CANADIAN CHARTERED BANK RATE-SETTING BEHAVIOUR

A TWO-TIER MODEL OF CANADIAN CHARTERED BANK RATE-SETTING BEHAVIOUR AND THE IMPLICATIONS FOR IDENTIFYING DEMAND FOR LOANS AND DEPOSITS EQUATIONS

By

FRANK OWEN TRIMNELL, B.Sc., M.A.

A Thesis

Submitted to the School of Graduate Studies

in Partial Fulfilment of the Requirements

for the Degree

Doctor of Philosophy

McMaster University

January 1981

DOCTOR OF PHILOSOPHY (1981)
(Economics)

McMASTER UNIVERSITY
Hamilton, Ontario

TITLE: A Two-tier Model of Canadian Chartered Bank Rate-setting Behaviour and the Implications for Identifying Demand for Loans and Deposits Equations

AUTHOR: Frank Owen Trimnell, B.Sc., (University College of Wales, Aberystwyth)

M.A. (McMaster University)

SUPERVISOR: Professor W.M. Scarth

MEMBERS OF SUPERVISORY COMMITTEE: Professors A.L. Robb and M.L. Kliman

NUMBER OF PAGES: xii, 161.

ABSTRACT

In this thesis deposit and loan rate-setting equations for chartered banks are derived on the premise that these rates are set so as to maximize the banking industry's profits. Because of the oligopolistic nature of the Canadian banking industry and because explicit collusion is illegal an optimizing model of chartered bank rate-setting behaviour was integrated into the institutional framework of the Canadian banking industry.

To do this a two-stage model of the Canadian banking industry is proposed. At the first stage, the prime rate on loans and the rate on non-chequing personal savings deposits are set so as to maximize the collective profits of the industry. To circumvent the illegality of explicit collusion a price leadership model is developed. In this model it is not one of the individual banks which is a price leader, but rather changes in the bank rate act as a signal for all of the individual banks to change their rates. The formulation proposed was tested and the hypothesis accepted for both rates. The second stage of the two-stage model is concerned with asset and liability management and is not developed in this thesis.

A second contribution of this thesis is to take into account chartered bank rate-setting behaviour when estimating demand equations for both business loans and non-chequing personal savings deposits. When the estimation procedure used reflects these problems it is found that there are large changes in the values of the estimated coefficients in the demand functions for loans and deposits, compared to the simple O.L.S. estimates of the parameter values.

ACKNOWLEDGEMENTS

When writing a thesis one can be overcome by a great sense of physical and mental burden. One of the last of these 'burdens' is to compile a list of acknowledgements. The reason for this seems to be to remind oneself that this burden was shared by many other people.

My greatest debts are completely personal. To my parents who instilled into me a great sense of perseverance. To Tony McGuinness who set a great example. To Deb Bye and Holly Trimnell, who provided the ultimate inducement to finish the thesis so I could spend time with them. To Daisy Owen, May Godley and Jean Trimnell who shared the burden but not the rewards.

A second set of debts has an academic orientation. My thesis committee, Bill Scarth, Les Robb and Mel Kliman, offered me varied and stimulating criticisms over a long period of time, the benefits of which extended far beyond the thesis. Many people at the Bank of Canada were very helpful with respect to providing data, especially Maggie Lapointe, Jamie Connelly, Robert Lussier, Paul Masson and Kevin Clinton, and I would also like to thank Bill White for taking the time to see whether my work overlapped with his.

A third set of debts goes to the performing of those ancillary functions without which any thesis would not be complete. To Claire Seddon for doing an excellent typing job, to Maureen Farrell for computer assistance and to McMaster University and Ontario Hydro for financial support.

Finally, no matter what time or effort is put into a task, perfection is hard to come by and responsibility for any remaining errors must remain with the author.

TABLE OF CONTENTS

LIST OF DIAGRAMS

LIST OF TABLES

CHAPTER 1 -- INTRODUCTION

Chartered banks play a central role in the financial sector of the Canadian economy. This role stems not only from the large size of chartered bank assets and liabilities but also from the importance of these assets and liabilities in the economy as a whole. Banks, for example, are a major source of credit to most types of borrowers. Chartered banks play a key role in helping all types of businesses meet their financial requirements and they are now the largest institutional holders of consumer credit. Since a considerable proportion of both consumption and investment expenditure is deficit financed, banks have an important direct effect on the real sector of the economy. The largest item on the liability side of the banks' balance sheet is deposits. These bank deposits make up the largest part of money even if the narrowest definition of money is chosen, this proportion remaining high for alternative definitions. Banks, therefore, are very important with respect to providing the economy with an efficient medium of exchange and store of value. For these reasons alone, a thorough knowledge of all aspects of chartered bank behaviour is desirable.

Unfortunately a very important part of chartered bank behaviour, the setting of rates on deposits and loans, has been relatively neglected in the literature. These rates are very important variables, both to banks and to the economy as a whole. Their importance to banks stems from the fact that interest payments on deposits constitute about two-thirds of the costs of banking, while interest income from loans accounts for about three-quarters of bank revenue. These costs and revenues will vary with the interest rates charged on loans and offered on deposits. In fact if, as is generally assumed, the quantities of loans and deposits are customer determined, then changing these rates is the major way banks can affect their profits.

The importance of the rates on deposits and loans in the economy in general can be seen most clearly by looking at the objectives and instruments of monetary policy. The ultimate objective of monetary policy is to influence the real variables in the economy and there are several ways this can be done, although there is no unanimity on either the absolute or relative effectiveness of any of the alternatives.

A great deal of consumption and investment expenditure is deficit financed, so that one obvious way to influence real variables is to affect the availability or terms of credit. In Canada the monetary authorities have had a dual thrust in this regard, attempting to affect both the availability of credit, by moral suasion and other means, and the cost of credit, which they influence via the prime rate on loans.[1] Thus when the Bank of Canada sells securities to chartered banks it reduces their liquid assets making them less able to make loans. Eventually either the interest rate on loans has to be increased to lessen loan demand or credit has to be rationed. The simultaneous rapid increase in credit, especially bank loans, interest rates and the rate of inflation in recent years has led to a great deal of discussion about the relationships between these three variables. An adequate explanation of chartered bank behaviour, with respect to making loans and setting the rates on them, will be necessary before this debate can be fully resolved.

More recently the Bank of Canada has followed a monetarist course and has tried directly to control the rate of growth of the money supply in the economy, reversing its previous policy of trying to influence interest rates

---

[1] See, for example, Courchene (1976a).

directly.[2] Interest rates are still important, however, for two reasons. First, they will be affected indirectly and they will then influence the real sectors of the economy. Secondly, the quantity of deposits and thus the total money supply can be expected to vary with the rate on deposits. In accepting this major policy recommendation of monetarist economists, the Bank also accepted the analysis which underlies their policy recommendations. Of primary importance is the existence of a stable demand function for money. For policy purposes it must be possible to estimate this function accurately and in particular the role of non-controllable variables, such as bank interest rates, in this function. Therefore chartered bank behaviour with respect to setting the rate on deposