (4.6.1) yields,

$$H^S = m'(i_m, i_a, i_f, i_c, i_d) \cdot M \quad (4.6.2)$$

Equation (4.6.2) takes into account two financial aggregates, (M) and (H^S) . Using the equilibrium conditions (4.4) and (4.7), we can eliminate one of the financial aggregates in the above equation as redundant. To proceed with only one financial aggregate in equation (4.6.2), we write this equation in an inverse functional form as

$$i_m = i_m(i_a, i_f, i_c, i_d, M, H^S) \quad (4.6.3)$$

The equilibrium conditions (4.4) and (4.7) imply that both monetary aggregates, (M) and (H^S) , can be considered with the same explanatory variables which are introduced by the demand equations (4.1)-(4.3). Hence, in estimation of equation (4.6.3) we will have a multicollinearity problem. To remove this problem the interest rate equation (4.6.3) can be represented by either of the following equations.

$$i_m = i_m(i_a, i_f, i_c, i_d, M) \quad (4.4a)$$

$$i_m = i_m(i_a, i_f, i_c, i_d, H^S) \quad (4.6a)$$

Equations (4.3) and (4.6a) are regarded as the equations which determine the equilibrium stock of the money base, (H). This stock is included in the portfolio balance identity, and hence the determination of its value in this analysis is important. The basic assumption behind equation (4.6a) is that the supply of base money is dependent on the demand for (a narrow) money, as implied by equations (4.4) and (4.6).

The supply of base money, specified by the credit divisor equation (4.6), has a slope which might be negative or positive. It can be shown that a positively sloped money base equation provides support for the monetarist view, regarding a positively sloped money supply function for a narrow definition of money; but a negatively sloped money base equation cannot be treated as a support for the post-Keynesian view, regarding a negatively sloped, (or a demand determined) money supply function. This is because, using the credit divisor equation (4.6), the supply of base money can be written in the following form

$$H^S = j [m' \cdot M^S (i_m, \dots)] \quad (4.6.2a)$$

where

$$m' = 1 / \{ m (i_m, \dots) \},$$

(M^S) is the money supply, and signs above functional arguments represent signs of partial derivatives. The sign of partial derivatives of the money supply is treated as ambiguous, and depends on a positively sloped money supply which is consistent with the monetarist view, or a negatively sloped money supply which is consistent with the post-Keynesian view.

The logarithmic forms of the credit divisor, (m'), and the money base equation (4.6.2a) can be represented by

$$\text{Log } m' = \text{Log } (1/m(i_m, \dots))$$

or $\text{Log } m' = - m \cdot \text{Log } i_m - \dots$

$$\text{Log } H^S = - h \cdot m \cdot \text{Log } i_m - \dots + h' \cdot \text{Log } i_m + \dots \quad (4.6.2b)$$

where (m) and (h) are positive scalars, and (h') represents a combination of a positive correlation between (M^S) and the money base, and a positive/negative correlation between (M^S) and (i_m). This implies that the sign of (h') is ambiguous. Equation (4.6.2b) can also be written as

$$\text{Log } H^S = (-h \cdot m + h') \cdot \text{Log } i_m + \dots \quad (4.6.2c)$$

In equation (4.6.2c), the slope of the money base function in a 'money base-interest rate' space can be negative or positive, depending on the alternative conditions implied by

$$(-h \cdot m + h') < 0 \quad \begin{array}{l} \text{if } h' < 0 \\ \text{if } h' > 0 \text{ and } (h \cdot m) > h' \end{array}$$

$$(-h \cdot m + h') > 0 \quad \text{if } h' > 0 \text{ and } (h \cdot m) < h'$$

The conditions imply that in the credit divisor model the monetarist and post-Keynesian views are two extremes, concerning the specification of the supply of base money function. The former view takes account of a positively sloped money supply function in the sense that it disregards the correlation between the base and the money multiplier, and assumes a positive (h') in equation (4.6.2c), (*i.e.* $h \cdot m = 0$ and $h' > 0$). The latter approach allows for solely a negatively sloped money supply function since it takes account of a credit divisor analysis of the supply of base money and assumes that the supply of money is fully accommodative to the demand for money, (*i.e.* $h' < 0$).

The money base equation (4.6.2c) takes into account either of the above extremes, and can be regarded as consistent with both a positively sloped and a negatively sloped money supply equation. In equation (4.6.2c), when the money supply, (M^S), is positively sloped, (*i.e.* $h' > 0$), the negative effects of (i_m) in the credit divisor (*i.e.* $-h \cdot m$) may be strong enough to compensate for the positive (h'). Therefore, a negative relationship between the supply of base money, (H^S), and (i_m) may also be consistent with a positively sloped money supply, (M^S), function.

4.2.2 Exchange rate determination

In the model, the demand equation for net foreign assets, equation (4.14), is regarded as the equation which determines the private sector's demand for net foreign assets, denominated in domestic currency. The specification of this equation corresponds with exchange rate determination in the portfolio balance theory.

Given that the private sector's demand for net foreign assets, denominated in foreign currency, is passively supplied by the foreign sector, *i.e.* ($F^S = F^d$), the exchange rate in the supply side, represented by equation (4.15), allows for the effects of foreign sector arbitrage by: 1) the real interest rate differential and relative prices in the Dornbusch-Frankel model; and 2) the adjustments in the long-run equilibrium real exchange rate (E'), via unexpected changes in the current account balance. The specification of these effects complies with the Hooper and Morton (1982) model of exchange rate determination described in the previous chapter.

In equation (4.15), the nominal exchange rate, (E), is responsive to movements in the current account balance through an expectations mechanism³, which relates the exchange rate, (E), to unexpected changes in the current account balance. Hooper and Morton (1982) have shown that the specification of a Dornbusch-Frankel type model with the effects of shifts in the long-run equilibrium real exchange rate, (E'), may allow additionally for the above expectations mechanism in the exchange rate equation. In their model, (E') is specified by the cumulative unexpected changes in the current account, represented by $\Sigma[CAB - \overline{CAB}_{LR}]$.

Given the current account balance identity, *i.e.* ($CAB = i_f F + TB$), where the interest income from holdings of foreign assets ($i_f F$), and the trade balance (TB), leads us to express Hooper and Morton's specification of the long-run equilibrium real exchange rate, (E'), in terms of separate expressions for: 1) the cumulative unexpected changes in the 'interest income from holdings of foreign assets'; and 2) the cumulative unexpected changes in the trade balance. This treatment of the current account balance

³. The specification of the demand equation with expectations mechanism is carried out in the forthcoming discussion on the model simplification in subsection 4.2.3.

in terms of its components represents a distinction between the effects of an improvement (deterioration) in foreign competitiveness (which is implied by the Marshall-Lerner condition) on the exchange rate, via changes in the trade balance, (TB), and the effects of the foreign interest rate and foreign assets via changes in $(i_f.F)$.

If the long-run values of the net interest income, $(i_f.F)_{LR}$, and the trade balance, $(TB)_{LR}$, are known, the exchange rate equation (4.15) can be written in terms of $\Sigma[(i_f.F) - \overline{(i_f.F)}_{LR}]$ and $\Sigma[TB - \overline{TB}_{LR}]$ which are substituted for $\Sigma[CAB - \overline{CAB}_{LR}]$ in $E'\{.\}$ function. In keeping with Hooper and Morton's specification of the long-run equilibrium real exchange rate, we use the following equations to estimate $(i_f.F)_{LR}$ and $(TB)_{LR}$.

$$E'_t = E'_{01} + \tau_1 \cdot \Sigma [TB_t - (1-\lambda_1)TB_{t-1}] + \tau_1 \cdot \lambda_1 \cdot TB_{LR} \cdot t \quad (4.15.1)$$

$$E'_t = E'_{02} + \tau_2 \cdot \Sigma [(i_f.F)_t - (1-\lambda_2)(i_f.F)_{t-1}] + \tau_2 \cdot \lambda_2 \cdot (i_f.F)_{LR} \cdot t \quad (4.15.2)$$

where

(E'_{01}) and (E'_{02}) are the initial equilibrium exchange rate,

(λ) 's represent constant fractions of the gap between the actual and equilibrium (TB) and $(i_f.F)$ to be filled in the next period,

(t) is the time trend,

(τ) 's are the estimated parameters in the regression equations which are specified in terms of predetermined values for (λ) 's,

$\Sigma[TB_t - (1-\lambda_1)TB_{t-1}]$ and $\Sigma[(i_f.F)_t - (1-\lambda_2)(i_f.F)_{t-1}]$ are the cumulative unexpected changes in (TB) and $(i_f.F)$, and $(i_f.F)_{LR}$ and $(TB)_{LR}$ in equations (4.15.1) and (4.15.2) are parts of the estimated coefficients for the trend variable, (t) , represented by $\{\tau_1 \cdot \lambda_1 \cdot TB_{LR}\}$ and $\{\tau_2 \cdot \lambda_2 \cdot (i_f.F)_{LR}\}$. $(i_f.F)_{LR}$ and $(TB)_{LR}$ can be obtained from the estimated coefficients (τ_1) and (τ_2) and the predetermined values of (λ_1) and (λ_2) .

Using the estimated values of $(i_f.F)_{LR}$ and $(TB)_{LR}$, obtained from equations (4.15.1) and (4.15.2), the resultant equation for the exchange rate is,

$$E \cdot F^S = F^S \cdot E \left(\{P/P_f\}, \{(i_m - \pi) - \{i_f - \pi_f\}, \tau_1 \cdot \Sigma [TB_t - (1-\lambda_1)TB_{t-1} - (\lambda_1) \cdot TB_{LR}], \right. \\ \left. \tau_2 \cdot \Sigma [(i_f.F^S)_t - (1-\lambda_2)(i_f.F^S)_{t-1} - (\lambda_2) \cdot (i_f.F^S)_{LR}] \right) \quad (4.15a)$$

where (i_m) represents the market determined rate of interest in asset markets. $\{P/P_f\}$ and $\{(i_m - \pi) - \{i_f - \pi_f\}$ represent respectively the long-run determinant of the exchange rate and the impact of changes in the domestic interest rate on the exchange rate in accordance with the Dornbusch-Frankel model. In equation (4.15a), (E'_{01}) and (E'_{02}) are regarded implicitly as parts of the constant term in the estimation of (4.15a).

4.2.3 Simplification of the asset market model

In order to simplify the asset market model with a smaller number of equations and rates of interest, Walras' law can be invoked to eliminate one of the market equilibrium conditions as redundant. We can also compress the model by constructing an implicit function for (i_e) in terms of explanatory variables in the supply and demand equations in the model.

$$i_e = i_e (\phi(i_b, i_e), i_b, i_f, Y, W, EQ, I, \Gamma)$$

$$\text{or } i_e = i_e (i_b, i_f, Y, W, EQ, I, \Gamma) \quad (4.13.1)$$

where (Γ) represents other exogenous variables in the model, mainly determined in the real sector.

In equation (4.13.1), (Y) includes the effects of investment spending, (I) , and also the effects of other variables determined in the real sector which are represented by (TB) , (GD) , $\{P/P_f\}$ and $\{\pi/\pi_f\}$; and (W) allows for the effects of the money value of the total outstanding stock of assets in the private sector portfolio. We can exclude the real sector variables (I) and (Γ) , and the separate treatment of the stock of equities, (EQ) , from the above implicit function. This is possible since a reduced form specification of equation (4.13.1) allows for the effects of these variables via the effects represented by (Y) and (W) .

Additionally we assume that (i_b) represents the effects of two rates of interest, consisting of a risk-free rate of interest on government bonds, (i_g) , guaranteed by the government, and the market determined rate of return on a competing asset in the money market, (i_m) . The latter rate allows for a risk premium which is determined by the equilibrium conditions in the model. With regard to this assumption, the

equilibrium condition in the bond market gives rise to the determination of the combination of the two rates of interest, (i_g) and (i_m), which can be represented by the following implicit function.

$$i_b = i_b(i_m, i_g)$$

Based on the above relation, the implicit function for (i_e) can be written as,

$$i_e = i_e(i_b(i_m, i_g), i_f, Y, W)$$

or
$$i_e = i_e(i_m, i_g, i_f, Y, W) \quad (4.13a)$$

Substituting the implicit functions for (i_b) and (i_e) into the demand equations (4.3) and (4.14), we obtain the following equations.

$$H^d = H^d(\phi[i_b(i_m, i_g), i_e(i_m, i_g, i_f, Y, W)], i_f, Y, W)$$

$$(F^d.E) = F^d(\phi[i_b(i_m, i_g), i_e(i_m, i_g, i_f, Y, W)], i_b(\cdot), i_e(\cdot), i_f, Y, W)$$

which can be written in reduced form functions as

$$H^d = H^d(i_m, i_g, i_f, Y, W) \quad (4.3.1)$$

$$(F^d.E) = F^d(i_m, i_g, i_f, Y, W) \quad (4.14.1)$$

These are two equations which determine the demand for base money and net foreign assets denominated in domestic currency. The two other equations in the model, which are concerned with the supply of these assets were specified by equations (4.6a) and (4.15a). In these equations we allowed for the above simplification, regarding (i_m) the market determined rate of interest in the domestic financial markets.

In demand equations (4.3.1) and (4.14.1), (i_g) and (i_f) are not market determined rates of interest. The former rate represents the rate of interest on three-month treasury notes guaranteed by the Commonwealth government; and the latter represents the rate of interest determined by the foreign sector. With regard to the former rate we assumed that (i_m) represents the sum of (i_g) and a risk premium, (ω), which is determined endogenously by the asset market equilibrium conditions. This implies that, using (i_m) in the demand and supply equations, we can easily ignore a separate effect for (i_g) in the reduced form equations (4.3.1), (4.14.1), (4.6a) and (4.15a). This is also because two exogenous rates of interest (i_g) and (i_a) represent the

policy instruments, and we have already allowed for the latter rate, (i_a), to represent the impact of monetary policy in the financial sector.

With regard to the other exogenous rate of interest in the model, *i.e.* (i_f), it is assumed that the demand equations take the same specification as implied by the portfolio balance theory. In this model the effects of the rate of interest of foreign assets are expressed by $[(E^e/E).i_f]$, where (E^e) represents expected values of the exchange rate. The term $[(E^e/E).i_f]$ is used to represent the impact of the expected rate of return on the demand for net foreign assets. In keeping with the portfolio balance model, PBM, analysed in the previous chapter, the demand equations can be extended to include the effects of uncovered interest differential, *i.e.* $[(1+i_m)-(E^e/E).(1+i_f)]$. In the PBM it is also implied that separate expressions for (i_m) and $(E^e/E).(1+i_f)$ reflect respectively the effects of the domestic rate of interest and uncovered foreign returns on the demand for net foreign assets. This treatment of uncovered interest differential in the model results in the following specification of the demand equations.

$$H^d = H^d(i_m, (E^e/E).(1+i_f), Y, W) \quad (4.3a)$$

$$(F^d.E) = F^d(i_m, (E^e/E).(1+i_f), Y, W) \quad (4.14a)$$

Equations (4.3a) and (4.14a) in the simplified model, with the equilibrium conditions for only the money base and net foreign assets, may result in the following being ignored: 1) the effects of changes in the market determined rate of interest, (i_m), on the excluded assets, bonds and equities; and, 2) the subsequent repercussions induced by changes in the outstanding stock of these assets on the assets retained in the model, given that the assets in the private sector portfolio are imperfectly substitutable. As explained in the previous chapter, one of the basic requirements of Tobin's (1969, 1982) approach to asset market disaggregation is that the model of asset market behaviour should allow for the repercussions when the stock of each asset changes in response to variations in the rates of interest⁴. To keep the demand

⁴. Based on the other requirement of Tobin's approach to asset market disaggregation, an implicit inclusion of the portfolio balance constraint requires that the structural equations after simplification should still allow for the equilibrium condition in the equity market. This feature requires that in the simplified model, the explicit function of the equity rate, represented by equation (4.13a), should be treated as a part of the model.

equations consistent with this requirement, we allow for a behavioural equation for the total outstanding stock of assets, (W), in which the demand for total wealth (W^d) changes in response to variations in the rates of interest in the asset markets. This demand equation can be represented by

$$W^d = W(W_{(-1)}, i_m, (E^e/E).(1+i_f)) \quad (4.17.1)$$

where (W^d) represents the demand for the total outstanding stock of assets in the private sector portfolio, and $W_{(-1)}$ represents the value of the portfolio with a one period lag. Equation (4.17.1) is obtained from a partial adjustment-type model of the demand for total wealth (W)⁵. We assume that the supply of assets in the portfolio is determined by the portfolio-balance condition (4.17). The interest rates in equation (4.17.1) are specified in the same way as for the demand for money and foreign asset equations.

We will ignore this feature of asset market disaggregation, when we introduce the reduced form equations in the simplified model with equilibrium conditions in the markets for the money base and net foreign assets. This is because the assets in these markets take into account two major channels of the monetary transmission mechanism which can be specified by changes in the money market interest rate and the exchange rate.

⁵. A partial adjustment model for (W) can be represented by

$$W_t - W_{t-1} = \mu.(W_{D,t} - W_{t-1}) \quad (4.17.1a)$$

where

W_t = the actual portfolio held by the public,

$W_{D,t}$ = the desired portfolio held by the public.

$(W_t - W_{t-1})$ = the disequilibrium arising from changes in the outstanding stocks of bonds and equities,

$(W_{D,t} - W_{t-1})$ = the difference between the desired holdings of the portfolio and the actual portfolio in the last period

μ = the adjustment coefficient.

Equation (4.17.1a) in the form of a standard partial adjustment model can be written as

$$W_t = \mu.W_{D,t} + (1-\mu).W_{t-1} \quad (4.17.1b)$$

In equation (4.17.1b) we assume that the desired holdings of the portfolio is determined by

$$W_{D,t} = a + b.i_m + c. [(E^e/E).i_f] + e_t \quad (4.17.1c)$$

Substituting the explanatory variables of (4.17.1c) in equation (4.17.1b) yields

$$W = \mu.a + \mu.b.i_m + \mu.c. [(E^e/E).i_f] + (1-\mu).W_{t-1} + \mu.e_t \quad (4.17.1d)$$

Equation (4.17.1d) has the same specification as implied by equation (4.17.1).

Equation (4.17.1), which is assumed to be a part of the simplified model, represents the repercussion effects induced by changes in the outstanding stocks of bonds and equities on the demand for money and foreign assets. This treatment of the total outstanding stock of assets, (W), which is used as a scaling variable in the demand equations, has the same implications as implied by Tobin's (1958) portfolio approach to the demand for money, and by the repercussion effects of the portfolio-balance condition in both Tobin's (1969, 1982) general equilibrium approach and the portfolio balance theory of the exchange rate.

Equation (4.17.1) also implies that, in the simplified system of equations, the demand equations take into account the effects of the private sector's proposed reallocation at the end of each period⁶. The partial adjustment model of the demand for total wealth, (W^d), allows for this reallocation process whereby the total outstanding stock of assets adjusts gradually until it satisfies the equilibrium conditions in the asset markets⁷.

4.2.4 policy reaction functions

Equations (4.18) and (4.19) represent the Reserve Bank's reaction functions in the domestic and foreign asset markets, respectively. In the model the repercussion effects of the policy variables (RBS/BB) and (RBF) on the private sector portfolio decisions are represented by the effects of (i_a) on the money market rate of interest, (i_m), in equation (4.6a), and via this rate on the exchange rate in equation (4.15a). This is because it is assumed that open market operations set the Reserve Bank's holdings of domestic and foreign assets, (RBS) and (RBF), at the level required by the exogenously determined interest rate in the cash market, (i_a). This is consistent with

⁶. Buiter (1980) argued that end-of-period models (in contrast with beginning-period models) bring about a reformulation of budget constraints in terms of the terminal value of total portfolio, as newly created assets enter the portfolio allocation.

⁷. In the model it is assumed that the aggregate supply of assets in the private sector portfolio can adjust towards its desired level under an interest rate mechanism. That is, it is the rates of interest that adjust to restore equilibrium in the asset markets.

the market determined approach to monetary policy which requires that the stocks of these assets should be determined in a manner consistent with the money market interest rate and the exchange rate⁸. Based on this assumption, the policy variables (RBS/BB) and (RBF) may be regarded as the variables whose effects can be observed mainly in the transmission mechanism between the financial and real sectors, regarding changes in the real variables such as productivity, employed labour force and the trade balance⁹.

The specification of equations (4.18) and (4.19) is consistent with the following assumptions. In equation (4.18) it is assumed that the ratio representing the Reserve bank's holdings of domestic securities, (RBS), to the total government securities, (BB), 1) provides the policy variable (RBS/BB) with a link between the Reserve Bank holdings of domestic securities and the accumulated budget deficit/surplus of the Commonwealth government, and 2) takes into account the process of the Reserve Bank open market operations via changes in (RBS). Equation (4.18) also implies that the Reserve Bank manages domestic securities in response to interest rate variations, the trend of price index and the cyclical variability of (GDP). The two latter terms are regarded as anti-inflationary and counter-cyclical goals for policy implementation. The Reserve Bank's counter-cyclical goal can also be considered with the separate terms

⁸. A generalization of the model of the financial sector requires that the portfolio decisions of the public sector should be modelled by separate equilibrium conditions for the Reserve Bank's holdings of domestic and foreign assets, and for the public sector's holdings of net foreign assets. Such a generalization also requires that, when the hypothesis is based on the effectiveness of the policy variables (RBS/BB) and (RBF) in the financial sector, the model should allow for the effects of these variables in the supply equations such as (4.6a) and (4.15a), respectively. As a consequence, the model of asset market behaviour should take account of other portfolio-balance conditions in the financial sector which are concerned with the Reserve Bank's holdings of domestic and foreign assets, and the Commonwealth government holdings of net foreign assets.

We may ignore separate equilibrium conditions, and also separate portfolio-balance conditions, for the Reserve Bank's holdings of domestic and foreign assets, and for the Commonwealth government holdings of net foreign assets in the model by assuming that (RBS/BB) and (RBF) are the policy variables with no repercussions on the private sector portfolio decisions. We will return to this feature of (RBS/BB) and (RBF) in the next section, where we examine empirical features of the model.

⁹. The model of asset market behaviour allows for the policy reaction function (4.18) and (4.19) in the modelling of the transmission mechanism between the financial and real sectors, provided that in the financial sector the causality runs from market determined rates of interest and the exchange rate to the policy variables (RBS/BB) and (RBF).

concerning the cyclical variability of the total employed labour force and of average productivity.

In equation (4.19), it is assumed that the Reserve Bank's holdings of foreign assets change in response to *a*) a depreciation/appreciation of the real exchange rate, $E.(P_f/P)$, and *b*) changes in the private sector's holdings of net foreign assets. This equation implies that, in the post-float period, the Reserve Bank manages the foreign exchange market in order to prevent the effects of unexpected appreciation (depreciation) of the exchange rate and of unexpected changes in foreign debt flowing onto the *long-run value* of the domestic currency. In this treatment, the use of monetary policy for external as well as internal *long-run stabilization* is consistent with an interest rate operating mechanism for implementing monetary policy post-deregulation, using a market-clearing cash market as the primary means through which the Reserve Bank influences interest rates.

4.2.5 Uncertainty and imperfect asset substitutability

In the model represented in this section, the equilibrium conditions are extended to incorporate complications arising from the demand for money under conditions of uncertainty and imperfect asset substitutability. A basic assumption is that, given that the public have well-behaved preference over the assets in their portfolio, assets in equilibrium offer differing rates of interest. As implied by Tobin (1969, 1982), this assumption requires that assets in the private sector portfolio should be treated as imperfect substitutes. The equilibrium conditions in the simplified model allow for imperfect substitutability between money and foreign assets, and hence the generation of differing rates of interest in equilibrium as represented by the money market interest rate, (i_m) , and the uncovered rate of return on foreign assets, $(E^e/E).(1+i_f)$, in the demand equations (4.3a) and (4.14a).

In the simplified model it is also assumed that the total outstanding stock of assets, (W) , in the demand for money equation reflects the existence of uncertainty, as modelled by Tobin's (1958) portfolio approach. In keeping with this approach, money



is treated as an alternative store of value to the holding of earning assets. In the portfolio approach, it is postulated that the rate of return on holding money, while on average less than the rate of return on holding earning assets, is nevertheless more certain than the rate of return on holding earning assets. The difference in riskiness may arise because bonds and other earning assets are subject to market price volatility, while money is not. Hence, risk-averse economic agents may wish to include some money in an optimally structured portfolio. In this approach, the resultant implications for asset holders are: 1) the optimal stock of real money balances is inversely related to the rates of interest on earning assets; and, 2) the total outstanding stock of assets is a scaling variable in the demand for money equation. In the transaction approach to the demand for money, suggested by Baumol (1952) and Tobin (1956), income is viewed as a scaling variable. In this thesis we allow for both scaling variables in the demand for money equation, along the lines suggested by Tobin (1969, 1982).

One important aspect of uncertainty in the model under discussion is that it may play a pivotal role in providing a link between the asset markets and the bank loan market. Such a link is based on a disequilibrium treatment of the loan market in which loan rate controls, rather than imperfect adjustment to market-equilibrating loan rate, is the major source of disequilibrium. A disequilibrium model for the loan market, using the credit rationing approach, will be elaborated in the next chapter. The asset market model in the next chapter includes additional assets, such as the public's deposits in banks and bank loans, and allows for further aspects of uncertainty in financial markets.

4.3 Empirical features of Australia's asset market and exchange rates

The equations of the modified model, specified in the previous section, can be represented as follows.

Money market

$$H^d = P \cdot H^d \overset{(-)}{(i_m)}, \overset{(-)}{(E^e/E)} \cdot (1+i_f), \overset{(+)}{Y}, \overset{(+)}{W/P} \quad (4.20)$$

$$i_m = i_m \begin{matrix} (+) & (+) & (+) & (+,-) \\ (i_a, & i_d, & i_f, & H^S) \end{matrix} \quad (4.21)$$

$$H^d = H^S (= H) \quad (4.22)$$

Foreign asset market

$$(F^d, E) = P, F^d \begin{matrix} (+) & (-) & (+,-) & (+,-) \\ (i_m, & (E^e/E).(1+i_f), & Y, & W/P) \end{matrix} \quad (4.23)$$

$$E = E \left(\begin{matrix} (+) & (-) & (-) \\ \{P/P_f\}, \{ (i_m - \pi) - (i_f - \pi_f) \}, \tau_1 \cdot \Sigma [TB_t - (1 - \lambda_1) \cdot TB_{t-1} - (\lambda_1) \cdot TB_{LR}], \right. \\ \left. \tau_2 \cdot \Sigma [(i_f \cdot F^S)_t - (1 - \lambda_2) \cdot (i_f \cdot F^S)_{t-1} - (\lambda_2) \cdot (i_f \cdot F^S)_{LR}] \right) \quad (4.24)$$

$$F^d = F^S (= F) \quad (4.25)$$

Portfolio balance equation

$$W^d = P, W^d \begin{matrix} (+) & (+,-) & (+,-) \\ (W_{(-1)}, i_m, & (E^e/E).(1+i_f)) \end{matrix} \quad (4.26)$$

$$W^d = W^S \quad (4.27)$$

Policy reaction functions

$$(RBS/BB) = RBS \begin{matrix} (-) & (-) & (-) \\ (i_m, & \underline{GDP/GDP}, & P) \end{matrix} \quad (4.28)$$

$$RBF = RBF \begin{matrix} (+) & (-) & (+) \\ (F, & E, & P/P_f) \end{matrix} \quad (4.29)$$

Identity

$$W^S = H + (B + EQ) - (E.F) \quad (4.30)$$

Endogenous variables:

$H^d, H^S, i_m, F^d, F^S, E, W^d, W^S, (RBS/BB), RBF, (B+EQ).$

Exogenous variables:

$E^e, i_f, Y, i_a, i_d, P, P_f, \pi, \pi_f, TR, TR_{t-1}, TR_{LR}, (i_f \cdot F^S)_{t-1}, (i_f \cdot F^S)_{LR}, W_{(-1)},$

$(\overline{\text{GDP}/\text{GDP}})$.

The glossary of variable names for the descriptions of the data is briefly presented in *appendix 4.A*.

Signs above functional arguments represent the signs of partial derivatives. Equations (4.20), (4.23) and (4.26), represent the demand for the money base, foreign assets, and the total outstanding stock of earning assets, respectively. Equations (4.21) and (4.24) are the supply equations which determine the money market rate of interest and the exchange rate. Equations (4.22) and (4.25) represent the equilibrium conditions in the money and foreign asset markets; equation (4.27) represents the equilibrium condition for the total outstanding stock of assets in the private sector portfolio. Equations (4.28) and (4.29) represent the policy reaction functions in terms of the proportion of government bonds held by the Reserve Bank and the total foreign reserves of the Reserve Bank. Identity (4.30) represents the portfolio balance condition. This identity determines the total outstanding stock of bonds and equities in the private sector portfolio. A consistent solution for equations (4.20)-(4.30) determines the equilibrium values of these assets.

The estimation results for equations (4.20)-(4.27) are obtained from the two stage least squares (2SLS) method, and the results for equations (4.28) and (4.29) are obtained from the 2SLS instrumental variable (IV) method. The estimation process in these methods bridges over difficulties arising from the identification problem in a simultaneous system of equations. Since standard regression analysis requires that data should be stationary, it is important that we test this requirement before we estimate the model equations. Stationarity of data implies that the mean and variance of distributions from which the observations are drawn should be unchanging through time. The stationarity requirement is rarely satisfied for levels of macroeconomic time series. Most series are subject to a trend which may be referred to as either a *stochastic trend* or a *deterministic trend*. In the former type of trend, variables are referred to as a

difference stationary process (DSP). That is, they may have a unit root. In the other type of trend, variables are referred to as a *trend stationary process (TSP)*. Variables of the *DSP* type should be made stationary by first differencing, and variables of the *TSP* type by regressing on time, *i.e.* detrending. For both types of trend, a unit root test is needed to distinguish between unit roots in data and deterministic trend. In the analysis of time series with unit roots model residuals do not have the properties needed for valid testing of the standard regression assumptions. What is needed, then, is removing the stochastic trend in the data by first differencing.

On the basis of the test results, which suggest the presence of one unit root in the data used in the model equations, the first difference data are stationary process. This implies that in the model equations the data are integrated of order one, denoted as $I(1)$, *i.e.* all variables are integrated to the same degree. This condition in the equations implies that the estimated parameters satisfy the long-run relationship between dependent and explanatory variables in the model. If in the model equations the residuals are integrated of order zero, denoted as $I(0)$, then the variables are said to be *cointegrated*. The cointegration condition implies that the regression equations make sense because the dependent and explanatory variables do not drift too far apart from each other over time. Thus, there is a long-run equilibrium relationship between them. This condition also implies that an equation in first differences of the form of an error-correction model is a valid equation. The results of tests for unit roots in the data are given in *appendix 4.B*. The test for cointegration is represented by the augmented Dickey-Fuller statistic, ADF, for each equation.

In regressions reported in this section we employ the LM and Chow statistics to test for up to fourth order autocorrelation, and for parameter stability, respectively. The latter test is used to examine whether any instability occurs after the second quarter 1986 with the removal of all controls on interest rates and bank deposits and loans. The other test for parameter stability, the Chow* test, represents the stability criterion, regarding other special dates for the process of deregulation in the demand and exchange rate equations.

4.3.1 The money market and interest rate variability

Empirical interest in the money market equilibrium condition arises because the interest elasticity of the demand for money and the money multiplier are of crucial importance for the effectiveness of monetary policy. Also, the stability of the demand and supply equations in the money market is always viewed as a necessary condition for the stability of the monetary transmission mechanism. Instability in the money market equations makes it impossible to predict the effects on interest rates or on optimal holdings of money of a given change in: *a*) the total outstanding stock of assets and/or income which are treated as scaling variables in the demand equation; *b*) the rates of interest on earning assets which are viewed as imperfect substitutes for money; *c*) the uncovered return on foreign assets; and, *d*) the rate of interest on short-term funds, which is treated as a policy instrument in the post-deregulation period. The equilibrium condition (4.22) reflects the effects of the changes in the variables outlined above on both the money market interest rate and the demand for money.

4.3.1a. Demand for the money base in Australia

The specification of the demand for base money complies with Tobin's (1956, 1969) portfolio approach, using (W) and (Y) as scaling variables. In this approach the scaling variable (W) in the demand equation implies that, at a given level of risk preferences of the public, an increase in the total outstanding stock of earning assets, which are viewed as risky assets, raises the demand for money. Also, in the demand equation the uncovered interest return $[(E^e/E).(1+i_f)]$ is included as a determinant. The inclusion of this variable in the demand equation reflects the fact that if expected returns from holding foreign-currency assets increased, then the private sector could substitute their holdings of money in favour of foreign-currency assets. Proxies for the expected spot exchange rate (E^e) is given in *appendix 4.C*.

The estimation of the demand for money equation shows instability when the sample period is extended into the late 1970s and early 1980s. If we leave this equation

in this state, the reliability of the model will be seriously impaired. To restore stability over the period extended into the late 1970s, we allowed for a simple modification using intercept and slope dummy variables. The dummies reflect regulations in the financial sector and the main financial events over the period that deregulation was in process¹⁰. The equation was expressed in terms of real money balance (H/P) and estimated using a 2SLS method with Australian data. The estimation results are shown in table 4.3.1 in the body of this chapter.

The slope dummy, introducing the removal of quantitative bank lending in June 1982, improves the stability criterion, represented by the Chow statistics, and provides the coefficients with the expected signs in the post-deregulation period. In the period prior to this date, the coefficient of (W) is of the wrong sign, suggesting that in this period the limited price variability of earning assets swamps the relationship between the risk preferences of the public and the demand for money. In this period the *t*-statistics for (Y) and $(E^e/E).(1+i_f)$ are not significant; however, since their *t*-statistics exceed unity, we retain (Y) and $(E^e/E).(1+i_f)$ for the period 1978:3 to 1982:2 in the equation. The other dummies in the equation, representing three financial events in the period 1978:3 to 1993:4, improve the explanatory power of the equation. Using the intercept and slope dummy variables, the estimation results suggest that the equation provides a reliable specification of a demand for money function which reflects the

¹⁰. To ensure stability in equations (4.20)-(4.30), we take account of dummy variables for the following events in the financial sector.

1) The removal of interest rate ceilings on all trading bank and savings bank deposits in December 1980.

2) The ending of quantitative bank lending guidance by the Reserve Bank in June 1982.

3) The floating of the Australian dollar and removing controls on foreign exchange in December 1983.

4) The removal of all remaining controls on bank deposits, including the removal of minimum and maximum terms on deposits and the removal of restrictions on the size of fixed deposits in August 1984.

5) The removal of the remaining ceilings on bank interest rates, with the exception of owner-occupied housing loans under \$100,000 in April 1985.

6) The reduction of the SRD ratio to zero and transferring the SRD funds to non-callable deposits in September 1988.

The modification of the model equations necessitates using dummy variables based on the financial events, outlined above. Of the six financial events, those outlined by items 2 and 5 are considered with both intercept and slope dummies, and the last item only with a slope dummy in the model equations. The other financial events are included using intercept dummies in the model equations.

Table 4.3.1: Demand for the money base, (H/P), equation (4.20)

$$H^d = P \cdot H^d \begin{matrix} (-) & (-) & (+) & (+) \\ (i_m, & (E^e/E) \cdot (1+i_f), & Y, & W/P) \end{matrix}$$

Sample period: 1978:3 to 1993:4

Dependent variable: log(H/P)

Explanatory variables	Coefficients	t-statistics
Period 1978:3 to 1982:2		
	7.94	(3.84)***
log(i_m)	-.244	(-3.46)***
log[(E^e/E) . ($1+i_f$)]	-.250	(-1.46)*
log(Y)	.345	(1.29)*
log(W/P)	-.056	(-2.24)**
Dummy (1)	.064	(3.58)***
Period 1982:3 to 1993:4		
	6.70	(8.76)***
log(i_m)	-.048	(-3.25)***
log[(E^e/E) . ($1+i_f$)]	-.347	(-1.83)**
log(Y)	.363	(6.16)***
log(W/P)	.028	(4.38)***
Dummy (4)	-.041	(-5.12)***
Dummy (5)	-.058	(-6.87)***

$$R^2 = .981$$

$$DW = 2.06$$

$$LM1 = .327 \quad LM4 = 5.68$$

$$Chow = .319, (.985)$$

$$Chow^* = .283, (.991)$$

$$ADF = -7.87$$

Note:

1. Two-stage least squares estimation: 2SLS.
2. Dummy(1) takes the value of unity before 1980:4, and zero thereafter.
3. Dummy(4) takes the value of unity before 1984:2, and zero thereafter.
4. Dummy(5) takes the value of unity before 1984:4, and zero thereafter.
5. (***) significant at the 99% level,
 (**) significant at the 95% level,
 (*) significant at the 90% level.
6. The critical values of χ^2 for LM1 (with d.f.=1) and LM4 (with d.f.=4) statistics at the 5% level of significance are respectively 3.84 and 9.49.
7. The Chow* statistic shows the parameter stability criterion after removing all controls on bank deposits in 1984:3.
8. The P-values for the Chow statistics are represented in parentheses.
9. The critical value for ADF at the 1% significance level is 4.61.

portfolio approach and the importance of the uncovered returns on foreign assets implied by the portfolio balance theory.

43.1b. The market determined rate of interest in Australia

The equilibrium condition in the money market is associated with another equation, representing an inverse functional form of the supply of the money base. In this equation the money market rate of interest, (i_m), is treated as a dependent variable which is affected by the other rates of interest in asset markets and the supply of the money base. An interest rate instrument for monetary policy, *i.e.* the rate of interest in the short-term cash market, (i_a), is viewed as the policy variable which affects the market determined interest rate, (i_m), which in turn affects the demand for the money base, (H/P), via equation (4.20). The estimation results are given in table 4.3.2.

Equation (3.21) was estimated with Australian data from 1978:3 to 1993:4, using the 2SLS method. The coefficients of the interest rates, (i_a), (i_f) and (i_d) are of expected sign and are significantly different from zero. The parameter stability test, *i.e.* the Chow test, suggests that we cannot reject the hypothesis of stability at the 5% level of significance. All the explanatory interest rates in the equation are treated as exogenous. When the loan rate was treated as an endogenously determined rate of interest, and (i_d) was replaced by its estimated values obtained from a reduced form equation, the t statistic of the coefficient of (i_d) reduced sharply. This is probably because the loan rate is determined under a different condition than the Walrasian market-equilibrating interest rate, which is necessary for all the equilibrium conditions in asset markets.

In the estimated equation the coefficient on the money base is negative. One interpretation is that the monetary authorities hold the money base at the level determined by the private sector's demand for transaction balances, *i.e.* they reduce the supply of base money to meet the private sectors' desired holdings of money balances at a higher rate of interest. This treatment of the monetary policy implies that the supply of base money is demand determined, but at a price set in the money market.

Table 4.3.2: Estimation results for the interest rate equation (4.21)

$$i_m = i_m \begin{matrix} (+) & (+) & (+) & (+) \\ (i_a, & i_d, & i_f, & H) \end{matrix} \begin{matrix} (-) \\ (-) \end{matrix}$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\log(i_m)$

Explanatory variables	Coefficients	t-statistics
	1.66	(3.12)***
$\log(i_a)$	.779	(9.2)***
$\log(i_d)$	.204	(2.50)***
$\log(i_f)$	.121	(1.60)*
$\log(H)$	-.196	(-3.36)***

$R^2 = .955$
 $DW = 1.97$
 $LM1 = .708$ $LM4 = 17.87$
 $Chow = .506, (.770)$
 $ADF = 8.75$

Note:

1. Two-stage least squares estimation: 2SLS.
2. For the statistics see footnotes of table 4.3.1.

This is because the monetary authorities have difficulties in thinking of monetary policy in terms of nominal monetary aggregates. Instead, they rely on an apparent correlation between the market determined rate of interest, (i_m), and a policy instrument such as the rate of interest in the short-term cash market, (i_a).

4.3.2 The foreign asset market and exchange rate determination

The net foreign assets of the private sector are determined by private sector foreign borrowing less private sector lending abroad. It is assumed that the net foreign borrowing, denominated in foreign currency, is demand determined, *i.e.* the foreign sector supplies in full the amount of foreign debt demanded by the private sector at a given rate of interest (i_f). This is a consequence of the small country assumption, so that changes in the domestic demand for foreign assets have no feedback effects on world economy (*i.e.* the foreign sector), and the supply of these assets by the world economy is exogenous to the domestic economy. This assumption implies that Australian agents in the foreign sector may raise or lower their borrowing (lending) without a perceptible influence on the international financial markets, and that their foreign counterparts merely react to a given market situation.

In the model the nominal spot exchange rate is assumed to be responsive to shifts in the real exchange rate which reflects movements in the current account balance, and hence its components: the trade balance and the income stream from holding foreign assets. There are two expectations relationships in the model. The first takes account of the conventional relationship underlying the portfolio balance model, in which (assuming static expectations) current account flows affect exchange rates through their impact on the total outstanding stock of assets, (W), and the expected future spot rate is tied down by an expectations mechanism for uncovered returns on foreign assets, $(E^e/E).(1+i_f)$. The second expectations mechanism allows for unexpected changes in the current account which are assumed to provide information about shifts in underlying determinants that necessitate offsetting shifts in the real exchange rate in order to maintain current account equilibrium in the long run. The

model of exchange rate determination with the expectations mechanisms outlined above is specified by equations (4.23) and (4.24). The estimates of these equations are presented in the following subsections.

4.3.2a. Australian private sector demand for net foreign assets

In equation (4.23) the specification of the demand for net foreign borrowing, *i.e.* domestic-currency denominated foreign debt, $(F^d.E)$, allows for the effects of a current account deficit or surplus through changes in the total outstanding stock of assets, (W) , and imperfect substitutability between domestic and foreign assets. As we have already noted, these assumptions comply with the portfolio balance theory of exchange rate determination. In keeping with the other assumption in this theory the expectations mechanism in equation (4.23) is specified by uncovered returns on foreign assets, $(E^e/E).(1+i_f)$.

In this equation it is assumed that the net foreign borrowing of the private sector is positively related to the domestic interest rate, (i_m) , and negatively related to the uncovered interest return, $(E^e/E).(1+i_f)$. This is because as the domestic interest rate rises, given that the expected foreign interest rate remains unchanged, the private sector would borrow abroad and lend domestically rather than abroad. This means that the net foreign borrowing of the private sector, represented by the foreign borrowing less foreign assets, increases as the domestic interest rate rises relative to the expected foreign interest rate. Also, a fall in the uncovered interest return, $(E^e/E).(1+i_f)$, given that the domestic interest rate remains unchanged, increases the net foreign borrowing. In equation (4.23) the relationships with respect to real income, (Y) , and the total outstanding stock of the assets in the private sector portfolio, (W) , are ambiguous. Real income as an indicator of domestic investment activity is expected to be positively related to the net demand for foreign borrowing. However, real income and interest rates are related in the analysis of the real sector which is not considered here. To the extent that a higher (Y) is associated with a lower (i_m) , this would, *cet. par.*, induce the private sector to borrow domestically. Also, as will be shown in the forthcoming

discussion, a higher (W) may be associated with a lower or higher uncovered interest differential, $\{(1+i_m)-(E^e/E).(1+i_f)\}$. A lower interest differential induces the private sector to borrow domestically, and a higher interest differential induces them to borrow abroad. Table 4.3.3 shows the results of a 2SLS estimation of equation (4.23).

All the coefficients are significantly different from zero, and the coefficients of (i_m) and $(E^e/E).(1+i_f)$ in the post-deregulation period and of (i_m) in the pre-deregulation period are of expected signs. The slope and intercept dummy variables are needed to bring about the parameter stability of the equation. In the pre-deregulation period, the sign of the coefficient of the uncovered interest return is the opposite of that expected. This shows that in this period and/or in the pre-float period the effects on foreign assets of the uncovered interest differential were subject to domestic monetary policy, regarding a managed exchange rate regime and the restrictions imposed on domestic interest rates. This is when the Reserve Bank fine tunes the foreign asset market, using its monetary policy instruments, by changing the exchange rate and/or the domestic interest rate. That is, if foreign interest rates fall relative to domestic interest rates, then it would pay to borrow abroad which increases net foreign borrowings which, *ceteris paribus*, causes the exchange rate to depreciate. In these circumstances the Reserve Bank intervened to appreciate the exchange rate, and hence to reduce the demand for net foreign borrowing, $(F^d.E)$.

The actual value of the coefficient of the uncovered interest return in the post-deregulation period implies that a one percent increase in that interest return reduces the demand for foreign borrowing more than 0.6 percent. This seems reasonable for the expected capital mobility under a deregulated financial system. In equation (4.23) the coefficients of the real income, (Y) , and the total outstanding stock of assets, (W) , are respectively negative and positive. As argued above, the signs of these coefficients show that a higher (Y) is consistent with a lower (i_m) , and a higher (W) is consistent with a lower interest differential, or with a lower uncovered interest return, $(E^e/E).(1+i_f)$. The relationship between (W) and the uncovered interest return on foreign assets will be described shortly.

Table 4.3.3: Demand for foreign borrowings, (F.E)/P, equation (4.23)

$$(F^d.E) = P \cdot H^d \begin{matrix} (+) & & & (+) & (+) \\ & (-) & & (-) & (-) \end{matrix} (i_m, (E^e/E) \cdot (1+i_f), Y, W/P)$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\log\{(F.E)/P\}$

Explanatory variables	Coefficients	t-statistics
Period 1978:3 to 1985:2		
	47.5	(8.3)***
$\log(i_m)$	.746	(5.5)***
$\log[(E^e/E) \cdot (1+i_f)]$	1.52	(2.74)***
$\log(Y)$	-7.63	(-16.7)***
$\log(W/P)$	1.46	(9.3)***
Period 1985:3 to 1993:4		
	1.01	(.150)
$\log(i_m)$	.287	(6.4)***
$\log[(E^e/E) \cdot (1+i_f)]$	-.615	(-1.42)*
$\log(Y)$	-1.00	(-1.65)*
$\log(W/P)$	.112	(2.35)**
Dummy(5)	.310	(5.6)***
Dummy(7)	.129	(1.90)**

$R^2 = .988$
 $DW = 1.72$
 $LM1 = .919$ $LM4 = 2.42$
 $Chow = .492, (.906)$
 $Chow^* = .231, (.995)$
 $ADF = -6.71$

Note:

1. Two-stage least squares estimation: 2SLS.
2. Dummy(5) takes the value of unity before 1984:4, and zero thereafter.
3. Dummy(7) takes the value of unity before 1988:3, and zero thereafter.
4. The Chow* statistic shows the parameter stability criterion after floating the exchange rate in 1983:4.
5. For the statistics see footnotes of table 4.3.1.

4.3.2b. Exchange rate determination

Given that net foreign borrowing, denominated in foreign currency, (F), are demand determined, the exchange rate equation (4.24) takes account of the determinants of the exchange rate in a conventional Dornbusch-Frankel model and the expectations mechanism in the Hooper and Morton's (1982) model. As we have already noted, in the latter model the expectations mechanism is specified by shifts in the long-run equilibrium real exchange rate. The determinants of the exchange rate in equation (4.24) are assumed to be effective in the supply side of the foreign asset market. The expectations mechanism in equation (4.24) represents the effects of the determinants of the equilibrium real exchange rate via the components of the current account balance, denoted by the trade balance, (TB), and the income stream from holding foreign assets, ($i_f F$). In this equation unexpected changes in the trade balance are used as an indicator of real shocks requiring adjustments in the real exchange rate.

The estimation of equation (4.24), using the determinants of the long-run equilibrium real exchange rate, requires that we should provide an estimation for the determinants of the unexpected changes in the trade balance and in the income stream from holding foreign assets. The estimation of the following equation for the real exchange rate provides the terms needed for the determination of unexpected changes in the trade balance.

$$E'_t = E'_0 - \tau \cdot \Sigma [TB_t - (1-\lambda)TB_{t-1}] + \tau \cdot \lambda \cdot TB_{LR,t} \quad (4.31)$$

The estimation results for equation (4.31) are shown in table 4.3.4, using the IV method for the 2SLS estimates. As a proxy for the equilibrium real exchange rate, (E'), we used the spot exchange rate, (E), multiplied by the ratio of OECD consumer price index to Australia's implicit price deflator for gross domestic product. Deflating the trade balance by trend growth in domestic nominal GDP, denoted by (TB/YT), improved the statistical fit of the equation. Equation (4.31) was estimated for different values of (λ) ranging between 0 and 1. The equation's statistical fit is maximized for a value equal to $\lambda=0.25$. With this value the long-run equilibrium balance of trade deficit

Table 4.3.4: Equilibrium real exchange rate, (E'), equation (4.31)

$$E'_t = E'_0 - \tau \cdot \sum [(TB/YT)_t - (1-\lambda) \cdot (TB/YT)_{t-1}] + \tau \cdot \lambda \cdot (TB/YT)_{LR} \cdot t$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\log(E'_t)$

Explanatory variables	Coefficients	t-statistics	R ²	DW
(λ=.01)				
$\Sigma [(TB/YT)_t - (1-\lambda) \cdot (TB/YT)_{t-1} ]$	.095	(.311)		
t (Time trend)	6.53	(2.02)**		
	.0027	(.423)	.822	1.80
(λ=.25)				
$\Sigma [(TB/YT)_t - (1-\lambda) \cdot (TB/YT)_{t-1} ]$	.040	(.156)		
t (Time trend)	2.26	(1.50)*		
	.0122	(1.61)*	.872	1.89
(λ=.50)				
$\Sigma [(TB/YT)_t - (1-\lambda) \cdot (TB/YT)_{t-1} ]$	.008	(.038)		
t (Time trend)	.630	(.640)		
	.009	(1.02)	.875	1.98
(λ=.75)				
$\Sigma [(TB/YT)_t - (1-\lambda) \cdot (TB/YT)_{t-1} ]$	.0002	(.001)		
t (Time trend)	.280	(.401)		
	.0075	(.812)	.875	1.99
(λ=.99)				
$\Sigma [(TB/YT)_t - (1-\lambda) \cdot (TB/YT)_{t-1} ]$	.0001	(.0007)		
t (Time trend)	.178	(.327)		
	.00699	(.732)	.874	2.00

$$\text{for } \lambda=0.25 \quad (TB/YT)_{LR} = \frac{.0122}{(-2.26) \cdot (0.25)} = -0.0216$$

$$E' = 0.04 - (-2.26) \cdot \Sigma [(TB/YT)_t - (1- 0.25) \cdot (TB/YT)_{t-1}] + (-2.26) \cdot (0.25) \cdot (-0.0216) \cdot t$$

Note:

1. Two-stage least squares estimation, using IV method.
2. For the t-statistics see footnote of table 4.3.1.

is equal to $-0.0215586.YT$, or about -2.16 per cent of the trend growth of nominal GDP.

Using the values ($\lambda=0.25$) and $(TB/YT) = -0.0215586$, we replace the term reflecting cumulative unexpected changes in the trade balance in equation (4.24) by

$$TBII = \tau \cdot \Sigma [\{ (TB/YT)_t - (0.75) \cdot (TB/YT)_{t-1} \} - (0.25) \cdot (-0.0215586)] \quad (4.32)$$

where (τ) is a negative coefficient.

The other equation for the real exchange rate, using the terms required by the income stream from holding foreign assets, ($i_f.F$), provides data for unexpected changes in this flow which is a non-stationary process, both in levels and in first difference. That is, the process is not integrated of order one. Since the data for ($i_f.F$) is integrated of order one, in equation (4.24) we replace the non-stationary process for 'the cumulative unexpected changes in the interest income from holdings of foreign assets' by ($i_f.F$).

The results of the estimation of the exchange rate equation (4.24), using the terms (TBII) reflecting unexpected changes in the trade balance and ($i_f.F$) the income stream from holding foreign assets, are shown in table 4.3.5.

Table 4.3.5 gives the results of a 2SLS estimation of equation (4.24). The shift dummy, introducing the floating of the Australian dollar in December 1983, and the other two intercept dummies, improved the parameter stability criterion in the equation. The results show that the coefficients of the real interest rate differential, $(i_m - \pi) - (i_f - \pi)$, in the post-float period, and of ($i_f.F$) in the pre-float period, are incorrectly signed. This, for the real interest rate differential, possibly reflects measurement problems. This was also the problem in the empirical findings of Blundel-Wignall *et al.* (1993), for the weighted-average real interest rate of foreign assets. In the findings of Blundel-Wignall *et al.* the inclusion of the Japanese rate was treated as the cause of this problem. In the model under discussion a weighted average of four foreign short-term interest rates, including the US and Japanese rates with weights equal to $1/3$, and the UK and German rates with weights equal to $1/6$, provides a proxy

Table 4.3.5: Estimation results for the exchange rate equation (4.24)

$$E = E \left(\begin{matrix} (+) \\ (P/P_f) \end{matrix}, \begin{matrix} (-) \\ (i_m - \pi) - (i_f - \pi_f) \end{matrix}, \begin{matrix} (-) \\ \text{TBII} \end{matrix}, \begin{matrix} (-) \\ (i_f \cdot F) \end{matrix} \right)$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\log(E)$

Explanatory variables	Coefficients	Coefficients
Period 1978:3 to 1983:3		
	-.021 (-.306)	-.008 (-.116)
log(P/P _f)	2.19 (11.3)***	2.19 (11.3)***
log(i _f ·F)	-.077 (8.00)***	-.077 (8.00)***
Period 1983:4 to 1993:		
log(P/P _f)	1.66 (12.1)***	1.43 (5.76)***
(i _m -π) - (i _f -π _f)	.006 (3.18)***	.005 (2.64)***
log(i _f ·F)	.203 (9.97)***	.164 (9.97)***
TBII	-.793 (-3.70)***	-7.65 (-3.58)***
Dummy(4)	-.113 (-2.71)***	-.211 (-2.72)***
Dummy(5)	-.193 (-13.2)***	-.108 (-11.9)***
	R ² = .958	R ² = .964
	DW = 1.59	DW = 1.57
	LM1 = 2.61	LM1 = 2.92
	LM4 = 3.25	LM4 = 3.90
	Chow = .403, (.927)	Chow = 1.04, (.429)
	Chow* = .464, (.891)	Chow* = .430, (.924)
	ADF = -6.22	ADF = -6.22

Note:

1. Two-stage least squares estimation: 2SLS.
2. Dummy(4) takes the value of unity before 1984:2, and zero thereafter.
3. Dummy(5) takes the value of unity before 1984:4, and zero thereafter.
4. The Chow* statistic shows the parameter stability criterion after floating the exchange rate, over two subsamples of the data before and after 1985:2.
5. For the statistics see footnotes of table 4.3.1.

for the foreign interest rate, (i_f) . The weights are of the same value as specified by the AEM model. This calculation of the weighted-average foreign interest rate possibly reflects the same problem as identified by Blundel-Wignall *et al.* However, the coefficient of the real interest rate differential in the post-float period is significantly different from zero, suggesting that the impact of this variable on the exchange rate, (E) , is important. The wrong sign for $(i_f.F)$ in the shorter pre-float period reflects the problem arising from managed exchange rate. Also in the other regression using (P/P_f) as an explanatory variable in the post-float period, the coefficient of the relative prices, (P/P_f) , in this period is insignificant and unexpectedly negative. In the pre-float period the relative prices, (P/P_f) , is shown as the major determinant of the exchange rate. The insignificant coefficient of this term in the post-float period may reflect the fact that the long-run purchasing power parity, PPP, condition is no longer valid in this period. This result is consistent with international evidence on PPP surveyed by MacDonald (1988). The evidence indicates that the models which include the PPP condition as a long-run determinant of the exchange rate performed reasonably well prior to 1980; however when data from 1980s are included in the analysis, the models typically fit poorly.

The estimation results for equation (4.24) in the period 1983:4 to 1993:4 are given in table 4.3.6. A 2SLS estimation of this equation has provided results which are close to those represented in the previous estimation, shown in table 4.3.5. In both the estimations the term, $(TBII)$, reflecting cumulative unexpected changes in the trade balance, is a reliable indicator for real shocks requiring adjustments in the real exchange rate. This term also reflects the fact that an improvement in the trade balance causes the exchange rate to appreciate, *i.e.* the nominal exchange rate (E) falls. This corresponds with the assumption implied by the Marshall-Lerner condition in a small open economy. The positive sign of $(i_f.F)$ in both the estimations shows that an increase in interest payments of foreign debt will tend to depreciate the exchange rate, that is (E) increases.

Table 4.3.6: Estimation results for the exchange rate equation (4.24)

$$E = E \left(\begin{matrix} (+) \\ (P/P_f) \end{matrix}, \begin{matrix} (-) \\ (i_m - \pi) - (i_f - \pi_f) \end{matrix}, \begin{matrix} (-) \\ TBII \end{matrix}, \begin{matrix} (-) \\ (i_f \cdot F) \end{matrix} \right)$$

Sample period: 1983:4 to 1993:4

Dependent variable: $\log(E)$

Explanatory variables	Coefficients	t-statistics
	1.75	(10.6) ***
$(i_m - \pi) - (i_f - \pi_f)$	.009	(3.02) ***
$\log(i_f \cdot F)$	.210	(8.68) ***
TBII	-.925	(-3.91) ***
Dummy (4)	-.189	(-2.45) ***
Dummy (5)	-.116	(-8.81) ***

$R^2 = .752$
 $DW = 1.81$
 $F = 20.2$
 $ESS = .075$

Note:

1. Two-stage least squares estimation, using IV method.
2. Dummy(4) takes the value of unity before 1984:2, and zero thereafter.
3. Dummy(5) takes the value of unity before 1984:4, and zero thereafter.
4. For the t-statistics see footnote of table 4.3.1.

4.3.3 Demand for the total outstanding stock of assets in Australia and the repercussion effects of the portfolio-balance condition

The total outstanding stock of assets, (W), in the model allows for holding money as a non-interest-bearing asset, and as an alternative store of value to the holding of interest-bearing assets: government bonds, equities and foreign assets. As explained in section 2, the simplified model with a reduced number of assets, *i.e.* money and foreign assets, should reflect the repercussions induced by changes in the outstanding stocks of excluded assets: bonds and equities. Changes in these assets occur in response to changes in the rates of interest in the asset markets. Given that assets are imperfectly substitutable, the repercussions in the model are represented by the behavioural equation for the total outstanding stock of assets, equation (4.26), which allows for changes in (W) in response to changes in the rates of interest on earning assets, (i_m) and $(E^e/E).(1+i_f)$. Equation (4.26) is specified in the form of a partial adjustment model and estimated, using the 2SLS method. The results of the estimation are given in table 4.3.7.

In this equation the GDP price deflator, (P), is proxied by the cumulative values of a purely random process, using a trend eliminating method. The cumulative series of residuals, ϵ_j , are obtained from regressing (P) against a trend variable, (t); and $\sum \epsilon_j$ is used for the price index in equation (4.26). The process $\sum \epsilon_j$ is integrated of order 1, *i.e.* its first difference is stationary. The estimation results show that all the coefficients are significantly different from zero apart from $(E^e/E)(1+i_f)$ which has a t-ratio of -1.002 . However, since the t-ratio of this variable at least exceeds one in absolute value we retained the variable in the equation. The stability criterion, the Chow statistic, shows that at the 5% level of significance we cannot reject the hypothesis of stability of the coefficients. This is achieved by a dummy variable used for the effects of the removal of interest rates ceilings in April 1985.

The results show that the coefficient of the lagged value of (W) is of expected sign. The sign of other coefficients in equation (4.26) were treated as ambiguous. This is because the interest rates (i_m) and $(E^e/E).(1+i_f)$ are assumed to be directly related to

Table 4.3.7: Demand for the total outstanding stock of assets (W), equation (4.26)

$$(W) = E \begin{matrix} (+) \\ (-) \end{matrix} (W_{(-1)}), \begin{matrix} (+) \\ (-) \end{matrix} i_m, \begin{matrix} (+) \\ (-) \end{matrix} (E^e/E) \cdot (1+i_f), \begin{matrix} (+) \\ (-) \end{matrix} P$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\log(PF)$

Explanatory variables	Coefficients	t-statistics
	4.89	(1.89) ***
$[\log(W)]_{(-1)}$	.817	(14.5) ***
$\log(i_m)$	-.178	(-2.26) **
$\log[(E^e/E) \cdot (1+i_f)]$	-.486	(-1.002)
P	-1.61	(-2.49) ***
Dummy(6)	-.176	(-2.42) ***

$R^2 = .961$
 DW = 2.09
 Durbin's h alt. = -.383
 LM1 = .151 LM4 = 5.56
 Chow = .609, (.722)
 ADF = -8.02

Note:

1. Two-stage least squares estimation: 2SLS.
2. Dummy(6) takes the value of unity before 1985:2, and zero thereafter.
3. For the statistics see footnotes of table 4.3.1.

holding bonds and foreign assets, respectively, and inversely related to holding their substitute assets in the private sector portfolio. Changes in the total outstanding stock of assets, (W), in response to an increase in (i_m) represent the combination of the changes required by an increase in holding bonds, a fall in holding money and equities, and a rise in holding net foreign borrowing. Also, an increase in $(E^e/E)(1+i_f)$ reduces net foreign borrowings, which increases total wealth, and reduces the holdings of money, and domestic bonds and equities, which reduce the total wealth. The aggregate effects of changes in either of the interest rates (i_m) and $(E^e/E)(1+i_f)$ on total net worth in table 4.3.7 is shown to be negative. This result for $(E^e/E)(1+i_f)$ is consistent with the results shown in table 4.3.3. In this table a higher (W) was considered to be associated with a lower uncovered interest return $(E^e/E)(1+i_f)$, which raises foreign borrowings.

The ambiguity for the sign of the coefficient of the price index (P) in equation (4.26) arises because the net effect of an increase in the price level is an increase in the flow demand for money, which has as its counterpart a reduction in the flow demand for earning assets. In table 4.3.7 the net effects of an increase in the price level on the total outstanding stock of assets is shown to be negative.

4.3.4 Policy reaction functions

Policy reaction functions, equations (4.28) and (4.29), represent the Reserve Bank's intervention in the domestic and foreign asset markets. In the domestic earning assets market the ratio of the Reserve Bank's holdings of government bonds to the total issued interest-bearing government debt, (RBS/BB), may change as a result of: 1) open market operations by the Reserve Bank; and, 2) a budget deficit or surplus of the Commonwealth government. Equation (4.28) implies that the Reserve Bank manages auction-market credit in response to interest rate variations, and in terms of its counter-cyclical and anti-inflationary goals. The stabilizing policy in the domestic earning assets market requires that the ratio (RBS/BB) should change in a manner consistent with the variations of the money market interest rate, which is induced by

changes in the demand for money or the interest rates (i_d) and (i_f). This consistency arises from the so-called market oriented approach to the implementation of the monetary policy in a liberalized financial system.

Equation (4.29) implies that the Reserve Bank manages the domestic market for foreign assets in response to an unexpected appreciation or depreciation of the exchange rate, and to unexpected changes in net foreign borrowings and relative prices. The implication of this policy function is that the Reserve Bank's holdings of foreign assets change to prevent large fluctuations in the stock of foreign debt having an impact on the value of domestic currency. This value is affected by changes in the exchange rate, net foreign borrowing and relative prices, and by the level of the Reserve Bank's foreign reserves. Equation (4.29) reflects the fact that the Reserve Bank's holdings of foreign reserves change in a manner consistent with changes in the market values of the real exchange rate.

A theoretical generalization of the model of the financial sector with the policy variables (RBF/BB) and (RBS) requires that: 1) the interest rate equation (4.21) should include the effects of the ratio (RBF/BB); and, 2) the exchange rate equation (4.24), should incorporate the effects of (RBF). Using a standard Granger-causality test, the postulated hypotheses are: 1) that changes in the (RBF/BB) ratio cause changes in (i_m); and, 2) that changes in (RBF) cause changes in (E).

The results of the estimation of equations (4.28) and (4.29), using the (IV) method for 2SLS estimates, and the Granger-causality tests are given in tables in the body of this section.

Tables 4.3.8, 4.3.9 and 4.3.10 present the estimation results for equation (4.28), using different indicators for the Reserve Bank's counter-cyclical goal. These indicators are concerned with the cyclical variability of GDP, of the employed labour force, (LF), and of the average productivity, (YP). The indicators are specified by $(\overline{Y/\overline{Y}})$, $(\overline{LF/\overline{LF}})$ and $(\overline{YP/\overline{YP}})$, respectively. (\overline{Y}) , (\overline{LF}) and (\overline{YP}) are the trend growth of the variables, and are obtained from the following standard equations.

$$\overline{Y} = Y_0 \cdot e^{r_0 \cdot t} \quad (4.33)$$

$$\overline{LF} = LF_0 \cdot e^{r_1 \cdot t} \quad (4.34)$$

$$\overline{YP} = YP_0 \cdot e^{r_2 \cdot t} \quad (4.35)$$

where

r_0 = the growth rate of GDP, \dot{Y} ,

r_1 = the growth rate of employed labour force, \dot{LF} ,

r_2 = the growth rate of productivity, $\dot{Y/LF}$,

$\dot{Y} = \dot{Y/LF} + \dot{LF}$,

Y_0 = the initial value of GDP,

LF_0 = the initial value of the employed labour force,

YP_0 = the initial value of the average productivity of the labour force,

The results in tables 4.3.8, 4.3.9 and 4.3.10, using (Y/\overline{Y}) , (LF/\overline{LF}) and (YP/\overline{YP}) respectively as the different indicators for the Reserve Bank counter-cyclical goal, show that the coefficients are of expected sign and are significantly different from zero. Also the estimated equations satisfy the criterion of parameter stability at the 1% level of significance. The dummy variable in the regressions reflects the effects of the ending of quantitative bank lending guidance in June 1982. This dummy variable improved the diagnostic statistics for the estimated coefficients. The GDP price deflator, (P), in the estimated equations was replaced by the same cumulative residuals as used in the estimation of equation 4.26, presented in the previous subsection.

The value of coefficients in 4.3.9 and 4.3.10 are similar, suggesting that either of the cyclical goals, represented by (LF/\overline{LF}) or (YP/\overline{YP}) , together with an anti-inflationary goal and the variability of the interest rate can be used satisfactorily in the determination of the policy variable (RBS/BB). The values of coefficients in table 4.3.8 are different from those in the two other tables. In the regression using the counter-cyclical variable (Y/\overline{Y}) , the elasticity of the policy variable (RBS/BB) with respect to the interest rate, (i_m) , is lower than the other two regressions, while the coefficient of the anti-inflationary target is higher. These results suggest that the policy variable

Table 4.3.8: Estimation results for Reserve Bank intervention function in domestic financial markets, equation (4.28)

$$(RBS/BB) = RBS \begin{matrix} (-) \\ (i_m) \end{matrix}, \begin{matrix} (-) \\ \overline{GDP/GDP} \end{matrix}, \begin{matrix} (-) \\ P \end{matrix}$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\log(RBS/BB)$

Explanatory variables	Coefficients	t-statistics
	-1.85	(-5.95) ***
$\log(i_m)$	-.164	(-1.31) *
$\log(\overline{Y/Y})$	-5.88	(-3.71) ***
P	-10.32	(-6.39) ***
Dummy(2)	-.819	(-8.47) ***

$R^2 = .768$
 $DW = 2.06$
 $F = 36.4$
 $Chow = 2.57$
 $ESS = 3.15$

Note:

1. Two-stage least squares estimation, using IV method with Fair correction for serial correlation.
2. Dummy(2) takes the value of unity before 1982:2, and zero thereafter.
3. The critical F-value for the Chow test, [with (30,25) d.f.] at the 1% level of significance is 2.53.
4. For the t-statistics see footnote of table 4.3.1.

Table 4.3.9: Estimation results for Reserve Bank intervention function in domestic financial markets, equation (4.28)

$$\log(RBS/BB) = \beta_0 + \beta_1 \log(i_m) + \beta_2 \log(\overline{LF/LF}) + \beta_3 P + \epsilon_t$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\log(RBS/BB)$

Explanatory variables	Coefficients	t-statistics
	-.732	(-1.27)
$\log(i_m)$	-.456	(-2.57)***
$\log(\overline{LF/LF})$	-.009	(-1.61)*
P	-7.20	(-2.89)***
Dummy (2)	-.525	(-2.60)***

$R^2 = .747$
 $DW = 2.27$
 $F = 32.5$
 $Chow = 2.68$
 $ESS = 3.4$

Note:

1. Two-stage least squares estimation, using IV method with Fair correction for serial correlation.
2. Dummy(2) takes the value of unity before 1982:2, and zero thereafter.
3. The cyclical variability of the employed labour force is a stationary process which is treated as a purely random series, and, hence, is proxied by the cumulative values of the ratio

$(\overline{LF/LF})$.

4. The critical F-value for the Chow test, [with (30,25) d.f.] at the 1% level of significance is 2.53.
5. For the t-statistics see footnote of table 4.3.1.

Table 4.3.10: Estimation results for Reserve Bank intervention function in domestic financial markets, equation (4.28)

$$(RBS/BB) = RBS \begin{matrix} (-) \\ (i_m) \end{matrix}, \begin{matrix} (-) \\ \overline{YP/YP} \end{matrix}, \begin{matrix} (-) \\ P \end{matrix}$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\log(RBS/BB)$

Explanatory variables	Coefficients	t-statistics
	-.726	(-1.26)
$\log(i_m)$	-.462	(-2.59)***
$(\overline{YP/YP})$	-.009	(-1.60)*
P	-7.26	(-2.93)***
Dummy (2)	-.529	(-2.64)***

$R^2 = .747$
 $DW = 2.27$
 $F = 32.5$
 $Chow = 2.67$
 $ESS = 3.44$

Note:

1. Two-stage least squares estimation, using IV method with Fair correction for serial correlation.
2. Dummy(2) takes the value of unity before 1982:2, and zero thereafter.
3. The cyclical variability of the average productivity of employed labour force is a stationary process which is treated as a purely random series, and, hence, is proxied by the cumulative values of the ratio $(\overline{YP/YP})$.
4. The critical F-value for the Chow test, [with (30,25) d.f.] at the 1% level of significance is 2.53.
5. For the t-statistics see footnote of table 4.3.1.

(RBS/BB) is more relevant to the financial sector than to the real sector. This possibly arises from the increased role of the interest-bearing debt of the Commonwealth government, (BB), in the determination of the appropriate stance of the monetary policy that aims to stabilize the nominal interest rates in financial markets.

In the other policy reaction function, equation (4.29), we examine the Reserve Bank's intervention in the domestic market for foreign assets. Tables 4.3.11 and 4.3.12 represent the estimation results for equation (4.29), using the real exchange rates calculated as $(\$A/\$US) \cdot (P_{US}/P_A)$ and the nominal exchange rate $(\$A/\$US)$ as the explanatory variables. Also in this equation the private sector borrowing, (F), was replaced by the total net foreign borrowings, (FT), represented by the sum of the private sector and the public sector net foreign borrowings. This is because the Reserve Bank's holdings of foreign assets are treated as responsive to the variations of the total borrowings of the domestic economy.

In the estimation of equation (4.29) a slope dummy variable improves the diagnostic statistics of the estimated coefficients. This dummy is used to show the effects of the floating of the exchange rate in December 1983. The estimated coefficients satisfy the criterion of parameter stability, the Chow statistic, at the 5% level of significance. The results show that the coefficients for the nominal and real exchange rates are significant only in the post-float period. The coefficient for relative prices in table 4.3.12 is significant only in the pre-float period. This result is consistent with the results obtained from the estimation of the exchange rate equation (4.24). In this equation the coefficient of the relative prices, used as a proxy for long-run purchasing power parity, was also significant only in the pre-float period. The estimated equations satisfy the criterion of the parameter stability.

The estimation results in tables 4.3.11 and 4.3.12 show that the coefficients for the real and nominal exchange rates are of the same size. The coefficients of the net

Table 4.3.11: Estimation results for Reserve Bank intervention function in domestic markets for foreign assets, equation (4.29)

$$\log(\text{RBF}) = \text{RBF} \left(E. \left(P_f/P \right)^{(-)}, FT \right)^{(+)}$$

Sample period: 1978:3 to 1993:4

Dependent variable: log(RBF)

Explanatory variables	Coefficients	t-statistics
Period 1978:3 to 1983:4		
	3.57	(2.88)***
log(FT)	.554	(4.28)***
Period 1984:1 to 1993:4		
	4.49	(3.99)***
log[E. (P _f /P)]	-1.25	(-3.25)***
log(FT)	.472	(4.68)***

R² = .94
 DW = 1.85
 Chow = 1.296
 ESS = .619

Note:

1. Two-stage least squares estimation, using IV method with Fair correction for serial correlation.
2. The critical F-value for the Chow test, [with (30,25) d.f.] at the 5% level of significance is 1.92.
3. For the t-statistics see footnote of table 4.3.1.

Table 4.3.12: Estimation results for Reserve Bank intervention function in domestic markets for foreign assets, equation (4.29)

$$(\text{RBF}) = \text{RBF} \left(\begin{matrix} (-) & (+) & (+) \\ \text{E}, & \text{FT}, & (\text{P}/\text{P}_f) \end{matrix} \right)$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\log(\text{RBF})$

Explanatory variables	Coefficients	t-statistics
Period 1978:3 to 1983:4		
	7.37	(3.90)***
$\log(\text{P}/\text{P}_f)$	4.87	(2.53)***
$\log(\text{FT})$	.190	(1.01)
Period 1984:1 to 1993:4		
	3.22	(3.17)***
$\log(\text{E})$	-1.25	(-3.28)***
$\log(\text{FT})$	.602	(6.39)***

$R^2 = .948$
 $DW = 1.85$
 $\text{Chow} = 1.134$
 $\text{ESS} = .564$

Note:

1. Two-stage least squares estimation, using IV method with Fair correction for serial correlation.
2. The critical F-value for the Chow test, [with (30,25) d.f.] at the 5% level of significance is 1.92.
3. For the t-statistics see footnotes of table 4.3.1.

foreign borrowings, (FT), in these equations are different. The coefficient of (FT) in table 4.3.12 is larger. One reason is that, in the absence of the long-run purchasing-power-parity condition, the Reserve Bank's holdings of foreign reserves are expected to be more responsive to the increased foreign debt in the post-float period than in the pre-float period. The results of estimated equation, shown in table 4.3.11, implicitly allow for this condition by treating the relative prices as the deflator of the real exchange rate in the post-float period. Other regressions were run replacing the US consumer price index by the OECD consumer price index in the calculation of the relative prices and the real exchange rate. There were no significant changes in the results.

Tables 4.3.13 and 4.3.14 show the Granger-causality tests for the postulated hypotheses that: 1) changes in the policy ratio (RBS/BB) cause changes in (i_m); and, 2) changes in the policy variable (RBF) cause changes in (E).

In testing the first hypothesis, regarding the causality between (i_m) and (RBS/BB), it was considered that the price level, (P), may affect the (RBS/BB) ratio but is contemporaneously correlated with (i_m). In this case, as suggested by Pindyck and Rubinfeld (1991), we run the standard Granger-causality regressions using lagged values of (P) as additional regressors. The Granger-causality regressions were run for post-deregulation periods, using 2, 4, 6, and 8 quarter lag lengths so as to increase the robustness of the results. The principal findings are that:

- 1) the money market rate of interest Granger-causes the policy ratio (RBS/BB),
- 2) the Reserve Bank policy ratio, (RBS/BB), does not Granger-cause the money market rate of interest, (i_m),
- 3) the exchange rate (E) Granger-causes the Reserve Bank's holdings of foreign reserves, (RBF),
- 4) the Reserve Bank's foreign reserves, (RBF), do not Granger-cause the exchange rate, (E).

These results are consistent with the specification of the money market rate of interest and the exchange rate equations (4.21) and (4.24), and the modelling of the

Table 4.3.13: The results of the Granger causality regressions between the policy variable ratio (RBS/BB) and the money market interest rate (i_m)

Sample period: 1982:3 to 1993:4

	2 lags	4 lags	6 lags	8 lags
1. (RBS/BB) \rightarrow i_m	.650 (.630)	1.24 (.300)	1.06 (.416)	1.13 (.371)
2. $i_m \rightarrow$ (RBS/BB)	.607 (.660)	1.87 (.088)	1.40 (2.07)	2.42 (.018)

Note:

Table (4.3.13) shows the F-statistics from the Granger causality regressions between the policy variable (RBS/BB) and the money market rate of interest, (i_m), in the period 1982:3 to 1993:4. Figures in parentheses represent P-values.

Table 4.3.14: The results of the Granger causality regressions between the policy variable (RBF) and the exchange rate (E)

Sample period: 1984:1 to 1993:4

	2 lags	4 lags	6 lags	8 lags
1. RBF \rightarrow E	1.08 (.350)	1.34 (.300)	1.69 (.165)	1.56 (.193)
2. E \rightarrow RBF	2.25 (.120)	2.06 (.110)	3.10 (.190)	1.89 (.111)

Note:

Table (4.3.14) shows the F-statistics from the Granger causality regressions between the policy variable (RBF) and the exchange rate, (E), in the period 1984:1 to 1993:4. Figures in parentheses represent P-values.

policy reaction functions, represented by equations (4.28) and (4.29). The absence of the effects of the policy ratio (RBF/BB) on the money market interest rate, and the absence of the effects of the policy variable (RBF) on the exchange rate, are consistent with the mechanisms expected for the implementing of monetary policy post-deregulation. In this period the monetary authorities rely to a greater extent on open market operations than on instruments which have direct impact on the asset market equilibrium conditions. The model under discussion takes into account the repercussions of open market operations through the effects of changes in the cash market interest rate, (i_a), on the money market interest rate, (i_m), and through this rate, and hence the real interest rate differential, on the exchange rate (E). The latter repercussions of open market operations were considered significant despite the measurement problem for the weighted-average real interest rate of foreign assets in equation (4.24).

4.4 Conclusions

In this chapter an asset market model, in which the supply of assets is endogenous, has been specified and estimated for Australia in the period 1978-1993. The structural equations estimated in this model are the demand and supply equations in the money and foreign asset markets, and the policy reaction functions. The response of the model to the process of financial deregulation is reflected in the operation of each of these equations. In the foreign asset market, the increased integration with overseas capital markets in the post-float period is analysed by the determinants of capital flows, such as the interest rate differential and investors' expectations of changes in the spot exchange rate.

There is evidence that expected interest differentials affect capital flows, and hence asset demands and supplies, and the exchange rate. The expected interest differentials themselves are affected by fundamentals such as relative expected secular inflation, and unexpected changes in the trade balance, which are used as indicators of real shocks requiring adjustments in the equilibrium real exchange rate. This treatment

of the expectations mechanism in the foreign exchange market is consistent with exchange rate overshooting as observed in flexible exchange rate regimes. In this model the responses of capital flows and the exchange rate to *monetary changes*, and hence to changes in the interest rate differential, are reflected in changes in the private sector's holdings of net foreign assets. The next chapter examines further aspects of the interest rate effects of *monetary changes* on net foreign borrowings, in a portfolio-loan model which embodies banks asset and liability choices in the determination of the money supply and foreign borrowings.

Appendix 4.A

This appendix briefly represents the names of variables and the data used for the variables.

<i>Variable</i>	<i>Description</i>
W	the private sector total outstanding stock of assets equal to the sum of the money base, H, the values of Commonwealth government securities, B, and equities in the stock exchange market, EQ, and net foreign asset (foreign borrowings) of the private sector, F,
i_f	the rate of interest on foreign assets, as the weighted average of the overseas short-term rate of interest including the US 3-month inter bank rate and Japanese call money rate with weights equal to 1/3, and the UK and German 3-month inter bank rates with weights equal to 1/6,
E	the spot exchange rate (\$A per \$US),
E^e	the expected spot exchange rate at quarter t, made at quarter t-1,
H	the money base, currency plus banks reserves,
P	implicit price deflator for GDP,
i_m	the rate of interest on 90-day bank accepted bills
Y	real GDP,
i_a	the rate of interest in the short-term cash market,
i_d	the loan rate, the rate on overdrafts less than \$100,000,
F	net foreign assets (borrowings) of the private sector, denominated in \$US,
FT	net foreign assets (borrowings) of the public and private sectors, denominated in \$US,
P_f	OECD consumer price index,
π	the Australian inflation rate,
π_f	the US inflation rate,
TB	trade balance on goods and services,
YT	trend growth of nominal GDP,
E'	equilibrium exchange rate, as the real rate in terms of OECD consumer price index,
RBS	the Reserve Bank holdings of the Commonwealth government securities,

<i>Variable</i>	<i>Description</i>
BB	cumulative government deficit, as the nominal value of total interest-bearing debt,
LF	total labour force,
YP	the average productivity of total labour force,
FRB	the reserve bank holdings of foreign assets,

Appendix 4.B

Tests for Unit Roots and Time Trends

These tests are typically based on equations of the following forms:

$$\Delta X_t = \alpha_0 + \alpha_1 \cdot X_{t-1} + \alpha_2 \cdot T + \sum_{j=1}^n \gamma_j \cdot \Delta X_{t-j} + \varepsilon_{1t} \quad 4.B.1$$

$$\Delta^2 X_t = \beta_{10} + \beta_{11} \cdot \Delta X_{t-1} + \beta_{21} \cdot T + \sum_{j=1}^n \gamma_{1j} \cdot \Delta^2 X_{t-j} + \varepsilon_{2t} \quad 4.B.2a$$

$$\text{or} \quad \Delta^2 X_t = \beta_{12} \cdot \Delta X_{t-1} + \sum_{j=1}^n \gamma_{2j} \cdot \Delta^2 X_{t-j} + \varepsilon'_{2t} \quad 4.B.2b$$

where T is a time trend, and ε_{1t} , ε_{2t} and ε'_{2t} are white noise. Sufficient terms in the AR process for $\sum \gamma_j \Delta X_{t-j}$ and $\sum \gamma_j \Delta^2 X_{t-j}$ are added to ensure non-autocorrelated residuals.

Equation 4.B.1 encompasses two different types of trend: stochastic trend and deterministic trend. Spurious correlations may occur between variables display a non-stationary process with each of the two types of trend. To test the equation for non-stationarity with need to test whether the equation has a unit root with drift, *i.e.* whether $\alpha_1=0$ and $\alpha_0 \neq 0$. If we reject the null hypothesis that $\alpha_1=0$, then this implies stationarity. The test for non-stationarity requires that we compare the t-statistic of α_1 with the critical values in the Fuler (1976) table.

In the case of non-stationarity, it is customary to test the joint hypothesis $\alpha_1=\alpha_2=0$. Failure to reject this joint hypothesis implies that (X_t) is subject to a stochastic but not a deterministic trend. Nelson and Plosser (1982) provided evidence that most economic time series do not display both types of trends. The joint hypothesis $\alpha_1=\alpha_2=0$ can be tested by comparing the usual F-statistic from equation 4.B.1 with the table presented by Dickey and Fuller (1981). A stochastic trend may be stationary by first differencing. This implies that, having found a series (X_t) to be non-stationary, rather than assume the first difference is stationary we must apply the Dickey-Fuller test to (Δx_t) . To determine whether (Δx_t) is stationary we estimate equations 4.B.2a and 4.B.2b. The DF statistics now refer to the coefficients of (ΔX_{t-1}) in

these equations. If we reject the null hypothesis that $\beta_{11}=0$ or $\beta_{12}=0$, then this implies stationarity.

Table 4.B reports the t-statistics for α_1 , β_{11} and β_{12} , for testing $\alpha_1=0$, $\beta_{11}=0$, $\beta_{12}=0$, and the F-statistics of equation 4.B.1 for testing $\alpha_1=\alpha_2=0$.

Table 4.B. Tests for unit roots and time trends

X	$\alpha_1=0$	$\alpha_1=\alpha_2=0$	order of AR	$\beta_{11}=0$	order of AR
				$\beta_{12}=0$	order of AR
log(H/P)	-2.15	1.96	1	(-3.11) (-4.45)***	5 2
log(i_m)	-2.00	3.80	4	(-3.42)* (-2.44)**	5 3
log[E ^e /E ₀ (1+i _f)]	-2.39	4.57	5	(-6.62)*** (-6.61)***	2 2
log(Y)	-2.73	3.08	5	(-3.80)** (-2.36)**	3 3
log(W/P)	-1.59	1.34	1	(-4.88)*** (-4.70)***	1 1
log(i_a)	-.744	1.10	1	(-5.71)*** (-5.08)***	1 1
log(i_f)	-2.94	3.07	5	(-3.76)** (-3.49)***	2 2
log(H)	-1.09	1.90	5	(-3.20)* (-2.52)**	5 2
log(F/P)	-.47	4.40	7	(-3.91)** (-1.76)*	6 2
log(E)	-1.53	.990	1	(-8.30)*** (-3.63)***	0 2
log(E')	-1.56	.994	1	(-3.86)** (-3.79)***	2 2
log(P/P _f)	-2.34	3.43	6	(-1.64) (-1.65)*	3 6
($i_m-\pi$)-($i_f-\pi_f$)	(-4.16)***	(24.9)***	1		
TBII	-160	2.96	2	(-3.74)** (-3.12)***	1 1
log(i_f .F)	-1.17	4.49	2	(-8.01)*** (-3.05)***	1 2

X	$\alpha_1=0$	$\alpha_1=\alpha_2=0$	order of AR	$\beta_{11}=0$ $\beta_{12}=0$	order of AR order of AR
log(W)	-1.79	1.32	1	(-4.96) ^{***} (-3.45) ^{***}	1 2
P	-2.92	3.34	6	(-3.75) ^{**} (-2.68) ^{***}	1 2
log(RBS/BB)	-1.68	2.93	1	(-6.52) ^{***} (-10.5) ^{***}	1 0
log($\overline{Y/Y}$)	-2.73	3.08	5	(-2.57) ^{***} (-2.61) ^{***}	4 4
($\overline{LF/LF}$)	-1.08	2.11	1	(-5.30) ^{***}	1
($\overline{YP/YP}$)	-2.61	4.35	1	(-7.30) ^{***}	1
log(RBF)	-1.63	1.64	1	(-4.96) ^{***} (-7.09) ^{***}	2 0
log(FT)	-.054	3.53	7	(-4.16) ^{***} (-2.19) ^{**}	1 1
log[E.(P_f/P)]	-1.63	1.19	1	(-3.85) ^{***} (-8.59) ^{***}	2 0

Note:

1. Full sample 1978:3 to 1993:4, Quarterly.

2. P is cumulative residuals obtained from regressing the actual GDP deflator against time trend variables T and T².

3. ($\overline{LF/LF}$) and ($\overline{YP/YP}$) are cumulative processes whose first differences are stationary.

4. (***) significant at the 99% level,

(**) significant at the 95% level,

(*) significant at the 90% level.

The results show that all variables, except $(i_m - \pi) - (i_f - \pi_f)$, follow a stochastic trend and are non-stationary but become stationary after first differencing, *i.e.* they are $I(1)$.

Appendix 4.C

Proxies for the Expected Spot Exchange Rate, Using Auto-Regressive Process

The estimation of the auto-regressive (AR) process for the spot exchange rate is represented in this appendix, using the least squares method. To test the stationarity of the exchange rate data, we applied Dickey-Fuller tests to (E), and then to (ΔE). Because of the OLS bias, the critical values of the Dickey-Fuller table (1981) and Fuller table (1976) are used to test the hypotheses of stochastic trend and non-stationarity of the data, respectively. We found that (E) is a difference stationary process, and the first difference of (E), *i.e.* (ΔE), is stationary. The result is shown in *appendix 4.B*.

To determine the order of autoregressive process for the estimation of the expected exchange rate with (ΔE), we used the adjusted R^2 , partial autocorrelation, and Akaike's FPE criteria in the autoregressive process, and applied Durbin's *h* test and the Schwartz Bayesian criterion, (SBC), to test the goodness of fit of the AR process.

Table 4.C.1 shows that in the autoregressive process of order 4, *i.e.* $p=4$, partial autocorrelation is maximum and FPE is minimum. Also, that order of the AR process has the highest adjusted R^2 , and amongst the first four AR's has the lowest SBC. The result of Durbin's *h* test shows that we cannot reject the null hypothesis of no serial correlation at the 5% level of significance for auto-regression(s) of degree(s) 4 (and 2, 5, and 6).

Table 4.C.1

p	partial auto-correlation	FPE	SBC	\bar{R}^2	DW	Durbin's h (h Alt.)
1	0.0094	0.5482E-3	-7.474	0.491	1.99	-1.428
2	0.104	0.5514E-3	-7.452	0.494	1.98	0.942
3	-0.0686	0.5539E-3	-7.427	0.495	2.02	-2.299
4	-0.167	0.5480E-3	-7.423	0.507	2.00	-0.367
5	-0.0271	0.5566E-3	-7.389	0.504	1.99	0.494
6	0.0365	0.5649E-3	-7.357	0.502	1.98	0.317

Table 4.C.2 gives the result of the estimation of the auto-regressive process of order 4 for the first difference of the spot exchange rate, (ΔE).

Table 4.C.2

Auto-Regression process for the spot exchange rate, ΔE , of order 4.

Dependent variable	Explanatory variables				
	ΔE_{t-1}	ΔE_{t-2}	ΔE_{t-3}	ΔE_{t-4}	
ΔE_t	-0.00284	0.00281	0.123	-0.065	-0.168
	** (-1.645)	(0.038)	** (1.689)	(-0.891)	** (-2.30)
$\bar{R}^2=0.507$ DW=2.00 Durin's h (alt.)=-0.37					

Notes:

1. Full Sample 1978:1 to 1993:12, Monthly.
2. t-statistics are in parentheses.
 (**) significant at 5 percent.

To calculate the expected spot exchange rate one month ahead, *i.e.* E_{t+1}^e , we replace the value of the coefficients in the above table in the following equations.

$$\Delta E_{t+1}^e = \alpha_0 + \alpha_1 \cdot \Delta E_t + \alpha_2 \cdot \Delta E_{t-1} + \alpha_3 \cdot \Delta E_{t-2} + \alpha_4 \cdot \Delta E_{t-3}$$

$$E_{t+1}^e = E_t + \Delta E_{t+1}^e$$

Chapter 5

A Simple Portfolio-Loan Model of the Financial Sector

5.1 Introduction

The model of asset market behaviour, including assets such as the public's deposits and bank loans, allows for further aspects of the interest rate effects of monetary changes on demand and supply in financial markets. In chapter three we examined the role played by these assets in the monetary transmission mechanism which includes the banks balance sheet identity in an asset market model. In this chapter we evaluate the portfolio-loan approach to monetary changes, which embodies the principle features of the portfolio balance model, analysed in the previous chapter, and takes into account the effects of bank lending on the money supply and net foreign borrowings. This represents the principle difference between the portfolio balance theory and the portfolio-loan approach. The different implications of this approach are introduced by the post-Keynesian's view of loan accommodation, and the Stiglitz and Weiss (1981) approach to credit rationing.

As we have noted in subsection 3.3.3 Palley's (1994) post-Keynesian model is suggestive of *a*) the importance of the private initiatives of banks for loan accommodation, and *b*) the structurally endogenous nature of money and loans. In Palley's model the marginal revenue on loans equalled the marginal cost of deposits, and the loan supply adjusts to fully accommodate changes in the demand for loans. The lending channel in the credit rationing approach is based on a quite different treatment of loan rate and loan supply determination. King (1986) introduced the relevance of the credit rationing approach in a model whereby the loan rate is determined solely by the risk of borrowers default, and in the credit-rationed state an increase in the demand for loans leaves the volume of loans unchanged. Jaffee and Stiglitz (1990) argued that

the theory of disequilibrium estimation can be applied to the loan market, to estimate the demand and supply curves and the amount of credit rationing.

In subsection 3.3.4, disequilibrium models were analyzed under different assumptions of loan market imperfections: *a)* imperfect adjustment of loan rates, and *b)* loan rate controls. Maddala (1983) introduced the basic characteristics of rationing models, using the assumption of *controlled prices (loan rates)* as the major sources of disequilibrium. In this chapter we evaluate the implications of the links between the bank loan market and the asset markets in terms of the post-Keynesian view and the new Keynesian approach to credit rationing. The latter approach is considered in a manner consistent with the Maddala's specification of rationing models.

Another important aspect of this analysis is the links between the loan market and the financial markets for securities of different maturities. In subsection 3.3.5 we concluded that such links are suggestive of the importance of portfolio investors' interest in borrowing from the banking sector for raising funds in the markets for securities with different terms to maturity. In this chapter we examine the implications of credit rationing for portfolio investors' preferences for securities with different yields to maturity, using the expectations theory of the term structure of interest rates.

The next section presents the structural equations of a simple portfolio-loan model. Section 3 develops the specification of the expectations theory of term structure. Section 4 presents two channels of the transmission mechanism in a simple model which is a variant of the textbook IS-LM framework. This model permits us to incorporate the implications of loan market imperfections into the monetary transmission mechanism. In section 5 we present a simple model of bank's optimizing behaviour, and examine the implication of credit rationing for bank behaviour, regarding the expectation of the default cost of bonds in the bank choices of bonds and loans. In this treatment, bond default provides the bank with information concerning the likelihood of default in asset markets and the risk of borrower default. This is the fundamental to the links between the bank loan market and asset markets in this thesis. Section 6 presents conclusions.

5.2 Specification of the portfolio-loan model

This section examines the implications of the model of asset market behaviour which deals with assets in the portfolio of the private sector, and assets and liabilities in the banks balance sheet identity. In this identity, bank loans are determined under conditions of uncertainty, concerning the risk of borrowers default in the repayment of loans. This source of uncertainty implies that there are instances in which borrowers receive loans of a smaller size than desired at a given loan rate. Such instances can be analysed by disequilibrium models in which the major source of disequilibrium is bank controls on loan rates.

The modelling of bank choice of assets and liabilities in this chapter, using a disequilibrium model of the loan market equations, embodies the new Keynesian approach to credit rationing whereby the underwriting process for new risky assets is intensive in gathering information concerning the borrowers' credit worthiness, and the likelihood of default is reflected in the rate of return required by asset holders. The difference from Palley's (1994) post-Keynesian model is the inclusion of banks optimal lending under credit rationing, and/or the disequilibrium modelling of the loan market.

As we have already noted, in the Palley's model the private initiatives of the banking sector provide banks with the ability *to fully accommodate the demand for loans* at the minimum cost of financing. In this approach, the banks secondary assets, bonds, are treated as a buffer for variations in the loan demand and the demand for deposits. In accordance with the Palley's model, the lending channel in this chapter allows for *a)* the private initiatives of banks in the determination of the actual volume of loans, and *b)* the buffer stock role of bonds in the banks balance sheet identity. This treatment in the following model allows for the same causality relationship between money and loans as implied by Palley's portfolio-loan model.

The equations of the model are as follows:

Money market

$$| C^d = C^d(i_m, i_c, (E^e/E).(1+i_f), Y, W) \quad (5.1)$$

$$| DD^d = DD^d(i_m, i_c, (E^e/E).(1+i_f), Y, W) \quad (5.2)$$

$$TD^d = TD^d (i_m, i_c, (E^e/E).(1+i_f), Y, W) \quad (5.3)$$

$$H^d = H^d (i_m, i_c, (E^e/E).(1+i_f), Y, W) \quad (5.4)$$

$$m = m (i_a, i_m, i_c, i_d) \quad (5.5)$$

$$(DD^s+TD^s) = m \cdot NBR (i_a, i_d, \dots) \quad (5.6)$$

$$(DD^d+TD^d) = (DD^s+TD^s) \{ = (DD+TD) \} \quad (5.7)$$

$$H^s = C^d + m' \cdot (DD+TD) \quad (5.8)$$

$$H^d = H^s (= H) \quad (5.9)$$

Foreign asset market

$$(F^d.E) = F^d (i_m, i_c, (E^e/E).(1+i_f), Y, W) \quad (5.10)$$

$$E = E (\{ (i_m - \pi) - (i_f - \pi_f) \}, \tau, \Sigma [TB_t - (1-\lambda)TB_{t-1} - \lambda.TB_{LR}], \{ i_f.F^s \}) \quad (5.11)$$

$$F^d = F^s (= F) \quad (5.12)$$

Portfolio-balance condition

$$W^d = W^d (W_{(-1)}, i_m, i_c, (E^e/E).(1+i_f)) \quad (5.13)$$

$$W = H + (B + EQ) + (E.F) \quad (5.14)$$

$$W^d = W \quad (5.15)$$

Loan market

$$L^d = L^d (i_d, i_m, Y) \quad (5.16)$$

$$L^s = L^s (i_d, i_m, (DD+TD)) \quad (5.17)$$

$$\Delta i_d = i_d ((L^d - L^s), i_m, (DD+TD)) \quad (5.18)$$

$$L^e = \min (L^d, L^s) \quad (5.19)$$

$$L^e + NBR + B_b = DD + DT \quad (5.20)$$

Policy reaction functions

$$(RBS/BB) = RBS (i_m, \overline{GDP/GDP}, P) \quad (5.21)$$

$$RBF = RBF (F, E, P/P_f) \quad (5.22)$$

where

TD^d = the demand for term deposits,

NBR = the non-borrowed reserves of banks, defined as the sum of required reserves and free reserves,

$DD^s + TD^s$ = the supply of deposits, demand deposits plus time deposits,

i_c = the rate of interest on short-term deposits,

i_d = the rate of interest on loans,

λ = a constant fraction of the gap between the actual and equilibrium (TR) to be filled in the next period,

τ = the estimated parameter in the regression equation for the long-run equilibrium real exchange rate, using a predetermined value for (1),

TB = the trade balance, deflated by trend nominal GDP,

TB_{LR} = the equilibrium long-run trade balance, deflated by trend nominal GDP,

W^d = the demand for the total outstanding stock of the assets in the private sector portfolio,

W = the total outstanding stock of the assets in the private sector portfolio,

L^d = the demand for loans,

L^s = the supply of loans,

Δi_d = changes in the loan rate, equal to $(i_{d,t} - i_{d,t-1})$,

L^e = the transacted quantity of loans.

B_b = the banks holdings of bonds, treated as secondary reserves.

The variables in equations (5.1)-(5.22) are classified as follows:

Identities:

$$W = H + B + EQ - (E.F)$$

$$L^e + NBR + B_b = DD^d + DT^d$$

Endogenous variables:

$C^d, DD^d, TD^d, H^d, (DD^s+TD^s), NBR, H^s, m, i_m, i_c, F^d, F^s, E, W^d, W, (B+EQ), L^d, L^s, L^e, B_b, i_d, (RBS/BB), RBF.$

Exogenous variables in the financial sector:

$i_a, i_f, P_f, TB_{LR}, (i_f.F^s)_{LR}, E^e, \pi_f.$

Variables determined in the real sector:

$Y, TB, P, \pi, (\overline{GDP/GDP}).$

Equations (5.1)-(5.4), (5.10) and (5.13) represent the demand for currency, demand deposits, term deposits, the money base, net foreign assets and the total outstanding stock of assets in the private sector portfolio. Equation (5.5) represents a functional form of the money multiplier. Equations (5.6) and (5.8) represent the supply of deposits and the money base which is specified by a credit divisor equation. In equation (5.6), the banks' holdings of reserves (NBR) are treated as dependent upon the interest rate policy instrument, (i_a), and upon bank loans, via the rate of return on loans. Equation (5.11) is the exchange rate equation which has the same functional form as estimated in the previous chapter. Equations (5.7), and (5.9) represent the equilibrium conditions in the money market, and equations (5.12) and (5.15) represent the equilibrium conditions for foreign assets and for the total outstanding stock of assets in the private sector portfolio, respectively. Equation (5.14) represents the portfolio-balance condition for the assets in the consolidated balance sheet of the non-bank private and banking sectors. Equations (5.16) and (5.17) represent the demand for and supply of loans, and equation (5.18) represents loan rate determination under a disequilibrium condition in the loan market. Equation (5.19) represents the disequilibrium condition in the loan market which is implied by the minimum condition for the transacted quantity of loans. Equation (5.20) represents the banks balance sheet identity. Equations (5.21) and (5.22) are the policy reaction functions which have the same form as estimated in the previous chapter.

The principle differences between this model and the model estimated in the previous chapter are: 1) the inclusion of the effects of bank lending on the supply of money, and the disequilibrium modelling of the bank loan market; and, 2) the inclusion of the demand for and supply of bank liabilities, deposits, and the modelling of bank choices, regarding the composition of bank assets and liabilities. Bank choice of the composition of assets and liabilities embodies Palley's (1994) treatment of the buffer stock approach to the banks holdings of secondary assets, bonds. In Palley's model holdings of secondary assets, (B_b), are treated as a buffer for disequilibria in the deposit and bank loan markets. The effects of loans on the money supply represents the core difference between the portfolio-loan model and the asset market model estimated in chapter four. In the latter model such effects are irrelevant to interest rate effects of monetary changes on net foreign borrowings.

The other important differences are: 1) the inclusion of the market determined rates of interest (i_c) and (i_d) in the money market equations, which reflect the fact that there may be variable spreads between these rates and the money market interest rate, (i_m); and, 2) the modelling of the effects of bank lending, *i.e.* (L^d-L^s), on the rate of interest of earning assets, (i_m), through loan rate adjustments which is modelled by equation (5.18). The asset market model estimated in the previous chapter abstracts from the interest rate effects of changes in the volume of loans, or (L^d-L^s), on net foreign borrowings.

The model represented by equations (5.1)-(5.22) is modified from a basic LM curve and represents the operation of key relationships within financial markets. The relationships in the model determine variables such as the supply of the money base and of deposits in banks, the transacted quantity of loans, the money market interest rate, the loan rate and the exchange rate. In the model, the demand equations for currency, demand and time deposits, the money base, net foreign assets and the behavioural equation for the total outstanding stock of assets in the private sector portfolio, are specified in accordance with the structure of the model examined in the

previous chapter¹. A reduced-form equation for the supply of the money base can also be obtained from the same procedure as implied in subsection 4.2.1. The resultant equation in an inverse functional form can be written as

$$i_m = i_m(i_a, i_f, i_c, i_d, H^S). \quad (5.8a)$$

Following the same procedure for the specification of the supply equations in the money market as implied in subsection 4.2.1, we obtain the following equation for the supply of deposits

$$(DD^S+TD^S) = m(i_a, i_m, i_c, i_f, i_d) \cdot NBR. \quad (5.6a)$$

The inverse functional form of the above equation can be written as

$$i_c = i_c(i_a, i_m, i_f, i_d, (DD^S+TD^S), NBR). \quad (5.6b)$$

Equations (5.8a) and (5.6b) allow for the effects of the loan rate on the money market equilibrium conditions which are modelled in a manner consistent with the post-Keynesian view on the endogeneity of money.

A consistent solution for the model implies that banks asset and liability choice is affected by changes in the money market interest rate, (i_m). In the equation for the supply of loans, equation (5.17), an increase (decrease) in (i_m) reflects a rise (fall) in the risk of borrowers default which reduces (increases) the supply of loans. An increase in (i_m) raises the demand for loans. The disequilibrium condition in the loan market represents loan market imperfections, regarding imperfect adjustment of the loan rate. Loan rate adjustment in equation (5.18) is made stochastic. This is based on the assumptions that (Δi_d) is observed and can be specified under some rules, using some specific historical data. Also, in this equation it is assumed that if $\Delta i_d > 0$, then we have excess demand, *i.e.* $L^d - L^s > 0$; and if $\Delta i_d < 0$, then we have excess supply, *i.e.* $L^d - L^s < 0$. This implies that (Δi_d) and ($L^d - L^s$) in equation (5.18) are positively correlated.

¹. For simplicity we can drop (i_c) from all demand equations other than the equation for (TD^d) without significant change in the nature of the model. In this regard the assumption needed for that simplification is that (i_c) and (i_m) will move together. On this assumption the close relationship between (i_c) and (i_m) does not mean necessarily that the two rates differ only by a constant spread. A different spread can be specified in the inverted supply functions for the money base and/or deposits which allow for the relationship between (i_c) and (i_m).

The specification of the loan market will be discussed in more detail in the next subsection.

The specification of the demand and supply equations in the loan market, and hence the lending channel in the model, incorporates a disequilibrium condition which may allow for either form of loan market imperfection: non-market clearing due to sluggish adjustment of the loan rate, or loan rationing with imperfect information. In the former case imperfect adjustment of loan rates is the major source of disequilibrium. In the latter case controlled loan rates are the major sources of disequilibrium. The disequilibrium modelling of the demand and supply of loans is elaborated in the following discussion.

5.2.1 Loan market specification

Disequilibrium states in the bank loan market can be explained by two types of disequilibrium models. The first type of model allows for disequilibrium only in the periods when there are rationing situations in the loan market. In this type of model *the controlled loan rate* is viewed as the major source of disequilibrium in the loan market. The second type of model takes account of disequilibrium in periods of both rationing and non-rationing situations. In this type of model, both *imperfect adjustment of loan rates* and *loan rate controls* are treated as the sources of disequilibrium. While it is expected that both types of models provide satisfactory estimates of the amount of credit rationing, $L^d - L^s > 0$, the theory of disequilibrium estimation with specific applications to the loan market, presented by Bowden (1978), Laffont and Garcia (1977), Sealey (1979), and King (1986), deals only with the second type of model.

There is one specification for the first type of disequilibrium model, and four for the second type. In the first specification, when disequilibrium occurs only in rationing periods, a general representation for loan market behaviour can be described by the following equations:

$$L^d = L^d(i_d, (i_m, \dots), Y)$$

$$L^s = L^s(i_d, (i_m, \dots), D)$$

$$\left| \begin{array}{ll} L^e = L^s(i_d, (i_m, \dots), D) & \text{if } L^e = L^s < L^d \\ & \text{or } i_d^e > i_d \\ L^e = (L^d = L^s) & \text{otherwise} \end{array} \right.$$

where

(i_m, \dots) = a vector of the rates of interest in financial markets,

L^e = the actual quantity of loans, representing banks optimal lending,

D = the public's deposits in banks,

i_d^e = the short-term rate of interest of loans that equilibrates demand and supply in the loan market.

In this model *the disequilibrium condition* implies that, in a sample period, rationing situations appear only in the periods when there are loan rate controls, and that actual loan rates are set below the market-clearing level, (i_d^e) . In these periods, the loan market is in disequilibrium and there are positive excess demands. In the other periods, the loan market is expected to be in equilibrium. Maddala (1983) represented an appropriate specification for the theory of disequilibrium estimation with price controls. Maddala's specification of disequilibrium models can be used with specific applications to the loan market.

Figure (5.1) illustrates the loan market in a rationing model in which in the credit-rationed state (i_d) equals (i_d^c) , the controlled loan rate. This rate is assumed to be determined exogenously or under some rules based on some specific historical data. In this model the supply schedule is stable but the demand schedule shifts to the left to accord with the quantity supplied when rationing arises and the loan rate is set below the equilibrium loan rate, (i_d^e) .

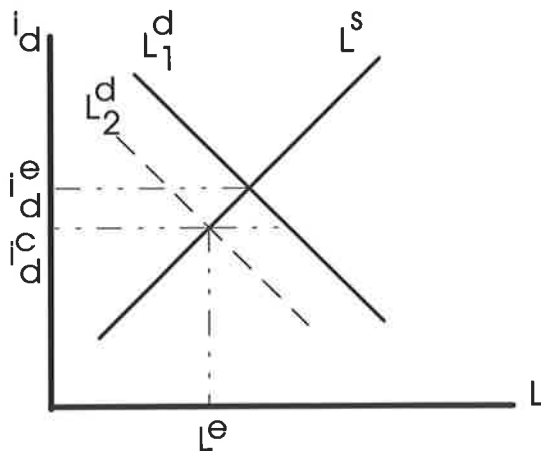


Figure 5.1

Alternatively, the rationing situation in the loan market can be analyzed by only positive excess demand, using a disequilibrium hypothesis in all the periods. Fair and Jaffee (1972) developed a basic technique which estimates the loan demand and supply schedules in a disequilibrium model. Further developments in the estimation of these models are represented by Amemyia (1974, 1985), Maddala and Nelson (1974) and Maddala (1983), using limited-dependent-variable methods. Specific applications of these models to loan markets are discussed by Laffont and Garcia (1977), Bowden (1978), Sealey (1979) and King (1986).

In disequilibrium models, the transacted quantity of loans, (L^e), corresponds to the supply schedule or to the demand schedule, depending on whether the excess demand is, respectively, positive or negative. In these models, the transacted quantity of loans can be specified by the demand and supply schedules and a minimum condition as

$$L^d = L^d(i_d, (i_m, \dots), Y)$$

$$L^s = L^s(i_d, (i_m, \dots), D)$$

$$L^e = \min \{L^d, L^s\}.$$

The above specification is shown in figure (5.2), where the darkened portions of the demand and supply schedules show the observed quantity of loans.

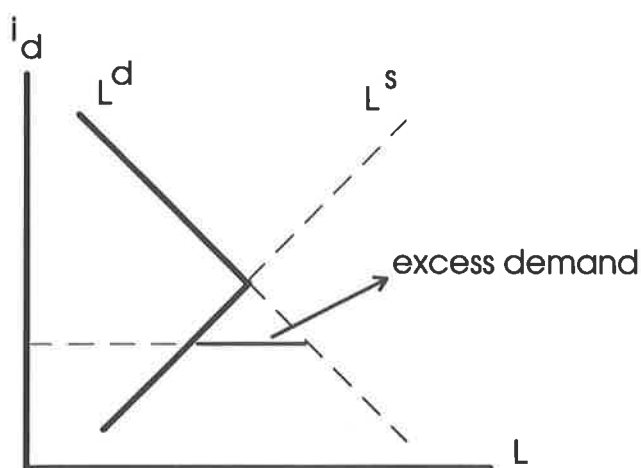


Figure 5.2

The minimum condition in figure (5.2) shows that when the excess demand is positive, the observed quantity of credit is on the supply function, and when the excess demand is negative the observed quantity is on the demand function. This is the rationale for the specification of loan market behaviour in disequilibrium models. These models can be represented under four different conditions which are concerned with the specification of disequilibrium models in the limited-dependent-variable framework. A detailed specification of the equations in these models is presented in *appendix 5*. The following discussion presents the basic characteristics of four models in which imperfect adjustment of loan rates is the major source of disequilibrium.

1) The models which are specified solely with a minimum condition such as $L^e = \min\{L^d, L^s\}$ take no account of the loan rate-adjustment mechanism, or a priori sample separation into the demand category and the supply category, in the specification of loan market behaviour.

2) The models with an additional condition, which is concerned with sample separation into the demand category and the supply category, take into account an *a priori* condition implying that: a) a positive loan rate differential between two periods, *i.e.* $\Delta i_{d,t} > 0$, represents excess demand in the former period; and, b) a negative loan rate differential, *i.e.* $\Delta i_{d,t} < 0$, represents excess supply in the former period. These models are referred to as directional models by Fair and Jaffee (1972). In this treatment, excess demand implies that the volume of loans is supply determined, and

excess supply suggests that loans are demand determined. In these models, even if the sample separation is correct, the condition implied by an *a priori* sample separation abstracts from the effects of other determinants of the supply of and demand for loans.

3) The models in which the minimum condition is considered with the other condition represented by

$$\Delta i_{d,t} = \gamma \cdot (L_t^d - L_t^s)$$

where $0 < \gamma < 1$ represents the adjustment coefficient for the loan rate. These models are referred to as quantitative models by Fair and Jaffee (1972). In these models the information on $(\Delta i_{d,t})$ can be used to classify the observations into those belonging to the demand category and the those belonging to supply category. The estimation of these models, as suggested by Amemiya (1974a) and Maddala (1983), is represented by the inclusion of $(L^d - L^s)$ in the supply and demand functions.

4) The remaining models are specified by the minimum condition $L^e = \min\{L^d, L^s\}$, and the loan rate-adjustment mechanism given by

$$\Delta i_{d,t} = \gamma \cdot (L_t^d - L_t^s) + u_t$$

In these models the adjustment mechanism for $(\Delta i_{d,t})$ is made stochastic, and there is no *a priori* condition for sample separation. Maddala (1983) argued that the specification of these models, as well as the models in the first category, without an *a priori* sample separation, results in correct statistical analysis, using limited-dependent-variable methods. This treatment of the disequilibrium condition in the modelling of the loan market was previously represented by equations (5.16)-(5.19). In this specification of the disequilibrium condition, we assume that in the credit-rationed state 1) the loan rate mechanism in the financial sector is determined by customer relationships between lenders and borrowers, and 2) bank lending, as typical of most lending, is based on imperfect information in the loan market.

The two types of disequilibrium models outlined above can be used to look for evidence that banks, in the aggregate, ration loans by non-price means. These models are in contrast with the models which only allow for a market-clearing condition, and

hence the market-equilibrating loan rate. As will be discussed shortly, in the models concerning credit rationing, the Walrasian market-equilibrating interest rate occurs generally at the level above, or equal to, the interest rate which maximizes the expected return to the banks².

The second type of disequilibrium model is based on the assumption that the loan market predominantly exhibits either excess demand or excess supply. This is because depositors, as the suppliers of loans (or more accurately suppliers of loanable funds), and borrowers, as the applicants for loans, meet supply and demand sides of the loan market with opposite incentives. The depositors seek to hold their savings without regard to default risk, and the borrowers seek to invest on projects which involve default risk³. To provide depositors with their expected safety from default, it is required that there should be a greater probability for excess demand than excess supply in the loan market. A greater probability for excess demand in the disequilibrium models means that there are considerably more periods of excess demand than periods of excess supply. In such a circumstance the second type of disequilibrium model provides estimates of excess demand under the same conditions as implied by the first type of models; namely the rationing models.

In the rationing models, when disequilibrium is considered in the periods of excess demand, *the equilibrium rationing hypothesis* implies that, 1) borrowers accept what is offered at the (controlled) ceiling rate, when the ceiling rate⁴ is less than the market-equilibrating loan rate; and, 2) there is never a case of predominantly excess supply in the loan market when the controlled rate is greater than the market-equilibrating rate. This implies that the loan rate, (i_D), is determined at the level equal

². The expected return is viewed as the required rate of return a bank must earn on each loan, given that it allows for expected loss if default occurs.

³. It should be noted that an excess supply of loans does not mean banks hold excess deposits in their balance sheet idle. Banks' asset management operations give rise to the banks investment on government securities, as their liabilities are in excess to their supply of loans. In the case of excess demand for loans, the government securities in the banks balance sheet identity can be viewed as banks secondary reserves.

⁴. The ceiling rate is set at the level which maximizes expected return to banks.

to the controlled loan rate, (i^c_d), which is in turn equal to or less than the equilibrium loan rate, (i^e_d), *i.e.* $i_d=i^c_d=i^e_d$ or $i_d=i^c_d<i^e_d$. Also, given that the transacted quantity of loans, (L^e), is determined by the minimum condition, $L^e=\min\{L^d,L^s\}$, when $i_d=i^e_d$, the loan market is in equilibrium, *i.e.* $L^d=L^s=L^e$; and when $i_d<i^e_d$, disequilibrium in the loan market brings about a positive excess demand, *i.e.* $L^d>L^s=L^e$.

The implication of the equilibrium rationing hypothesis can be represented by a modification in equation (5.18), implying a restriction on the variation of the loan rate when there is excess demand in the loan market. This restriction implies that $\Delta i_d=0$ when $L^d-L^s>0$. This in turn requires that, in the disequilibrium models, loan rate adjustments should be described when there are instances of excess supply, $L^d-L^s<0$, in the loan market. This implication of the credit rationing hypothesis can be represented by the following modification in equation (5.18).

$$\Delta i_d = i_d ((L^d-L^s)^R, i_m, D) \quad (5.18a)$$

where $(L^d-L^s)^R = L^d-L^s \leq 0$.

Given the disequilibrium condition $L^e=\min\{L^d,L^s\}$, in equation (5.18a) the term $(L^d-L^s)^R$ takes negative values when $L^e=L^d<L^s$, and is zero when $L^d>L^s=L^e$. This corresponds with the modelling of the loan market with only negative excess demand, which indeed complies with the conditions required by the equilibrium rationing hypothesis. A significant relationship between $(\Delta i_{d,t})$ and $(L^s-L^d)^R$ in the disequilibrium model, represented by equations (5.16), (5.17), (5.18a) and (5.19), can be used to examine the equilibrium rationing hypothesis in the Australian loan market.

5.2.2 Deposit market equations

In the model of the loan market, an increase in the stock of deposits raises loanable funds, and hence bank loans, given that loans will be issued only to the point at which the expected return to banks is maximized. This implies that when there is an excess demand for loans and banks also have incentive to increase loans, an addition to the deposits brings about an increase in the supply of loans.

The determination of the stock of deposits, (DD+TD), is described by the demand and supply equations, and the equilibrium condition in the deposit market. The equations are

$$(DD^d+DT^d) = D^d (i_m, i_c, (E^e/E).(1+i_f), Y, PF) \quad (5.3a)$$

$$i_c = i_c (i_a, i_m, i_d, NBR, (DD^s+TD^s)) \quad (5.6a)$$

$$(DD^d+DT^d) = (DD^s+TD^s) \{ = (DD+TD) \} \quad (5.7)$$

Equation (5.3a) has the same specification as implied by the other demand equations in the money and foreign asset markets. Equation (5.6a) represents an inverse functional form for the supply of deposits, and equation (5.7) represents the equilibrium condition in the deposit market.

In the supply equation (5.6a), (NBR) has the same implication as implied by the money base in the money multiplier models. This implies that the demand and supply equations in the deposit market are viewed in the absence of cash. Further development of the deposit market is considered with the endogeneity of (NBR) which is specified as

$$NBR = NBR (i_a, i_d, (DD+TD)) \quad (5.23)$$

The endogenous treatment of (NBR) has the same implications as implied by credit divisor models, *i.e.* reserves are dependent upon the demand for (stock of) broad money.

The behavioural equations in the simplified model give rise to the determination of the short-term interest rates, (i_m), (i_c) and (i_d). The subsequent issue in the model is concerned with the variability of the long-term rate of interest, (i_{LR}). As explained in subsection 3.3.5, the relationship between the short rates and the long rate in the model can be specified by the expectations theory of the term structure of interest rates. The model specification of the term structure equation provides the link from the bank loan market to the financial markets for securities of different maturities.

5.3. The specification of the expectations theory of term structure

In the expectations theory of the term structure of interest rates, long-term securities are viewed as perfect substitutes for short-term securities. In this theory the long-term interest rate is assumed to be dependent upon the short-term interest rates in financial markets. In the modelling of the linkages between the money and loan markets and the financial markets for securities of different maturities, a combination of the interest rates, (i_m) and (i_d) , can be treated as a proxy for the rate of interest of short-term securities.

As described in subsection 3.3.5, the term structure of interest rates takes into account a collection of securities across the maturity spectrum. Since the term structure of interest rates is determined by a yield-maturity relation, it can also be defined by the link between the yield of an n -period security and the yields of *one*-period securities over ' n ' periods⁵. This link in the expectations theory of term structure is specified by the expected values for the yields on *one*-period securities over " n " periods. According to the expectations theory:

$$(1 + i_{LR})^n = (1 + i_{SRt}^e) \cdot (1 + i_{SR,t+1}^e) \cdot \dots \cdot (1 + i_{SR,t+n-1}^e) \quad (5.24)$$

where, (i_{LR}) is the long rate, and $(i_{SR,t+j}^e)$ s are the expected values for the short rates which are unobserved except for the current value⁶, *i.e.* $i_{SRt}^e = i_{SR,t}$.

In this thesis the short rates $(i_{SR,t+j})$ s in each period are treated as a weighted average of the interest rates of banks' accepted bills, (i_m) , and of banks' loans, (i_d) . The expected values of the short rates over ' n ' periods are unobserved. Hence, an

⁵. In other words the yields of one-period securities over " n " periods stand for the yields of the securities in the collection specified by the maturity spectrum as maturity increases to " n ". As explained in texts (Shiller and McCulloch (1990), Juttner (1990), Fabozzi and Modigliani(1992)), investors (borrowers) are indifferent between holding (issuing) an n -period (long-term) security or " n " one-period (short-term) securities in succession. This implies that, since a higher yield on long-term securities than on short-term securities causes borrowers to issue more short-term securities and lenders to invest more on the long-term securities, the equilibrium demand for and supply of the short-term, and also long-term, securities represent the same yield on both the securities, *i.e.* *short- and long- term securities are perfect substitutes*.

⁶. This is the specification of the expectations theory of the term structure of interest rates which is used in the TRYM (1993) and Fair's (1979, 1984) models.

assumption about how the expectations are formed must be made in order to estimate the long rate (i_{LR}).

Along the lines of Fair (1979, 1984), it is assumed that over a long period the expected values of short rates ($i_{SR,t+j}^e$) is a function of ($i_{LR,t-1}$), of ($i_{SR,t}$) and of lagged values of ($i_{SR,t}$). It is also assumed that in this function, the current and lagged values of (i_{SR}) take a weighted average of both the short rates in the money and loan markets, *i.e.* (i_m) and (i_d). In the expectations theory, it is assumed that (i_{LR}) in equation (5.24) takes the same lag structure as implied by the functional form of ($i_{SR,t+j}^e$)s. This implies that the term structure equation (5.24) also allows for both the rates of interest in the money and loan markets.

Given the above functional form for the term structure equation, the relationship between the short rates and the long rate in the model is specified as

$$i_{LR,t} = i_{LR} (i_{LR,t-1}, i_{SR,t}, i_{SR,t-1}, \dots) \quad (5.25)$$

where

$i_{LR,t}$ = the long-term rate of interest, referred to the 10-year bond rate,

$i_{SR,t}$'s = the short-term rates of return, referred to one-quarter securities, and

$$i_{SR,t-j} = w \cdot i_{m,t-j} + (1-w) \cdot i_{d,t-j}$$

When ($i_{SR,t}$)s are considered in terms of a weighted average of (i_m) and (i_d), we find the problem that the values of ($i_{SR,t}$)s are unknown. This arises from the unknown weights given to (i_m) and (i_d), which are used in the determination of ($i_{SR,t-j}$). This problem leads us to the other specification of the term structure equation as

$$i_{LR,t} = i_{LR} \{ i_{LR,t-1}, (w \cdot i_{m,t} + (1-w) \cdot i_{d,t}), (w \cdot i_{m,t-1} + (1-w) \cdot i_{d,t-1}), \dots \} \quad (5.26)$$

It can be shown that a least squares estimate for equation (5.26) provides proxies for the weights and for the original coefficients in equation (5.25). Such proxies for the term structure equation (5.25), with no lag variable for (i_{SR}), can be obtained from estimating the following equation

$$i_{LR,t} = \rho_0 + \rho \cdot i_{LR,t-1} + (\rho_1 \cdot w) \cdot (i_{m,t} - i_{d,t}) + \rho_1 \cdot i_{d,t} + \zeta_t \quad (5.27)$$

where ρ_0 , ρ , and ρ_1 are the coefficients of the following term structure equation

$$i_{LR,t} = \rho_0 + \rho \cdot i_{LR,t-1} + \rho_1 \cdot i_{SR,t} + \zeta_t \quad (5.27a)$$

where

$$i_{SR,t} = w \cdot i_{m,t} - (w-1) \cdot i_{d,t} \quad ^7.$$

⁷. Under a linear specification of the term structure equation with a one-quarter lag, the estimated coefficients in equations (5.25) and (5.26) can be expressed as

$$i_{LR,t} = \gamma_0 + \gamma \cdot i_{LR,t-1} + \gamma_1 \cdot i_{SR,t} + \gamma_2 \cdot i_{SR,t-1} + \zeta_{1t} \quad (5.25a)$$

where

$$i_{SR,t-j} = w \cdot i_{m,t-j} + (1-w) \cdot i_{d,t-j} \quad \text{for } j=0,1$$

and

$$i_{LR,t} = \alpha_0 + \alpha \cdot i_{LR,t-1} + \alpha_1 \cdot i_{m,t} + \alpha_2 \cdot i_{d,t} + \alpha_3 \cdot i_{m,t-1} + \alpha_4 \cdot i_{d,t-1} + \zeta_{2t} \quad (5.26a)$$

w and γ 's in equation (5.25a) are unknown. Unknown w makes the estimation of this equation impossible. α 's in equation (5.26a) can be estimated properly and be used to obtain proxies for w and γ 's in equation (5.25a). We make use of the link between two equations by considering the following relations

$$\begin{aligned} \gamma_1 \cdot w &= \alpha_1 \\ \gamma_1 \cdot (1-w) &= \alpha_2 \\ \gamma_2 \cdot w &= \alpha_3 \\ \gamma_2 \cdot (1-w) &= \alpha_4 \end{aligned}$$

The above relations imply that the estimated coefficients (α 's) are individually the product of a weight parameter, (w or (1-w)), and each of the original coefficients of the equation, *i.e.* (γ_1), (γ_2).

The problem with equation (5.26a) is that it is overidentified, that is, it provides estimations for six parameters, (α 's), and we would have to make use of them to obtain estimates of five parameters, (γ_0), (γ), (w), (γ_1), (γ_2). If we are to obtain a unique estimate of (w) and (γ 's), a modification in the estimation procedure with (α 's) is necessary.

To proceed with that modification we take account of the results of equation (5.25a) in the following functional form

$$i_{LR,t} = \gamma_0 + \gamma \cdot i_{LR,t-1} + (\gamma_1 \cdot w) \cdot i_{m,t} + (\gamma_1 \cdot (1-w)) \cdot i_{d,t} + (\gamma_2 \cdot w) \cdot i_{m,t-1} + (\gamma_2 \cdot (1-w)) \cdot i_{d,t-1} + \zeta_{1t}$$

and then reparameterize this equation into the following form,

$$i_{LR,t} = \gamma_0 + \gamma \cdot i_{LR,t-1} + (\gamma_1 \cdot w) \cdot (i_{m,t} - i_{d,t}) + \gamma_1 \cdot i_{d,t} + (\gamma_2 \cdot w) \cdot (i_{m,t-1} - i_{d,t-1}) + \gamma_2 \cdot i_{d,t-1} + \zeta_{1t} \quad (5.25b)$$

To remove the over-identification problem in equation (5.25b), we allow for a simplifying assumption implied by the following equation.

$$(i_{m,t-1} - i_{d,t-1}) = \tau_0 + \tau_1 \cdot (i_{m,t-2} - i_{d,t-2})$$

Substituting $\{\tau_0 + \tau_1 \cdot (i_{m,t-2} - i_{d,t-2})\}$ for $(i_{m,t-1} - i_{d,t-1})$ in equation (5.25b), we obtain

$$i_{LR,t} = \beta_0 + \beta \cdot i_{LR,t-1} + \beta_1 \cdot (i_{m,t} - i_{d,t}) + \beta_2 \cdot i_{d,t} + \beta_3 \cdot (i_{m,t-2} - i_{d,t-2}) + \beta_4 \cdot i_{d,t-1} + \zeta_{2t} \quad (5.25c)$$

where

$$\begin{aligned} \beta_1 &= \gamma_1 \cdot w \\ \beta_2 &= \gamma_1 \cdot (1-w) \\ \beta_3 &= (\gamma_2 \cdot w) \cdot \tau_1 \\ \beta_4 &= \gamma_2 \cdot w \end{aligned}$$

and (τ_0) is a part of the constant term (β_0) in equation (5.25c).

The estimation of equation (5.25c) provides unique values for (w), (γ_1) and (γ_2) in equation (5.25a) which was specified in terms of ($i_{SR,t}$) and ($i_{SR,t-1}$).

With more attention paid to the estimation of the values of the weights for (i_m) and (i_d), we can examine the term structure equation for the other important feature of the financial sector, implying that the expected return on two-period securities may equal the expected return on one-period securities over two successive periods. This approach was represented by Tease (1988) in his test for the rational expectations hypothesis for the yields on short-term securities in the Australian financial markets⁸. The findings of Tease can be regarded as support for the pure expectations hypothesis in a two-period context⁹.

If expectations in the markets for short-term securities are formed rationally, the one-period expected yields on two-period securities and the yields on one-period securities are equal. This requires that in the following equation the predicted values of the rate of return on two-period securities, ($i_{LSR,t}$), based on the particular values of the weights for (i_m) and (i_d), should satisfy the term structure equation (5.24) in a two period context.

$$i_{LSR,t} = \kappa_0 + \kappa \cdot i_{LSR,t-1} + (\kappa_1 \cdot w') \cdot (i_{m,t} - i_{d,t}) + \kappa_1 \cdot i_{d,t} + \omega_t \quad (5.28)$$

where

$i_{LSR,t}$ = the one-period rate on two-period securities,

$i_{SR,t} = w' \cdot i_{m,t} - (w'-1) \cdot i_{d,t}$, and

If there is no lag in the term structure equation, we can drop the above simplifying assumption and estimate (γ_1) and (w) directly from the following equation.

$$i_{LR,t} = \rho_0 + \rho \cdot i_{LR,t-1} + (\rho_1 \cdot w) \cdot (i_{m,t} - i_{d,t}) + \rho_1 \cdot i_{d,t} + \zeta_{3t} \quad (5.25d)$$

The estimation of (ρ)s obtained from equation (5.25d) corresponds to the estimation results in the following equation, provided that in the latter equation we allow for the same value of (w) as obtained from the equation (5.25d).

$$i_{LR,t} = \rho_0 + \rho \cdot i_{LR,t-1} + \rho_1 \cdot i_{SR,t} + \zeta_{3t}$$

where

$$i_{SR,t} = w \cdot i_{m,t} - (w-1) \cdot i_{d,t}$$

⁸. Juttner (1990) emphasized that much of the international evidence failed to support the rational expectations hypothesis in the theory of term structure. Juttner concluded that Tease's (1988) confirmation of the expectations hypothesis stands in stark contrast to the results achieved by Juttner, Madden and Tuckwell (1975) and other researchers with the Australian data.

⁹. Campell's (1986) defence of the traditional expectations hypothesis about the term structure of interest rates criticized Cox, Ingersoll and Ross's (1981) propositions of a continuous time rational expectations equilibrium in the sense that the propositions take a restrictive assumption concerning the pure expectations theory with zero risk prima.

(w') and (w'-1) are the weights given to the short rates (i_m) and (i_d) in short term security markets.

Equation (5.28) provides predictions for ($i_{LSR,t}$), using the backward-looking expectations assumption as implied by equation (5.27). The estimation of this equation also provides proxies for the weights (w') and (1-w') in the short-term security market.

The rational expectations hypothesis in the market for short-term securities can be tested in the following equation¹⁰.

$$\{2.(i_{LSR,t})\} - i_{SR,t+1}^e = \eta_0 + \eta_1.i_{SR,t} + \xi_{t+1} \quad (5.29)$$

where

$$i_{SR,t} = w''.i_{m,t} - (w''-1).i_{d,t},$$

(w'') and (w''-1) are the weights under the rational expectations hypothesis in the market for short-term securities.

Given rational expectations, the expected one-period yield, ($i_{SR,t+1}^e$), can be written as

$$i_{SR,t+1} = i_{SR,t+1}^e + \varepsilon_{t+1}. \quad (5.30)$$

Under the rational expectations hypothesis, (η_1) equals one, and (ξ_{t+1}) and (ε_{t+1}) are white noise processes. One important assumption in Tease' model is that the weight given to ($i_{m,t}$) in equation (5.29) equals unity. That is, $i_{SR,t} = i_{m,t}$, or $w''=1$.

Equation (5.30) and the conditions of rationality in this equation and equation (5.29), outlined above, imply that the expected yield on a two-period security is equal to the current yield on a one-period security plus a risk premium, (η_0). That is,

$$\{2.(i_{LSR,t})\} - i_{SR,t+1} = \eta_0 + i_{SR,t} + \xi_{t+1} \quad (5.31)$$

which can be written as

$$\{2.(i_{LSR,t})\} = \eta_0 + (i_{SR,t} + i_{SR,t+1}) + \xi_{t+1}. \quad (5.32)$$

Also, given that

$$i_{SR,t+j} = w''.i_{m,t+j} + (1-w'').i_{d,t+j} \quad \text{for } j=0,1 \quad (5.33)$$

¹⁰. Tease (1988) and Juttner (1990) mentioned that equation (5.29) is taken as the basis for much of the empirical work on forward-looking term structure.

in order to hold equations (5.32) and (5.33) consistent, we should allow for the rational expectations assumption in the market for short-term securities with the particular values of the weights for (i_m) and (i_d) , represented by (w) and $(1-w)$ respectively. These weights determine the short-term interest rate, $(i_{SR,t+j})$, which satisfies equation (5.32), under the rational expectations hypothesis.

It can be shown that the particular values of the weights in equation (5.32) under the rational expectations hypothesis, can be obtained from the estimation of the following equation¹¹

$$\{2 \cdot (i_{LSR,t})\} - (i_{d,t+1} + i_{d,t}) = \eta_0 + w \cdot \{ (i_{m,t+1} + i_{m,t}) \cdot (i_{d,t+1} + i_{d,t}) \} + v_{t+1}. \quad (5.34)$$

A re-examination of the rational expectations hypothesis in Tease's (1988) model requires that the weight given to (i_m) in this model should be equal to the weight obtained from the estimation of equation (5.34). This weight in Tease's model is set equal to unity. Also, the weights under the rational expectations hypothesis, obtained from equation (5.34), can be compared with the weights estimated by equation (5.28) to test if the expectations of the future values of (i_{SR}) in the short-term security market are rational.

One important aspect of this analysis is the implication of credit rationing for portfolio investors' preferences for securities with different terms to maturity. In a rationed credit market, the loan rate reflects banks' proxies for the expected rate of return and default risk of the average projects in the economy. If there is no regulation

¹¹. To derive equation (5.34), we replace $(i_{SR,t})$ and $(i_{SR,t+1})$ in equation (5.32), using their values obtained from equation (5.33). This yields

$$\{2 \cdot (i_{LSR,t})\} = \eta_0 + \{ w \cdot i_{m,t} + (1-w) \cdot i_{d,t} \} + w \cdot \{ i_{m,t+1} + (1-w) \cdot i_{d,t+1} \} + v_{t+1} \quad (5.32a)$$

Equation (5.32a) can be re-written as

$$\{2 \cdot (i_{LSR,t})\} = \eta_0 + w \cdot \{ (i_{m,t} - i_{d,t}) + (i_{m,t+1} - i_{d,t+1}) \} + (i_{d,t+1} + i_{d,t}) + v_{t+1} \quad (5.32b)$$

Rearranging equation (5.32b), we obtain

$$\{2 \cdot (i_{LSR,t})\} - (i_{d,t+1} + i_{d,t}) = \eta_0 + w \cdot \{ (i_{m,t} - i_{d,t}) + (i_{m,t+1} - i_{d,t+1}) \} + v_{t+1}$$

which has the same specification as implied by equation (5.34).

in financial markets it is more likely that the proxies conform to *the actual rate of return* on average projects. Also, if there is no substitute for bank loans, portfolio investors' incentive to borrow from the banking sector implies that borrowers allow for, on average, *the same rate of return* on their portfolio investment as for the banks' proxies of the expected rate of return. Therefore, in completely deregulated financial markets, when there is no substitute for bank loans, credit rationing provides portfolio investors with the ability to adjust to *the actual rate of return* on their portfolios. This requires that portfolio investors' expectations in financial markets should be model consistent, or rational. The analysis of the term structure of interest rates in this thesis evaluates the relevance of the portfolio investors' incentives to borrow from the banking sector, and examines the importance of economic information available to portfolio investors under credit rationing. The empirical results of this approach will be presented in the next chapter.

The model developed in sections 5.2 and 5.3 of was based on the assumption that the lending channel provides links from the bank loan market to the rest of the model, and from the loan market to the financial markets for securities with different terms to maturity. A consistent solution for the model allows for bank lending in the process of money creation, and takes into account of bank loans in the modelling of the interest rate effects of monetary changes on net foreign assets.

In the model it is assumed that the bank lending under credit rationing is subject to the maximum expected return on loans. This is implied by the disequilibrium modelling of the loan market, specified by equations (5.16), (5.17), (5.18a) and (5.19). In this model loan rate adjustments are specified by some rules under which loan rate controls depend on some specific historical data. Such rules give rise to the determination of the loan rate under credit rationing.

In what follows, we model the transmission mechanism between financial markets and the real sector, which includes the loan rate in the interest rate-GNP relationship. The model, which is modified from a basic IS-LM framework, has a

simple graphical representation like IS-LM, and permits us to incorporate the implications of loan market imperfections, and also credit rationing, into the monetary transmission mechanism.

5.4 Two channels of the monetary transmission mechanism

The textbook LM curve can be reconciled with the money and lending channels, regarding the relationships between the short rates, *i.e.* the money market interest rate, (i_m), and the loan rate, (i_d), and GNP in financial markets, and between these rates and the long-term interest rate, (i_{LR}). In this section we develop a simple model which is a variant of the textbook LM curve and permits us to view the equilibrium loci in financial markets consisting of both the money and loan markets. There are some differences between two LM curves which are analysed in this section, using a graphical representation.

5.4.1 A simple model of credit-GNP relationship

The model, at the first step, takes account of two short rates with separate LM curves. The LM_m curve is the textbook LM curve relating GNP (Y) and the money market interest rate, (i_m). The LM_d curve is the other basic LM curve which relates (Y) to the loan market rate of interest, (i_d). The relationship between (Y) and (i_m) in the LM_m curve can be obtained from the model examined in the previous chapter, given that assets other than money are perfect substitutes. This assumption also requires that loans and earning assets should be treated as perfect substitutes. The other assumption in the LM_m curve is that financial markets clear by only asset prices. The basic LM_d curve represents the relationship between (Y) and (i_d), using the assumption of perfect substitutability in asset markets. This implies that (i_m) and (i_d) should differ by a constant spread.

The conventional LM_m and LM_d curves can be represented by the following equilibrium conditions in financial markets.

$$i_m = i_m(i_d, Y, \vartheta) \quad (5.35)$$

$$i_d = i_d(i_m, Y, \vartheta) \quad (5.36)$$

where (ϑ) represents a vector of all other exogenous variables in financial markets. In the above relations, as is implied by the conventional LM curve, (i_d) and (i_m) differ by a constant spread.

When we relax the assumption of perfect substitutability between loans and earning assets, the model takes account of variable spreads between (i_m) and (i_d) in the LM relations (5.35) and (5.36), and hence allows for the effects of both (i_m) and (i_d) on the asset holders' optimal holdings of money. In this model an increase in the loan rate, (i_d) , reduces the demand for loans, and via a reduction in the demand for earning assets, *e.g.* bonds, raises the rate of interest on these assets which results in a fall in the demand for money. This analysis implies that the asset holders' optimally structured portfolio depends on the asset holder choices between money and earning assets, and between money and loans. This requires that the asset holders' optimal holdings of money in financial markets should be analysed by the aggregate variant LM curve, represented by relations (5.35) and (5.36), which now reflects variable spreads between (i_m) and (i_d) . The different implications of such variable spreads are absent in the conventional LM_m curve.

When we relax the other simplifying assumption, which implies financial markets clear only by prices, loan market imperfections provide the asset holders with different choices between money and loans than those implied by the LM_d relation (5.36). Such differences can be represented by the following specification of the LM_d relation. This relation represents a functional form of the disequilibrium condition in the loan market.

$$(i_{d,t} - i_{d,t-1}) = i_d(i_{m,t}, \psi(L_t^d - L_t^s), Y_t, \vartheta_t) \quad (5.36a)$$

where

$i_{d,t} - i_{d,t-1} = \Delta i_{d,t}$, which represents changes in the loan rate, and $(i_{d,t})$ is endogenous and $(i_{d,t-1})$ is exogenous; and $\psi(L^d - L^s)$ defines the excess demand function, implied by loan market imperfections.

Equation (5.36a) allows for the specific feature of the loan market, concerning loan market imperfections, in the asset holder choices between money and loans. In this equation it is assumed that Δi_d , under the disequilibrium condition of loan market imperfections or more specifically under credit rationing, depends on some specific historical data. This is the assumption which was made when we allowed for the stochastic treatment of the loan rate, represented by equation (5.18). In this model a positive (negative) Δi_d , represents excess demand (excess supply) in the loan market¹². When $\Delta i_d > 0$, an increase in the loan rate via a reduction in the demand for loans, and hence a fall in the demand for earning assets, raises the rate of interest on these assets, which in turn reduces the demand for money. Hence, the optimal holdings of money in the incorporated LM relations (5.35) and (5.36a) can be considered in a manner consistent with the amount of excess demand, or of credit rationing, in the loan market. The aggregate variant LM curve, represented by relations (5.35) and (5.36a), incorporates credit rationing into the optimal holdings of money.

The relationships between (Y) and (i_m) and between (Y) and (i_d), using the conventional LM relations (5.35) and (5.36), are represented in figure 5.3.

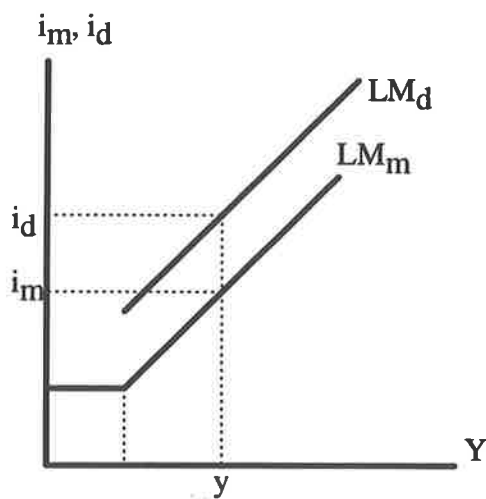


Figure 5.3

¹². This assumption is implied by directional methods for the disequilibrium estimation of demand and supply in the loan market, first introduced by Fair and Jaffee (1972). These methods are described in more detail in the appendix.

The LM_m and LM_d curves, as we have already noted, are based on the assumption of perfect substitutability between bank loans and earning assets, and hence a constant spread between the loan rate and the money market interest rate. In figure (5.3) a change in the underlying conditions that shifts LM_m curve must also shift the LM_d curve. What remains impossible, however, is to determine the effects of a change affecting any one of money or credit markets without making an assumption that requires a corresponding change in the other market. As is analogous to the practice in the conventional Hicks-Keynes IS-LM analysis, an increase in the money supply shifts the LM_m curve to the right, and is associated with a specific shift in the LM_d curve. That is credit market passively absorbs the necessary shifts in the money market. However, changes in the money supply may or may not have implications for real income, depending on what is happening to the quantity of credit.

The implication of the short rate equations (5.35) and (5.36), and the constant spread between (i_m) and (i_d) , for the term structure of interest rates can be represented by the following relations between the long rate (i_{LR}) and the short rates (i_m) and (i_d) .

$$i_{LR,t} = i_{LR} (i_{LR,t-1}, i_{m,t}, i_{m,t-1}, \dots) \quad (5.37)$$

$$i_{LR,t} = i_{LR} (i_{LR,t-1}, i_{d,t}, i_{d,t-1}, \dots) \quad (5.38)$$

In equation (5.37), the rate of interest on short-term securities is set equal to (i_m) . In equation (5.38), the short rate is set equal to (i_d) , and the term structure equation is analysed by the relationship between (i_{LR}) and (i_d) . The former relationship allows portfolio investors to raise funds by changing the maturity position of their portfolios. The latter allows changes in the maturity position of portfolios by borrowing from the banking sector. In the term structure equations (5.37) and (5.38) a constant spread between the short rates (i_m) and (i_d) implies that a change in the underlying conditions in the relation between (i_{LR}) and (i_m) , which may cause market participants to exhibit a preference for short-term funds, will reduce the rate on longer term securities, and causes a specific shift in the relation between (i_{LR}) and (i_d) . However, credit market behaviour may or may not warrant such a specific shift in borrowers preferences for raising funds.

The aggregate variant LM curve, using the LM relations (5.35) and (5.36a), is represented in figure 5.4. The relationship between (Y) and (i_m) in figure 5.4, as distinct from the conventional models, is represented by LLM curve to indicate that it allows for "bank Lending" in the analysis of the LM curve. The LLM curve, in comparison with the conventional LM curve, allows for imperfect substitutability between loans and earning assets, and the disequilibrium condition in the loan market. This provides the variant LM curve consistent with the portfolio-loan model, developed in section 2. In this model the effects of bank lending on the money supply is the significant difference from the asset market model, examined in the previous chapter.

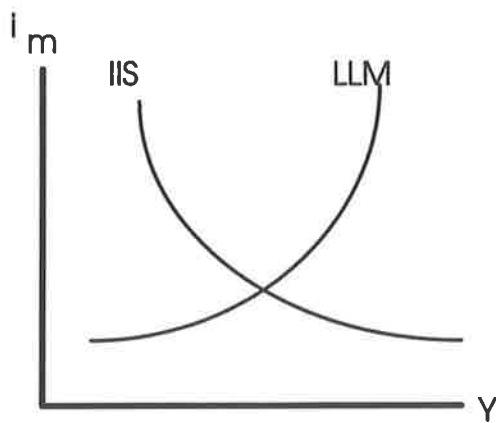


Figure 5.4

In the portfolio-loan model the short rate relations (5.35) and (5.36a) make a significant difference to the linkages between the loan market and the financial markets for securities of different maturities. The difference provides either of the term structure equations (5.37) and (5.38) with links between the yield to maturity of long-term securities and both the short rates (i_m) and (i_d) . Such links in the term structure equation (5.25) were represented by direct relationships between the long rate (i_{LR}) and the two short rates (i_m) and (i_d) , using a weighted average of these short rates. These relationships in equation (5.25) allow the portfolio investors to seek the minimum cost of raising funds, using bank loans to change the maturity position of their portfolios.

Figure (5.4) also represents the relationship between (i_m) and (Y) in a variant IS curve. This curve as distinct from the conventional models, is called the IIS curve to indicate that it refers to "Incorporated rates of interest" in the IS curve. A consistent specification of the IIS curve with the two channels of the transmission mechanism can be represented by the following functional form:

$$Y = Y(i_m, \Delta i_d(\cdot), \Omega) \quad (5.39)$$

where, Ω is a vector of all other exogenous variables in the commodity market, and $\Delta i_d(\cdot)$ represents the functional form of loan rate adjustments, which is shown by equation (5.36a).

Bernanke and Blinder (1988) introduced a different treatment of the variant of the textbook IS curve in which the loan market clears by loan rates. In their model the loan effects in the commodity market are represented by the effects of the market-equilibrating loan rate, rather than $\Delta i_d(\cdot)$, on aggregate demand. The significant difference from the Bernanke-Blinder model is the inclusion of the loan market disequilibrium condition, represented by $\psi(L_t^d - L_t^s)$, in the IIS relation (5.39). It is easy to verify that the IIS curve is negatively sloped, for the same reason as for the Bernanke-Blinder model and for the conventional IS curve. However, the IIS and LLM curves will be shifted by credit market shocks that affect the amount of excess demand for loans, (or of credit rationing), or the loan rate function (5.36a).

The noteworthy difference between this model and the IS-LM model is that positive excess demand for credit is associated with $\Delta i_{d,t} > 0$, and negative excess demand is associated with $\Delta i_{d,t} < 0$. The availability of credit, and hence the amount of positive or negative excess demand, is determined under the minimum condition $L^e = \min(L^d - L^s)$. In the IIS-LLM model an increase in the amount of excess demand for credit, indicated by a rise in (Δi_d) , reduces the private sector's holdings of money and the investment spending, and causes both the IIS and LLM curves to shift to the left. A similar analysis applies to opposite instances where a decrease in the amount of excess demand for credit, indicated by a fall in (Δi_d) , increases the private sector's holdings of money and investment spending, and shifts both the IIS and LLM curves outward to

the right. Therefore, the credit channel, represented by the output effects of changes in the amount of excess demand for credit, or of credit rationing, makes the availability of credit more contractionary or expansionary than the standard IS-LM model. In the IS-LM model the availability of credit is assumed to be equal to the demand for credit, which might change, for example, as a result of new net investment or because of changes in the transactions demand for money¹³. In the textbook IS-LM model, the money channel, acting through changes in liquid assets (money and bonds) and interest rates, affects the availability of credit and, via changes in the investment demand, affects the aggregate economic activity.

5.4.2 Comparative statics

The LLM and IIS curves represent the effects on economic activity of given changes in the amount of excess demand in the loan market. The LLM curve may reduce to the conventional LM curve if 1) loans and assets other than money are perfect substitutes, or 2) the excess demand in the loan market, and/or credit rationing, does not have any repercussions on the probability of default of earning assets. In the first case the loan rate varies with a constant spread on the rate of interest on the substitute assets for money. Under credit rationing, changes in the spread becomes unpredictable, which make the linkages between the loan market and asset markets only consistent with the LLM curve. In the second case, the spread between the loan rate and the money market interest rate becomes irrelevant to the optimal holdings of money in the model.

The opposite extreme, or a credit-only view, arises if money and earning assets are perfect substitutes¹⁴. When this occurs, the LM_m curve (or the conventional LM curve) becomes horizontal, and the emergence of liquidity trap causes the increased

¹³. As we have already noted, in this treatment it is assumed that loans and earning assets (bonds) are perfect substitutes.

¹⁴. Bernanke and Blinder (1988) argue that even with a liquidity trap, monetary policy may affect aggregate economic activity because it influences their variant IS curve.

demand for transaction balances to lose its cost reducing effects on creating opportunities for exchange in financial markets¹⁵. In such a circumstance financial innovations and/or the reduced amount of credit rationing, motivated by the low level of default risk in asset markets, may create successive effects and develop opportunities for exchange via the expansion of loans. Such effects imply that in the IIS-LLM model, despite the liquidity trap, there may still be some interactions between financial markets, and between the bank loan market and the commodity market which are induced by the increased supply of credit in the economy.

The IIS curve can also be analysed in similar cases, when loans and assets other than money are perfect substitutes, or the commodity market is insensitive to the amount of excess demand for credit, or of credit rationing. In the first case, the IIS curve reduces to the conventional IS curve and the basic IS-LM framework seems applicable to the model. In the second case, given that the excess demand for credit still affects the optimal holdings of money, a suitable framework for analyzing the monetary transmission mechanism is an IS-LLM framework¹⁶. The IIS curve may also reflect the monetary influences of financial innovations when the liquidity trap occurs, and opportunities for exchange are created by the expansion of loans¹⁷.

The model analysed in this section permits us to incorporate the implications of loan market imperfections, and/or credit rationing, into the monetary transmission mechanism. Another important aspect of this analysis is the implication of credit rationing for bank behaviour, and for the links between the bank loan market and asset

¹⁵. The cost reducing effect of money in Brunner and Meltzer's, (1971, 1989) explanations of the role of money were considered to be important in the extension of exchange. Such effects were also considered important in King and Plosser's (1986) consideration of a general equilibrium model for the mechanism of exchange.

¹⁶. This implies that in the basic IS-LM framework the effects on holding money of a given change in the loan rate can be described by shifts in the LM curve.

¹⁷. Bernanke and Blinder's (1988, 1992) explanation of an equilibrium model for the lending channel allows for imperfect substitutability between earning assets and loans, using the conventional LM curve. In their model the lending channel is specified by the influences of the loan rate on total output, and hence by shifts in their variant IS curve.

markets. In this thesis a necessary condition for these links under the credit rationing hypothesis is that the expectation of the default cost of bonds in the bank balance sheet plays an important role in accommodating increases in bank's optimal lending. Inherent in this condition is the fact that the underwriting process for new risky bonds is intensive in gathering information concerning the borrowers' credit worthiness, and the likelihood of default is reflected in the rate of interest of bonds. This permits us to place a consistent assumption on the portfolio-loan model, presented in section 5.2, implying that bank's optimal lending depends on the default cost of bonds.

To consider how this consistency arises, we examine the implication of the expectation of the default cost of bonds for bank's optimizing behaviour under credit rationing. This analysis is based on the existing class of theories on banks optimizing behaviour, and equilibrium rationing with imperfect information.

5.5 A model of bank lending with the default cost of bonds

In this section we analyse the loan decision of a bank which incorporates the implication of asset market instruments, such as bonds, into credit transactions. A preliminary question is that of how the expectation of some default on bonds affects bank lending. One possible explanation is that banks hold bonds as risk-free assets against unanticipated deposit shortfalls. In this treatment a bank finds it optimal to keep a fraction of its assets in liquid form which makes a relatively low return. But market determined bond rates and the links between the bank loan market and asset markets imply that: 1) bonds are no longer risk-free assets in the bank balance sheet; and, 2) the likelihood of default of bonds results in a higher expected cost of liquidity than if there is no provision for default in the bank's buffer stock motive for holding bonds. Given that the expected return on loans exceeds the return on bonds, an increase in the default cost of bonds reduces the liquidity of the bank reserve assets, bonds, and prompts the bank to borrow on open markets. This increases the marginal cost of funds for a given level of loan supply, and may result in a rise in the loan rate. A different result arises from bank behaviour under credit rationing. In this treatment

an increase in the default cost of bonds is suggestive of the increased probability of the default of borrowers. Under credit rationing raising the loan rate does not result in a proportionate increase in the receipts of the bank because the default risk of loans rises. In the following discussion we examine the implication of the default cost of bonds for bank's optimizing behaviour, and for credit transactions under the condition implied by the non-monotonic relationship between the loan rate and the expected return on loans.

5.5.1 Bank lending and bank's optimizing behaviour

The characteristics of bank lending can be modelled in a three-market setting for loans, deposits and earning assets. In the deposit and loan markets, a bank takes deposits, (D), on which it pays an interest rate, (i_c), and satisfies all or a part of applications for loans. In the asset markets, bank asset-management operations are carried out to attain interest-bearing assets (bonds) which may be used as a precaution against unanticipated outflow or slowed inflow of deposits.

Given that the net interest-bearing assets, *i.e.* government bonds, in the bank portfolio are positive, the bank's balance sheet can be specified as follows:

<i>Assets</i>	<i>Liabilities</i>
Reserves=R	Deposits=D
Bonds= B_b	Capital=K
Loans= L^e	
$B_b + L^e = D + K - R$	(5.40)

where capital is added as a constant, and banks non-borrowed reserves, (R), are held in proportion to deposits, that is, $R=r_d \cdot D$. The volume of deposits can be treated as a stochastic variable which affects the bank's holdings of bonds and loans via changes in $(1-r_d)D+K$. In addition, bonds in the bank's balance sheet are viewed as the assets with a rate which is lower than the loan rate.

It can be assumed, realistically, that the bank sets the interest rate charged on each loan so that it earns the required rate of return on deposits and satisfies the required liquidity in the bank balance sheet; if this is not possible, the bank will not make loans. On a given amount of deposits, (D), the bank's choice of loans and bonds is made on the basis of the maximum expected return on loans¹⁸.

It is convenient to assume that the bank, as a lender, is a *price-taker* in the asset markets as well as in the deposit market, and is a *price-maker* in the loan market. The interest rate on bonds is (i_b), and the interest rate paid on deposits is (i_c). The interest rate on bonds, as analysed in the previous chapter, can be represented by an implicit function as

$$i_b = (i_m, i_g) \quad (5.41)$$

where, (i_m) is the market determined rate of interest in asset markets, and (i_g) is the safe rate on bonds, set by the government. As we have already noted, the former rate allows for a risk premium which is determined by the equilibrium conditions in asset markets. This implies that a market determined rate of return on the bank's secondary assets, bonds, is given by (i_m). This rate can be represented by:

$$i_m = i_g + b \quad (5.42)$$

where (b) is the spread on the safe rate, (i_g), and allows for some default costs on the bank's holdings of bonds.

In the remainder of this discussion we assume that the bond safe rate, (i_g), exceeds the rate that bank pays for deposits, (i_c). Based on this assumption the loan rate, (i_d), is set at a level higher than the safe rate on bonds, and hence at a level higher than the required rate of return on deposits.

The expected return on loans can be represented by a function as $\rho(i_d)$. This formulation allows for the expectation of some default and administrative costs on loans. Hence, the assumption relating the expected return on loans to the bond safe-rate can be expressed by:

¹⁸. Two models of bank optimizing behaviour with stochastic treatment of deposits are represented by King (1986) and Blinder (1989).

$$\rho(i_d) = i_g \cdot L^e + \rho_1(a) \quad (5-43)$$

where (a) is the spread on the bond safe-rate equal to the difference between (i_g) and (i_d) . Equation (5.43) implies that the expected return on loans takes account of an addition to the risk-free return on loans, $i_g \cdot L^e$, which is equal to the expected return from the spread (a) . The functional form $\rho_1(a)$, with the same implication as for $\rho(i_d)$, allows for some default and administrative costs of loans.

In the loan market without rationing, $\rho(i_d)$ is a monotonic increasing function. That is, a rise in the rate of interest on loans, (i_d) , or a rise in the spread (a) , results in a proportionate increase in the return to the bank. In this case, the monotonicity of either $\rho(i_d)$ or $\rho_1(a)$ arises from excluding the effects of the increasing probability of default on the expected return to the bank, as the interest rate charged on loans increases.

In King's (1986) and Blinder's (1989) models of the optimizing behaviour of a bank, the volume of loans, (L^e) , and the loan rate, (i_d) , are viewed as the decision variables, and their optimal values are obtained from the stochastic treatment of deposits in the bank's balance sheet. The models imply that, in a competitive loan market, the Walrasian framework requires the demand for loans equals the supply of loanable funds, and a zero expected profit on loans causes the expected return to the bank to equal zero, *i.e.* (a) is set equal to the administrative and default costs of loans. However, imperfect competition in the loan market changes the situation in the sense that the bank yields profit equal to the difference between the market rate and the marginal cost of loans, *i.e.* (a) exceeds the costs.

In these approaches, bonds are viewed as secondary assets, and when the loan demand exceeds the bank's loanable funds, the bank increases the funds by selling bonds at a marginal cost equal to the bond safe rate, (i_g) . In contrast to the King and Blinder approaches, this source of financing, and also the other source implied by borrowing on open markets, can be analysed using a marginal cost equal to (i_m) which allows for the expectation of some default on bonds in the bank balance sheet. This implies that the bank may rely on bonds as the sources of financing in the short run,

provided that the marginal cost of funds, (i_g+b) , is less than the marginal rate of return on loans, (i_d) .

In the King and Blinder models a different treatment of the decision variables (L^e) and (i_d) arises from bank's optimizing behaviour in response to the risk of borrowers default. This is reflected in (a) , the difference between the safe rate (i_g) and the rate of return on loans, (i_d) . The functional form of $\rho_1(a)$ allows for the probability of default as a determinant of the expected return on loans, and then the supply of loans. In this analysis, a predominantly excess demand may arise when the probability of default has risen enough and an increase in the spread (a) , which may clear the market, results in a fall in the expected return from that spread, $\rho_1(a)$.

Again, in contrast to the King and Blinder approaches we allow for bank's optimizing behaviour, and hence banks' consideration of default risk, regarding uncertainty in the rate of return on the bank's secondary assets, bonds. In this approach the expected return $\rho_1(a)$ is affected by the risk of borrowers default and the default of bonds, which is represented by (b) . As the probability of default of bonds increases, *i.e.* (b) rises, for a given level of deposits, and hence $(1-r_d).D+K$, the bank becomes less liquid. Lower liquidity prompts the bank to borrow on open markets which increases the marginal cost of funds. This in turn leads the bank to increase the loan rate. The volume of loans, made on the higher loan rate, will be used by applicants who undertake riskier projects. If the bank is risk neutral, it will choose the higher level of loan rate to maximize the expected return on loans. In this analysis the higher loan rate is set consistent with the higher level of expected default of bonds, given that the volume of bonds in the bank balance sheet is positive.

In the loan market under credit rationing, for a given level of loanable funds, $(1-r_d).D+K$, raising the rate of interest charged on loans is considered in a manner consistent with a reduction in the expected return to the bank, *i.e.* $\rho_1(a)$ decreases. In the absence of effective monitoring of borrowers, the bank attempts to control the expected default of loans by rationing loans to riskier borrowers. This in turn reduces bank lending and leads to a change in the bank's holdings of reserve assets, bonds, in

identity (5.40). In this approach the inclusion of the default of bonds in the determination of the supply of loans still requires that bonds in the bank balance sheet should be treated as safer assets than loans. This is because the spread for the loan rate, (a) , is set at a level higher than the expected default of bonds. Since changes in uncertainty, concerning the expectation of default of bonds and loans, have an ambiguous effect on the loan rate¹⁹, and hence on the spread (a) , the effects of uncertainty on assets' return should be analysed by variations in the bank's expected return on loans, $\rho_1(a)$, or by changes in the availability of loans, (L^e) . This in turn affects the asset market equilibrium conditions, and brings about changes in the market determined rate of interest (i_m) ²⁰.

The analysis of the optimizing behaviour of banks, using $\rho_1(a)$ as a function which allows for the expectation of some default of bonds, provides banks with the ability to obtain information concerning the likelihood of default on earning assets, and hence the credit worthiness of portfolio investors²¹. The links between the bank loan market and asset markets can be analysed by the underwriting process for risky bonds, in which banks appraisal of the risk determines the supply of loans.

In what follows we examine the implication of equilibrium credit rationing for the model which embodies the expectation of the default cost of bonds in the bank choice of bonds and loans.

¹⁹. Jaffee and Stiglitz (1990) argued that the quoted rate on loans, (i_d) , is set by the bank and there is no a priori reason to believe that the quoted rate, at which the expected return is maximized, will change as the economy goes into a recession and the probability of success of projects falls. In the above analysis we set the quoted loan rate, (i_d) , equal to $i_g + (a)$. Changes in uncertainty in the Jaffee and Stiglitz approach can be represented by ambiguous changes in (a) as uncertainty in the loan and bond markets rises.

²⁰. In the previous section this is explained by the explicit inclusion of the amount of credit excess demand in the IIS and LLM equations.

²¹. Bank's optimizing behaviour can also be regarded as consistent with excess supply in the loan market. As the excess supply arises, the bank may put all the remaining funds into bonds. When the bank holds simultaneously bonds and loans, the actual supply of loans restores equilibrium in the loan market. Conversely, when bonds in the bank balance sheet are treated as the bank's holdings of reserve assets, excess supply in the loan market will be consistent with the disequilibrium condition implied by the models of loan market imperfections.

5.5.2 Bank's optimizing behaviour and equilibrium credit rationing

In market-clearing models it is assumed that the bank is risk neutral and that the expected return on loans allows for monotonic increasing functions of $\rho(i_D)$ and $\rho_1(a)$. In these models the equilibrium level of the spread (a) is set at a level equal to the sum of expected default and administrative costs of loans, and, if applicable, the monopolist profit. In the rationing models the expected return on loans, $\rho(i_D)$, does not increase monotonically with the rate of interest charged on loans. In the literature on credit rationing, which is based on Stiglitz and Weiss (1981), there are two basic reasons why an increase in the rate of interest on loans, (i_D), may decrease the expected return to the bank: 1) adverse selection effects, and 2) adverse incentive effects. The former implies that as the loan rate rises, the mix of applicants changes adversely, *i.e.* safe borrowers drop out of the market. The latter reveals the fact that as the interest rate increases, applicants are encouraged to undertake riskier projects.

The implications of the adverse selection effects and the adverse incentive effects in the optimizing behaviour of bank can be represented by: 1) a non-monotonic function for the expected return $\rho(i_D)$; and, 2) an extra constraint concerning the situation of persisting excess demand in a rationed credit market.

The implication of a non-monotonic function of $\rho(i_D)$ is that the optimal (L^e) and (i_D), must satisfy the following condition.

$$d [\rho(i_D)] / d(i_D) = 0 \quad (5.44)$$

or
$$d [\rho_1 (a)] / d(a) = 0 \quad (5.44a)$$

Condition (5.44) is based on the assumption that $\rho(i_D)$ is a non-monotonic function, reflecting the adverse selection and adverse incentive effects in the loan market. Condition (5.44a) gives an alternative representation of condition (5.44), given that $\rho(i_D) = i_g.L^e + \rho_1(a)$, where ($i_g.L^e$) is the safe return on loans, and (a) is the spread which allows for the expectation of some default of both loans and the bank secondary assets, bonds.

Condition (5.44), or equivalently (5.44a), implies that if the probability of default increases sufficiently, raising the rate of interest charged on loans, represented

by a rise in (i_d) , or in the spread (a) , results in a decrease in the expected return to the bank, $\rho(i_d)$. In rationing models, condition (5.44) determines the loan rate, (i_d) , at a level which is different from the market-equilibrating rate, (i^e_d) .

As explained by Stiglitz and Weiss (1981), the constraint concerning the situation of rationing in the loan market should also be consistent with predominantly excess demand in the sense that: 1) some individuals obtain loans while apparently identical individuals do not, and the rejected applicants can not obtain a loan even if they offer a higher interest rate, and; 2) there are a large number of groups, classified by lenders, so that each group has a small number of borrowers. In this approach when rationing arises, changes in the availability of loans, (L^e) , not changes in the rate of interest (i_d) , determines the extent of borrowing. In this case the optimal quantity of loans can be represented by

$$\begin{aligned} & | L^e = L^s(i_d, i_m, \dots) \\ \text{and} \quad & | L^s \leq L^d(i_d, i_m, \dots) \end{aligned} \quad (5.45)$$

Condition (5.45) implies that in a rationed credit market the transacted quantity of loans is equal to the supply of loans, and there is never a case of excess supply. Based on conditions (5.44), (5.44a) and (5.45), the availability of loans under the equilibrium rationing hypothesis can be obtained from differentiating the expected return to the bank, represented by equation (5.43), with respect to (L^s) . That is,

$$d[\rho(i_d)] / d(L^s) = i_g + d[\rho_1(a)] / d(L^s) \quad (5.46)$$

Equation (5.46) implies that the marginal net return on loans is equal to the bond safe rate plus the marginal net return from the spread (a) . Again, as the risk of default in asset markets increases, for a given level of deposits and hence $(1-r_d) \cdot D+K$, an increase in the supply of loans will be invested on riskier projects which in turn reduces the expected return from the spread, *i.e.* $\rho_1(a)$ falls. This is different from the case when the bank is assumed risk neutral. In this case a rise in the volume of loans increases the expected return $\rho_1(a)$, and the bank equates the expected return $d[\rho_1(a)]/d(L^s)$ to the expected cost of entering open markets as a borrower. Since the loan rate is determined by equations (5.44) and (5.44a), equation (5.46) determines the volume of

loans given the predetermined volume of deposits, $(1-r_d).D$, and level of bank capital, (K) .

Equation (5.44a) also determines the expected spread between the loan rate and the bond safe rate, which is affected by the probability of bond default. The implication of this equation is that increasing the likelihood of default of bonds results in a rise in the expected cost of liquidity, which provides bank with information concerning the increasing default risk of earning assets. In this approach a necessary condition for rationing to exist is that raising the probability of bond default results in a fall in the bank's expected return on loans. This condition plays a pivotal role in providing links from asset markets to the bank loan market under credit rationing, and is consistent with the implication of *asymmetrical information* for the response of banks to the risk of borrowers default²².

A simple modelling of conditions (5.44) and (5.45) in this chapter is represented by the implication of loan market imperfections, given by equations (5.16), (5.17), (5.18a) and (5.19). In equation (5.19) the transacted quantity of loans must be the minimum of demand and supply, *i.e.* $L^e = \min\{L^s, L^d\}$. Also, under the equilibrium rationing hypothesis it is possible to obtain estimates of the demand and supply equations, represented by (5.16) and (5.17), and therefore the amount of credit rationing.

In equation (5.18a) the loan rate is made stochastic. In this equation it is assumed that there are some rules under which loan rate controls under credit rationing depend on some specific historical data. In this equation loan rate adjustments also satisfy the minimum condition $L^e = \min\{L^s, L^d\}$. The rules in equation (5.18a) are consistent with the equilibrium rationing hypothesis in the sense that, 1) the actual loan rate in rationing periods is assumed to be different from the equilibrium loan rate; and, 2) the loan rate adjusts mainly in response to excess supply rather than to excess

²². We refer to *asymmetrical information* as the case in which borrowers and lenders have different access to information concerning the risk of an earning asset, *i.e.* borrowers know the expected return and default risk of their interest-bearing assets, whereas lenders, banks, know only the expected return and default risk of the average earning asset in the financial sector.

demand in the loan market. The latter issue is implied by the relationship between loan rate adjustments, implied by (Δi_d) , and excess supply $(L^d - L^s) \leq 0$. In the model of loan market imperfections the effects of the likelihood of bond default, implied by condition (5.44a), is represented by the inclusion of the money market interest rate, (i_m) , in the demand and supply equations, and in the equation of loan rate adjustment.

5.5.3 Comparative statics, and the implications for the monetary transmission mechanism

In the simplified model presented in section 5.2, the risk of default in the asset markets is reflected in the rates of return required by asset holders. In this model we assumed that assets in the private sector portfolio are imperfect substitutes and, in equilibrium, offer different rates of interest. We also assumed that the links between the bank loan market and asset markets determine the variables such as the money supply, interest rates, the exchange rate, and the amount of credit rationing.

In the absence of default risk, we may assume that: 1) the rate of return on earning assets is the discount factor, which equates the price of asset with the present value of the expected stream of income to which the asset entitles the bearer; and, 2) the interest streams of earning assets will continue with certainty into future. If these assumptions are valid, then asset holders should have no particular preferences for one earning asset over the other earning assets, and market forces should, therefore, ensure an identical rate of interest for all earning assets. In this circumstance, the money market rate of interest, (i_m) , which is the identical discount factor for all earning assets, is treated as the rate of return required by asset holders, and the loan rate, (i_d) , as the rate which is determined by a spread on the money market interest rate. The spread allows for administrative and default costs of loans and, if applicable, the monopolist profit. In this case the expected return to banks can be represented by

$$[\rho(i_d)] = i_m + [\rho_1(\alpha)] \quad (5.47)$$

where (α) is the spread set equal to its equilibrium level in a perfect or imperfect competitive loan market, and both $[\rho(i_d)]$ and $[\rho_1(\alpha)]$ are increasing monotonic

functions, implying that the model takes no account of the likelihood of default in the loan market.

The effects of the spread (α) on the private sector's optimal holdings of money can be analysed along the same lines as the transaction costs in Baumol's (1952) and Tobin's (1956) models of the demand for money. In this treatment the links between the bank loan market and asset markets, as implied by the standard LM equation (5.35), take into account the effects of administrative and default costs of loans on the optimal holdings of money.

When the likelihood of default is considered implicit in the required rates of return on both earning assets and loans, the links between the bank loan market and earning asset markets can be analysed by the models in which, 1) the expected default of earning assets affects the optimal holdings of money in the private sector portfolio, and 2) the expected default of bank secondary assets, bonds, affects the optimal lending of banks. In this case the loan market can be characterized by the possibility of either the rationing or non-rationing behaviour of banks.

In the absence of rationing, when the expected default on bonds rises, the liquidity of the banks' reserve assets, bonds, falls. This increases the probability that banks will have to borrow on the open market, which increases the marginal cost of funds for a given level of loan supply, and may result in a rise in the loan rate. At a higher loan rate borrowers invest on riskier projects. If banks are risk neutral, they choose the higher loan rate to maximize their expected return. Under this condition the expected return to banks, represented by equation (5.47), determines the supply of loans; and the private sector's optimal holdings of money can be analysed by the implications of risky assets in an optimally structured portfolio, as suggested by the portfolio approach. Equations (5.44), (5.44a) and (5.46) reveal that such a situation is different under credit rationing.

Equation (5.44) implies that, the increased probability of default of earning assets causes the loss of monotonicity of the loan rate. Equation (5.44a) reflects the fact that an increase in the probability of default in asset markets raises the risk of

borrowers default and reduces the expected return to banks. In order to reduce the expectation of default of loans, banks ration loans to riskier borrowers, using non-price terms in loan contracts. Equation (5.46) implies that, when rationing arises, a rise in the supply of loans reduces the expected return to banks.

In macroeconomic models, different implications of the effects of loans on aggregate economic activity depend on the inclusion of the default risk in banks' optimizing behaviour. The likelihood of default of bonds in banks' optimizing behaviour under credit rationing requires that the lending channel in an IS-LM model should be specified by loan rate controls and the availability of credit. This implies that, when a rise in the marginal cost of funds, and hence an increase in the rate of interest charged on loans, does not result in a proportionate increase in the receipts of banks, credit rationing arises, and the rules under which loan rate controls are imposed and the availability of credit might explain the real impact of bank lending. In the absence of rationing the output effects of changes in the transacted quantity of credit can be modelled by the effects of market-equilibrating loan rate on aggregate demand. Without regard to the default risk of bonds in banks' optimizing behaviour, the links between the bank loan market and asset markets can be represented by a basic IS-LM model in which the output effects of changes in aggregate credit reflect the response of aggregate demand to changes in administrative and default costs of loans.

5.6 Conclusion

This chapter has analysed the portfolio-loan approach to the determination of the interest rate effects of monetary changes. The critical differences between the portfolio-loan model and the model analysed in the previous chapter were identified in terms of 1) the importance of the private initiatives of the banking system in the determination of the supply of loans, and 2) the structurally endogenous nature of money and loans. These features of the model reflect Palley's (1994) post-Keynesian view of endogenous money whereby bank choice of the composition of assets and liabilities provides the bank with the minimum cost of financing. The significant

difference from the Palley's model is the disequilibrium modelling of the loan market, which is implied by loan market imperfections. This treatment of loan market behaviour complies with the Stiglitz and Weiss (1981) approach to credit rationing whereby the underwriting process for risky bonds is intensive in gathering information concerning borrower's default risk, and credit rationing may arise when there is imperfect information. One important aspect of this approach was identified in terms of the relevance of the portfolio investors' incentives to borrow from the banking sector in the analysis of the term structure of interest rates. In this analysis, the rationally formed behaviour of portfolio investors is suggestive of the importance of the economic information available to the portfolio investors under credit rationing.

In this chapter we also examined the implications of loan market imperfections for the transmission mechanism in a simple model which is a variant of the textbook IS-LM model. In this model loan rate adjustments, as implied by the models of loan market imperfections and credit rationing, make the availability of credit more expansionary or contractionary than in the standard IS-LM model. Also, in a simple model we examined the implication of credit rationing for bank's optimizing behaviour, regarding the expectation of bond default in the bank's optimal lending. In this model the expectation of bond default provides bank with information concerning the likelihood of default on earning assets, and hence the credit worthiness of portfolio investors. The links between the bank loan market and asset markets under credit rationing are suggestive of the importance of banks' appraisal of the default risk of average earning asset in financial markets in the underwriting process for new risky bonds.

The next chapter provides evidence on the implication of loan market imperfections and credit rationing for the portfolio-loan approach. Also we present evidence on the relevance of the portfolio investors' incentives to borrow from the banking system in the financial markets for securities of different maturities, and examine the implication of credit rationing for the term structure of interest rates.

Appendix 5

Specification of Loan market equations in disequilibrium models

The preceding discussion in section 5.2 refers to models in which sources of disequilibrium are *a*) imperfect adjustment of loan rates, and *b*) loan rate controls. In the first type of model, the loan rate-adjustment equation can be represented by imperfect adjustment of loan rates, using $(\Delta i_{d,t})$ as dependent variable, or imperfect forecasts of market-equilibrating loan rates, using $(\Delta i_{d,t+1})$ as dependent variable. The model can be specified under the following conditions, and provides estimates for the demand and supply equations in the loan market.

$$L^d = L^d(i_d, (i_m, \dots), Y)$$

$$L^s = L^s(i_d, (i_m, \dots), D)$$

$$1) \quad L^e = \min(L^s, L^d)$$

$$2) \quad \left| \begin{array}{l} L^e = \min\{L^d, L^s\} \\ i_{d,t+1} - i_{d,t} > 0 \quad \text{if } L^d > L^s \quad \text{hence, } L^e = L^s \\ i_{d,t+1} - i_{d,t} < 0 \quad \text{if } L^d < L^s \quad \text{hence, } L^e = L^d \end{array} \right.$$

$$3) \quad \left| \begin{array}{l} L^e = \min\{L^d, L^s\} \\ i_{d,t+1} - i_{d,t} = \gamma_1 (L_t^d - L_t^s) \quad \text{if } L_t^d > L_t^s \quad \text{(excess demand)} \\ i_{d,t+1} - i_{d,t} = \gamma_2 (L_t^d - L_t^s) \quad \text{if } L_t^d < L_t^s \quad \text{(excess supply)} \end{array} \right.$$

$$4) \quad \left| \begin{array}{l} L^e = \min\{L^d, L^s\} \\ (i_{d,t+1} - i_{d,t}) = \gamma \cdot (L_t^d - L_t^s) + \delta \cdot i_m + \varepsilon_t \end{array} \right.$$

The first condition is considered in the context of a *switching regression model*, suggested by Maddala and Nelson (1974). In this model there is no need to rely on a priori information concerning the loan rate adjustment process. In addition, the model itself provides efficient estimates for the demand and supply equations, and allows us to determine the probabilities that the transacted quantity of loans belong to the demand or the supply equation.

The second condition represents a *directional disequilibrium model* which takes into account a sample separation in the model estimation. The condition on the loan rate differential implies that if there is excess demand, the loan rate rises; and if there is excess supply, the loan rate falls. This condition can be used to classify the observations into those belonging to the demand category and those belonging to the supply category.

The third condition shows a *quantitative model* in which γ 's represent the speeds of adjustment of the rate of interest of loans. A two-stage least squares method of estimation, suggested by Amemiya (1974a), allows for the differing speeds of adjustment in the demand and supply equations. With respect to this condition, the modified version of the demand and supply equations can be written as,

$$\left\{ \begin{array}{l} L^e = L^d = L^d(i_d, i_m(\cdot), \Delta_1 i_{d,t+1}, Y) \\ \text{where, } \Delta_1 i_{d,t+1} = -(i_{d,t+1} - i_{d,t}) \quad \text{if } i_{d,t+1} - i_{d,t} > 0, \\ \quad \Delta_1 i_{d,t+1} = 0 \quad \text{otherwise;} \\ L^e = L^s = L^s(i_d, i_m(\cdot), \Delta_2 i_{d,t+1}, D) \\ \text{where, } \Delta_2 i_{d,t+1} = -(i_{d,t+1} - i_{d,t}) \quad \text{if } i_{d,t+1} - i_{d,t} < 0, \\ \quad \Delta_2 i_{d,t+1} = 0 \quad \text{otherwise;} \end{array} \right.$$

where

$$\Delta_1 i_{d,t+1} = \gamma_1 (L_t^d - L_t^s) \quad \text{if } L_t^d > L_t^s \text{ (excess demand)}$$

$$\Delta_2 i_{d,t+1} = \gamma_2 (L_t^d - L_t^s) \quad \text{if } L_t^d < L_t^s \text{ (excess supply)}$$

The fourth condition provides another model with sample separation unknown which is the same as the first model, except that the loan rate equation is made stochastic.

Conditions 2-4 are expressed in terms of $(\Delta i_{d,t+1})$. Alternatively we may express these conditions in terms of $(\Delta i_{d,t})$. Maddala (1983) argued that in the second and third models the price-adjustment mechanism brings about a quantity adjustment in the model. When the price is treated as endogenous, the resultant quantity adjustment

is inconsistent with the adjustment explained by the minimum condition $L^e = \min\{L^S, L^D\}$ ²³. Maddala concluded that the only way out of this inconsistency is either to drop the minimum condition or to drop the assumption of price endogeneity. This implies that, holding the nature of the disequilibrium models, and hence the minimum condition unchanged, $(i_{d,t})$ in models (2) and (3) should be treated as exogenous and $(i_{d,t+1})$ as endogenous. With a minimum condition and the exogeneity of $(i_{d,t})$ in these models, the source of disequilibrium is not imperfect adjustment of the rates but *imperfect forecasts of market-equilibrating loan rates*,

In the second type of model, with loan rate controls, we may specify a disequilibrium model which allows for the rationing behaviour of banks in the sense that: 1) the market is sometimes in equilibrium and sometimes in disequilibrium; and, 2) when disequilibrium arises, the volume of loans is supply determined, and loan rate controls determine the ceiling loan rate. With no more assumption on when controls are operative or not operative, we may specify the loan market equations by

$$L^d = L^d(i_d, (i_m, \dots), Y)$$

$$L^s = L^s(i_d, (i_m, \dots), D)$$

$$\begin{cases} L^e = \min\{L^s, L^d\} \\ \Delta i_d = i_d((L^d - L^s)^R, i_m) \end{cases}$$

where $(L^d - L^s)^R$ represents excess supply in the loan market which is negative or zero, depending on $(L^e = L^d < L^s)$ or $(L^e = L^d = L^s)$, respectively. Also (Δi_d) represents loan rate changes, which is equal to $(i_{d,t} - i_{d,t-1})$.

In this model (L^s) , (L^d) and $(i_{d,t})$ are dependent variables and sample separation is unknown. This model, with no data available on the exact level of controlled loan rates, can be estimated in the limited-dependent-variable framework, using observed values for (L^e) and $(\Delta i_{d,t})$.

²³ . Maddala indicated that a consistent solution for the quantity adjustment in the models gives rise to an ambiguity for considering the minimum condition consistent with the price-adjustment mechanism. This is also because with the minimum condition and the endogeneity of $i_{d,t}$, there are two equations for three unknowns, L^d , L^s and $i_{d,t}$.

Chapter 6

Estimation of a Portfolio-Loan Model of the Australian Financial Sector

6.1 Introduction

This chapter evaluates the relevance of the equilibrium credit rationing approach in a portfolio-loan model, by examining: 1) whether the capacity of the Australian banking system to underwrite financial assets plays an important role in the process of money supply creation; and whether the reserve pressures, induced by an increase in money income, increases bank lending; 2) whether the likelihood of default of borrowers, Australian portfolio investors, affects the expected return to lenders, banks; and, 3) whether the Australian banks, in the aggregate, act as though they ration credit.

The first hypothesis examines the endogenous nature of the money supply and loans, and the implication of bank lending for the money supply process in the portfolio-loan model. The second hypothesis examines the implication of asset market instruments, such as risky bonds, for credit transactions, and is treated as a necessary condition for credit rationing. We examined this condition for credit rationing in the previous chapter, using a model of bank's optimizing behaviour with the default cost of bonds. In this model the probability of default on bonds provides banks with information concerning the risk of borrowers default. The third hypothesis examines the credit rationing hypothesis in the Australian financial sector.

In this chapter we also evaluate the implication of credit rationing for portfolio investors' preferences for securities with different terms to maturity, by examining: 4) whether the cost of borrowing under credit rationing provides portfolio investors with

rationally formed expectations in Australian short-term security markets. This hypothesis implies that *a*) the loan rate under credit rationing reflects banks' proxies for the expected rate of return on average projects, which in completely deregulated financial markets conforms to the actual rate of return in the economy, and *b*) the cost of borrowing from the banking sector under credit rationing provides portfolio investors with information concerning the actual rate of return on average securities with different terms to maturity.

In the portfolio-loan model, the links from the earning asset and deposit markets to the bank loan market provides banks with information concerning the likelihood of default of the underwriting process for new risky assets, such as equities. Without regard to the implication of the banks' incentive in gathering such information, borrowers' credit worthiness would be irrelevant to the credit transactions, and loans would be issued to the point at which the marginal return to a loan equalled the securities rate. Given that borrowers and lenders, banks, have differential access to information concerning the risk of interest-bearing assets, we evaluate the implications of *asymmetrical information* for bank lending, using a disequilibrium model of the Australian loan market.

The next section presents a simple model which is derived from the portfolio-loan model elaborated in the previous chapter. Section 3 provides evidence on the hypotheses regarding the causality relation between the money supply and loans, and the implications of asymmetrical information for bank lending. In this section we evaluate the implication of the risk of borrowers default for credit transactions, by examining the effects of risk preferences of portfolio investors, which is reflected in the expected rate of return on their portfolios, on the banks' expected return on loans. These effects provide a necessary condition for credit rationing, which incorporates the risk of borrowers default into credit transactions. A capital asset pricing approach is used to embody the risk preferences of portfolio investors in determining the expected rate of return on a diversified portfolio. The evaluation of the rationing behaviour of banks is represented by the estimation results of the disequilibrium models for the

credit market, elaborated in the previous chapter. Section 4 presents the implication of credit rationing for portfolio investors' preferences for securities with different terms to maturity, using the expectations theory of the term structure of interest rates. Section 5 presents conclusions.

6.2 The portfolio-loan model

The equations of the portfolio-loan model, developed in the previous chapter, are as follows.

Money market

$$H^d = P \cdot H^d(i_m^{(-)}, (E^e/E)^{(-)}, (1+i_f)^{(+)}, Y, W/P)^{(+)} \quad (6.1)$$

$$i_m = i_m(i_a^{(+)}, i_d^{(+)}, i_f^{(+)}, H^s)^{(+)} \quad (6.2)$$

$$H^d = H^s (= H) \quad (6.3)$$

Foreign asset market

$$(F^d \cdot E) = P \cdot F^d(i_m^{(+)}, (E^e/E)^{(-)}, (1+i_f)^{(-)}, Y, W/P)^{(-)} \quad (6.4)$$

$$E = E(\{P/P_f\}^{(+)}, \{(i_m - \pi)^{(-)} - (i_f - \pi_f)^{(-)}\}, \tau \cdot \Sigma [TB_t - (1-\lambda) \cdot TB_{t-1} - (\lambda) \cdot TB_{LR}]^{(-)}, (i_f \cdot F^s)^{(+)}) \quad (6.5)$$

$$F^d = F^s (= F) \quad (6.6)$$

Portfolio balance equation

$$W^d = P \cdot W^d(W^{(-1)}, i_m^{(+)}, (E^e/E)^{(-)}, (1+i_f)^{(+)}) \quad (6.7)$$

$$W^d = W^s \quad (6.8)$$

Loan market

$$L^d = L^d(i_d, i_m, Y) \quad (6.9)$$

$$L^s = L^s(i_d, i_m, D) \quad (6.10)$$

$$\Delta i_d = i_d(\{L^d - L^s\}, i_m, D) \quad (6.11)$$

$$L^e = \min\{L^d, L^s\} \quad (6.12)$$

Deposit market

$$D^d = P \cdot D^d(i_m, i_c, (E^e/E) \cdot (1+i_f), Y, W/P) \quad (6.13)$$

$$i_c = i_c(i_m, i_d, D^s, NBR) \quad (6.14)$$

$$NBR = NBR(i_a, i_d, D^s) \quad (6.15)$$

$$D^d = D^s (=D) \quad (6.16)$$

Policy reaction functions

$$(RBS/BB) = RBS(i_m, \frac{GDP}{GDP}, P) \quad (6.17)$$

$$RBF = RBF(F, E, P/P_f) \quad (6.18)$$

Identities

$$W^s = H + (B + EQ) - (E.F) \quad (6.19)$$

$$L^e + NBR + B_b = D \quad (6.20)$$

Endogenous variables:

$H^d, H^s, i_m, F^d, F^s, E, W^d, W^s, L^d, L^s, i_d, L^e, D^d, D^s, i_c, NBR, (RBS/BB), RBF, (B+EQ), B_b.$

Exogenous variables:

E^e , i_f , Y , i_a , P , P_f , π , π_f , TR , TR_{t-1} , TR_{LR} , (i_f^{FS}) , $W_{(-1)}$, (GDP/\overline{GDP}) .

The glossary of variable names for the description of the data is represented in *appendix 6.A*.

Signs above functional arguments represent the signs of partial derivatives. Equations (6.1)-(6.8) and (6.17)-(6.19) represent the same functional form as implied by the asset market model estimated in chapter 4. Equations (6.9) and (6.13) represent the demand for loans and deposits held in banks, respectively. Equations (6.10) and (6.14) represent the supply of loans and the supply equation for deposits. Equations (6.11) and (6.12) represent loan rate adjustment and the disequilibrium condition in the loan market. Equation (6.15) represents the supply function for banks' non-borrowed reserves. Equation (6.16) represents the equilibrium condition in the deposit market. Equation (6.20) represents the banking sector balance sheet identity. This identity determines the banks holdings of bonds, (B_b) . A consistent solution for the model determines the equilibrium values of the assets in the private sector's portfolio and the banks balance sheet.

The estimation results for equations (6.13)-(6.16) are obtained from the two stage least squares (2SLS) method. The estimation results for equations (6.9)-(6.12) are obtained from the OLS and maximum likelihood methods used for disequilibrium models in the limited-dependent-variable framework. The result of the test for unit roots in the data is given in *appendix 6.B*. In the regressions reported in this chapter the test for cointegration is represented by the augmented Dickey-Fuller, ADF, statistic for each equation. The LM and Chow statistics represent the tests for up to fourth order autocorrelation, and for parameter stability, respectively. The latter test is used to examine the predictive ability of the equations after the second quarter 1986 with the removal of all controls on interest rates and bank deposits and loans. The Chow*

test represents the stability criterion for other special dates in the demand for deposits and bank reserves equations.

6.3 The loan market and post-deregulation developments in Australia

A consistent solution for the model requires that the linkages between the asset markets, *i.e.* the money and interest-bearing asset markets, and the two remaining markets in the model, *i.e.* the loan and deposit markets, should be specified in a manner consistent with banks' choices of assets and liabilities. In this section we examine different implications of such choices, regarding the private initiatives of banks in the process of money supply creation and the banking system response to the increased supply of reserves. This is followed by the empirical features of loan market behaviour and loan rate adjustments using results from a disequilibrium model of the loan market.

6.3.1 Bank lending and the causality between the money supply and loans

In the model under discussion banks' asset and liability choices influence the money market equilibrium condition. This is implied by a consistent solution for the model, reflecting the effects of bank lending, (L^e), on the money base, (H), and on the money supply, (M), using narrow and broad definitions of money. The money multiplier in these definitions can be obtained from the following equations¹.

¹. In chapter 4 we specified the money market equilibrium condition, using the following equations.

$$C^d = C^d(i_m, i_c, (E/E^e), (1+i_f), Y, W) \quad (4.1)$$

$$DD^d = DD^d(i_m, i_c, (E/E^e), (1+i_f), Y, W) \quad (4.2)$$

$$H^d = DD^d(i_m, i_c, (E/E^e), (1+i_f), Y, W) \quad (4.3)$$

$$M = C^d + DD^d \quad (4.4)$$

$$m_1 = m(i_a, i_m, i_c, i_d) \quad (4.5)$$

$$m_1 \cdot H^s = M \quad (4.6)$$

$$H^s = H^d \quad (4.7)$$

where

M = the supply of money, $M1$,

m_1 = the money multiplier for narrow money.

Equations (4.1)-(4.3) represent the demand for currency, demand deposits and the money base.

Equations (4.4) and (4.6) are definitions. Equation (4.5) represents the money multiplier function.

Equation (4.7) represents the money market equilibrium condition. A consistent solution for the

$$M = m_1 \cdot H \quad (6.21)$$

$$D = m_2 \cdot \text{NBR} \quad (6.22)$$

where (D) is the public's (demand and time) deposits in banks, (m_1) is the money multiplier for a narrow definition of money, and (m_2) is the deposit multiplier, using a broad definition of money in the absence of cash. The effects of bank lending on narrow and broad money can be represented by changes in reserves (H) and (NBR), and changes in the monetary preferences of asset holders through changes in the money multipliers (m_1) and (m_2)². A consistent solution for the model also requires that changes in the money base and changes in the monetary preferences of asset holders cause changes in bank lending, so that (H) and (NBR), and the money multipliers (m_1) and (m_2) Granger-cause (L^e). Testing these causality hypotheses involves standard bivariate Granger-causality regressions between bank lending, (L^e), and the other variables outlined above.

Such a Granger-causality framework complies with the modelling of the lending channel in Palley's (1994) approach. Palley's model embodies the post-Keynesian view of endogenous money whereby the money supply rises in response to an increase in bank lending. The significant feature of the lending channel in Palley's

money market equations determines the equilibrium values of the endogenous variables C^d , DD^d , H^d , i_m , H^s , M , and m_1 .

In chapter 5 equations (4.4) and (4.6) were replaced by

$$(DD^s + TD^s) = m_2 \cdot \text{NBR} \quad (5.6)$$

$$H^s = C^d + \text{NBR} \quad (5.8)$$

where

$$TD^d = TD^d(i_m, i_c, (E/E^e) \cdot (1+i_f), Y, W) \quad (5.3)$$

$$(DD^s + TD^s) = (DD^s + TD^s) \{=(DD + TD)\} \quad (5.7)$$

$$\text{NBR} = \text{NBR}(i_a, i_d, (DD + TD)) \quad (5.23)$$

and (NBR) represents non-borrowed reserves of the banking sector. In the model given by equations (4.1)-(4.3), (4.5), (4.7), (5.3), (5.6)-(5.8) and (5.23) the endogenous variables are C^d , DD^d , TD^d , H^d , i_m , i_c , H^s , $(DD^s + TD^s)$, NBR , and m_2 .

² . Given that equation (4.6) provides a link from (H) and (m_1) to (M_1), the relationship between (L^e) and (M) can be represented by the bivariate causality between both (L^e) and (H), and (L^e) and (m_1). Using equation (5.6), the causality relationship between (L^e) and $(DD^s + TD^s)$ can be represented by the bivariate causality between both (L^e) and (NBR), and (L^e) and (m_2).

model is the introduction of banks' choice of asset and liability using a buffer stock approach to the banks holdings of bonds in identity (6.20). The buffer variations of bond holdings allow banks to adjust their balance sheet in response to unexpected changes in their liabilities, (D^d), and to changes in the demand for loans, (L^d). To increase the supply of loans, individual banks sell their holdings of bonds through their own internal open market operations between their portfolios and those of the non-bank public. Increased lending causes liability transformations that increase the money multiplier and reserves. In this approach the process of financing through selling of secondary assets, bonds, and transformations of checkable deposits into time deposits first reduce the money multiplier, but the increased lending causes the money multiplier to return to its initial level. The causal link between loans and the money multiplier is the key innovation in Palley's (1994) model, compared with the post-Keynesian approach, presented by Moore (1988, 1989). In Palley's approach an increase in the money supply, induced by increased non-borrowed or borrowed reserves, raises the total stock of reserves, and makes the banking system use this stock more intensively in its production of loans. This procedure complies with the traditional money multiplier approach. In Palley's analysis changes in the money multipliers (m_1) and (m_2), or changes in the supply of reserves, (H), cause changes in bank lending, and changes in the bank lending can cause changes in both (H) and the money multipliers (m_1) and (m_2).

Test results for the Granger-causality hypotheses in the model under discussion are given in tables 6.3.1a and 6.3.1b, using standard Granger-causality regressions with Australian data in two periods: 1978:3 to 1993:4 and 1984:1 to 1993:4. In the whole sample period, *i.e.* 1978:3 to 1993:4, all the variables are stationary when expressed as first difference of log levels. This is shown in *appendix 6.B*, using the tests for unit roots. Only the regressions with stationary series are reported. The results using log levels (non-stationary variables) showed significant results for almost all the Granger-causality hypotheses.

Table 6.3.1a. The results of the Granger causality regressions between the money supply and bank lending

Sample period: 1978:3 to 1993:4

	2 lags	4 lags	6 lags	8 lags
1. $H \rightarrow L^e$	1.92 (.157)	3.57 (.012)	2.26 (.055)	1.73 (.122)
2. $NBR \rightarrow L^e$	1.90 (.159)	1.42 (.241)	1.07 (.398)	.977 (.468)
3. $m_1 \rightarrow L^e$	.175 (.840)	.784 (.541)	.536 (.778)	.502 (.846)
4. $m_2 \rightarrow L^e$	1.38 (.260)	1.22 (.313)	.954 (.468)	.842 (.572)
5. $L^e \rightarrow H$	.114 (.893)	.341 (.849)	.309 (.929)	.665 (.718)
6. $L^e \rightarrow NBR$	.069 (.934)	.076 (.989)	.332 (.916)	1.26 (.295)
7. $L^e \rightarrow m_1$	2.65 (.079)	1.98 (.112)	1.53 (1.91)	1.19 (3.29)
8. $L^e \rightarrow m_2$	1.07 (.351)	.706 (.592)	.732 (.627)	1.69 (.133)

Note:

Table (6.3.1a) shows the F-statistics from the Granger causality regressions between bank lending, the money base, banks reserves, and M1 and M2 multipliers, in the period 1978:3 to 1993:4. Figures in parentheses represent P-values.

Table 6.3.1b. The results of the Granger causality regressions between the money supply and bank lending

Sample period: 1984:1 to 1993:4

	2 lags	4 lags	6 lags	8 lags
1. $H \rightarrow L^e$	5.88 (.006)	2.79 (.044)	2.09 (.087)	1.37 (.260)
2. $NBR \rightarrow L^e$	2.33 (.112)	1.32 (.283)	1.04 (.420)	.798 (.610)
3. $m_1 \rightarrow L^e$	.641 (.533)	.941 (.453)	.757 (.610)	.799 (.609)
4. $m_2 \rightarrow L^e$	1.81 (.179)	1.09 (.379)	.889 (.517)	.758 (.641)
5. $L^e \rightarrow H$	1.02 (.372)	.906 (.472)	.619 (.713)	.916 (.521)
6. $L^e \rightarrow NBR$	.670 (.518)	.309 (.869)	.557 (.761)	1.66 (.163)
7. $L^e \rightarrow m_1$	5.08 (.012)	3.09 (.030)	2.27 (.067)	2.12 (.077)
8. $L^e \rightarrow m_2$	1.73 (.192)	.865 (.496)	.999 (.446)	2.08 (.081)

Note:

Table (6.3.1b) shows the F-statistics from the Granger causality regressions in the period 1984:1 to 1993:4. Figures in parentheses represent P-values.

The principle findings are that:

- 1) the money base Granger-causes loans, (line 1 in the tables 6.3.1a and 6.3.1b),
- 2) banks reserves do not Granger-cause loans, (line 2 in the tables 6.3.1a and 6.3.1b),
- 3) the M1 money multiplier and M3 deposit multiplier do not Granger-cause bank loans, (lines 3 and 4 in the tables 6.3.1a and 6.3.1b),
- 4) bank loans do not Granger-cause the money base and banks reserves, (lines 5 and 6 in the tables 6.3.1a and 6.3.1b),
- 5) bank loans Granger-cause the M1 money multiplier, (line 7 in the tables 6.3.1a and 6.3.1b),
- 6) bank loans Granger-cause the M3 deposit multiplier only in the post-deregulation period, (line 8 in the table 6.3.1b).

These results are consistent with the Granger-causality hypotheses in the model under discussion, and also in Palley's (1994) model. The absence of an effect of bank lending on the money base is inconsistent with the post-Keynesian accommodative theory of endogenous money. The presence of an effect of the money base on bank lending is also inconsistent with this theory. The presence of effects of bank lending, (L^e), on the monetary multipliers, (m_1) and (m_2), and the money base, (H), on (L^e) are both consistent with the model represented by equations (6.1)-(6.20)³. In this model the capacity of the Australian banking system to underwrite financial assets, and the implications of asset substitutabilities for the supply of monetary base are suggestive of the endogeneity of the money supply. The results suggest that, as a result of the private initiatives of Australian banks, an increase in bank lending through the process of 'loans creating deposits' causes liability transformations that increase the money multiplier. In this model raising the money supply increases the total stock of reserves which makes the banking system use this stock in production of loans.

³ . The empirical results of Palley's (1994) model with the U.S. data are similar to the results represented by tables (6.3.1a) and (6.3.1b). That is in Palley's model (L^e) Granger-causes (m_1), (H) Granger-causes (L^e), and (L^e) does not Granger-cause (H).

6.3.2 Bank lending and banks' expectation of the default cost of bonds

In Palley's (1994) model, banks choice of assets and liabilities and the buffer variations of the banks' holdings of secondary reserves, bonds, allow the banking system to accommodate loan demand. As described in chapter 3, these are the assumptions which provide banks with an incentive to minimize the cost of financing, and allow for the equilibrium condition in the loan market, i.e. $L^e=L^d=L^s$. Palley's model abstracts from the implication of default risk for banks' expected return on loans. In section 5.5 we examined a model of bank lending which incorporates the expectation of the default risk on bonds into the supply of loans. In this model changes in the default risk on earning assets, including risky bonds, affects the liquidity of the banks' holdings of secondary assets, bonds⁴. The default risk of bonds is reflected in the expected rate of return required by asset holders.

In a portfolio-loan model with instances of credit rationing, banks' expectations of the default risk on bonds provides them with information concerning the default risk of portfolio investors. In the model under discussion, we evaluate the implication of *asymmetrical information* for bank lending by examining the effects of the likelihood of default of risky assets, and hence the expected rate of return on a diversified portfolio, on the banks' expected return on loans. These effects provide a necessary condition for credit rationing, incorporating the implication of the risk of borrowers default into bank lending. According to the credit rationing hypothesis, an increase in the likelihood of default of risky assets, which is reflected in the expected rate of return required by asset holders, reduces banks' expected return on loans. We use a capital

⁴ . This implies that the bank secondary assets, bonds, are no longer risk-free assets whose market value remains unchanged with certainty into the indefinite future. As the expected default of bonds increases, for a given level of deposits, banks become less liquid. Lower liquidity prompts banks to borrow on open markets, which increases cost of funds. This requires that the banks should increase the loan rate. Lending at a higher rate of interest encourages applicants to undertake riskier projects. If banks are risk neutral, they will provide loans at the higher level of loan rate to maximize their expected return on loans. If the response of banks to the increased cost of funds is determined by the extent of their risk aversion, banks may use credit rationing to reduce the expected default of loans. Credit rationing requires that the expected return on loans, received by the banks, should not increase monotonically with the rate of interest charged. As described in the previous chapter, two basic reasons for a non-monotonic relationship between the expected return on loans and the loan rate are adverse selection and adverse incentive effects.

asset pricing approach to embody the risk preferences of portfolio investors in determining the expected rate of return on earning assets.

Testing this hypothesis requires elaboration of a model representing the expectations generating process for the bank's expected return on loans. Using the adaptive expectations mechanism, the banks' expected return on loans can be represented by

$$[\rho_1(a)]_t = \gamma_1 \cdot z_{t-j} + \vartheta_{1t} \quad j=1, \dots, n \quad (6.23)$$

where (γ_1) is a vector of coefficients, (z_{t-j}) is a vector of variables that have a systematic influence on the expected return to banks⁵.

In equation (6.23), the vector (z_{t-j}) includes lagged values of $\rho_1(a)$, and of the expected rate of return on a diversified portfolio, (ER). This is because the expected rate of return of the portfolio is subject to the price volatility of earning assets, and hence the risk of default on these assets; and in the capital asset pricing models⁶, (CAPM), the public's well-behaved preferences for holding a diversified portfolio is represented by their expected rate of return on the portfolio. Hence, in equation (6.23) the expected rate of return (ER_{t-j}) is referred to as the rate reflecting the public's risk preferences for holding the diversified portfolio in preceding periods. Only lagged values are included because it is assumed that at time t banks do not have information about period t values.

The expectations mechanism for the expected rate of return (ER), representing the public's risk preferences on the diversified portfolio, can be expressed using the previous functional form as

$$ER_t = \gamma_2 \cdot z_{t-j} + \vartheta_{2t} \quad (6.24)$$

⁵. Equation (6.23) has the same functional form as implied by Cuthbertson and Taylor (1986, 1988) and is used for testing the rational expectations hypothesis in a buffer stock type model of the demand for money.

⁶. The modelling of the public's well-behaved preferences on holding a diversified portfolio requires an explicit stochastic treatment of asset pricing, and the capital asset pricing model summarized by Ross (1978) provides such a framework. The framework is not easily incorporated into macroeconomic models. We therefore use that framework only to present the public's risk preferences on holding the diversified portfolio, regarding the relationship between the rates of return on risky assets and the expected rate of return on the portfolio.

where (γ_2) is a vector of coefficients. In equation (6.24) the vector (z_{t-j}) incorporates the effects of the lagged values of the expected rate of return on the portfolio and the lagged values of $\rho_1(a)$.

The structural equations (6.23) and (6.24) can be represented by a simultaneous system of equations as

$$\left\{ \begin{array}{l} [\rho_1(a)]_t = \sum_{j=1}^n \gamma_{31}^{(+)} \cdot [\rho_1(a)]_{t-j} + \sum_{j=1}^n \gamma_{32}^{(-)} \cdot ER_{t-j} + \vartheta_{3t} \\ ER_t = \sum_{j=1}^n \gamma_{41} \cdot [\rho_1(a)]_{t-j} + \sum_{j=1}^n \gamma_{42}^{(+)} \cdot ER_{t-j} + \vartheta_{4t} \end{array} \right. \quad \begin{array}{l} (6.23a) \\ (6.24a) \end{array}$$

where γ_{ij} is the vector of coefficients. Signs above the functional arguments represent expected signs of partial derivatives. In equation (6.23a) the expected return $\rho_1(a)$ is negatively correlated to the expected rate of return of earning assets, (ER). In this equation $[\rho_1(a)]_t$ is the expected return from the spread between lending at the safe bond rate, (i_g), and lending at the loan rate (i_d). This spread abstracts from the conceptual difficulties, concerning the statistical nature of the receipts of the banks and the payments of borrowers when both are affected by the same variable such as the expected rate of return of earning assets, (ER). In equation (6.24a) the effects of $[\rho_1(a)]_{t-j}$ on (ER) is ambiguous. In the credit-rationed state an increase in the expected return to banks is consistent with a fall in the loan rate, and hence with a reduction in the rate of return on earning assets. In the absence of rationing, an increase in the expected return to banks is consistent with a rise in the loan rate, and hence with an increase in the expected rate of return in asset markets.

In this model the data for the expected rate of return on the portfolio depends on the public's risk preferences on holding a diversified portfolio in each period. Given that the portfolio consists of money, government bonds, equities and foreign assets, the expected rate of return on the portfolio, (ER), can be obtained from the following equation.

$$ER = W_m \cdot i_{mor} + W_b \cdot i_g + W_{eq} \cdot i_e^e - W_f \cdot i_f^e \quad (6.25)$$

where

ER = the expected rate of return on the portfolio,

W_m = percentage of the portfolio held in money,

W_b = percentage of the portfolio held in the government security,

W_{eq} = percentage of the portfolio held in equity,

W_f = percentage of the portfolio held in foreign assets,

i_{mor} = the money own rate of interest,

i_g = the rate of interest on short-term (13-weeks) treasury notes, guaranteed by the government,

i_e^e = the expected rate of return on equities,

i_f^e = the uncovered rate of return on foreign assets.

In equation (6.25) money is viewed as a safe asset and its own rate of interest is set equal to zero. In this equation government bonds are treated as risk-free assets, and its nominal interest stream is specified by a given rate of interest, such as (i_g). Since the rates of return on equities and foreign assets are subject to price volatility, we allow for these rates in the determination of (ER), using their expected values in equation (6.25). This is because in the CAPM the rates of return of the assets with price volatility are estimated by their expected rates of return.

Using the process of calculating the present values of shares through discounting, the expected rate of return on equities is specified by⁷,

$$i_{e,t}^e = [(P_{eq,t}^e - P_{eq,t-1}) / P_{eq,t-1}] + (i_{dv,t}^e / P_{eq,t-1}) \quad (6.26)$$

where

$P_{eq,t}^e$ = per annum expected share price for quarter t+1, made at quarter t, and calculated as the average of four-quarter share prices to the end of quarter t,

⁷ . In this process, it is generally assumed that an investor purchases a stock at time t for a price of $P_{q,t}^e$, receives dividend yield of $i_{dv,t+1}^e$, and can sell the stock for a price of $P_{q,t+1}^e$ at time "t+1". The rate of return of this investment is equal to capital gain (loss) of the cash flows at time "t+1" plus dividend yield, Juttner (1990). That is,

$$i_{e,t+1}^e = [(P_{eq,t+1}^e - P_{eq,t}^e) / P_{eq,t}^e] + (i_{dv,t+1}^e / P_{eq,t}^e)$$

$P_{eq,t-1}$ = per annum share price at quarter t-1, calculated as the average of four-quarter share prices to the end of quarter t-1,

$i_{dv,t}^e$ = per annum expected dividend yield at quarter t+1 made at quarter t.

The expected uncovered rate of return on foreign assets, (i_f^e), is specified in terms of uncovered foreign investment returns as

$$i_f^e = (E^e/E).i_f \quad (6.27)$$

where

E = the spot exchange rate (\$A per \$US),

E^e = the expected spot exchange rate at quarter t+1 made at quarter t,

i_f = the rate of interest on foreign assets.

In this analysis we model the expected equity prices, ($P_{eq,t}^e$), dividend yield, ($i_{dv,t}^e$), and spot exchange rate, (E^e), as separate equations using their own actual values in previous periods as explanatory variables. The estimation of ($P_{eq,t}^e$) and ($i_{dv,t}^e$) are presented in *appendix 6.C* of this chapter. The estimation of (E^e) was presented in *appendix 4.C*. Using the expected rates of return of equities and foreign assets, obtained from equations (6.26) and (6.27), the expected rate of return on the portfolio, over the period 1978:2 to 1993:4, can be determined by equation (6.25). In this equation (ER) reflects the public's risk preferences for holding the diversified portfolio (W).

We assume that in equation (6.25) the proportions of the portfolio invested in each asset, in each period, are the same as those implied by the equilibrium portfolio in the single-period capital asset pricing models⁸. Also, we assume that the expected rate of return on the portfolio in each period, (ER), gives the highest expected return on the portfolio for the same level of risk as implied by the CAPM. Based on these assumptions, changes in the expected rate of return on the portfolio in the period

⁸ . The capital-asset pricing model (CAPM) is a single-period model that relates a stock's expected rate of return to the returns on a risk-free assets and the risk premium of the stock. In this model, in equilibrium all investors hold a portfolio composed of risk-free and risky securities, and the proportions of the portfolio invested in each depends on the risk preferences of the public, Livingston (1990).

1978:2 to 1993:4 provide information about shifts in the risk of default on earning assets that necessitate corresponding shifts in the proportions of these assets in the portfolio, in order to maintain the total holdings of the portfolio in equilibrium.

In equation (6.25) government bonds are risk-free assets, and equities and foreign assets with the rates of interest (i^e_{eq}) and (i^e_f), respectively, are risky assets. Given that the public have well-behaved preferences over these assets, as implied by the public's choice of the composition of risk-free and risky assets in the CAPM, the relationship between banks' expected return on loans and the expected rate of return on the portfolio in equation (6.23) provides a link from the public's risk preferences to the banks' expected return on loans.

To investigate whether the banks' expected return on loans in the post-deregulation period is correlated to changes in the expected rate of return on earning assets, and hence to shifts in the risk of default on these assets, we estimate equations (6.23a) and (6.24a), using an unrestricted VAR model with up to six lags. The estimation results are given in table 6.3.2.

The results of estimating equation (6.23a) show that the coefficient of the 4 quarter of lagged variable for (ER), and the coefficients of the 1, 2 and 3 quarter of lagged variables for $\rho_1(a)$ are significant, with expected signs. The results of estimating equation (6.24) show that the coefficients of the 1, 4 and 5 quarter of lagged variables for (ER), and the coefficient of the 5 quarter of lagged variable for $[\rho_1(a)]$ are significant. The results are obtained from a VAR model estimation in the post-deregulation period, 1984:1 to 1993:4. When we extended the sample period into the late 1970's, some coefficients of (ER) in equation (6.23), which were significant, were of the wrong sign. This situation arose because in quarters before 1984:1 banks operations were under the prevalence of some regulations which caused ambiguity in the relationship between these rates and banks' expected return on loans.

The estimation was run with up to 8 quarter lags for explanatory variables. The estimation results are presented with up to 6 lags. Since the latter equations are nested within the former, we can use the F -statistic to test the restrictions in the restricted

Table 6.3.2: VAR model estimation of the relationship between banks' expected return on loans and the expected rate of return on the portfolio held by the private sector, equations (6.23) and (6.24)

$$\left[\begin{array}{l} [\rho_1(a)]_t = \sum_{j=1}^n \gamma_{31} \cdot [\rho_1(a)]_{t-j} + \sum_{j=1}^n \gamma_{32} \cdot ER_{t-j} + \vartheta_{3t} \\ ER_t = \sum_{j=1}^n \gamma_{41} \cdot [\rho_1(a)]_{t-j} + \sum_{j=1}^n \gamma_{42} \cdot ER_{t-j} + \vartheta_{4t} \end{array} \right.$$

Sample period: 1984:1 to 1993:4

Explanatory variables	Dependent variable [$\rho_1(a)$] _t		Dependent variable ER _t	
	24347.1	(.155)	1.67	(.665)
[$\rho_1(a)$] _{t-1}	.463	(2.36)**	-.00029	(-.912)
[$\rho_1(a)$] _{t-2}	.329	(1.55)*	-.00005	(-.136)
[$\rho_1(a)$] _{t-3}	.295	(1.43)*	-.00014	(-.419)
[$\rho_1(a)$] _{t-4}	.191	(.881)	-.00018	(-.513)
[$\rho_1(a)$] _{t-5}	-.169	(-.794)	-.00066	(1.95)**
[$\rho_1(a)$] _{t-6}	-.119	(-.532)	-.00011	(-.294)
ER _{t-1}	99.5	(.805)	.813	(4.11)***
ER _{t-2}	151.6	(.998)	-.088	(-.362)
ER _{t-3}	-7.63	(-.053)	.134	(.582)
ER _{t-4}	-210.6	(-1.47)*	-.391	(-1.71)**
ER _{t-5}	97.96	(.632)	.378	(1.53)*
ER _{t-6}	-96.08	(-.777)	-.069	(-.351)

R² = .902
 DW = 1.89
 ESS = 1286.2
 The F-test for linear restrictions = .475

R² = .756
 DW = 1.89
 ESS = 2.05
 The F-test for linear restrictions = .497

Note:

1. t-statistics are in brackets.
2. (***) significant at the 99% level,
 (**) significant at the 95% level,
 (*) significant at the 90% level.

equations with up to 6 lags. Treating the equations with up to 8 quarters of the lagged variables as unrestricted equations, the value of F -statistics for linear restrictions in equations (6.23a) and (6.24a) are 0.475 and 0.497, respectively. These F values suggest that the restrictions are not rejected at the 5% level of significance, hence we can safely ignore lags of more than 6 quarters.

In equation (6.23a) the correct signs for the estimated coefficients which are significantly different from zero show that the equation satisfies the conditions required by a structural equation. Hence, the estimation of this equation provides a means of testing the hypothesis that banks' expected return on loans is determined by the expected rate of return on earning assets. The estimation results of equation (6.23a) suggest that the expected rate of return on earning assets, which is used as an indicator for shifts in the risk preferences of borrowers, Australian portfolio investors, is a determinant of the banks' expected return on loans in the post-deregulation period. This provides support for the possibility of credit rationing, implying that an increase in the expected default of earning assets reduces the banks' expected return on loans.

6.3.3 Disequilibrium models of the loan market and the implications of credit rationing

Since, in the previous subsection, we found evidence that raising the default cost of earning assets reduces the banks' expected return on loans, rationing is at least feasible. When rationing occurs banks secondary assets, bonds, are used as a buffer for variations in the banks' optimal lending. In this section we evaluate the relevance of the equilibrium credit rationing approach, by examining whether Australian banks, in the aggregate, ration credit by non-price means, using the following disequilibrium models.

$$\text{Model 1: } \begin{cases} L^d = L^d(i_d, i_m, Y) \\ L^s = L^s(i_d, i_m, D) \\ L^e = \min \{L^d, L^s\} \end{cases}$$

$$\begin{array}{l}
\text{Model 2:} \\
L^d = L^d(i_d, i_m, Y) \\
L^s = L^s(i_d, i_m, D) \\
L^e = \min\{L^d, L^s\} \\
\left. \begin{array}{l}
i_{d,t} - i_{d,t-1} > 0 \quad \text{if } L_t^d > L_t^s \quad \text{hence, } L_t^e = L_t^s \\
i_{d,t} - i_{d,t-1} < 0 \quad \text{if } L_t^d < L_t^s \quad \text{hence, } L_t^e = L_t^d
\end{array} \right\} \\
\text{or} \\
\left. \begin{array}{l}
i_{d,t+1} - i_{d,t} > 0 \quad \text{if } L_t^d > L_t^s \quad \text{hence, } L_t^e = L_t^s \\
i_{d,t+1} - i_{d,t} < 0 \quad \text{if } L_t^d < L_t^s \quad \text{hence, } L_t^e = L_t^d
\end{array} \right\}
\end{array}$$

$$\begin{array}{l}
\text{Model 3:} \\
L^d = L^d(i_d, i_m, Y) \\
L^s = L^s(i_d, i_m, D) \\
L^e = \min\{L^d, L^s\} \\
\left. \begin{array}{l}
(\Delta i_{d,t}) = i_{d,t} - i_{d,t-1} = \gamma_1(L_t^d - L_t^s) \quad \text{if } L_t^d > L_t^s \\
(\Delta i_{d,t}) = i_{d,t} - i_{d,t-1} = \gamma_2(L_t^d - L_t^s) \quad \text{if } L_t^d < L_t^s
\end{array} \right\} \\
\text{or} \\
\left. \begin{array}{l}
(\Delta i_{d,t+1}) = i_{d,t+1} - i_{d,t} = \gamma'_1(L_t^d - L_t^s) \quad \text{if } L_t^d > L_t^s \\
(\Delta i_{d,t+1}) = i_{d,t+1} - i_{d,t} = \gamma'_2(L_t^d - L_t^s) \quad \text{if } L_t^d < L_t^s
\end{array} \right\}
\end{array}$$

$$\begin{array}{l}
\text{Model 4:} \\
L^d = L^d(i_d, i_m, Y) \\
L^s = L^s(i_d, i_m, D) \\
L^e = \min\{L^d, L^s\} \\
\Delta i_{d,t} (= i_{d,t} - i_{d,t-1}) = i_d(\{L^d - L^s\}, i_m, D)
\end{array}$$

In the disequilibrium models outlined above loan market imperfections are characterized by either excess demand or excess supply. These models are classified by Maddala and Nelson (1974) and Maddala (1983) as disequilibrium models which can be used for estimating the demand and supply equations using the limited-dependent-variable methods.

The first empirical study on models of this type was that undertaken by Fair and Jaffee (1972). However, that study did not use either the limited-dependent-variable

methods, analyzed by Amemiya (1974b), Maddala and Nelson (1974), and Maddala (1983), or the switching-regression method, suggested by Quandt (1972) and Goldfeld and Quandt (1972, 1975). Using these methods, specific applications to the loan market are discussed by Bowden (1978), Laffont and Garcia (1977), Sealey (1979), Ito and Ueda (1981), and King (1986). We shall now discuss the main features of the above four models.

In model (1) the loan rate, $(i_{d,t})$, is treated as exogenous and the demand for and supply of loans, $(L^d_t$ and $L^s_t)$, as endogenous. In model (2), (L^d_t) and (L^s_t) are also endogenous and the information on imperfect adjustment of the loan rate, represented by $(\Delta i_{d,t})$, or on imperfect forecasts of market-equilibrating loan rates, represented by $(\Delta i_{d,t+1})$, is used to classify the observations into those belonging to either the demand category or the supply category. This is the model Fair and Jaffee (1974) called the directional model. In model (3) the adjustment mechanism under the assumption of imperfect adjustment of the loan rate, $\Delta i_{d,t} = \gamma \cdot (L^d_t - L^s_t)$, or alternatively under the assumption of imperfect forecasts of market-equilibrating loan rates, $\Delta i_{d,t+1} = \gamma' \cdot (L^d_t - L^s_t)$, is used to estimate the demand and supply equations. This is the model Fair and Jaffee called the quantitative model. Under the former assumption, Fair and Jaffee (1972) and Amemiya (1974a) suggested a two-stage estimation method whereby $(i_{d,t})$, (L^d) and (L^s) are treated as endogenous. Maddala (1983) pointed out that in models (2) and (3) we do not have enough equations to estimate the models for three endogenous variables. He prefers the alternative assumption, suggested by Laffont and Garcia (1977), of looking at the loan rate adjustment equation as a forecast equation, treating the loan rate $(i_{d,t})$ as exogenous. Using the alternative assumptions in model (3), the demand and supply equations can be represented by the following models.

$$\text{Model 3.1: } \begin{cases} L^d = L^d(i_d, i_m, Y, (\overset{-}{\Delta i_{d,t}})) & \text{where } (\Delta i_{d,t}) \geq 0 \\ L^s = L^s(i_d, i_m, D, (\overset{+}{\Delta i_{d,t}})) & \text{where } (\Delta i_{d,t}) \leq 0 \end{cases}$$

$$\text{Model 3.2: } \begin{cases} L^d = L^d(i_d, i_m, Y, (\Delta i_{d,t+1})^{(-)}) & \text{where } (\Delta i_{d,t+1}) \geq 0 \\ L^s = L^s(i_d, i_m, D, (\Delta i_{d,t+1})^{(+)}) & \text{where } (\Delta i_{d,t+1}) \leq 0 \end{cases}$$

Models (3.1) and (3.2) are the quantitative models under the assumptions of imperfect adjustment of the loan rate, and of imperfect forecasts of market-equilibrating loan rates, respectively. These models are derived from model (3), by substituting the term representing the loan rate adjustment mechanism into the demand and supply equations.

Model (4) is the same as model (3) except that the term representing the loan rate adjustment mechanism is made stochastic. In this model the imperfect adjustment of the loan rate, $(\Delta i_{d,t})$, is treated as the source of disequilibrium in the loan market. As discussed in the previous chapter, under the assumption of equilibrium credit rationing the loan rate adjustment equation is restricted by a rule implying that $L^d \leq L^s$. This rule implies that under the minimum condition, $L^e = \min\{L^d, L^s\}$, the loan rate is responsive to only excess supply. In the case of excess demand the loan rate remains unchanged and the transacted quantity of loans is determined by the supply schedule.

We will illustrate the estimation of models (1)-(4), using techniques represented by the limited-dependent-variable framework, and the maximum likelihood and OLS estimation methods. The estimation of models (1) and (4) is undertaken using the switching regression method. In model (4) the switching regression method is combined with the OLS estimation method used for the estimation of the loan rate adjustment equation. In this model first we estimate the reduced form equation for $(i_{d,t})$, then we substitute the estimated values of $(i_{d,t})$ in the demand and supply equations and estimate these equations, using the switching regression method.

The estimation of model (2) is carried out using the OLS and sample selection Tobit methods. The sample selection method is a generalization of the Tobit method, used when the observability of the dependent variable is affected by factors other than the explanatory variables in the equation. Using this method, if we have observations

on the transacted quantity of loans, we can specify the demand for loans and the loan rate adjustment mechanism as

$$\text{Model 2.1.1: } \begin{cases} L^e = L^e(i_d, i_m, Y) \\ (-\Delta i_{d,t+1}) = i_d(i_{d,t}, i_m, Y) \\ L^d = L^e & \text{if } (-\Delta i_{d,t+1}) > 0 \\ L^d = 0 & \text{if } (-\Delta i_{d,t+1}) \leq 0 \end{cases}$$

It is assumed that the sign of $(-\Delta i_{d,t+1})$ is observed, and $L^e(=L^d)$ is observed only when $(-\Delta i_{d,t+1}) > 0$. This model is specified as the Tobit type 2 model described by Amemiya (1985). Using the Tobit type 2 estimation method, in model (2.1.1) the regression equation is the equation in which the demand for loans, $L^e(=L^d)$, is treated as the dependent variable in the selected sample; and the selection equation is the equation in which $(-\Delta i_{d,t+1})$ is the dependent variable. The model connects the two equations by estimating a correlation between their disturbances. Using a two-step method estimation, the selection equation is estimated by the probit method and the regression equation by OLS.

Using a similar Tobit type 2 model, the supply of loans can be specified by the following model.

$$\text{Model 2.1.2: } \begin{cases} L^e = L^e(i_d, i_m, D) \\ \Delta i_{d,t+1} = i_d(i_{d,t}, i_m, D) \\ L^s = L^e & \text{if } \Delta i_{d,t+1} > 0 \\ L^s = 0 & \text{if } \Delta i_{d,t+1} \leq 0 \end{cases}$$

In model (2.1.2) it is also assumed that only the sign of $(\Delta i_{d,t+1})$ is observed and $L^e(=L^s)$ is observed only when $(\Delta i_{d,t+1}) > 0$. In this model the regression equation is the equation in which the supply of loans, $L^e(=L^s)$, is the dependent variable; and the selection equation is the equation in which $(\Delta i_{d,t+1})$ is the dependent variable. The Tobit estimation in model (2.1.2) has the same features as described for model (2.1.1).

Alternatively, the demand and supply equations in model (2) can be estimated using the OLS estimation method. The OLS estimates for the demand for and supply

of loans uses information on $(\Delta i_{d,t+1})$ to classify observations into those belonging to the demand category and those belonging to the supply category. The following models are used for the OLS estimation of the demand and supply equations.

$$\text{Model 2.1.3: } \begin{cases} L^e = L^e(i_d, i_m, Y) \\ L^d = L^e & \text{if } (\Delta i_{d,t+1}) < 0 \\ L^d = 0 & \text{if } (\Delta i_{d,t+1}) \geq 0 \end{cases}$$

$$\text{Model 2.1.4: } \begin{cases} L^e = L^e(i_d, i_m, D) \\ L^s = L^e & \text{if } (\Delta i_{d,t+1}) > 0 \\ L^s = 0 & \text{if } (\Delta i_{d,t+1}) \leq 0 \end{cases}$$

The principal assumption in the Tobit type 2 and the OLS estimation methods of model (2) is that, in the loan market, there are instances in which, at the market loan rates, some borrowers (or some lenders), who are willing to borrow (or lend) under precisely the same conditions, are excluded from the market. When we have observations on the transacted quantity of loans, the demand for loans and the supply of loans are specified by the selected sample, representing a demand determined or a supply determined loan schedule respectively.

The estimation of model (3) will be illustrated by the demand and supply equations under alternative assumptions, regarding imperfect adjustment of the loan rate and the imperfect forecasts of market-equilibrating loan rates as different sources of disequilibrium in the loan market. Under the former assumption the loan rate, $(i_{d,t})$, is treated as endogenous, and under the latter assumption the loan rate is exogenous. The demand and supply equations under both assumptions have the same specification as shown by models (3.1) and (3.2). These models are estimated by the two-stage estimation method suggested by Amemiya (1974a). The estimation is carried out, using the two-stage OLS method and the limited-information maximum likelihood, LIML, method.

In the estimation of the models we have used a number of different specifications to achieve significant results consistent with the disequilibrium models

(1)-(4). Changes in the specification of equations are not essential and provide results which are in the aggregate consistent.

The estimation results of model (1) are given in table 6.3.3. Using the switching regression method, the results show that both demand and supply equations are reasonably estimated and the coefficients have the expected signs. The presence of a time trend in the demand equation and two dummy variables in the supply equation improved the *t*-statistics of the coefficients. The results are obtained under the disequilibrium condition, represented by $L^e = \min\{L^d, L^s\}$, and the estimates of the supply and demand equations reveal a state of predominantly either excess demand or excess supply in the loan market. The evidence on persisting excess demand in 58 periods, comparing with excess supply in 4 periods, is consistent with the equilibrium rationing hypothesis. Further evidence on this hypothesis can be obtained from the models which include the loan rate adjustment mechanism in the estimation of the demand and supply equations. In the subsequent models we allow for such an adjustment mechanism in disequilibrium estimates of the credit market equations.

The estimation results of models (2.2.1)-(2.2.4) are shown in tables 6.3.4 and 6.3.5. The estimation results are based on the assumption that the imperfect forecasts of market-equilibrating loan rates is the source of disequilibrium in the loan market. The regressions based on the assumption of the imperfect adjustment of the loan rate were run and did not yield significant results for either of the demand and supply equations. In tables 6.3.4 and 6.3.5 only the results obtained from the former assumption are reported. Table 6.3.4 presents the OLS and Tobit estimates of the demand equation. The estimates of the parameters obtained from the Tobit method for all the variables except (GDP) are very close to those obtained from the OLS method. However, it should be noted that two of the coefficients in the demand function, estimated by the Tobit method, are not significantly different from zero. In both the estimates the sign of the coefficient of the loan rate, $(i_{d,t})$, is opposite to the expected sign. This possibly arises from the exogeneity of the loan rate and persisting excess

Table 6.3.3: The demand for and supply of loans, using switching regression method, equations (6.9), (6.10) and (6.12)

$$\begin{cases} L^d = L^d(i_d, i_m, Y, T) \\ L^s = L^s(i_d, i_m, D) \\ L^e = \min \{L^d, L^s\} \end{cases}$$

Sample period: 1978:3 to 1993:4

Dependent variables: $\log(L^d)$, $\log(L^s)$

Explanatory variables	Demand	Supply
	-16.76 (-4.31)***	-2.99 (-14.9)***
$\log(i_d)$	-.228 (-1.56)*	.107 (2.79)***
$\log(i_m)$	.175 (2.20)**	-.059 (-2.67)***
$\log(Y)$	2.53 (6.67)***	
$\log(D)$		1.23 (79.1)***
T (time trend)	.0226 (9.58)***	
Dummy(2)		-.0515 (-3.83)***
Dummy(6)		(.068) (5.80)***
Sigma	.00306 (2.18)**	.0205 (8.19)***

Note:

1. t-statistics in brackets.
2. Dummy(2) takes the value of unity before 1982:3, and zero thereafter.
3. Dummy(6) takes the value of unity before 1985:2, and zero thereafter.
4. (***) significant at the 99% level,
 (**) significant at the 95% level,
 (*) significant at the 90% level.

Table 6.3.4: Demand for loans, using directional method, equation (6.9)

$$\begin{cases} L^d = L^d(i_d, i_m, Y) \\ L^s = L^s(i_d, i_m, D) \\ L^e = \min\{L^d, L^s\} \end{cases}$$

$$\Delta i_{d,t+1} \leq 0 \quad \text{hence } L^e_t = L^d_t$$

In the demand equation ($i_{d,t-1}$) and ($L_{d,t-1}$) are used as regressors.

Sample period: 1978:3 to 1993:4

Number of observations: 28

Dependent variable: $\log(L^d)$

Explanatory variables	Tobit estimate	OLSQ estimate
	-1.49 (-.068)	-1.73 (-1.21)
$\log(L)_{t-1}$	.969 (-1.90)**	.964 (29.6)***
$\log(i_d)$	.173 (1.89)**	.181 (2.24)**
$\log(i_d)_{t-1}$	-.128 (-.640)	-.139 (-1.65)*
$\log(Y)$	.016 (.063)	.189 (1.14)
Sigma	.016 (1.21)	
RHO	-.139 (-.014)	
		$R^2 = .99$ $DW = 1.32$ $ESS = .00674$

Note:

1. t-statistics in brackets.
2. For the t-statistics see footnote of table 6.3.3.

Table 6.3.5: Supply of loans, using directional method, equation (6.10)

$$\begin{cases} L^d = L^d(i_d, i_m, Y) \\ L^s = L^s(i_d, i_m, D) \\ L^e = \min\{L^d, L^s\} \end{cases}$$

$$\Delta i_{d,t+1} \geq 0 \quad \text{hence } L^e_t = L^s_t$$

In the supply equation (L_{t-1}) is used as a regressor.

Sample period: 1978:3 to 1993:4

Number of observations: 41

Dependent variable: $\log(L^s)$

Explanatory variables	Tobit estimate	OLSQ estimate
	-.551 (-1.73) **	-.289 (-1.08)
$\log(L)_{t-1}$	.776 (8.4)	.863 (10.5) ***
$\log(i_d)$	.0676 (2.96) ***	.059 (2.68) ***
$\log(i_m)$	-.027 (-1.68) ***	-.025 (-1.63) *
$\log(D)$	.262 (2.22) ***	.154 (1.48) *
Sigma	.0184 (3.91) ***	
RHO	-.953 (-159.9) ***	
		$R^2 = .99$ DW = 1.69 ESS = .00728

Note:

1. t-statistics in brackets.

2. For the t-statistics see footnote of table 6.3.3.

demand in the loan market. In such a circumstance borrowers are primarily reacting to loan market conditions, and the transacted quantity of loans are supply determined.

Table 6.3.5 presents the OLS and Tobit estimates of the supply equation. The estimates of the parameters obtained from both the methods are significantly different from zero, with expected signs. The coefficients obtained from the Tobit estimate are also close to those obtained from the OLS estimate, except that the coefficient of deposits is higher and more significant in the former estimate. The results on both the estimates for the supply of loans provide evidence on the sample separation assumption in the model, regarding the imperfect forecast of market-equilibrating loan rates as the source of disequilibrium.

The estimation results of models (2.3.1) and (2.3.2) under two different assumptions are shown in tables 6.3.6 and 6.3.7. In the former table the imperfect adjustment of loan rates is assumed to be the source of disequilibrium, and in the latter table the imperfect forecast of loan rates is assumed to be the source of disequilibrium. The estimation results for demand and supply equations are obtained, using LIML and 2SLS methods.

Table 6.3.6 presents the estimation results for the demand and supply equations under the assumption of imperfect adjustment of the loan rate. The estimates of the parameters in the demand equation in two estimation methods, LIML and 2SLS, are different. Almost none of the coefficients in the demand function estimated by the LIML method are significantly different from zero. The t -ratios for the coefficients estimated by 2SLS are significant and the R^2 shows that the fit for the demand function is very good.

In the LIML and 2SLS estimates of the demand equation, the coefficients of the loan rate, $(i_{d,t})$, and the cash market rate of interest, $(i_{a,t})$, are of opposite signs. The sign of $(i_{d,t})$ is consistent with the results represented in table 6.3.4. The negative sign of $(i_{a,t})$ possibly results from the rule by which the Reserve Bank plays the role of 'leaning against the wind'. This can be described by the fact that when the likelihood of default on risky projects rises the demand for loans increases. This occurs because,

Table 6.3.6: Demand for and supply of loans, using quantitative method, equations (6.9), (6.10) and (6.12)

$$\begin{cases} L^d = L^d(i_d, i_m, Y, \Delta i_d, t) \\ L^s = L^s(i_d, i_m, D, \Delta i_d, t) \\ L^e = \min \{L^d, L^s\} \end{cases}$$

$$\Delta i_d, t \leq 0, \text{ hence } L^e_t = L^d_t$$

$$\Delta i_d, t \geq 0, \text{ hence } L^e_t = L^s_t$$

Sample period: 1978:3 to 1993:4

Dependent variables: $\log(L^d)$ and $\log(L^s)$

Explanatory variables	Demand		Supply	
	LIML	OLSQ	LIML	OLSQ
	.693 (.145)	-1.79 (-1.47) *	-1.17 (-2.62) ***	-1.38 (-4.04) ***
$\log(L)_{t-1}$	.993 (11.4) ***	.951 (39.9) ***	.715 (5.68) ***	.581 (6.07) ***
$\log(i_d)$	.230 (1.00)	.0998 (1.97) **	.155 (2.75) ***	.119 (3.01) ***
$\log(i_a)$	-.146 (-.890)	-.052 (-1.46) *		
$\log(i_m)$			-.076 (-2.06) **	-.050 (-2.08) **
$\log(Y)$	-.079 (-.145)	.204 (1.47) *		
$\log(D)$			.366 (2.30) **	.521 (4.34) ***
$\Delta i_d, t$	-.971 (-1.894)	-.333 (-1.50) *	.744 (2.13) **	.312 (1.31) *
Dummy (1)				-.021 (-2.20) **
Dummy (2)			.042 (2.18) **	.0304 (2.32) **
Dummy (5)				-.018 (-1.76) **
	R ² =.996 DW=2.26 ESS=.105	R ² =.99 DW=1.60 Durbin's h=1.58 Chow=1.58, (.173) ADF=-6.18	R ² =.99 DW=2.03 ESS=.0255	R ² =.99 DW=1.60 Durbin's h(Alt.)=1.62 Chow=2.38, (.028) ADF=-6.12

Note:

1. OLSQ estimates represent the results obtained from the 2SLS method.
2. Dummy(1) takes the value of unity before 1980:4, and zero thereafter.
3. Dummy(2) takes the value of unity before 1982:3, and zero thereafter.
4. Dummy(5) takes the value of unity before 1984:4, and zero thereafter.
5. For the t-statistics see footnote of table 6.3.3.
6. The P-values for Chow statistics are represented in parentheses.
7. The critical value for the ADF test at the 1% level of significance is 4.61.

Table 6.3.7: Demand for and supply of loans, using quantitative method, equations (6.9), (6.10) and (6.12)

$$\begin{cases} L^d = L^d(i_d, i_m, Y, \Delta i_d, t+1) \\ L^s = L^s(i_d, i_m, D, \Delta i_d, t+1) \\ L^e = \min \{L^d, L^s\} \end{cases}$$

$$\Delta i_d, t+1 \leq 0, \text{ hence } L^e_t = L^d_t$$

$$\Delta i_d, t+1 \geq 0, \text{ hence } L^e_t = L^s_t$$

Sample period: 1978:3 to 1993:4

Dependent variables: $\log(L^d)$ and $\log(L^s)$

Explanatory variables	Demand		Supply	
	LIML	OLSQ	LIML	OLSQ
	-.688 (-.255)	-1.62 (-1.35) *	-.880 (-2.03) **	-1.18 (-3.71) ***
$\log(L)_{t-1}$	.979 (17.2) ***	.956 (37.8) ***	.827 (5.98) ***	.690 (6.7) ***
$\log(i_d)$	.208 (1.75) **	.118 (2.68) ***	.111 (3.10) ***	.104 (4.01) ***
$\log(i_a)$	-.083 (-1.12)	-.062 (-2.02) ***		
$\log(i_m)$			-.039 (-1.68) **	-.034 (-2.15) **
$\log(Y)$	.069 (.222)	.180 (1.30)		
$\log(D)$			.233 (1.37) *	.396 (3.17) ***
$\Delta i_d, t+1$	-.800 (-1.963)	-.538 (-1.63) *	.833 (2.24) **	.538 (2.09) **
$\log(i_d)_{t-1}$	-.063 (-.683)			
Dummy (1)				.020 (2.24) **
Dummy (2)			.0296 (1.97) **	.024 (2.33) **
Dummy (5)				.012 (1.33) **
	R ² = .998 DW = 2.24 ESS = .062	R ² = .99 DW = 1.59 Durbin's h = 1.61 Chow = 3.8, (.003) ADF = -6.09	R ² = .99 DW = 2.06 ESS = .0227	R ² = .99 DW = 1.73 Durbin's h(Alt.) = 1.0 Chow = 1.83 (.091) ADF = -6.60

Note:

1. OLSQ estimates represent the results obtained from the 2SLS method.
2. Dummy(1) takes the value of unity before 1980:4, and zero thereafter.
3. Dummy(2) takes the value of unity before 1982:3, and zero thereafter.
4. Dummy(5) takes the value of unity before 1984:4, and zero thereafter.
5. For the statistics see footnotes of tables 6.3.3 and 6.3.6.

given that the safer borrowers are charged the prime rate, the riskier borrowers apply for loans at a premium over the prime rate. At a higher premium, the applicants undertaking riskier projects increase their demand for loans. At the same time the Reserve Bank reduces the cash market rate of interest, $(i_{a,t})$, to reduce the required rate of return on earning assets. This results in a fall mainly in the rate of return on safer assets, bonds. This in turn reduces the quantity demanded of these assets, and hence reduces the demand for loans by safer borrowers, but has ambiguous effects on riskier borrowers. This group of borrowers may still increase their demand for loans at a higher premium which is consistent with the required rate of return on riskier projects.

Table 6.3.6 also presents the estimates of the parameters in the supply equation, using two estimation methods, LIML and 2SLS. The coefficients in both the estimates are significantly different from zero, with the expected signs. The estimates of the parameters in the supply equation obtained from the LIML method are not very close to those obtained from the 2SLS method. This is because in the supply equation, estimated by the 2SLS method, we allow for more dummy variables to satisfy the criterion of parameter stability. This criterion is considered essential in all the equations estimated by the OLS and 2SLS methods. In both the LIML and 2SLS estimates of the demand and supply equations the coefficients on the loan rate adjustment variables, $(\Delta i_{d,t})$, have the expected sign; and in all the estimates, except the LIML estimate of the demand equation, these coefficients are significantly different from zero.

Table 6.3.6 presents the estimation results for the demand and supply equations under the assumption of imperfect forecasts of market-equilibrating loan rates. Using this assumption, the loan rate in both the demand and supply equations is treated as exogenous. The estimates of the parameters in the demand equation in the two estimation methods, LIML and 2SLS, are different. In the LIML estimate of the demand equation all the coefficients except $(i_{d,t})$ and $(i_{a,t})$ are of expected sign, and again half of the coefficients are insignificant. The supply equation estimated by the two methods has the same feature as shown by the assumption of imperfect adjustment

of the loan rate in table 6.3.6. This equation under both the assumptions, using the quantitative methods represented by the LIML and 2SLS methods, is reasonably estimated. This was also shown in the switching regression method and in the directional method, which is represented by the OLS and Tobit type 2 methods for the estimation of the supply equations. This implies that in the disequilibrium models of the loan market the estimated coefficients of the supply equation are always significant with the expected sign. The estimates of the demand equation obtained by the directional and quantitative methods are shown to be reasonable, using the OLS and 2SLS methods. One important feature of the estimates of the demand equation in the directional and quantitative methods is that the demand for loans is positively related to the loan rate. As we have already noted, this may arise from persisting excess demand in the loan market.

In the estimation of model (4) we incorporate the loan rate adjustment mechanism into the switching regression estimate of the demand and supply equations, using a stochastic loan rate equation. As shown above, the appropriate treatment of the loan rate adjustment mechanism in the directional and quantitative methods is to take the loan rate, $(i_{d,t})$, to be exogenous. This also applied to model (1) when estimated by the switching regression method. Table 6.3.8 presents the estimation results for the demand and supply equations in model (4), using a two-step switching regression method. In this model there are three endogenous variables, (L_t^d) , (L_t^s) and $(i_{d,t})$.

In the estimation of the demand and supply equations, at the first step we estimate the loan rate, $(i_{d,t})$, in a reduced form equation, using the exogenous variables of the model as explanatory variables. In the second step we use the switching regression method, substituting the estimated values of the loan rate in the demand and supply equations. The results show that both the demand and supply equations are reasonably estimated, and coefficients are of the expected signs. The coefficients in these equations are very close to those estimated by model (1). Hence, we can hold the same interpretation of results in model (4) as implied by model (1). As mentioned previously one important feature of model (4) is the endogeneity of the loan rate.

Table 6.3.8: Demand for and supply of loans, using switching regression method, equations (6.9), (6.10) and (6.12)

$$\begin{cases} L^d = L^d (i_d, i_m, Y, T) \\ L^s = L^s (i_d, i_m, D) \\ L^e = \min \{L^d, L^s\} \end{cases}$$

$$\Delta i_{d,t} = i_d ((L^d - L^s), i_m, D)$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\log(L^e)$

Explanatory variables	Demand	Supply
	-17.57 (-8.00)***	-2.95 (-17.6)***
$\log(i_d)$	-.271 (-6.85)***	.137 (3.21)***
$\log(i_m)$	.216 (6.50)***	-.077 (-3.06)***
$\log(Y)$	2.60 (12.4)***	
$\log(D)$		1.23 (84.6)***
T (time trend)	.023 (15.1)***	
Dummy(2)		-.0497 (-4.24)***
Dummy(6)		.069 (6.98)***
Sigma	.00199 (1.37)*	.0201 (8.73)***

Notes:

1. Dummy(2) takes the value of unity before 1982:3, and zero thereafter.
2. Dummy(6) takes the value of unity before 1985:2, and zero thereafter.
3. For the t-statistics see footnote of table 6.3.3.

The estimation of the loan rate equation in this model is considered under two different assumptions. The first assumption is that the loan rate rises, $\Delta i_d > 0$, when there is excess demand, $(L^d - L^s) > 0$, and falls, $\Delta i_d < 0$, when there is excess supply $(L^d - L^s) < 0$. Under this assumption the term $L^d - L^s$ in the loan rate equation represents the consequences of loan market imperfections for loan rate adjustments. The second assumption is that the loan rate adjusts frequently when there are instances of excess supply. The latter assumption is based on the equilibrium rationing hypothesis, implying that the loan rate adjusts to reduce the amount of excess supply, but remains unchanged or varies slightly when there is excess demand. Under the second assumption, it is expected that the loan rate will be more responsive to excess supply than to excess demand. As discussed in the previous chapter the stochastic treatment of the loan rate in this model is based on some rules under which loan rate controls in a rationing model depend on specific historical data.

The estimation results of model (4) showed that in the loan market there have been 57 periods of excess demand and only 5 periods of excess supply. Hence, the estimation of the loan rate equation in this model under the first assumption, using $(L^d - L^s)$ as the regressor, is more consistent with situations concerning excess demand in the loan market. The adjustment of the loan rate under the second assumption can be represented by the equation in which there are only instances of excess supply. This requires that the term $(L^d - L^s)$ in the loan rate equation should be replaced by $(L^d - L^s) < 0$, representing only excess supply in the loan market.

The estimation results of the first order error-correction models for the loan rate equation under the two different assumptions, outlined above, are given in table 6.3.9.

In both equations the lagged variables are integrated of order 1, and the difference variables and the variable represented by $(L^d - L^s) < 0$ are integrated of order zero. Therefore, the results can be regarded as consistent with the dynamic properties of the short-run error-correction models. All the coefficients in both equations are significant, and are correctly signed except the coefficient of $(\Delta \log D_t)$. This possibly

Table 6.3.9: Estimation results for the loan rate equation in the switching regression model, using error correction estimation, equation (6.10)

$$\text{Equation (1): } \Delta i_{d,t} = i_d \left((L^d - L^s)^{(+)}, i_m^{(+)}, D^{(-)} \right)$$

$$\text{Equation (2): } \Delta i_{d,t} = i_d \left(\Sigma[(L^d - L^s) < 0]^{(+)}, i_m^{(+)}, D^{(-)} \right)$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\Delta \log(i_d)$

Explanatory variables	Equation (1)	Equation (2)
	.443 (2.49) ***	.219 (3.20) ***
$\Delta \log(i_m)$	.060 (2.96) ***	.055 (2.97) ***
$\Delta \log(D)$	.262 (1.33) *	.245 (1.32) *
$\Delta(L^d - L^s)$...	
$(L^d - L^s) < 0$		1.87 (3.72) ***
$\log(i_d)_{t-1}$	-.102 (-2.35) **	-.152 (-4.13)
$\log(i_m)_{t-1}$	.0496 (1.90) **	.075 (3.59) ***
$(L^d - L^s)_{t-1}$	.063 (1.42) *	
$\Sigma(L^d - L^s)_{t-1} < 0$		.482 (2.26) **
Dummy (2)	-.028 (-2.13) **	-.033 (-2.93) ***
Dummy (6)	-.020 (-1.37) *	-.018 (-1.68) ***
	$R^2 = .539$	$R^2 = .605$
	DW = 1.76	DW = 1.79
	LM1=.55 LM4=7.71	LM1=.37 LM4=5.0
	Chow = 2.81, (.011)	Chow = 2.64, (.016)
	ADF = -6.67	ADF = -6.57

Note:

1. Dummy(2) takes the value of unity before 1982:3, and zero thereafter.
2. Dummy(6) takes the value of unity before 1985:2, and zero thereafter.
3. The critical values of χ^2 for LM1 (with d.f.=1) and LM4 (with d.f.=4) statistics at the 5% level of significance are respectively 3.84 and 9.49.
4. For the other statistics see footnotes of tables 6.3.3 and 6.3.6.

arises from the special feature of loan rationing whereby an increase in the loan rate requires a rise in the risk of default for banks. In the short run the banks need more funds because of the greater risk required by the increased loan rate. In the long run banks increase their loanable funds to create more loans which in turn may cause a reduction in the loan rate. This long-run relationship in the equations was considered insignificant.

Using $(L^d - L^s)$ as the regressor in the loan rate equation, the loan rate elasticity with respect to $(L^d - L^s)$ implies that a one per cent increase in excess demand (excess supply) increases (decreases) the loan rate, (i_d) , by 6.55 per cent in the long run. In the other equation, using $\Sigma[(L^d - L^s) \leq 0]$ as the regressor, the corresponding elasticity implies that a one per cent increase in excess supply reduces the loan rate, (i_d) , by 8.5 per cent in the long run and by 0.22 per cent in the short run. Such a short-run elasticity in the former equation was not significant. Comparing the R^2 criteria for the goodness of fit in the two loan rate equations, the equation estimated using $\Sigma[(L^d - L^s) \leq 0]$ as the regressor shows a higher R^2 . The results are therefore more consistent with the second assumption implying that loan rate responses to excess supply are more significant than responses to excess demand. Under this assumption the loan rate adjusts frequently to reduce excess supply, but varies only slightly when there is excess demand in the loan market. As discussed earlier, this assumption represents the rule for loan rate adjustments, which is consistent with the equilibrium rationing hypothesis, and the results can be treated as support for this hypothesis.

The evidence of this subsection, therefore, has provided support for the credit rationing hypothesis. A necessary condition for rationing to exist was that the expected default on earning assets, which is reflected in the expected rate of return required by portfolio investors, is a determinant of the banks' expected return on loans. The evidence of table 6.3.2 in the previous subsection supported that hypothesis for the post-deregulation period. A possible explanation for banks behaviour under this condition is that banks use credit rationing to reduce the risk of borrowers default

since credit rationing is more likely when lenders have a higher degree of risk aversion. The disequilibrium modelling of the demand for and supply of loans in the switching regression estimates revealed states of predominantly excess demand and excess supply in the loan market. In these estimates 57 periods are attributed to excess demand and 5 periods to excess supply. These results are consistent with the equilibrium rationing hypothesis. Further, the stochastic treatment of the loan rate, using some rules for loan rate controls, presents support for persisting excess demand, and hence for the rationing hypothesis, in the loan market. The directional and quantitative estimates of the demand equation for a sample size of more than 5 periods showed that the demand for loans is positively correlated with the loan rate. This reflects the importance of instances in which borrowers are primarily reacting to loan market conditions, implying that the transacted quantity of loans is supply determined. Under these circumstances an increase in the demand for loans is associated with a reduction in the amount of positive excess demand, and a fall in the excess demand results from a rise in the loan rate, *i.e.* i_d increases and $\Delta i_{d,t} > 0$. The graphical representation is shown in Figure 5.2. In these estimates the supply equations revealed an economically and statistically significant response of the loan supply to the loan rate which implies that the limits on loan rates under credit rationing are not exactly fixed.

6.3.4 The deposit market and banks non-borrowed reserves in Australia

The analysis in the previous subsection was suggestive of the role of banks secondary assets, bonds, as a buffer for disequilibrium in the loan market, and of the ability of the banking system to accommodate their optimal quantity of loans, regarding bank lending under credit rationing. Following Palley (1994), bank choice of assets and liabilities in the model given by equations (6.1)-(6.20), implies that banks actively manage their asset and liability positions to minimize the cost of financing. This has been implied by the inclusion of the banks balance sheet identity in the model, and the role of banks secondary assets, bonds, as a buffer for variations in the banks' loan and reserve assets and deposit liabilities. In this subsection we allow for such choices in the

model by the inclusion of the demand equation for deposits and banks response functions which are identified by the equations for the deposit rate and banks' reserve assets. These extensions to the model are specified by the equilibrium condition in the deposit market, equations (6.13)-(6.16).

The equation of the demand for deposits, equation (6.13), has the same specification as implied by the demand equations for money and foreign assets, with the exception that in this equation we included the deposit rate of interest as a regressor. In this equation the deposit rate is positively correlated with the quantity demanded by depositors. The supply of deposits, equation (6.14), was specified by an inverse functional form, regarding the deposit rate as the dependent variable. In the model the banks holdings of non-borrowed reserves are treated as stochastic as shown by equation (6.15). The deposit market equilibrium condition was represented by equation (6.16). In the previous chapter equations (6.13)-(6.16) were specified as parts of the money market equilibrium condition. The estimation results of these equations are shown in tables 6.3.10, 6.3.11, 6.3.12.

Table 6.3.10 gives the results of a 2SLS estimation of equation (6.13). The results show that the demand function is reasonably estimated and all the coefficients, except (W/P) in the period 1978:3 to 1985:1, are correctly signed. In this equation the LM statistics show the possibility of first-order autocorrelation. The Durbin-Watson statistic for first-order autocorrelation is inconclusive at the 5% level of significance. The slope dummy variable, introducing the removal of remaining interest rate ceilings on bank deposits and loans in April 1985, improved the stability criterion in the equation. The results show that prior to April 1985, the effects of (W/P), the total outstanding stock of assets in the public's portfolio, on the demand for deposits was ambiguous. This is consistent with the results shown for the demand for the money base equation, represented in table 4.3.1. As discussed in section 5.2, both the demand equations in the model are viewed as parts of the money market equations.

Table 6.3.10: Demand for deposits, (D/P), equation (6.13)

$$D^d = P \cdot D^d \begin{matrix} (-) & (+) & (-) & (+) & (-) \\ (i_m, & i_c, & (E^e/E) \cdot (1+i_f), & Y, & W/P) \end{matrix}$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\log(D/P)$

Explanatory variables	Coefficients	t-statistics
Period 1978:3 to 1985:1		
	4.88	(5.7) ***
$\log(i_m)$	-.100	(-5.2) ***
$\log(i_c)$	.100	(2.67) ***
$\log[(E^e/E) \cdot (1+i_f)]$	-.236	(-3.82) ***
$\log(Y)$	.634	(7.3) ***
$\log(W/P)$	-.056	(1.77) **
Dummy (5)	.072	(-7.1) ***
Period 1985:2 to 1993:4		
	-7.38	(2.67) ***
$\log(i_m)$	-.277	(-2.10) **
$\log(i_c)$	.214	(1.43) *
$\log[(E^e/E) \cdot (1+i_f)]$	-1.64	(-2.28) **
$\log(Y)$	2.58	(22.9) ***
$\log(W/P)$	-.145	(-6.92) ***

$R^2 = .991$

DW = 1.25

LM1 = 8.6 LM4 = 8.76

Chow = .227, (.997)

Chow* = .021, (.999)

ADF = -5.13

Note:

1. Two-stage least squares estimation: 2SLS.
2. Dummy(5) takes the value of unity before 1984:4, and zero thereafter.
3. (***) significant at the 99% level,
 (**) significant at the 95% level,
 (*) significant at the 90% level.
4. The critical values of for χ^2 LM1 (with d.f.=1) and LM4 (with d.f.=4) statistics at the 5% level of significance are respectively 3.48 and 9.49.
5. The Chow* statistic shows the parameter stability criterion after removing all controls on bank deposits in 1984:3.
6. The P-values for the Chow statistics are in parentheses.
7. The critical value for ADF at the 1% level of significance is 4.61.

Table 6.3.11 presents the results of a 2SLS estimation of the banks response function, equation (6.14). The results show that the coefficients are of expected sign, and with the exception of (D) all the variables have coefficients which are significantly different from zero. However, since the t -statistic of the coefficient of (D) exceeds unity, we retain (D) in the equation. The parameter stability criterion, the Chow statistic, suggest that the hypothesis of stability cannot be rejected at the 5% level of significance. The loan rate in this equation is replaced by its estimated values, obtained from a reduced form equation for (i_d). This is in contrast to the estimation results of the equation for the money market interest rate, (i_m), equation (6.2), represented in table 4.3.2. In the latter equation the coefficient of the loan rate was seen as significant when the loan rate was treated as exogenous in the model. The endogenous treatment of the loan rate in equation (6.14) is consistent with the modelling of banks asset and liability choices, regarding the composition of loans and deposits in the banks balance sheet identity.

The elasticities of the deposit rate with respect to deposits held in banks, and of the banks holdings of non-borrowed reserves, (NBR), are respectively -0.037 and -0.456. Such a relatively high elasticity for (NBR) implies that, if (NBR) is treated as an exogenously determined policy variable, as implied by textbooks, a one per cent increase in (NBR) reduces the deposit rate 12.3 times more than a one percent increase in deposits (D). Hence, the exogeneity of (NBR) reduces the banks ability to manage their liability position actively. Such a restriction on banks operation is inconsistent with deregulation and development of financial markets post-deregulation. In equation (6.15) we assume that (NBR) is endogenous and the cash market rate of interest, (i_a), is the variable through which the Reserve Bank affects the deposit market. Based on this assumption the deposit rate, (i_c), will be affected by an interest rate operating instrument, such as (i_a), via changes in the banks holdings of reserve assets.

Table 6.3.12 presents the results of the estimation of equation (6.15), using the 2SLS method. The results show that all the coefficients are significantly different from zero. In this equation the cash market rate of interest, (i_a), is treated as the rate

Table 6.3.11: Estimation results for the deposit rate (i_c), equation (14)

$$i_c = i_c \left(\begin{matrix} (+) \\ i_m, \end{matrix} \begin{matrix} (+) \\ i_d, \end{matrix} \begin{matrix} (-) \\ D, \end{matrix} \begin{matrix} \{- \\ +\} \\ \text{NBR} \end{matrix} \right)$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\log(i_c)$

Explanatory variables	Coefficients	t-statistics
	2.46	(1.94)**
$\log(i_m)$	.277	(3.46)***
$\log(i_d)$	1.20	(8.1)***
$\log(D)$	-.037	(-1.05)
$\log(\text{NBR})$	-.456	(-3.04)***
Dummy (2)	-.061	(-1.93)**
Dummy (4)	.077	(1.54)*

$R^2 = .969$
 $DW = 1.66$
 $LM1 = 1.72$ $LM4 = 5.13$
 $Chow = .489, (.834)$
 $ADF = -6.67$

Note:

1. Two-stage least squares estimation: 2SLS.
2. Dummy(2) takes the value of unity before 1982:3, and zero thereafter.
3. Dummy(4) takes the value of unity before 1984:2, and zero thereafter.
4. For the statistics see footnotes of table 6.3.10.

Table 6.3.12: Estimation results for the banks non- borrowed reserves, (NBR), equation (6.15)

$$\text{NBR} = \text{NBR} \begin{pmatrix} (-) \\ (+) \\ (+) \end{pmatrix} (i_a, i_d, D)$$

Sample period: 1978:3 to 1993:4

Dependent variable: $\log(\text{NBR})$

Explanatory variables	Coefficients	t-statistics
Period 1978:3 to 1988:3		
	3.57	(4.45)***
$\log(i_a)$	-.181	(-2.68)***
$\log(i_d)$	.332	(3.20)***
Period 1988:4 to 1993:4		
	.631	(.562)
$\log(i_a)$	-1.06	(-6.2)***
$\log(i_d)$	2.07	(7.2)***
Period 1978:3 to 1993:4		
$\log(D)$	.351	(4.81)***
Dummy (4)	-.132	(-3.12)***

$R^2 = .908$
 $DW = 1.71$
 $LM1 = .986$ $LM4 = 6.22$
 $Chow = .302, (.961)$
 $CHOW^* = .680, (.712)$
 $ADF = -6.53$

Note:

1. Two-stage least squares estimation: 2SLS.
2. Dummy(4) takes the value of unity before 1984:2, and zero thereafter.
3. The Chow* statistic shows the parameter stability criterion after removing all controls on bank deposits in 1984:3.
4. For the statistics see footnotes of table 6.3.10.

proxying for the marginal cost of reserves. The loan rate (i_d) is treated as the rate at which the required reserves of banks are set against loans. Given that such reserves are set to meet the risk of default on loans, the higher the loan rate, the higher the expectations of default of loans, and hence the higher the reserves held against the default of loans. The shift and slope dummy variables in the equation improved the diagnostic statistics of the estimated coefficients and the criterion of the parameter stability. The slope dummy in the equation represents the reduction of the SRD ratio to zero and the transferring of SRD funds to non-callable deposits in September 1988. The intercept dummy represents the replacement of LGS convention by Prime Asset Ratio, (PAR), in May 1985.

Table 6.3.12 also indicates that in the whole sample period the elasticity of reserves with respect to the public's deposits in banks remains unchanged. As is implied by intercept and slope dummies in equation (6.15), in the period prior to 1988:3 more reserves were held mainly due to the restrictions imposed by the LGS and SRD mechanisms. These were two main channels through which monetary policy could be tightened. In this period the effects of the rates of interest (i_a) and (i_d) on the banks holdings of reserves were low. This was because controls over the banks' non-borrowed reserves reduced the correlation between these reserves and the rates of interest, (i_a) and (i_d). In the shorter post-deregulation period the elasticities of reserves with respect to these interest rates are significantly higher. This shows that with greater freedom to adjust the reserves, banks moved towards active management of their reserves in this period. During this period the cash market interest rate, (i_a), is the primary means through which the Reserve Bank acts to influence interest rates and banks reserves.

In general, the portfolio-loan model embodies banks choice of the composition of assets and liabilities and the buffer stock role of banks secondary assets, bonds, in the banks balance sheet identity. A necessary condition for such choices was that banks actively manage their asset and liability positions. Further, the modelling of the deposit

market equilibrium condition revealed that the ability of the banking system to adjust its assets and liabilities is dependent upon the demand for deposits and on an interest rate operating instrument through which the Reserve Bank affects the deposit rates and banks reserves. This complies with Palley's (1994) model in which an increase (decrease) in the volume of loans depends on the private initiatives of banks and the stance of the monetary authorities. In the model under discussion we provided evidence on the equilibrium rationing hypothesis. The latter feature introduces a new-Keynesian element, and reveals a significant difference from Palley's post-Keynesian model. The rationing hypothesis implies that the secondary assets, bonds, buffer variations in the banks' optimal lending and the demand for bank deposits.

6.4 The expectations theory of the term structure of interest rates in Australia

A consistent solution for the model, represented by equations (6.1)-(6.20), generates the values for the rates of interest on short-term assets in Australia. In order to examine their implications for the rates of interest on longer term securities, some assumption about the determination of the term structure of interest rates must first be made. The following analysis is based on the assumption that the term structure is determined according to the expectations theory. In this analysis the expectations theory of the term structure of interest rates provides some links between the short rates, (i_m) and (i_d) , and the longer-term rates of interest⁹. In this section the key points in the model of expectations theory of term structure, explained in section 5.3, will be discussed in brief to give information concerning the relationship between interest rates on short-term and long-term securities.

Recall that according to the expectations theory of the term structure short-term and long-term securities are perfect substitutes. This implies that the return from

⁹. It is worth noting that the 10-year or 5-year long rates in macro-econometric models are regarded as the required rates of return in the capital market and in the modelling of the permanent effects of interest rates on the aggregate demand.

holding an *n-period* security at the end of period *n* is equal to the expected return from holding a series of *one-period* securities over the *n* periods. Let $(i_{SR,t+j}^e)$ denote the expected *one-period* rate of return for period $t+j$, where this expectation is conditional on information available as of the beginning of period t ; and let $(i_{LR,t})$ denote the yield to maturity in period t on an *n-period* (10-year) security. It is assumed that the available information set in the expectations theory of term structure allows for the linkages between the short-term interest rates and the other endogenous variables in the model, and comprises all the explanatory variables which are implicit in the assets and loan market equations¹⁰. According to the expectations theory:

$$(1+i_{LR,t})^n = (1+i_{SR,t}^e)(1+i_{SR,t+1}^e)\dots(1+i_{SR,t+n-1}^e) \quad (6.28)$$

Since the values of $(i_{SR,t+j}^e)$ in equation (6.28) are unobserved, some assumptions about how expectations are formed must be made in order to implement this theory. In this analysis we assume that each $(i_{SR,t+j}^e)$ is a function of the lagged value of the long rate, and of current and lagged values of $(i_{m,t})$ and $(i_{d,t})$. Given this assumption, $(i_{LR,t})$ is, then according to equation (6.28), a function of the same variables. That is,

$$i_{LR,t} = i_L (i_{LR,t-1}, \{i_{m,t}, i_{d,t}\}, \{i_{m,t-1}, i_{d,t-1}\}, \dots) \quad (6.29)$$

Using a similar specification, the expectations theory of term structure relating the yield on a *two-period* security and the yield on *one-period* securities over two periods can be expressed by

$$i_{LSR,t} = i_{LSR} (i_{LSR,t-1}, \{i_{m,t}, i_{d,t}\}, \{i_{m,t-1}, i_{d,t-1}\}, \dots) \quad (6.30)$$

where $(i_{LSR,t})$ represents the yield to maturity in period t on a *two-period* security.

¹⁰. This assumption is based on the modelling of the expected values of $(i_{SR,t+j}^e)$'s, using the conditional expectations of the short-term interest rate in the following equation,

$$i_{SR,t+j}^e = E({}_t i_{SR,t+j} | \Phi)$$

where $E(. | \Phi)$ denotes the subjective expectations of the short-term interest rate, $({}_t i_{SR,t+j})$, being conditional on information available as of the beginning of period t ; and (Φ) represents the information set. Given that a consistent solution for the model, represented by equations (6.1)-(6.20), provides a contemporaneous link from the model endogenous variables to $(i_{SR,t+j})$, the information set, (Φ) , takes into account the relationships between the endogenous variables in the model and $(i_{SR,t+j})$, and all the explanatory variables used in the model. The conditional expectations of the term structure equation are elaborated in chapter 3.

We refer to equation (6.29) as the long-term term structure equation and to equation (6.30) as the short-term term structure equation. To examine the specification of the two term structure equations, using a fairly complicated lag structure of the expected short-term interest rate, $(i_{SR,t+j}^e)$, we estimate equations (6.29) and (6.30) with up to two period lagged values of (i_m) and (i_d) . The results are given in tables 6.4.1 and 6.4.2, using Australian monthly data for the short and long rates. It is worth noting that the data used in this section are of the DSP type and are integrated of order 1. This is because when we specify regression models in time series we have to make sure that variables are integrated to the same order; otherwise, the equations do not make sense. The unit root tests in this case show the order of integration of the data. The results of these tests are given in *appendix 6.B*.

The results in tables 6.4.1 and 6.4.2 show that in equations (6.29) and (6.30) the current values of (i_m) and (i_d) , and one-period lagged value of (i_m) and two-period lagged value of (i_d) , have coefficients which are significantly different from zero. The Chow statistics in these equations show that we can reject the parameter stability at 5% level of significance. The F -statistics for testing the linear restrictions in the equations, concerning the exclusion of variables $(i_{m,t-2})$ and $(i_{d,t-1})$, show that the restrictions in the equations cannot be rejected at the 5% level of significance.

Based on these results, we may replace the previous assumption about how expectations in equation (6.28) are formed by the assumption regarding a fairly complicated lag structure of $(i_{SR,t+j}^e)$ on both the long-term rates. The assumption implies that in this equation each $(i_{SR,t+j}^e)$ is a function of the lagged value of the long rate, $(i_{LR,t})$ or $(i_{LSR,t})$, of the combination of the current values of (i_m) and (i_d) , and of the lagged values of the short rates represented by $(i_{m,t-1})$ and $(i_{d,t-2})$. Given this assumption, the long- and short-term term structure equations can be represented by

$$i_{LR,t} = i_L (i_{LR,t-1}, i_{SR,t}, i_{m,t-1}, i_{d,t-2}) \quad (6.31)$$

$$i_{LSR,t} = i_{LSR} (i_{LSR,t-1}, i_{SR,t}, i_{m,t-1}, i_{d,t-2}) \quad (6.32)$$

where

$$i_{SR,t} = w \cdot i_{m,t} + (1-w) \cdot i_{d,t} \quad (6.33)$$

Table 6.4.1: Estimation results for the term structure of interest rates,
equation (6.29)

$$i_{LR,t} = i_L (i_{LR,t-1}, i_{m,t}, i_{m,t-1}, i_{m,t-2}, \\ i_{d,t}, i_{d,t-1}, i_{d,t-2})$$

Sample period: 1978:1 to 1993:12, Montly.

Dependent variable: $\log(i_{LR,t})$

Explanatory variables	Coefficients	t-statistics
	.071	(2.26)**
$\log(i_{LR,t-1})$	.942	(39.2)***
$\log(i_{m,t})$	.251	(7.92)***
$\log(i_{m,t-1})$	-.199	(-5.99)***
$\log(i_{d,t})$	-.064	(-1.39)*
$\log(i_{d,t-2})$	.043	(.954)

$R^2 = .979$
 DW = 2.01
 Durbin's h (Alt.) = -.141
 LM1 = .087 LM4 = 5.23
 Chow = 2.35, (.033)
 ADF = -13.9
 F-test for linear
 restrictions = .909

Note:

For the statistics see footnotes of table 6.3.10.

Table 6.4.2: Estimation results for the term structure of interest rates,
equation (6.30)

$$i_{LSR,t} = i_L (i_{LSR,t-1}, i_{m,t}, i_{m,t-1}, i_{m,t-2}, \\ i_{d,t}, i_{d,t-1}, i_{d,t-2})$$

Sample period: 1978:1 to 1993:12, Montly.

Dependent variable: $\log(i_{LSR,t})$

Explanatory variables	Coefficients	t-statistics
	-.0503	(-1.86)**
$\log(i_{LSR,t-1})$	.726	(9.2)***
$\log(i_{m,t})$	.766	(18.4)***
$\log(i_{m,t-1})$	-.549	(-8.6)***
$\log(i_{d,t})$	.231	(3.44)***
$\log(i_{d,t-2})$	-.151	(-2.61)***
Dummy(6)	-.032	(-3.02)***

$R^2 = .99$
 DW = 1.86
 Durbin's h = 1.61
 LM1 = 1.36 LM4 = 6.87
 Chow = 3.89, (,001)
 ADF = -12.8
 F-test for linear
 restrictions = .924

Note:

1. For the statistics see footnotes of table 6.3.10.
2. Dummy(6) takes the value of unity before 1985:2, and zero thereafter.

Equation (6.33) represents the combination of the two short rates, (i_m) and (i_d), using a weighted average of these rates with weights (w) and ($1-w$), respectively.

In section 5.3 it was shown that a least squares estimation for the term structure equations (6.31) and (6.32) gives proxies for the weights (w) and ($1-w$), provided that we allow for the following functional form for these equations.

$$i_{LR,t} = i_L (i_{LR,t-1}, i_{m,t}, \{i_{d,t}-i_{m,t}\}, i_{m,t-1}, i_{d,t-2}) \quad (6.31a)$$

$$i_{LSR,t} = i_{LSR} (i_{LSR,t-1}, i_{m,t}, \{i_{d,t}-i_{m,t}\}, i_{m,t-1}, i_{d,t-2}) \quad (6.32a)$$

The estimation of equations (6.31a) and (6.32a) provides proxies for the weights in the long-term and short-term term structure equations (6.31) and (6.32), respectively. The estimation results of equations (6.31a) and (6.32a) are shown in tables 6.4.3 and 6.4.4. Using these weights in the calculation of ($i_{SR,t}$)'s, it can be shown that the coefficients in equations (6.31) and (6.32) are the same as those obtained from the estimation of the equations (6.31a) and (6.32a), respectively. In tables 6.4.3 and 6.4.4 the slope dummy variables in the equations improved the diagnostic statistics of the equations. The Chow statistics show that at the 5% level of significance we cannot reject the hypothesis of parameter stability in both the term structure equations.

Using slope dummies in the estimation of equations (6.31a) and (6.32a), for each equation we obtained different weights for the periods 1978:1 to 1984:12 and 1985:1 to 1993:12. The former period allows for some regulations in financial markets while the subsequent period encompassed deregulation of financial markets. Theoretically, in the latter period interest rates should have been more volatile. For this reason the weights given to two short rates, (i_m) and (i_d), in pre- and post-deregulation may have been significantly different. The results shown in tables 6.4.3 and 6.4.4 are consistent with this theoretical treatment of different weights in the two periods. The weight given to the loan rate in equation (6.31a) in the post-deregulation period is negative. This is consistent with the results obtained from the estimation of equation (6.29) in which the long rate ($i_{LR,t}$) and the current value of the loan rate, ($i_{d,t}$), are negatively correlated.

Table 6.4.3: Estimation results for the term structure of interest rates,
equation (6.31a)

$$i_{LR,t} = i_L (i_{LR,t-1}, i_{m,t}, (i_{d,t} - i_{m,t}), \\ i_{m,t-1}, i_{d,t-2})$$

Sample period: 1978:1 to 1993:12, Montly.

Dependent variable: $\log(i_{LR,t})$

Explanatory variables	Coefficients	t-statistics
Period 1978:1 to 1984:12		
	.034	(.916)
$\log(i_{LR,t-1})$	.948	(35.1)***
$\log(i_{m,t})$	.217	(5.46)***
$\log(i_{m,t-1})$	-.177	(-4.29)***
Period 1985:1 to 1993:12		
	.137	(1.62)*
$\log(i_{LR,t-1})$	.854	(16.2)***
$\log(i_{m,t})$	.227	(2.57)***
$\log(i_{m,t-1})$	-.292	(-3.71)***
$\log(i_{d,t}) - \log(i_{m,t})$	-.143	(-1.87)**
$\log(i_{d,t-2})$	.152	(2.22)**

Period 1978:1 to 1984:12, Weight (w) = 1
(1-w) = 0.

Period 1985:1 to 1993:12, Weight (w) = 1.627
(1-w) = -.627

$R^2 = .98$
 $DW = 2.00$
 $LM1 = .026$ $LM4 = 2.56$
 $Chow = .901, (.535)$
 $ADF = -13.8$

Note:

For the statistics see footnotes of table 6.3.10.

Table 6.4.4: Estimation results for the term structure of interest rates,
equation (6.32a)

$$i_{LSR,t} = i_L (i_{LSR,t-1}, i_{m,t}, (i_{d,t} - i_{m,t}), i_{m,t-1}, i_{d,t-2})$$

Sample period: 1978:1 to 1993:12, Montuly.

Dependent variable: $\log(i_{LSR,t})$

Explanatory variables	Coefficients	t-statistics
Period 1978:1 to 1984:12		
	.026	(.455)
$\log(i_{LSR,t-1})$	.792	(10.4)***
$\log(i_{d,t} - i_{m,t})$	.367	(6.25)***
$\log(i_{d,t-2})$	-.286	(-4.6)***
Period 1985:1 to 1993:12		
	-.091	(-3.36)***
$\log(i_{LSR,t-1})$	.541	(6.9)***
$\log(i_{d,t}) - \log(i_{m,t})$	.073	(3.69)***
Period 1978:1 to 1993:12		
$\log(i_{m,t})$	1.04	(19.8)***
$\log(i_{m,t-1})$	-.555	(9.01)**

Period 1978:1 to 1984:12, Weight (w) = .647
(1-w) = .353

Period 1985:1 to 1993:12, Weight (w) = .9297
(1-w) = .0703

$R^2 = .99$
 $DW = 1.98$
 $LM1 = .032$ $LM4 = 2.54$
 $Chow = .290, (.977)$
 $ADF = -13.57$

Note:

For the statistics see footnotes of table 6.3.10.

The results obtained from the estimation of equation (6.31a), the long-term term structure equation, can be used in the modelling of the permanent effects of interest rates on aggregate demand, (Y), and in the modelling of the transmission mechanism, using the 10-year long rate as the required rate of return on fixed capital. The results obtained from equation (6.32a), the short-term term structure equation, can be used in the specification of the short-run relationship between (Y) and the weighted average of the two short rates, (i_m) and (i_d).

Equations (6.31) and (6.32) may be inconsistent with the expectations theory of term structure *if expectations of the future values of ($i_{SR,t}$) are rational*. This is because in simulations of the model the predicted values of ($i_{LR,t}$) or ($i_{LSR,t}$), and of ($i_{SR,t}$), ($i_{SR,t+1}$), ..., ($i_{SR,t+n-1}$), do not in general satisfy equation (6.28). Three endogenous variables in the model are ($i_{SR,t}$), ($i_{LR,t}$) and ($i_{LSR,t}$). If the values of these variables satisfy equation (6.28), then the expectations assumption is consistent with the rational expectations hypothesis, *i.e.* expectations are model consistent.

The short-term term structure equation can be used for testing the rational expectations hypothesis in the short-term security market. As discussed in the previous chapter Tease's (1988) test for the rationality hypothesis in a term structure equation gave support to this hypothesis for the Australian short-term security market. Juttner (1990) emphasized that much of the international evidence failed to support the rational expectations hypothesis in the term structure of interest rates. Tease's (1988) specification of the term structure equation for the short-term security market, using a forward-looking expectations assumption in a two period context, can be represented by

$$\{2 \cdot (i_{LSR,t})\} - i_{SR,t+1}^e = \eta_0 + \eta_1 \cdot i_{SR,t} + v_{t+1} \quad (6.34)$$

where

$$i_{SR,t+j} = i_{m,t+j} \quad \text{for } j=0,1 \quad (6.35)$$

Given rational expectations, the expected one-period yield, ($i_{SR,t+1}^e$), can be written as

$$i_{SR,t+1} = i_{SR,t+1}^e + \varepsilon_{t+1} \quad (6.36)$$

Under the assumption of rational expectations $\eta_0=0$ and $\eta_1=1$, and (v_{t+1}) and (ε_{t+1}) are white noise processes. The other important assumption in Tease's specification of the term structure equation, as implied by condition (6.35), is that the weight given to $(i_{m,t})$ equals unity. Given that $\eta_0=0$ and $\eta_1=1$, equation (6.34) has the same specification as implied by equation (6.28) in a two-period context.

As will be shown in the following discussion, if the actual values of the weights of (i_m) and (i_d) differ significantly from those determined under the rational expectations hypothesis, then there is no support for this hypothesis in the Australian short-term security market. In the case of Tease's findings, support for the rational expectations hypothesis arises from the fact that, in the post-deregulation period, the weight given to (i_m) under the rational expectations assumption is close to unity. This weight accords with Tease's assumption implied by equation (6.35).

In this analysis we make use of the weights obtained from the estimation of equation (6.32a) as proxies for the actual weights in the Australian short-term security market. This is because, using these weights, the relationship between the rate of return on a *two-period* security and the rate of return on a *one-period* security, $(i_{SR,t})$, in equation (6.32) satisfies the criterion of parameter stability and gives the best fit and high level of significance of its coefficients. A comparison between these weights and the weights obtained under the rational expectations assumption will show how expectations are formed in the Australian short-term security market. In other words, such a comparison shows how in general the results obtained from equation (6.32a) satisfy the expectations theory expressed by $\eta_0=0$ and $\eta_1=1$ in equation (6.34), or by equation (6.28) in a two period context.

To provide proxies for the weights under the rational expectations hypothesis, condition (6.35) can be re-written as

$$i_{SR,t+j} = w' \cdot i_{d,t+j} + (1-w') \cdot i_{m,t+j} \quad \text{for } j=0,1 \quad (6.37)$$

where (w') and $(1-w')$ are the weights given to (i_d) and (i_m) under the assumption of rational expectations, given by $\eta_1=1$. Using this assumption the weights can be obtained from the estimation of the following equation

$$\{2.(i_{LSR,t})\} - (w'. i_{d,t+1} + (1-w'). i_{m,t+1}) = \eta_0 + w'. i_{d,t} + (1-w'). i_{m,t} + v_{t+1} \quad (6.38)$$

where (η_0) is the risk premium which, under a less restrictive expectations hypothesis, may be significantly different from zero. Equation (6.38) can be re-written as

$$\{2.(i_{LSR,t})\} - (i_{m,t+1} + i_{m,t}) = \eta_0 + w'. (\{i_{d,t+1} + i_{d,t}\} - \{i_{m,t+1} + i_{m,t}\}) + v_{t+1} \quad (6.39)$$

The estimation of equation (6.39) provides proxies for the weights, (w') and ($1-w'$), under the assumption of rational expectations. Using these weights in the calculation of the data for ($i_{SR,t+j}$), as implied by equation (6.37), it can be shown that the proxies for the weights satisfy the basic assumptions of the rational expectations hypothesis, regarding $\eta_1=1$ and $\eta_0=0$ in equation (6.34). The results are given in tables 6.4.5 and 6.4.6.

The results in table 6.4.5 show that under the assumption of rational expectations the values of the weight for (i_m) in two different periods, 1978:1 to 1984:12 and 1985:1 to 1993:12, are respectively 0.8476 and 0.9376. Using these weights, the results in table 6.4.6 give evidence for the rationality hypothesis in equation (6.34). The rational expectations hypothesis in this equation implies that $\eta_0=0$ and $\eta_1=1$. This joint hypothesis is tested via the F-statistic in the following equation.

$$\{2.(i_{LSR,t})-i_{SR,t+1}\} - i_{SR,t} = \eta_{01} + \eta_{11} \cdot \{2.(i_{LSR,t-1})-i_{SR,t}\} \quad (6.34a)$$

Equation (6.34a) has the same specification as implied by standard tests for rationality¹⁰. Rationality in this equation implies that $\eta_{01}=0$ and $\eta_{11}=0$. The F-statistic in this equation can be used for the test implied by $\eta_{01}=\eta_{11}=0$. The F-value in this equation is 1.42 which is less than the critical F value at the 5% level of significance.

¹⁰. Maddala (1992) argued that in tests for rationality it is customary to start with a test of unbiasedness by estimating the following regression equation, and testing the hypothesis $\beta_0=0, \beta_1=1$.

$$y_t = \beta_0 + \beta_1 \cdot y_t^* + e_t$$

where y_t^* is the expectations for y_t as formed at $t-1$. Since y_{t-1} is definitely in the information set, the following equation is estimated:

$$y_t - y_t^* = \alpha_0 + \alpha_1 \cdot y_{t-1} + e_t$$

and the hypothesis $\alpha_0=0, \alpha_1=0$ is tested. Rationality implies that $\alpha_1=0$.

Table 6.4.5: Estimation results for the term structure of interest rates, equation (6.39)

$$\{2 \cdot (i_{LSR,t})\} - (i_{m,t+1} + i_{m,t}) = w' \cdot (\{i_{d,t+1} + i_{d,t}\} - \{i_{m,t+1} + i_{m,t}\}) + v_{t+1}$$

Sample period: 1978:1 to 1993:12, Montly.

Dependent variable: $\{2 \cdot (i_{LSR,t})\} - (i_{m,t+1} + i_{m,t})$

Explanatory variables	Coefficients	t-statistics
Period 1978:1 to 1984:12		
	.046	(3.96)***
$\frac{\{i_{d,t+1} + i_{d,t}\} - \{i_{m,t+1} + i_{m,t}\}}$	.152	(4.29)***
Period 1985:1 to 1993:12		
	-.042	(-2.42)***
$\frac{\{i_{d,t+1} + i_{d,t}\} - \{i_{m,t+1} + i_{m,t}\}}$	.062	(2.61)***

Period 1978:1 to 1984:12, Weight (1-w') = .1524

(w') = .8476

R² = .289

DW = 1.94

Period 1985:1 to 1993:12, Weight (1-w') = .0624

(w') = .9376

F = 11.4

Note:

1. All variables are in logarithmic form.

2. For the t-statistics see footnote of table 6.3.10.

Table 6.4.6: Estimation results for the term structure of interest rates, equation (6.34), using the weights shown in table (6.4.5) for calculating (i^e_{SR,t+1}) and (i_{SR,t})

$$\{2 \cdot (i_{LSR,t})\} - i_{SR,t+1}^e = \eta_0 + \eta_1 \cdot i_{SR,t} + v_{t+1}$$

Sample period: 1978:1 to 1993:12, Montly.

Dependent variable: $\{2 \cdot (i_{LSR,t})\} - i_{SR,t+1}^e$

Explanatory variables	Coefficients	t-statistics
	-.215	(-2.68)***
i _{SR,t}	1.084	(34.1)***

R² = .954

DW = 2.07

The F-test for the rational expectations hypothesis = 1.42

Note:

1. All variables are in logarithmic form.

2. For the t-statistics see footnote of table 6.3.10

The critical F-value with (1, 189) degree of freedom at the 5% level is 3.84. Hence, even at the 5% level of significance we cannot reject the hypothesis that $\eta_{01}=\eta_{11}=0$. This supports the rational expectations hypothesis in equation (6.34), using the weights obtained from equation (6.39).

The slope dummy variable in equation (6.39) provides the results for the weights which are comparable with the results obtained from equation (6.32a), shown in table 6.4.4. The comparison shows that there is no significant difference between the weights in the two equations in the period 1985:1 to 1993:12. To examine how important the difference is, we estimate equation (6.34) in the period 1985:1 to 1993:12, using the weights obtained from equation (6.39), and then the weights obtained from equation (6.32a). The results are given in tables 6.4.7 and 6.4.8.

The F-statistics for the test of rationality in both equations provide evidence on the rational expectations hypothesis in the Australian short-term security market in the post-deregulation period. Therefore, we can rely on the results obtained from equation (6.32a) as the results which are consistent with the expectations assumption in the period 1985:1 to 1993:12, as implied by equation (6.32).

In general the results show that the evidence for rationality in Tease's study, using the restrictive condition implied by equation (6.35), is a special case in which the value of the weight for (i_m) , required by the rational expectations hypothesis, is close to unity. If the required value of the weight for (i_m) consistent with this hypothesis is significantly different from unity, then Tease's specification of the term structure equation, given by equations (6.34)-(6.36), is not consistent with the expectations theory. In this case the actual value of the weight for (i_m) should be compared with the required value of the weight under the rationality hypothesis. The estimate of the actual value of the weight for (i_m) can be obtained from equation (6.32a). The results also suggest that in other cases where the estimation of the system of equations (6.34)-(6.36) rejects the rationality hypothesis, using some other international data, the required value of the weight for (i_m) , which is consistent with this hypothesis, is significantly different from unity.

Table 6.4.7: Estimation results for the term structure of interest rates, equation (6.34), using the weights shown in table (6.4.4) for calculating $(i_{SR,t+1}^e)$ and $(i_{SR,t})$ in period 1985:1 to 1993:12

$$\{2 \cdot (i_{LSR,t})\} - i_{SR,t+1}^e = \eta_0 + \eta_1 \cdot i_{SR,t} + v_{t+1}$$

Sample period: 1985:1 to 1993:12, Montuly.

Dependent variable: $\{2 \cdot (i_{LSR,t})\} - i_{SR,t+1}^e$

Explanatory variables	Coefficients	t-statistics
	-.131	(-2.68)***
$i_{SR,t}$	1.036	(53.1)***
$R^2 = .98$ DW = 2.09 The F-test for the rational expectations hypothesis = 1.41		

Note:

1. All variables are in logarithmic form.
2. For the t-statistics see footnote of table 6.3.10.

Table 6.4.8: Estimation results for the term structure of interest rates, equation (6.34), using the weights shown in table (6.4.5) for calculating $(i_{SR,t+1}^e)$ and $(i_{SR,t})$ in period 1985:1 to 1993:12

$$\{2 \cdot (i_{LSR,t})\} - i_{SR,t+1}^e = \eta_0 + \eta_1 \cdot i_{SR,t} + v_{t+1}$$

Sample period: 1985:1 to 1993:12, Montuly.

Dependent variable: $\{2 \cdot (i_{LSR,t})\} - i_{SR,t+1}^e$

Explanatory variables	Coefficients	t-statistics
	-.153	(-3.18)***
$i_{SR,t}$	1.043	(54.1)***
$R^2 = .984$ DW = 2.08 The F-test for the rational expectations hypothesis = 3.57		

Note:

1. All variables are in logarithmic form.
2. For the t-statistics see footnote of table 6.3.10.

Given rational expectations in the Australian short-term security market in the post-deregulation period, in order to incorporate this important feature of the Australian economy into the modelling of the transmission mechanism, we allow for the actual weights in the short-term security market post-deregulation in the specification of the long-term term structure equation (6.31). The estimation results are given in table 6.4.9.

The results show that there is no deterioration in the diagnostic statistics, and the long-term term structure equation still satisfies the criterion of parameter stability, represented by the Chow statistic. We therefore prefer the results of this estimation to the results presented in table 6.4.3 since the estimated equation in table 6.4.9 takes into account the special feature of the Australian short-term security markets, regarding rational expectations in these markets in the post-deregulation period.

The modelling of the expectations theory of the term structure of interest rates, given by equations (6.31) and (6.32), takes into account the linkages between the loan market and the financial markets for securities of different maturities. Using the expectations theory of the term structure, it is possible to predict the effects on the long rates ($i_{LR,t}$) and ($i_{LSR,t}$) of given changes in the short-term rates of interest ($i_{m,t}$) and ($i_{d,t}$). Equations (6.31) and (6.32) embody the traditional view of the expectations theory of term structure whereby the short-term interest rate in the money market does matter for the determination of the long-term interest rates. In the model under discussion, a formal difference from the traditional view is the inclusion of the loan rate, and the modelling of the linkages between financial markets, using a weighted average of the short rates as a proxy for the expected rate of interest on short-term securities. This model can be used to test the expectations theory if expectations of the future values of the short rates, (i_{SR}) are rational. This requires that the predicted values of ($i_{LR,t}$), ($i_{LSR,t}$), ($i_{SR,t}$), ($i_{SR,t+1}$), ..., ($i_{SR,t+n-1}$), should satisfy equation (6.28), implied by the expectations theory.

Table 6.4.9: Estimation results for the term structure of interest rates, equation (6.31), using the weights shown in table (6.4.4) for calculating $(i_{SR,t})$

$$i_{LR,t} = i_L (i_{LR,t-1}, i_{SR,t}, i_{m,t-1}, i_{d,t-2})$$

$$\log(i_{SR,t}) = (.9297) \cdot \log(i_{m,t}) + (.0703) \cdot \log(i_{d,t})$$

Sample period: 1978:1 to 1993:12, Montly.

Dependent variable: $\log(i_{LR,t})$

Explanatory variables	Coefficients	t-statistics
Period 1978:1 to 1984:12		
	.034	(.917)
$\log(i_{LR,t-1})$	.948	(35.1) ***
$\log(i_{m,t})$	.217	(5.46) ***
$\log(i_{m,t-1})$	-.177	(-4.3) ***
Period 1985:1 to 1993:12		
	.066	(.808)
$\log(i_{LR,t-1})$	.876	(17.1) ***
$\log(i_{SR,t})$	.356	(5.36) ***
$\log(i_{m,t-1})$	-.292	(-3.62) ***
$\log(i_{d,t-2})$	.025	(.928)

$R^2 = .979$
 $DW = 1.98$
 $LM1 = .031$ $LM4 = 2.04$
 $Chow = 1.289, (.246)$
 $ADF = -13.6$

Note:
For the statistics see footnotes of table 6.3.10.

The estimation results of the term structure equations in this section suggest that: 1) the cost of borrowing, (i_d), plays an important role in the determination of the Australian term structure of interest rates; and, 2) the short rates (i_m) and (i_d), and the long rate (i_{LSR}) in Australian short-term security markets in the post-deregulation period behave in a manner consistent with the expectations hypothesis. The evidence of the previous section provided support for the rationing hypothesis. As we have already noted the loan rate under credit rationing reflects banks' proxies for the expected rate of return of average projects, which, in completely deregulated financial markets conforms to the actual rate of return in the economy. The evidence of this section, therefore, supports the hypothesis that for many borrowers bank loans have no close substitutes, and that the cost of borrowing under credit rationing provides portfolio investors with information concerning the actual rate of return on average securities in the short-term (two-period) security markets.

6.5 Conclusions

In this chapter we examined the portfolio-loan model, given by equations (6.1)-(6.20), for Australia in the period 1978:3 to 1993. The Australian post-deregulation experience provided Granger-causality evidence on the structurally endogenous nature of the money supply and loans. This is consistent with Palley' (1994) model which focuses on the private initiatives of banks in accommodating increases in loan demand and the banking system response to the increased supply of reserves. The significant difference from Palley's post-Keynesian view is the modelling of loan market imperfections; in particular the optimal lending of banks under credit rationing. There is evidence that Australian banks, in the aggregate, ration credit by non-price means. A necessary condition for rationing was that the risk of default of borrowers is a determinant of the banks' expected return on loans. Further, disequilibrium modelling of demand for and supply of loans revealed a state of predominantly excess demand for loans which is consistent with the credit rationing hypothesis. One important aspect of this analysis is the implication of credit rationing for portfolio investors' preferences for

securities with different terms to maturity. There is evidence that the economic information available to investors under credit rationing provides them with the actual rate of return on average securities, which suggests that agents are risk neutral and rational in the Australian short-term security markets. In the next chapter we evaluate another important implication of credit rationing by examining whether credit rationing has any significant effect on aggregate economic activity.

Appendix 6.A

This appendix briefly represents the names of variables and the data used for the variables in this chapter.

<i>Variable</i>	<i>Description</i>
m_1	the money multiplier for a narrow definition of money,
m_2	the deposit multiplier for a broad definition of money in the absence of cash,
ER	the expected rate of return on the private sector portfolio,
i_g	the rate of interest on 13-week treasury notes,
i_e^e	the expected rate of interest on equities at quarter t, made at quarter t-1,
i_f^e	the uncovered rate of interest on foreign assets at quarter t, made at quarter t-1,
$P_{eq,t}^e$	per annum expected share price, calculated as the average of 4-quarter share prices to the end of quarter t,
$P_{eq,t-1}$	per annum share price at quarter t-1, calculated as the average of 4-quarter share prices to the end of quarter t-1,
$i_{dv,t}^e$	per annum expected dividend yield at quarter t, made at quarter t-1,
$i_{dv,t-1}$	per annum dividend yield at the end of quarter t-1,
i_c	the rate of interest on 3-month term deposits, deposits less than \$50,000 ,
$\rho_1(a)$	the expected return of loans obtained from the spread between the bond safe rate and the loan rate,
L	bank lending to the private sector,
D	sum of demand and term deposits,
NBR	non-borrowed reserves of banks,
i_{LR}	the rate of interest on 10-year government bonds,
i_{LSR}	the rate of interest on two-period (or 180-day) bank accepted bills,

Appendix 6.B

Tests for Unit Roots and Time Trends

These tests are based on equations 4.B.1, 4.B.2 and 4.B.2a represented in Appendix 4.B. Tables 6.B.1 and 6.B.2 report the t-statistics for testing $\alpha_1=0$, $\beta_{11}=0$ and $\beta_{12}=0$, and the F-statistics for testing $\alpha_1=\alpha_2=0$.

Table 6.B.1 Tests for unit roots and time trends

X	$\alpha_1=0$	$\alpha_1=\alpha_2=0$	order of AR	$\beta_{11}=0$	order of AR
				$\beta_{12}=0$	order of AR
ER	-1.59	1.80	4	(-4.63) ^{***} (-4.68) ^{***}	3 3
$\rho_1(a)$	-2.75	4.35	2	(-6.41) ^{***} (-4.34) ^{**}	1 2
m_1	-2.53	1.25	1	(-5.50) ^{***} (-4.68) ^{***}	1 1
m_{12}	-1.87	1.65	1	(-6.97) ^{***} (-6.17) ^{***}	1 1
P_{eq}	(-3.35) ^{**}	(26.5) ^{***}	1		
\dot{i}_{dv}	-2.98	3.09	2	(-4.32) ^{***} (-4.34) ^{***}	1 1
log(L)	-1.70	(6.47) ^{**}	2		
log(D)	-1.88	(8.61) ^{***}	2		
log(D/P)	-2.66	5.37	3	(-4.90) ^{***} (-3.45) ^{***}	0 0
log(\dot{i}_c)	-1.30	5.24	2	(-5.58) ^{***} (-3.29) ^{***}	0 1
log(NBR)	-1.28	2.14	2	(-7.50) ^{***} (-7.28) ^{***}	1 1
L^d-L^s	-2.47	3.91	1	(-6.27) ^{***} (-5.94) ^{***}	1 2

Note:

1. Full sample period for ER and $r_1(a)$ is 1984:1 to 1993:4, and for other variables 1978:3 to 1993:4, Quarterly.
3. (***) significant at the 99% level,
(**) significant at the 95% level,
(*) significant at the 90% level.

The results indicate that $\log(L)$ and $\log(D)$ display deterministic trends, and (P_{eq}) is a stationary process. The other variables in table 6.B.1 follow a stochastic trend and are non-stationary but become stationary after first differencing, *i.e.* they are $I(1)$.

Table 6.B.2 Tests for unit roots and time trends in the term structure equations

X	$\alpha_1=0$	$\alpha_1=\alpha_2=0$	order of AR	$\beta_{11}=0$	order of AR
				$\beta_{12}=0$		order of AR
$\log(i_{LR})$	-0.680	3.10	1	$(-8.12)^{***}$ $(-9.64)^{***}$	4 1
$\log(i_{LSR})$	-0.906	2.18	1	$(-10.2)^{***}$ $(-9.86)^{***}$	1 1
$\log(i_d)$	-0.382	3.48	4	$(-6.40)^{***}$ $(-4.77)^{***}$	2 3
$\log(i_m)$	-1.30	2.06	1	$(-10.1)^{***}$ $(-9.93)^{***}$	1 1
$\log(i_d-i_m)$	$(-3.80)^{**}$	4.99	1		
$\log(i_{SR})$	-0.713	2.28	1	$(-9.51)^{***}$ $(-9.20)^{***}$	1 1

Note:

1. Full sample period 1978:1 to 1993:12, Monthly.
2. i_{SR} is a weighted average of the short rates (i_d) and (i_m) , in the term structure equations (6.31) and (6.32a), using the weights shown in table 6.4.4.
3. (***) significant at the 99% level,
(**) significant at the 95% level.

The results show that all variables follow a stochastic trend, and with the exception $\log(i_d-i_m)$ all variables are non-stationary but become stationary after first differencing.

Appendix 6.C

Proxies for Share Prices and Dividend Yields, Using Auto-Regressive Process

1) *The expected share prices:* The estimation of the auto-regressive process for the expected share prices was carried out, using the same procedure as represented for the exchange rate AR function, represented in appendix 4.C. The table presented in appendix 6.B shows the results of testing the hypotheses of stochastic trend and non-stationarity for the share prices data, (P_{eq}). From the test result we found that the data for (P_{eq}) is a stationary process. This process is trend stationary since its second difference is a de-trended series.

The degree of the auto-regressive process in the estimation of the expected share prices is determined by the Durbin-Watson (DW), and Durbin's h-alternative tests. Table 6.C.1 gives the result of the estimation of the auto-regressive process of order 3 for the share prices.

Table 6.C.1

Auto-Regression process for the share prices, P_{eq} 's, of order 3.					
Dependent variable	Explanatory variables				
$P_{eq,t}$	T	$P_{eq,t-1}$	$P_{eq,t-2}$	$P_{eq,t-3}$	
	0.0159	0.0022	1.860	-1.163	0.233
	(1.32)*	(2.50)***	(14.25)***	(-4.97)***	(1.76)**
$R^2=0.994$ DW=1.99 Durin's h (alt.) =-1.698					

Notes:
 1.Full Sample 1978:1 to 1993:4, Quarterly.
 2.t-statistics are in parentheses.
 (***) significant at the 99% level,
 (**) significant at the 95% level,
 (*) significant at the 90% level.

Using the result of the above autoregressive process, the expected share prices one quarter ahead, *i.e.* ($P_{eq,t+1}^e$), were calculated from the following equation.

$$P_{eq,t+1}^e = \alpha_0 + \alpha_1 \cdot T + \alpha_2 \cdot P_{eq,t-1} + \alpha_3 \cdot P_{eq,t-2} + \alpha_4 \cdot P_{eq,t-3}$$

2) *The expected dividend yield:* The auto-regressive process for the expected dividend yield was estimated, using the same procedure as undertaken for the previous AR function. The test results for stationarity of $(i_{dv,t})$ are represented in *appendix 6.B*. The results show that the data for dividend yields is non-stationary. The criteria used for choosing the order of AR under the assumption of stochastic regressors are in table 6.C.2.

Table 6.C.2 shows that for the AR functions without the auto-correlation problem, *i.e.* AR's of orders 3, 4 and 5, the adjusted R^2 's, partial autocorrelations and Akaike's FPE criteria suggest that the appropriate order of autoregression is 3. Also, amongst the first three AR's, the lowest Durbin's h and Schwartz Bayesian criterion (SBC) belong to the AR of order 3.

The estimation results of the autoregression of order 3 for the dividend yield, $(i_{dv,t})$, is presented in table 6.C.3.

Table 6.C.2

p	partial auto-correlation	FPE	SBC	\bar{R}^2	DW	Durbin's h (h Alt.)
1	0.854	0.2176	-1.459	0.776	1.52	2.175
2	-0.209	0.2125	-1.448	0.786	2.106	-1.84
3	-0.204	0.2109	-1.421	0.792	1.961	0.382
4	0.0023	0.2211	-1.339	0.787	1.992	-0.568
5	0.0498	0.2312	-1.259	0.784	1.982	-0.339
6	0.0409	0.2418	-1.178	0.781	1.943	1.707

Table 6.C.3

Auto-Regression process for the dividend yield, i_{dv} , of order 3.

Dependent variable	Explanatory variables			
$i_{dv,t}$		$i_{dv,t-1}$	$i_{dv,t-2}$	$i_{dv,t-3}$
	0.809	1.068	-0.008	-0.236
	*** (2.59)	*** (8.45)	(-0.043)	** (-1.845)
$\bar{R}^2=0.79$ DW=1.96 Durin's h (alt.) =-0.382				

Notes:

1.Full Sample 1978:1 to 1993:4, Quarterly.

2.t-statistics are in parentheses.

(***) significant at the 99% level,

(**) significant at the 95% level.

The expected dividend yield one quarter ahead, *i.e.* ($i_{dv,t+1}^e$), is calculated, using the following equation. The coefficients, *i.e.* α 's, take the values shown in table C.3.

$$i_{dv,t+1}^e = \alpha_0 + \alpha_1 \cdot i_{dv,t} + \alpha_2 \cdot i_{dv,t-1} + \alpha_3 \cdot i_{dv,t-2}$$

Chapter 7

The Monetary Transmission Mechanism in Australia

7.1. Introduction

This chapter examines the effects of financial variables on the aggregate economic activity in Australia through four main channels: 1) interest rate effects on aggregate demand; 2) credit availability; 3) exchange rate; and, 4) wealth effects. Simes (1991) emphasized that to model the transmission mechanism between the financial and real sectors, the following elements are required. First, an elaboration of the relationships within financial markets which determine financial variables such as the money supply, credit, interest rates and the exchange rate. Second, an understanding of the effects of these variables on aggregate demand, and then on total output. In macroeconomic models these elements are examined in empirical versions of the standard IS-LM framework; and in empirical research this framework is augmented by some extensions which provide a better understanding of the transmission mechanism between financial markets and the real sector.

In chapters 3-6 we examined the key relationships in a simple portfolio-loan model of the Australian financial sector, in which the supply of financial assets is endogenous and changes in the availability of credit, not changes in the market-equilibrating loan rate, determines the extent of borrowing. In this model the structurally endogenous nature of money and loans implies that an expansion of reserves enables banks to increase loans to their previously rationed borrowers. We examined the implication of such an expansion in a simple model, a variant of the textbook IS-LM model, in section 5.4. In this model an increase in bank loans to the previously rationed borrowers, which is associated with a fall in (Δi_D) , raises the private sector's holdings of money and investment spending, and then shifts both the

LLM and IIS curves outward to the right. This makes the monetary policy more expansionary than the standard IS-LM model. In the textbook IS-LM model, the money channel, acting through changes in liquid assets (money and bonds) and interest rates, affects the availability of credit and, via changes in the investment demand, affects the aggregate economic activity. The equilibrium rationing hypothesis in this thesis, therefore, presents an elaboration of the non-monetarist interpretation of the potency of monetary policy that results from a distinct role played by bank loans in the monetary transmission mechanism.

A better understanding of a distinctive lending channel under credit rationing can be represented by the credit-GNP relationship in a model which examines the output effects of a downward shock to the credit supply. According to the credit rationing hypothesis, such a shock results from the increased riskiness of loans and banks' concern for liquidity in the face of unexpected withdrawals of deposits¹. The evidence of the previous chapter has provided support for the credit rationing hypothesis in Australia. In this chapter we examine the reduced-form relation between bank loans and aggregate economic activity in order to determine whether credit rationing is of macroeconomic importance. In the reduced-form equation the explanatory variables for the main channels of the transmission mechanism are those which account for monetary changes in the portfolio-loan model. This provides the reduced-form equation consistent with the implications of the endogeneity of the money supply and loans, and the credit market with imperfect information in the portfolio-loan model. In this reduced-form equation we evaluate the relevance of the credit rationing hypothesis by examining whether in the credit-rationed state the effects on output of higher levels of aggregate demand relative to its trend values are depressed.

¹. In section 5.5 we examined a model of bank's optimizing behaviour with default cost of bonds, in which an increase in the default risk of bonds reduces banks' liquidity. In this model the riskiness of bonds provides the bank with information concerning the likelihood of default in asset markets. The response of banks to the increased riskiness of their secondary reserves, bonds, is determined by the extent of their risk aversion.

In this chapter we also examine Blinder's (1987) model of credit rationing, implying that a tightening of monetary policy has strong effects on the real sector when credit is already tight, but weak effects when credit is initially plentiful. In the model presented in section 5.4, a tightening of monetary policy can be represented by a fall in the supply of total reserves, which causes banks to use credit rationing to provide enough liquidity required by the expected withdrawals of deposits. In this model a reduction in bank loans in the credit-rationed state, which is associated with a rise in (Δi_d) , reduces the private sector's holdings of money and investment spending, and shifts both the LLM and IIS curves to the left. In this treatment of the credit channel, the monetary policy is more contractionary than in the standard IS-LM model. We evaluate the implication of the tightening state of monetary policy when the economy is credit-constrained by examining whether credit rationing makes a significant difference to the contribution of a downward monetary shock to output fluctuations.

Another important aspect of the reduced-form relation in this thesis is the implication of the buffer stock role of money for disequilibria in asset markets. According to the buffer stock approach the interest rate effects of monetary changes on real output are less severe than the conventional models of the monetary transmission mechanism, since most of the changes in nominal money balances are absorbed in the short run as transitory balances. In the buffer stock models, as will be elaborated in the next section, unexpected changes in the money supply, represented by the difference between the actual and expected money balances, $M - M^e$, has little immediate influence on the price level but mainly affects real income and interest rates. In the buffer stock model, presented by MacKinnon and Milbourne (1984), the expectations of real money balances, (M^e/P) , represents the contribution of the unexpected changes in the money supply to interest rate and output fluctuations. If the buffer stock approach is valid, then, in the absence of a significant effect of the interest rate on real output, the expectations generating process for real money balances, (M^e/P) , can be treated as the main channel for monetary changes. We evaluate the relevance of the buffer stock approach by examining, *a*) whether holdings of money in

Australia differs from their desired level as a result of money acting as a buffer for disequilibria in other asset markets, and b) whether the buffer stock role of money makes a significant difference to the contribution of monetary shocks to output fluctuations.

The next section presents the specification of the reduced-form equation. In this section two particular avenues of research relate to the specification of tests of the credit rationing hypothesis and the buffer stock approach for Australia. Section 7.3 presents the results of the estimation of buffer stock models and reduced-form equations, and analyses the implications for monetary policy. Section 7.4 presents conclusions.

7.2 Specification of the reduced-form equation, and the transmission mechanism between the financial and real sectors

To model the reduced-form equation of the transmission mechanism, we specify the model presented in section 5.4 using the following equations. This model is augmented by extensions, including expected changes in the spot exchange rate and the labour market.

$$\text{LLM:} \quad \left| \begin{array}{l} i_m = i_m (i_a, i_d, H (i_m, (E^e/E).(1+i_f), W, Y, P)) \\ (i_{d,t} - i_{d,t-1}) = \Delta i_d (i_{m,t}, \psi (L_t^d - L_t^s), D_t(\cdot)) \end{array} \right. \quad (7.1)$$

$$(i_{d,t} - i_{d,t-1}) = \Delta i_d (i_{m,t}, \psi (L_t^d - L_t^s), D_t(\cdot)) \quad (7.2)$$

$$\text{IIS:} \quad Y = Y (i_m, \Delta i_d, \Omega) \quad (7.3)$$

$$(E^e/E) = E ((i_m - \pi) - (i_f - \pi_f), \text{TBII}, \{i_f, F(\cdot)\}) \quad (7.4)$$

$$\text{Aggregate supply:} \quad Y = P \cdot \Phi (LF, K) \quad (7.5)$$

$$LF = LF (\psi (L^d - L^s), \text{WA}) \quad (7.6)$$

where

H = the money base, and $H(\cdot)$ represents the equation of demand for the money base,
 D = the sum of the demand and term deposits, and $D(\cdot)$ represents the equation of demand for deposits, using the same explanatory variables as for $H(\cdot)$,
 F = the stock of foreign assets, and $F(\cdot)$ represents the equation of the demand for foreign assets, using the same explanatory variables as for $H(\cdot)$,

P = the price level,

$\Delta i_d = i_{d,t} - i_{d,t-1}$,

$\psi(L_t^d - L_t^s)$ = a function representing excess demand for loans,

LF = the employed labour force, and $LF(\cdot)$ represents a reduced form equation for the labour market,

K = the stock of capital, assumed to be fixed in the short run,

$\Phi(LF, K)$ = production function,

WA = the real wage rate, and

Ω represents a vector of other exogenous variables in the real sector.

Equations (7.1) and (7.4) represent the equilibrium conditions in the monetary base market, and the foreign asset market, respectively. The latter equation also gives a representation of the expected changes in the spot exchange rate. Equation (7.2) gives an equilibrium rationing representation of loan rate adjustments. In this equation ($i_{d,t}$) is endogenous and ($i_{d,t-1}$) is exogenous. Equation (7.3) represents a reduced form equation of the aggregate demand for commodities. Equation (7.5) represents the aggregate supply of commodities which is the product of the price level (P) and the total output, obtained from the production function, $\Phi(LF, K)$. Equation (7.6) represents the level of employment determined by the equilibrium condition in the labour market. In this equation, $\psi(L^d - L^s)$ determines the quantity of loans used by firms to produce commodities.

The system of equations (7.1)-(7.6) can be incorporated to yield a reduced-form equation for total output (Y). The explanatory variables in such a reduced-form equation are the exogenous variables in the financial sector and the variables such as (Ω) and (WA) in the real sector. As we have noted in section 4.2.3, total net worth in equations (7.1), (7.2) and (7.4) reflects the fact that changes in the nominal asset values will affect the total wealth of asset holders, and are expected to have repercussions in the allocation of portfolios. To allow for such factors in the reduced form equation (7.3), we rewrite the wealth equation as follows:

$$W = W_{(-1)} (i_m, (E^e/E) \cdot (1+i_f)) \quad (4.17.1)$$

where $W_{(-1)}$ represents lagged values of the total wealth of asset holders.

To obtain a reduced-form equation for aggregate demand, we, firstly, substitute the explanatory variables of the total wealth equation (4.17.1) into (7.1), (7.2) and (7.4); secondly, we substitute equation (7.4) into equations (7.1) and (7.2); and thirdly, we substitute equations (7.1) and (7.2) into equation (7.3). The resultant equation for aggregate demand can be represented by

$$Y = Y (i_a, \psi (L^d-L^s), (i_m-\pi)-(i_f-\pi_f), TBII, W_{(-1)}, P, \Omega) \quad (7.7)$$

In equation (7.7), the effects of the foreign market interest rate, (i_f) , on aggregate demand is summarized by the effects of the real interest rate differential $(i_m-\pi)-(i_f-\pi_f)$.

Also, to obtain a reduced-form equation for aggregate supply, we substitute equation (7.6) into equation (7.5), this eliminates LF, and gives:

$$Y = P \cdot \Phi (\psi (L^d-L^s), WA, K) \quad (7.8)$$

Equation (7.7) summarizes the aggregate demand side and equation (7.8) summarizes the aggregate supply side of the economy. Therefore, solving equations (7.7) and (7.8) simultaneously for (Y) and (P) , by substituting (P) into the supply equation (7.8), gives:

$$Y = Y (i_a, \psi (L^d-L^s), (i_m-\pi)-(i_f-\pi_f), TBII, W_{(-1)}, WA, \Omega) \quad (7.9)$$

In this equation asset prices, notably interest rates, affect total output through three main channels, namely, 1) through their impact on components of aggregate demand, particularly on private investment and expenditures on consumer durables; 2) through their impact on the exchange rate; and, 3) through their impact on the value of wealth. The former two channels in equation (7.9) are respectively represented by (i_a) and $(i_m-\pi)-(i_f-\pi_f)$. The last channel is modelled by substituting equation (4.17.1) into the reduced-form equations (7.7) and (7.9). In these equations wealth effects are represented by $W_{(-1)}$. This variable, as we have already noted, is the exogenous variable in a wealth equation which allows for the effects of changes in the nominal asset values on the total wealth of asset holders, and the expected repercussions of such changes in the allocation of portfolios. In equations (7.7) and (7.9), $(TBII)$ represents the other channel of the exchange rate mechanism which works through

unexpected changes in the trade balance. This mechanism was elaborated in sections 4.2.2 and 4.3.2. The lending channel in equation (7.9) is represented by $\psi(L^d - LS)$, and allows for the implication of loan market imperfections for credit availability, elaborated in sections 5.2, 5.4 and 6.3. The reduced form equation (7.9), therefore, complies with the implications of imperfect asset substitutability and the endogenous nature of money and loans, and the credit market with imperfect information, examined in the portfolio-loan model. This equation can be used to test the importance of the main channels, outlined above, in output fluctuations in Australia.

In the following discussion we present the specification of tests for the buffer stock approach and the credit rationing hypothesis in the reduced form equation (7.9).

7.2.1 Specification of tests for the buffer stock role of money in the transmission mechanism

To incorporate the buffer stock role of money into the monetary transmission mechanism, we start with the following specification of the adjustment process in the demand for money, represented by a standard partial adjustment equation as

$$\bar{M}_t - \bar{M}_{t-1} = \tau \cdot (\bar{M}_{D,t} - \bar{M}_{t-1}) \quad (7.10)$$

where

$$\bar{M} = (M/P)$$

$$\bar{M}_D = (M/P)_D$$

$\bar{M}_t - \bar{M}_{t-1}$ = disequilibrium in the money market,

$\bar{M}_{D,t} - \bar{M}_{t-1}$ = the difference between the desired holdings of money and the actual money balances in the last period

τ = the adjustment coefficient.

In equation (7.10) the desired holdings of money, $(\bar{M}_{D,t})$, is assumed to be

dependent upon the interest rate, (i_m), the value of total wealth, (W), and real money income, (Y). Equation (7.10), which allows for a partial-adjustment type model of the demand for money, can be represented by²

$$\bar{M}_t = \tau \cdot \bar{M}_{D,t} + (1 - \tau) \bar{M}_{t-1} \quad (7.10a)$$

Carr and Darby (1981) argued that empirical evidence suggests that unexpected increases in the nominal money supply have little immediate influence on prices but mainly affect real income and interest rates. In their specification of the buffer stock role of money, unexpected changes in the nominal money supply plays an important role in the determination of the interest rate effects of monetary changes on aggregate economic activity. The Carr-Darby model can be represented by the following modification of equation (7.10a).

$$\bar{M} = \tau \cdot \bar{M}_{D,T} + (1-\tau) \cdot \bar{M}_{t-1} + \gamma \cdot Y_t^t + \theta \cdot (M_t - M^e_t) + v_{1t} \quad (7.11)$$

where $(M_t - M^e_t)$ represents unexpected changes in the money supply, and (Y_t^t) represents transitory income which is assumed to be absorbed into transitory money balances. In this equation if $\theta > 0$, then an unexpected change in the money supply pushes asset holders away from their desired level of real balances. If $\gamma > 0$ then a receipt of transitory income represents the same effect. Hence, we can eliminate one of the variables (Y_t^t) and $(M_t - M^e_t)$ as redundant. We choose to eliminate (Y_t^t) , because the estimation of the coefficient of $(M_t - M^e_t)$ is always treated as crucial in tests of the buffer stock hypothesis. The resultant equation can be represented by

$$(M/P)_t = \tau \cdot (\alpha_0 + \alpha_1 \cdot i_{m,t} + \alpha_2 \cdot Y_t + \alpha_3 \cdot W_t) + (1-\tau) \cdot (M/P)_{t-1} + \theta \cdot (M_t - M^e_t) + v_{1t} \quad (7.12)$$

² In equation (7.10a) we assume that the desired money balances, $(\bar{M}_{D,t})$, is determined by,

$$\bar{M}_{D,t} = \alpha_0 + \alpha_1 \cdot i_m + \alpha_2 \cdot Y_t + \alpha_3 \cdot W_t + \varepsilon_t$$

Substituting the explanatory variables in the above equation for $(\bar{M}_{D,t})$ in equation (7.10a) yields,

$$\bar{M}_t = \tau \cdot \alpha_0 + \tau \cdot \alpha_1 \cdot i_m + \tau \cdot \alpha_2 \cdot Y_t + \tau \cdot \alpha_3 \cdot W_t + (1-\tau) \cdot \bar{M}_{t-1} + \tau \cdot \varepsilon_t$$

This equation represents a partial adjustment model for the demand for money. We have used the same procedure in deriving the partial adjustment model for the total outstanding stock of assets, (W), in section 4.2 which is represented by equation (4.17.1).

In empirical study, the expected money supply, (M^e_t) , can be estimated in a separate equation using actual previous money supply values as dependent variables. In equation (7.12) the key proposition to be tested is that $0 < \theta < 1$.

One serious problem with equation (7.12) is that there is a possibility of contemporaneous correlation between $(M_t - M^e_t)$ and the disturbances (u_{1t}) . As Carr and Darby pointed out we can use an instrumental variable method to eliminate the effects of such an implausible correlation.

MacKinnon and Milbourne (1984) argued that a correlation between $(M_t - M^e_t)$ and (v_{1t}) in equation (7.12) is not merely a possibility but inevitable. Dropping the transitory income variable from equation (7.11), they first add a term representing the expected nominal money supply (M^e_t) , and obtain an equation such as,

$$(M/P)_t = \tau.(M/P)_{D,t} + (1-\tau).(M/P)_{t-1} + \theta.(M_t - M^e_t) + \phi.(M^e_t) + v_{2t} \quad (7.13)$$

Transferring (M_t) from the right hand side of the above equation to the left, they, then, suggest the estimation of the following equation for testing the buffer stock hypothesis

$$(M/P)_t = \left(\frac{\tau}{1-\theta}\right).(M/P)_{D,t} + \left(\frac{1-\tau}{1-\theta}\right).(M/P)_{t-1} - \left(\frac{\theta}{1-\theta}\right).(M^e/P)_t + \left(\frac{\phi}{1-\theta}\right).(M^e)_t + v_{3t} \quad (7.14)$$

where

$$(M/P)_{D,t} = \alpha_0 + \alpha_1.i_{m,t} + \alpha_2.Y_t + \alpha_3.W_t.$$

The buffer stock hypothesis implies that $0 < \theta < 1$ and $\phi = 0$. Hence, the propositions to be tested in equation (7.14) are that the coefficient of (M^e/P) should be negative, and that on $(M^e)_t$ should be zero. Equations (7.12) and (7.13) with their dependent variable $(M_t - M^e_t)$, are appropriate estimating equations only when the money supply is assumed to be exogenous. This assumption reduces the probability of the correlation between $(M_t - M^e_t)$ and the disturbances v_{1t} and v_{2t} . In equation (7.14) the money supply can be assumed endogenous. This is because in equation (7.14) the money supply (M_t) appears only as a dependent variable.

According to the buffer stock hypothesis, money is the residual or buffer asset in a portfolio, because asset holders permit money balances $(M/P)_{D,t}$ to fluctuate up

and down in response to any changes in the overall size of the portfolio (W) resulting from disequilibria in other asset markets. Hence, the other proposition in the equations (7.12)-(7.14) to be tested is that the coefficient of (W) should be positive and significant.

In equations (7.12)-(7.14) the expected money supply (M_t^e) can be determined by a separate equation, using the expectations generating process as

$$M_t^e = M_{t-1} + \rho \cdot Z_{t-1} \quad (7.15)$$

where (ρ) is a vector of coefficients, and (Z_{t-1}) is a vector of variables that money holders believe have a systematic influence on changes in the money supply, (ΔM_{t-1}). Only lagged values are included in the determination of the expected money supply (M_t^e) because it is assumed that at time t money holders do not have information about period t values. $\rho \cdot Z_{t-1}$ determines the expected changes in the stock of money, and we assume that it is itself determined by a dynamic short-run error correction model as

$$\Delta M_{t-1} = \beta_0 + \beta_1 \cdot \Delta Y_{t-1} + \beta_2 \cdot \Delta i_{m,t-1} + \beta_3 \cdot M_{t-2} + \beta_4 \cdot Y_{t-2} + \beta_5 \cdot i_{m,t-2} + \varepsilon_t \quad (7.16)$$

To obtain estimation for (M_t^e), we replace $\rho \cdot Z_{t-1}$ in equation (7.15) by the coefficients and variables of equation (7.16), using the estimated values of (β_j) and the explanatory variables of the latter equation for (ρ) and (Z_{t-1}) respectively. The estimated values of (M_t^e) can be used as expected money balances (M_t^e) in the buffer stock equations (7.12)-(7.14).

Supporting evidence for the buffer stock hypothesis in equations (7.12)-(7.14) requires that unexpected changes in the money stock, ($M_t - M_t^e$), or the expected real money balances, (M^e/P) $_t$, should be included in the reduced-form equation (7.9), representing the transmission mechanism between the financial and real sectors.

7.2.3 Specification of tests for the credit rationing hypothesis

In the previous chapter the estimates of the demand for and supply of loans revealed a state of predominantly excess demand for loans in the Australian credit market. This result is consistent with the credit rationing hypothesis. In response to the

question whether this rationing is an important macroeconomic phenomenon, we examine the reduced-form relation between loans and aggregate economic activity.

In the reduced-form equation (7.9) we evaluate the relevance of the credit rationing approach in three ways. Firstly, we examine the credit-GDP relationship, replacing $\psi(L^d-L^s)$ by the transacted quantity of loans, (L^e) , in equation (7.9).

$$Y_t = Y(i_{a,t}, L^e_t, (i_{m,t}-\pi_t)-(i_{f,t}-\pi_{f,t}), TBII_t, W_{t-1}, WA_t, G_t) \quad (7.17)$$

where (G_t) represents the real value of government spending. The key proposition to be tested is that the coefficient of (L^e) is significantly positive.

In equation (7.17), (L^e) is used as a proxy for the availability of credit, given that the quantity of credit corresponds with the quantity required by the credit rationing hypothesis. This hypothesis implies that in the credit-rationed state (L^e) equals the loan supply, (L^s) , and in the non-rationing state equals the loan demand, (L^d) , which also requires $L^d=L^s$. Using the results of the estimates of (L^d) and (L^s) shown in table 6.3.3.6, the estimated values of (L^e) can be used to test the credit rationing hypothesis in equation (7.17). These estimates of (L^d) and (L^s) provided support for the credit rationing hypothesis in the Australian loan market.

Secondly, we examine the tightening impact of credit rationing on real output when, in the credit-rationed state, the effects on output of higher levels of aggregate demand relative to its trend values are depressed. The higher the level of aggregate demand relative to its trend value, the more likely it is that the risk of borrowers default will rise. In such a circumstance it is expected that banks ration loans by non-price means, and that a downward shock to credit causes the output effects of high levels of aggregate demand to fall. This specification of the credit rationing hypothesis can be represented by the following equation.

$$Y_t = Y(i_{a,t}, (i_{m,t}-\pi_t)-(i_{f,t}-\pi_{f,t}), TBII_t, [(\gamma_0 + \gamma_1 \cdot DUM) \cdot YDIF_t], W_{t-1}, WA_t, G_t) \quad (7.18)$$

where $(YDIF)$ represents the difference between the actual and trend growth of aggregate demand, and (Dum) is a dummy variable which is set equal to 1 if the economy is credit-constrained, and is otherwise zero.

Equation (7.18) has the same specification as equation (7.9) with the exception that $\psi(L^d-L^s)$, used as an indicator of excess demand in the credit-rationed state, is replaced by (DUM), and is augmented with (YDIF), and that (YDIF) represents the effects of actual-minus-trend values of aggregate demand on the output capacity of economy. In equation (7.18) the key proposition to be tested is that $\gamma_1 < 0$. This proposition implies that while the higher levels of aggregate demand relative to its trend values, (YDIF), is expected to motivate economic activity, *i.e.* $\gamma_0 > 0$, in the credit-rationed state (DUM) and (YDIF) are negatively correlated, and the actual output (Y) is depressed, *i.e.* $\gamma_1 < 0$.

Thirdly, we evaluate the credit rationing hypothesis in Blinder's (1987) model, which suggests that credit rationing makes a significant difference to the contribution of downward monetary shocks to output fluctuations. This hypothesis is also consistent with the strong effects of a tightening monetary policy under credit rationing in the model presented in section 5.4. The tighter the state of monetary policy, the more likely it is that the economy will be credit-constrained. This requires that the output effects of a tightening monetary policy would be augmented by downward shocks to credit. The implication of credit rationing for monetary policy can be examined by the following reduced-form equation.

$$Y_t = Y(i_{a,t}, (i_{m,t} - \pi_t) - (i_{f,t} - \pi_{f,t}), TBII_t, [(\gamma_0 + \gamma_1 \cdot DUM) \cdot YDIF_t], [(\gamma_2 + \gamma_3 \cdot DUM) \cdot MV_t], W_{t-1}, WA_t, G_t) \quad (7.19)$$

where (MV_t) represents detrended changes in the money supply M1, used as an indicator for the state of monetary policy. The detrended monetary variable (MV) equals actual-minus-trend growth of reserves, $M1 - \overline{M1}$, where $\overline{M1} = M1_0 \cdot e^{r \cdot t}$, (in this relation r and t respectively represent the growth rate and time trend). More specifically, positive and negative values of (MV_t) are treated as consistent with easy and tight states of monetary policy, respectively. Such a specification of the states of monetary policy requires that there should be a positive correlation between (Y) and (MV), *i.e.* $\gamma_2 > 0$. In equation (7.18) the key proposition to be tested is that $\gamma_3 > 0$. This

proposition implies that the output effects of a tightening of monetary policy in the credit-rationed state is greater than the state in which credit is plentiful.

The criterion used for the determination of the credit-rationed states in equations (7.18) and (7.19) is based on the results of the estimates of excess demand for loans, (EDL), which is obtained from the switching regression estimation of the demand and supply equations presented in table 6.3.3.6. The approach to defining the dummy variable (DUM), used for the representation of the credit-rationed states in the economy, is as follows:

$$\begin{aligned} \text{DUM} &= 1 && \text{if } \text{EDL} > \mu + k\sigma \\ &= 0 && \text{otherwise.} \end{aligned} \tag{7.20}$$

Condition (7.20) says that the economy is credit-constrained if (EDL) is k standard deviation, (σ), greater than its mean, (μ). In the regressions to be reported in the next section, k was selected so as to maximize the likelihood function of the output equations (7.18) and (7.19)³.

Another important aspect of this analysis is the implication of credit rationing for loan rate adjustments, represented by equation (7.2). In the model presented in section 5.4, in the credit-rationed state the main source of disequilibrium in the loan market is loan rate controls. In the non-rationing state the major source of disequilibrium can be attributed to the imperfect adjustment of loan rates. According to the credit rationing hypothesis, in the non-rationing state the loan rate falls (rises) to reduce, if not to eliminate, the amount of excess demand in the loan market.

We evaluate the relevance of the credit rationing approach to loan rate adjustments, by examining *a*) whether the actual loan rate adjusts to the controlled rate of interest in the loan market, and *b*) whether in the non-rationing state the controlled loan rate adjusts to reduce the amount of excess demand in the loan market. Testing this hypothesis requires an elaboration of the loan rate equation (7.2).

³. Condition (7.20) for the specification of the dummy variable (DUM) for the credit-rationed state follows the same logic as implied by McCallum (1991).

The loan rate adjustment consistent with the credit rationing hypothesis can be represented by the following partial adjustment model.

$$(i_{d,t} - i_{d,t-1}) = \tau_1 \cdot (i_{d,t}^c - i_{d,t-1}) \quad (7.21)$$

In equation (7.21), $(i_{d,t})$ is the actual loan rate, and $(i_{d,t}^c)$ is the controlled loan rate; and τ_1 is the adjustment coefficient. This equation implies that $(i_{d,t})$ adjusts to the interest rate $(i_{d,t}^c)$ which is set by banks. This equation can also be represented by

$$i_{d,t} = \tau_1 \cdot i_{d,t}^c + (1-\tau_1) \cdot i_{d,t-1} \quad (7.21a)$$

As we have already noted, in a credit rationing model bank controls on the loan rate can be represented by some rules under which loan rate controls depend on some specific historical data. We specify the following equation as the rules for loan rate controls in the Australian loan market.

$$i_{d,t}^c = v + \overset{(+)}{\kappa} \cdot i_{m,t} + \overset{(-)}{\omega} \cdot D_t + \overset{(+)}{\lambda} \cdot (DUM_1) \cdot (L_t^d - L_t^s) + u_t \quad (7.22)$$

Signs above functional arguments represent the signs of partial derivatives. In equation (7.22) the dummy variable (DUM_1) represents the non-rationing state in the loan market, which can be determined by the same criterion as used for differentiating between the rationing and non-rationing states in condition (7.20). That is

$$\begin{aligned} DUM_1 &= 0 && \text{if } EDL > \mu + k\sigma \\ &= 1 && \text{otherwise.} \end{aligned} \quad (7.23)$$

where $(\mu+k\sigma)$ has the same value as given by equation (7.18) or (7.19).

Equation (7.22) implies that the controlled loan rate, $(i_{d,t}^c)$, rises as the rate of interest in the money market, (i_m) , increases, and falls as the public's deposits in banks, (D) , increase. This equation also says that excess demand in the non-rationing state is positively correlated with the rate of interest required by banks. The resultant partial adjustment equation for $(i_{d,t})$ can be represented by,

$$i_{d,t} = \tau_1 \cdot v + \overset{(+)}{\tau_1 \cdot \kappa} \cdot i_{m,t} - \overset{(-)}{\tau_1 \cdot \omega} \cdot D_t + \overset{(+)}{\tau_1 \cdot \lambda} \cdot (DUM_1) \cdot (L_t^d - L_t^s) + (1-\tau_1) \cdot i_{d,t-1} + u_{1t} \quad (7.24)$$

In equation (7.24) the actual loan rate adjusts to the controlled rate $(i_{d,t}^c)$ via the partial adjustment mechanism. Estimation of (7.24) enables estimates of the

underlying loan rate control parameters v , k , $\bar{\omega}$ and λ , together with the adjustment parameter τ_1 to be obtained. In equation (7.24) the key proposition to be tested is that $0 < \tau_1 < 1$ and that $\lambda > 0$. This implies that while in the credit-rationed state the loan rate adjusts to the controlled rate of interest required by banks, in the non-rationing state the loan rate falls to reduce excess supply in the loan market. Consequently, the rules for loan rate controls via a partial adjustment mechanism aid prediction of loan rate variation in a manner consistent with the credit rationing hypothesis. The variation of the loan rate caused by excess demand for loans may explain the credit-GNP relationship in the model presented in section 5.4. Whether or not credit rationing is of macroeconomic importance is a separate question which can be examined by equations (7.17)-(7.19).

7.3 Empirical features of the monetary transmission mechanism of the Australian economy

In this section we seek evidence on the buffer stock role of money, and the macroeconomic importance of credit rationing, using Australian data. In section 6.3 we found evidence that Australian banks, in the aggregate, ration credit by non-price means. In this section we examine the reduced-form relation between credit and aggregate economic activity to analyse the implications of the credit rationing hypothesis for the monetary transmission mechanism. The LM and Chow statistics represent the tests for up to fourth and eighth order autocorrelation, and for parameter stability, respectively. The latter test is used to examine whether any stability occurs after the second quarter 1986 with the removal of all controls on interest rates and loans, imposed by the Reserve Bank.

7.3.1 Empirical evidence on the buffer stock hypothesis

In the buffer stock equations (7.12)-(7.13) unexpected changes in the money supply is represented by the difference between actual and expected money supply, (M^e_t). The latter variable can be estimated by the expectations generating process,

represented by equations (7.15) and (7.16). The estimation results of equation (7.16) are given in table 7.3.1, using a dynamic short-run error correction estimate of the real money supply with up to two quarter lags. Since the value of the F-statistic for restrictions imposed in the first order error correction model is less than the critical F-value with (3, 62) degree of freedom, we prefer the first order model.

In the next step we examine the buffer stock hypothesis in equations (7.12) and (7.13), using the estimates of (M^e_t) . The estimation results are given in table 7.3.2, using 2SLS estimates with Australian data. The results show that the coefficients of $(M_t - M^e_t)$ in both the equations are positive and significant, and the coefficient of (M^e_t) in equation (7.13) is insignificant. These results provide support for the buffer stock hypothesis in the Australian financial sector. These results are consistent with Carr *et al.* (1985) findings which were represented by the estimation of an equation similar to equation (7.13), using US data. Also, positive and significant coefficients of (W) in equations (7.12) and (7.13) imply that the actual money balances fluctuate in response to changes in the value of total net worth. This result is consistent with the basic idea in the buffer stock approach, in which money is treated as a buffer asset for changes in the overall size of portfolio.

As was described in the previous section, despite an instrumental variable method used in the estimation of $(M_t - M^e_t)$, equations (7.12) and (7.13) may still show a correlation between $(M_t - M^e_t)$ and residuals, v_{1t} and v_{2t} . This is because (M_t) appears in both sides of equations (7.12) and (7.13). One response to this problem, as argued by Carr, *et al.*, (1985), is that money is exogenous and cannot be correlated with the error terms.

By contrast, as we have already noted, the portfolio-loan model estimated for Australia is suggestive of the endogeneity of the money supply M1. An appropriate test for the buffer stock hypothesis, therefore, can be represented by the estimation of equation (7.14). In this equation (M_t) is no longer used as an explanatory variable. Hence, (M_t) can be expected to be determined endogenously, as implied by the dependent variable $(M/P)_t$ in the model. In equation (7.14) there is still a possibility of

Table 7.3.1: Estimation results for changes in the money supply (ΔM_{t-1}), equation (7.16)

$$\text{First-order ECM: } \Delta M_{t-1} = P. (\beta_0 + \beta_1 \cdot \Delta Y_{t-1} - \beta_2 \cdot \Delta i_{m,t-1} - \beta_3 \cdot M_{t-2} + \beta_4 \cdot Y_{t-2} - \beta_5 \cdot i_{m,t-2})$$

$$\text{Second-order ECM: } \Delta M_{t-1} = P. (\beta_0 + \beta \cdot \Delta(M/P)_{t-1} + \beta_1 \cdot \Delta Y_{t-1} + \beta_{10} \cdot \Delta Y_{t-2} - \beta_2 \cdot \Delta i_{m,t-1} - \beta_{20} \cdot \Delta i_{m,t-2} - \beta_3 \cdot (M/P)_{t-3} + \beta_4 \cdot Y_{t-3} - \beta_5 \cdot i_{m,t-3})$$

Sample period: 1978:3 to 1993:4, Quarterly.

Dependent variable: $\Delta \log(M/P)_{t-1}$

Explanatory variables	First-order ECM	Second-order ECM
	-.653 (-2.77)***	-.619 (-2.89)***
$\Delta \log(M/P)_{t-1}$	-.165 (-1.22)	
$\Delta \log(Y_{t-1})$	.....	.....
$\Delta \log(Y_{t-2})$	.174 (1.25)	
$\Delta \log(i_{m,t-1})$	-.021 (-1.04)	-.022 (-1.12)
$\Delta \log(i_{m,t-2})$	-.067 (-3.74)***	
$\log(M/P)_{t-2}$		-.138 (-3.42)***
$\log(M/P)_{t-3}$	-.141 (-3.55)***	
$\log(Y_{t-2})$		.201 (4.14)***
$\log(Y_{t-3})$	.208 (4.07)***	
$\log(i_{m,t-2})$		-.067 (-5.27)***
$\log(i_{m,t-3})$	-.069 (-5.16)***	
	$R^2 = .408$ DW=2.01	$R^2 = .407$ DW=2.05
Durbin's h (Alt.)=-1.036	LM1=.05, LM4=1.21	LM1=1.09, LM4=1.34
Chow=1.53, (.116)	ADF=-7.6	Chow=1.53, (.116)

Note:

1. t-statistics are in brackets, (***) significant at the 99% level.
2. The critical values of χ^2 for LM1 (with d.f.=1) and LM4 (with d.f.=4) statistics at the 5% level of significance are respectively 3.84 and 9.49.
3. The P-values for the Chow statistics are in parentheses.
4. The critical value for ADF at the 5% level (with n=5) is 4.02.

Table 7.3.2: Estimation results for the buffer stock model, equations (7.12) and (7.13).

$$\text{Equation (7.12): } (M/P)_t = \tau \cdot (\alpha_0 - \alpha_1 \cdot i_{m,t} + \alpha_2 \cdot Y_t + \alpha_3 \cdot W_t) + (1-\tau) \cdot (M/P)_{t-1} + \theta \cdot (M_t - M^e_t)$$

$$\text{Equation (7.13): } (M/P)_t = \tau \cdot (M/P)_{D,t} + (1-\tau) \cdot (M/P)_{t-1} + \theta \cdot (M_t - M^e_t) + \phi \cdot (M^e_t)$$

Sample period: 1978:3 to 1993:4, Quarterly.

Dependent variable: $\log(M/P)_t$

Explanatory variables	Equation (7.12)	Equation (7.13)
	-.469 (-2.44) ***	-.0997 (-.149)
$\log(i_{m,t})$	-.0415 (-5.20) ***	-.049 (-6.41) ***
$\log(Y_t)$	.119 (3.43) ***	.098 (1.34) *
$\log(W/P)_t$	.0103 (1.26)	.015 (2.63) ***
$\log(M/P)_{t-1}$	.918 (33.1) ***	.888 (33.5) ***
$\log(M_t - M^e_t)$	.758 (7.80) ***	.609 (4.85) ***
$\log(M^e_t)$		.012 (.498)
	$R^2 = .998$ DW = 1.82 ESS = .0054	$R^2 = .997$ DW = 1.67 ESS = .0079

Note:

- Two-stage least squares method, using IV method with Fair Correction for serial correlation.
- t-statistics are in brackets.
 - (***) significant at the 99% level.
 - (**) significant at the 95% level.
 - (*) significant at the 90% level.

a correlation between the money deflator (P) and residuals, v_{3t} , since (P) appears in both sides of the equation. We therefore estimate equation (7.14) by a 2SLS instrumental variable method. The results of the 2SLS estimation of equation (7.14) with Australian data are given in table 7.3.3.

The results show that, with the exception of $(M^e/P)_t$ and (M^e_t) , all variables have the coefficients which are statistically significantly different from zero. However, since the t-ratio of the coefficient of the former variable exceeds unity in absolute value, $(M^e/P)_t$ can be treated as the variable which is worth incorporating. This treatment of the coefficients of $(M^e/P)_t$ implies that $\theta=0.37$. As was implied by the propositions on the buffer stock hypothesis in equation (7.14), the results obtained for coefficients θ and ϕ are suggestive of the importance of the buffer stock role of money in the Australian financial sector. These results stand in contrast to the results for US and UK quarterly data obtained respectively by Mackinon and Milbourne (1984) and Cuthbertson (1986). In their estimation of equation (7.14) they found the coefficients on $(M^e/P)_t$ and (M^e_t) both to be significantly positive. These results completely refuted the buffer stock hypothesis, using US and UK data.

As with Australian quarterly data, the estimation results of equation (7.14) imply that holdings of money may differ from their desired level as a result of money acting as a buffer for disequilibria in other asset market. Therefore, in the absence of a significant effect of the interest rate on real output, the expected real money balances, $(M^e/P)_t$, can be treated as the main channel for monetary changes in the reduced-form equation (7.9). We examine this approach in the next subsection where we present the reduced-form evidence on the monetary transmission mechanism of Australia.

Table 7.3.3: Estimation results for the buffer stock model, equation (7.14).

$$\left(\frac{M}{P}\right)_t = \left(\frac{\tau}{1-\theta}\right) \cdot \left(\frac{M}{P}\right)_{D,t} + \left(\frac{1-\tau}{1-\theta}\right) \cdot \left(\frac{M}{P}\right)_{t-1} - \left(\frac{\theta}{1-\theta}\right) \cdot \left(\frac{M^e}{P}\right)_t + \left(\frac{\phi}{1-\theta}\right) \cdot \left(\frac{M^e}{P}\right)_t$$

Sample period: 1978:3 to 1993:4, Quarterly.

Dependent variable: $\log(M/P)_t$

Explanatory variables	Coefficients	t-statistics
	-1.231	(-.811)
$\log(i_{m,t})$	-.091	(-3.93)***
$\log(Y_t)$	.299	(1.78)**
$\log(W/P)_t$	.024	(1.79)**
$\log(M/P)_{t-1}$	1.41	(2.95)***
$\log(M^e_t/P_t)$	-.590	(-1.12)
$\log(M^e_t)$	-.024	(-.419)

$$\frac{1-\tau}{1-\theta} = 1.41$$

$$\frac{\theta}{1-\theta} = -.590$$

$$\theta = .37 \quad \tau = .112$$

$$R^2 = .988$$

$$DW = 1.99$$

$$ESS = .0335$$

Note:

1. Two-stage least squares method, using IV method with Fair Correction for serial correlation.
2. For the t-statistics see footnote of table 7.3.2.

7.3.2 Empirical evidence on the lending channel and the credit rationing hypothesis

In this subsection we evaluate the monetary transmission mechanism through bank lending and the relevance of the credit rationing hypothesis, by examining whether bank credit aggregates have any predictive content for economic activity. In section 6.3 we concluded that Australian banks act, in the aggregate, as though they ration credit. The relevance of this conclusion to the linkages between financial markets and the real sector, which is augmented by some other conventional transmission mechanisms, will be evaluated in three ways, by examining: 1) the 'credit availability doctrine' in the reduced-form equation (7.17); 2) the 'credit rationing hypothesis' in the reduced-form equation (7.18), implying that in the credit-rationed state the effects on output of higher levels of aggregate demand relative to its trend growth are depressed; and, 3) the Blinder's credit rationing hypothesis in the reduced form equation (7.18), suggesting that a tightening of monetary policy has strong effects on the real sector when the economy is credit-constrained.

Also the implication of the credit rationing hypothesis for loan rate adjustments, represented by equation (7.24), will be examined under three specifications of the excess-demand rule, $(DUM_1) \cdot (L^d - L^s)$. In the first specification of this rule (DUM_1) is replaced by the dummy variable (DUU) , which is set equal to 1 if the excess demand, $(L^d - L^s)$, is negative, and is otherwise zero. This assumption implies that the controlled loan rate remains unchanged when loans are constrained but falls when credit is plentiful, *i.e.* when $L^s > L^d$. In the second and third specification of the excess demand rule (DUM_1) complies with condition (7.23), and k takes the same values as implied by the estimates of equations (7.18) and (7.19), respectively. In the absence of an excess-demand rule in the loan rate adjustment mechanism, credit rationing does not have any influence on portfolio allocations, and variation in the loan rate will be irrelevant to the model of interest rate-GNP relationship, presented in section 5.4.

Table 7.3.4 gives the results of the estimation of equation (7.17). In this equation the key proposition to be tested is that the coefficient of (L^e) is positive and

Table 7.3.4: Estimation results of the reduced-form equation (7.17)

$$Y_t = Y \left(\begin{matrix} (-) & (+) \\ i_{a,t}, & L^e_t, \end{matrix} \begin{matrix} (-) \\ (i_{m,t} - \pi_t) - (i_{f,t} - \pi_{f,t}), \end{matrix} \begin{matrix} (-) & (+) \\ TBII_t, & (M/P)_{t-1}, \end{matrix} \begin{matrix} (-) & (+) \\ WA_t, & G_t \end{matrix} \right)$$

Sample period: 1978:3 to 1993:4, Quarterly.

Dependent variable: $\log(Y_t)$

Explanatory variables	Coefficients	t-statistics
	10.06	(16.6) ***
$\log(i_{a,t})$	.015	(2.18) ***
$\log(L^e_t)$	.082	(6.47) ***
$\log(M/P)_{t-1}$	.173	(6.83) ***
$\log(WA_t)$	-.371	(3.82) ***
$\log(G_t)$	.123	(1.80) **
Dummy1	.067	(9.91) ***
Dummy3	.044	(3.78) ***

$R^2 = .992$
 $DW = 1.91$
 $LM1 = .059, \quad LM8 = 9.96$
 $Chow = .992, \quad (.455)$
 $ADF = -6.41$

Note:

1. Dummy1 takes the value of unity before 1980:4, and zero thereafter.
2. Dummy3 takes the value of unity before 1983:4, and zero thereafter.
3. The critical values of χ^2 for LM1 (with d.f.=1) and LM8 (with d.f.=8) statistic at the 5% level of significance are respectively 3.84 and 16.9.
4. Figures in parentheses represent p-values for Chow and ADF statistics.
5. For the t-statistics see footnote of table 7.3.2.

significant. The results show that all coefficients are significantly different from zero, and that the diagnostic statistics are satisfactory. In the estimated equation, when (W_{t-1}) was replaced by $(M/P)_{t-1}$, we obtained satisfactory values for the LM statistics for autocorrelation problems of the first and fourth orders. The latter variable can be treated as a narrow definition for total net worth. All of the coefficients are of the expected signs except that of the short-term cash rate, (i_a) . This is possibly because the interest rate (i_a) is set exogenously by the central bank, and because the central bank plays the role of 'leaning against the wind' of volatile changes in the money market interest rate⁴. The variables $(i_m - \pi) - (i_f - \pi_f)$ and $(TBII)$ which represent the exchange rate effects on total output, are excluded from the estimated equation. This is because the coefficients of these variables have t-statistics lower than the critical t-value. We will examine the effects of these variables in the other reduced-form equations, used for testing the credit rationing hypotheses.

Two dummy variables (Dummy1) and (Dummy3) in the estimated equation point to important changes in the financial sector, resulting respectively from: *a*) the removal of interest rate ceilings on deposits in banks after December 1980, and *b*) the floating of the exchange rate after December 1983. The former change resulted in an increase in banks' loanable funds, and hence a rise in the supply of bank loans after December 1980. The further effects of such a change are expected to be an increase in the supply of loans, and hence in aggregate demand. The latter change brought about increased fluctuations in the exchange rate after December 1983, and hence exchange rate depreciation as a result of the current account deficit. It is expected that the exchange rate depreciation gives rise to an improvement in the trade balance, and

⁴ In section 4.3 we examined the policy reaction function in terms of the ratio of the Reserve Bank holdings of government bonds to the total government bonds, (RBS/BB) . In the policy equation (4.28) an increase in the interest rate (i_m) , resulted in a reduction in the policy variable (RBS/BB) . If such a fall in the policy ratio is offset by an increase in the Reserve Bank's holdings of government bonds, the supply of short-term funds rises and the interest rate in the short-term cash market, (i_a) , falls. This implies that, given that an increase in the interest rate (i_m) will eventually reduce the aggregate demand, (Y) , a reduction in (Y) will be accompanied by a fall in the short-term cash rate (i_a) . In this treatment, the Reserve Bank open market operations play the role of 'leaning against the wind' of volatile changes in the interest rate (i_m) , and there will be a positive correlation between (Y) and (i_a) .

hence to a rise in the aggregate demand. The above analysis, therefore, refers to positive correlations between these dummy variables and total output, (Y).

In table 7.3.4, the coefficient of bank loans is positive and significantly different from zero. This result provides evidence on the importance of credit availability in the monetary transmission mechanism with Australian data. The estimation of equation (7.17) using the fitted values of the quantity of loans from the estimates of (L^d) and (L^s) in table 6.3.3.6, gave almost identical results. These results imply that the actual values of credit availability serves equally well as the indicator of the predominantly excess demand in the Australian loan market. However, testing the credit rationing hypothesis does require a more specific indicator for the credit rationing hypothesis in the reduced-form relation between bank loans and aggregate economic activity. Such an specification of the credit rationing indicator is represented by the inclusion of condition 7.20 in the reduced-form relation, represented by equations (7.18) and (7.19).

Table 7.3.5 gives the results of the estimation of equation (7.18) with Australian data. In this equation the key proposition for testing the credit rationing hypothesis is $\gamma_1 < 0$. There appears to be no autocorrelation problem with the estimation results, and all the variables have statistically significant coefficients apart from (i_a). The coefficient of (i_a) has the expected sign but is insignificant. Also, $(M/P)_{t-1}$ and the dummy variable (DUM) have the same significance as explained for the results of table 7.3.4.

In table 7.3.5 the coefficients of unexpected changes in the trade balance and the real interest rate differential, used as indicators of adjustments in the nominal exchange rate, are of the expected signs. Also, consistent with the credit rationing hypothesis, $\gamma_0 > 0$ and $\gamma_1 < 0$. This implies that the detrended growth of aggregate demand, represented by the actual-minus-trend values of aggregate demand, (YDIF), is positively correlated with total output, *i.e.* $\gamma_0 > 0$, but its effect is less when the economy is credit-constrained. In the credit-rationed state the coefficient of the detrended growth of aggregate demand, (YDIF), is shown by $(\gamma_0 + \gamma_1 \cdot \text{DUM})$.

Table 7.3.5: Estimation results of the reduced-form equation (7.18)

$$Y_t = Y (i_{a,t}, (i_{m,t} - \pi_t) - (i_{f,t} - \pi_{f,t}), TBII_t, [(\gamma_0 + \gamma_1 \cdot DUM) \cdot YDIF], W_{t-1}, WA_t, G_t)$$

Sample period: 1978:3 to 1993:4, Quarterly.

Dependent variable: $\log(Y_t)$

Explanatory variables	Coefficients	
	4.73 (4.04) ***	5.13 (5.02) ***
$\log(i_{a,t})$	.004 (.311)	
$\log(M/P)_t - 1$	.189 (6.23) ***	
$\log(M^e/P)_t$		.196 (6.85) ***
$(i_{m,t} - \pi_t) - (i_{f,t} - \pi_{f,t})$	-.0008 (-1.38) *	-.0007 (-1.11)
TBII _t	-.313 (-1.85) **	-.186 (-.943)
YDIF _t	.869 (5.26) ***	.856 (5.38) ***
(DUM) · YDIF _t	-.655 (-2.03) **	-.577 (-1.94) **
$\log(WA_t)$	-.371 (-2.49) ***	-.414 (-3.19) ***
$\log(G_t)$	.767 (13.0) ***	.755 (14.4)
Dummy3	.057 (4.29) ***	.062 (5.53) ***
	k = 0.9	

log of likelihood function = 165.739

R ² = .985	R ² = .984
DW = 1.84	DW = 1.88
LM1 = .383	LM1 = .195
LM8 = 6.01	LM8 = 4.67
Chow = 3.07, (.005)	Chow = 2.38, (.028)
ADF = -7.12,	ADF = -7.21

Note:

1. Dummy3 takes the value of unity before 1983:4, and zero thereafter.
2. t-statistics in brackets.
3. For the statistics see footnotes of tables 7.3.2 and 7.4.

As is illustrated in table 7.3.5, since in equation (7.18) the interest rate effects on real output is insignificant, we may examine the buffer stock approach to monetary changes using $(M^e/P)_t$ as an explanatory variable. The results, using $(M^e/P)_t$ for (W_{t-1}) in equation (7.18), are also given in table 7.3.5. The results show that all variables are correctly signed, and with the exception of (TBII) and $(i_m - \pi) - (i_f - \pi_f)$ all variables have statistically significant coefficients. However, since the t-ratio in absolute value for the former variable is close to one, and for the latter variable exceeds unity we retain these variables in the equation. The estimation results of equation (7.18) using $(M^e/P)_t$ as a regressor suggest that the buffer stock role of money makes a significant difference to the contribution of monetary shocks to output fluctuations. The results also imply that the buffer stock mechanism represents the effects on real output of unexpected changes in the overall size of the portfolio (W), resulting from disequilibria in asset markets.

The results of the test for the credit rationing hypothesis in equation (7.19), concerning the strong effects of a tightening of monetary policy when the economy is credit-constrained, are given in table 7.3.6. As we have already described, it is expected that the tighter the state of monetary policy, the more likely it is that the economy's credit constraint is binding. This implies that the dummy variable (DUM) in equation (7.19) reflects the additionally tightening impact of monetary policy on total output. In this equation the key proposition to be tested is that $\gamma_3 > 0$. As is shown in the estimation results, with the exception of (i_a) all the variables have coefficients which are statistically different from zero. Since the t-ratio of the coefficient of (i_a) exceeds one in absolute value, we treat it as the variable which is worth incorporating. Also, all the coefficients are of the expected signs except (γ_2) , the coefficient of the monetary variable (MV).

In equation (7.19), (i_a) is treated as the indicator of adjustments in the money market interest rate, and the monetary variable (MV) as the indicator of the state of monetary policy, which will be either tight or easy. The sign of the coefficient (γ_2) , which is unexpectedly negative, possibly reflects the fact that in domestic monetary

Table 7.3.6: Estimation results of the reduced-form equation (7.19)

$$Y_t = Y \begin{matrix} (-) \\ (i_{a,t}, \end{matrix} \begin{matrix} (-) \\ (i_{m,t} - \pi_t) - (i_{f,t} - \pi_{f,t}), \end{matrix} \begin{matrix} (-) \\ TBII_t, \end{matrix} \begin{matrix} (+) \\ [(\gamma_0 + \gamma_1 \cdot DUM) \cdot YDIF_t], \end{matrix} \begin{matrix} (-) \\ [(\gamma_2 + \gamma_3 \cdot DUM) \cdot MV_t], \end{matrix} \begin{matrix} (+) \\ W_{t-1}, \end{matrix} \begin{matrix} (-) \\ WA_t, \end{matrix} \begin{matrix} (+) \\ G_t \end{matrix}$$

Sample period: 1978:3 to 1993:4, Quarterly.

Dependent variable: $\log(Y_t)$

Explanatory variables	Coefficients	t-statistics
	6.58	(5.79)***
$\log(i_{a,t})$	-.016	(-1.06)
$\log(W/P)_{t-1}$	.015	(1.33)*
$(i_{m,t} - \pi_t) - (i_{f,t} - \pi_{f,t})$	-.114	(-1.51)*
$TBII_t$	-.948	(-5.49)***
$YDIF_t$	1.11	(5.82)***
$(DUM) \cdot YDIF_t$	-.610	(-2.76)***
MV_t	-.865 E-05	(-3.93)***
$(DUM) \cdot MV_t$	.168 E-04	(4.12)***
$\log(WA_t)$	-.575	(-4.21)***
$\log(G_t)$	.937	(16.0)***
Dummy3	.061	(4.28)***
	$k = 0.5$	

\log of likelihood function = 160.09

$R^2 = .982$
 $DW = 1.81$
 $LM1 = .615, \quad LM8 = 10.21$
 $Chow = 1.98, \quad (.055)$
 $ADF = -7.17$

Note:

1. Dummy3 takes the value of unity before 1983:4, and zero thereafter.
2. For the statistics see footnotes of tables 7.3.2 and 7.4.

policy, generally, the Australian central bank 'fine tunes' the economy with its monetary policy instruments. That is, when aggregate demand is rising too fast, the central bank tightens monetary policy to rein in aggregate demand. It is, therefore, expected that domestic monetary policy causes the money stock to differ from its trend growth. Such a difference is represented by (MV) , the values of detrended changes in the monetary aggregate M1. As is implied by $\gamma_2 < 0$, while the current effects of a tightening of monetary policy seem not to be reliable, in the rationing state these effects appear to be strong. This is implied by $(\gamma_2 + \gamma_3 \cdot DUM) > 0$, which represents the effectiveness of a tight monetary policy when the economy's credit constraint is binding.

As was already described, the evaluation of the credit rationing hypothesis in the context of the IIS-LLM model also requires that *a*) the loan rate adjusts to the controlled rate of interest in the loan market, and *b*) in the non-rationing state the loan rate falls to reduce the amount of excess supply in the loan market. We examine the loan rate adjustment mechanism in equation (7.24), using three specifications of the excess-demand rule. In the first specification of the excess demand rule, the loan rate falls/rises in order to reduce the amount of excess demand in both the rationing and non-rationing states. In this treatment of the excess demand rule, the response of the loan rate to $(L^d - L^s)$ is consistent with the assumption that imperfect adjustments of the loan rate, rather than loan rate controls, are the major source of disequilibrium. In the second and third specifications, the excess demand rule is modelled in a manner consistent with the credit rationing hypothesis. This is implied by the loan rate adjustment mechanism in equation (7.24), in which the excess demand rule is specified by $(DUM_1) \cdot (L^d - L^s)$. In the second and third specifications, the dummy variables $(DUM_1)^{R1}$ and $(DUM_1)^{R2}$ are represented by condition (7.23), using $k=0.9$ and $k=0.5$ respectively. These values of k are obtained from the estimation of equations (7.18) and (7.19), respectively. In these equations the values of k were selected so as to maximize the likelihood functions. The results of the estimates of equation (7.24) are given in table 7.3.7.

Table 7.3.7: Estimation results for the loan rate, equation (7.24)

$$i_{d,t} = \tau_1 \cdot v + \tau_1 \cdot \kappa \cdot i_{m,t} - \tau_1 \cdot \omega \cdot D_t + \tau_1 \cdot \lambda \cdot (\text{DUM}_1) \cdot (L_t^d - L_t^s) + (1 - \tau_1) \cdot i_{d,t-1}$$

Sample period: 1978:3 to 1993:4, Quarterly.

Dependent variable: $\log(i_{d,t})$

Explanatory variables	Coefficients (t-statistics)	Coefficients (t-statistics)	Coefficients (t-statistics)
	.746 (2.00) **	.775 (3.19) ***	.812 (3.11) ***
$\log(i_{d,t-1})$	.682 (8.46) ***	.613 (9.36) ***	.603 (8.12) ***
$\log(i_{m,t})$	.202 (4.44) ***	.240 (6.30) ***	.248 (5.67) ***
$\log(D_t)$	-.032 (-1.22)	-.027 (-1.45) *	-.028 (-1.35) ***
$(L_t^d - L_t^s)$	.118 (1.29)		
$(\text{DUM}_1)^{R1} \cdot (L_t^d - L_t^s)$		.202 (2.30) **	
$(\text{DUM}_1)^{R2} \cdot (L_t^d - L_t^s)$			.145 (1.05)
Dummy2	-.058 (-2.05)	-.084 (-3.92) ***	-.080 (-3.59) ***
Dummy6	-.080 (-2.73)	-.075 (-3.92) ***	-.085 (-3.69) ***
	$\tau_1 = .318$ $\lambda = .371$	$\tau_1 = .387$ $\lambda = .522$	$\tau_1 = .397$ $\lambda = .365$
	$R^2 = .973$ DW=2.19 Durbin's h (Alt.)=-.825 LM1=.904 LM4=7.17 Chow=3.15 (.008) ADF=-7.63	$R^2 = .974$ DW=2.13 Durbin's Alt.=-1.35 LM1=2.02 LM4=6.63 Chow=2.51 (.028) ADF=-7.38	$R^2 = .973$ DW=2.24 Durbin's h Alt.=-1.04 LM1=1.31 LM4=6.30 Chow=2.38 (.036) ADF=-8.87

Note:

1. Dummy2 takes the value of unity before 1982:3, and zero thereafter.
2. Dummy6 takes the value of unity before 1985:2, and zero thereafter.
3. For the statistics see footnotes of tables 7.3.2 and 7.4.

In three regressions the LM statistics indicate no autocorrelation problems. All the variables have statistically significant coefficients apart from the excess demand coefficients in the first and third regressions. However, since the t-ratios for $(L_t^d - L_t^s)$ and $(DUM_1)^{R^2} \cdot (L_t^d - L_t^s)$ in these regressions exceed unity we treat them as worth incorporating. The criterion of parameter stability in three regressions examines the stability for a new system of controls on the loan rate imposed by savings and trading banks after removing all remaining controls imposed by the Reserve Bank in April 1986. The resulting Chow statistics in the second and third regressions are significant at the levels higher than the 5% level. Hence, we do not reject the hypothesis of stability in these equations. The dummy variables show that the removal of the Reserve Bank's quantitative lending guidance in June 1982, and the removal of interest rate ceilings on bank loans in April 1985 resulted in more controls on the loan rate imposed by savings and trading banks in the post-deregulation period.

In the regressions reported in table 7.3.7 the key propositions to be tested are $0 < \tau_1 < 1$ and $\lambda > 0$. The results suggest that the actual loan rate adjusts to some controlled rates, and that in the non-rationing state the loan rate falls/rises to reduce the amount of excess demand. These results, as we have already noted, are consistent with the credit rationing hypothesis. The coefficients of adjustment, τ_1 , in the second and third equations are higher than the first equation, and the coefficient of the excess demand rule, λ , in the second equation is greater than the other two equations. The results are, therefore, consistent with the estimates of equations (7.18) and (7.19) in which we examined the macroeconomic importance of credit rationing. In general the results suggest that loan rate controls via a partial adjustment mechanism aid prediction of loan rate variations in a manner consistent with the credit rationing hypothesis; and that the variation of the loan rate caused by excess demand for loans may explain the credit-GNP relationship in the IIS-LLM model.

7.4 Conclusions

In this chapter we examined the transmission mechanism between the monetary and real sectors, using the basic form of the theoretical framework of the model described in section 5.4. Two noteworthy avenues of research in this chapter relate to the buffer stock role of money and the rationing behaviour of banks in the analysis of the potency of monetary policy. The empirical results of the buffer stock models suggest that monetary disequilibrium plays an important role in the Australian monetary sector, and in the determination of the interest rate effects of monetary changes on real output. There is evidence that the output effects of downward shocks to credit are significantly higher when banks use credit rationing to reduce the risk of borrowers default. In the reduced-form evidence the detrended growth of aggregate demand presents information concerning the borrowers' credit worthiness. The higher the growth of aggregate demand relative to its trend growth, the more likely it is that the risk of borrowers default will be increasing. The reduced-form evidence is, therefore, consistent with the credit rationing hypothesis. The Australian experience also suggests not only that the credit-rationing mechanism exists, but also that the output effects of monetary shocks rise when recent monetary policy is tight and the economy's credit constraint is binding.

The evidence on loan rate variations provides mixed support for the credit rationing hypothesis. The evidence of section 6.3 revealed a state of predominantly excess demand in the loan market. The loan rate estimates in the previous section reveals the fact that the actual loan rate adjusts to some control rates, and that the controlled loan rate in the non-rationing state falls to reduce the amount of excess supply. These results are, therefore, consistent with the credit rationing hypothesis, and imply that credit rationing is relevant to the interest rate-GNP relationship, presented by the IIS-LLM model. In this model variation in the loan rate, initiated by the response of banks to the risk of borrowers default, influences portfolio allocations and makes a significant difference to the contribution of monetary shocks to output fluctuations.

Chapter 8

CONCLUSIONS

The aim of this thesis has been to evaluate some of the major changes that have occurred to the Australian monetary transmission mechanism as a result of deregulation of the financial sector. The study provided new insight into three main areas, 1) the response of the exchange rate to monetary changes in the post-float period, 2) the credit rationing approach to monetary fluctuations, and 3) the importance of credit rationing in output fluctuations.

First, an asset market model, in which the supply of assets is endogenous, has been specified and estimated for Australia in the period 1978 to 1993. There is evidence that the uncovered interest differential is a determinant of capital flows, and hence of the demand for net foreign borrowing in the post-float period. In this period capital flows are viewed as important determinants of the exchange rate. However, the uncovered interest differential is determined by investors' expectations of changes in future exchange rates. The latter were treated as dependent on fundamentals such as relative expected secular inflation, and adjustments in the long-run equilibrium real exchange rate. This treatment of the expectations mechanism in the foreign exchange market allows for exchange rate overshooting, and hence complies with the facts of observation in flexible exchange rate regimes. We presented evidence that, as well as being affected by demand and supply in the markets for financial assets, the exchange rate is also affected by fundamentals.

Second, in the asset market model the responses of capital flows and the exchange rate to *monetary changes*, and hence to changes in the interest rate differential, are reflected in changes in the private sector's holdings of foreign assets. In a model, labelled the portfolio-loan model, we examined the money supply implications

of the imperfect substitutability between customer-market credit, loans, and auction-market credit, bonds, and the banking system's response to the increased riskiness of credit. In the Australian financial system, Granger-causality evidence on timing relations is suggestive of the importance of asset substitutability for the money supply, and the banking system's response to monetary changes. The evidence, therefore, implies that in the post-deregulation period increased bank lending causes liability transformations that increase the money multipliers for the narrow and broad money supplies. This strongly supports the hypothesis that the rapid growth in the broad money supply in the post-deregulation period occurs largely as a result of factors influencing the supply of loans. The Granger-causality evidence also suggests that Australian banks use the increased supply of reserves in their production of loans, and that this is the major channel for variations in the narrow and broad money supplies. This is consistent with the post-Keynesian structuralist view and the traditional money multiplier approach. Consequently, variation in the quantity of bank loans caused by reserve changes might explain the real impacts of monetary policy.

The portfolio-loan model also focuses on the implication of downward shocks to credit supply stemming from the increased riskiness of loans. In this model the banks' secondary assets, bonds, act as a buffer for unexpected withdrawals of deposits, and for unexpected changes in the riskiness of loans. The Australian post-deregulation experience is suggestive of the importance of credit rationing in the contribution of credit shocks to monetary fluctuations. A necessary condition for credit rationing to exist was that the expected return to banks falls as a result of an increase in the risk of borrowers default. The post-deregulation evidence on the expectations generating process for the banks' return on loans supported this hypothesis. Further, the evidence on disequilibrium modelling of demand and supply of loans revealed a state of predominantly excess demand for loans. These results are consistent with the credit rationing hypothesis, and suggest that Australian banks, in the aggregate, act as though they ration credit by non-price means.

The evidence on the loan rate adjustment mechanism provided support for the proposition that in the post-deregulation period the loan rate adjusts to some rates controlled by banks, and that the controlled loan rates fall when there are instances of excess supply in the loan market. This is consistent with credit rationing, and the fact that the tests based on disequilibrium modelling of the credit market provide further support for the rationing behaviour of Australian banks. These results imply that for many borrowers bank loans have no close substitute, and that variations in the quantity of loans might reflect the real impact on aggregate economic activity of changes in uncertainty arising from a move into recession.

In addition we presented evidence for the proposition that in deregulated short-term security markets credit rationing provides portfolio investors with the ability to adjust to the actual rate of return on their portfolios. This is possible because the loan rate under credit rationing reflects banks' proxies for the expected rate of return and default risk of the average projects in the economy, and in completely deregulated financial markets these proxies conform to the actual rate of return of the average projects. The evidence is certainly consistent with the rational expectations hypothesis, and reveals the fact that while Australian agents are risk neutral and rational in short-term security markets post-deregulation, they were not so in the pre-deregulation period when banks provided short-term funds under the prevalence of regulations. The test results based on the expectations theory of the term structure of interest rates reject any risk premium in the short-term security markets. The existence of such a risk premium in the yield to maturity of longer term (10-year) securities implies that these securities for portfolio investors are less desirable than one-quarter securities, and that short- and long-term securities are imperfect substitutes. Therefore, if policy makers wish to alter long-term rates through their influence on the maturity composition of government debts, they must succeed in altering the risk premium requested by the private lenders in long-term security markets. Changes in the risk premium of long-term securities results in a shift in the relation between the short- and long-term (10-year) interest rates.

Third, the reduced-form evidence on the credit-GDP relationship suggests that credit rationing plays a significant macroeconomic role in the Australian economy. In the reduced-form relation two noteworthy avenues of research relate to the macroeconomic importance of exchange rate overshooting and, of the role of money as a buffer for disequilibria in asset markets. In this section the output effects of monetary changes reflect the fact that in the post-deregulation period the major determinants of exchange rate overshooting, examined in the asset market model, aid prediction of the future behaviour of GDP. The reduced-form evidence also revealed the fact that in the absence of a significant effect of the interest rate on real output the monetary disequilibria plays an important role in the transmission mechanism between the monetary and real sectors. This result is consistent with the buffer stock approach to monetary changes, and the fact that in the Australian monetary sector most changes in nominal money balances are regarded as transitory in the short run.

Turning to credit rationing, the reduced-form evidence indicated that the output effects of increased private investment are less severe, when banks use credit rationing to reduce the increased riskiness of credit associated with the higher levels of aggregate demand relative to its trend values. This result suggests that our understanding of the mechanism by which monetary changes are transmitted to the real sector of the Australian economy can be significantly improved by the consideration of equilibrium rationing in the post-deregulation period. The other reduced form evidence provided support for the proposition that the output effects of monetary shocks are large when a tightening of monetary policy is associated with the credit-rationed state. The evidence on the credit rationing hypothesis in this thesis, therefore, provides a non-monetarist interpretation of the potency of monetary policy in the Australian economy.

As a direction for future research, the work in this thesis could be applied to extend Australian macro models in four major areas as follows:

1) the estimation of a dynamic simulation of the asset market model in order to determine the degree of exchange rate overshooting that results from monetary shocks, and/or from a tightening of monetary policy under credit rationing;

2) the consideration of business borrowing and household borrowing separately in order to examine how the financial sector affects the business cycle; and the identification of areas where credit is more cyclical, and/or subject to rationing;

3) the specification of the term structure of interest rates for other interest rates, such as the rate on banks' certificates of deposits and the rate on call and overnight funds, in order to examine the implication of credit rationing for the impact of other rates on the cost of short-term funds to financial institutions.

4) the evaluation of a tightening of monetary policy under credit rationing, using other financial aggregates and policy variables in the post-deregulation period, such as the rate of change in the Reserve Bank holdings of government bonds and foreign assets, which may reflect more adequately the cyclical response to financial conditions.

The four themes outlined above throw light on the importance of the credit channel, and the effects on aggregate economic activity of monetary shocks under credit rationing. Research on these issues and their implications for monetary policy should provide a better understanding of the monetary transmission mechanism in the Australian economy.

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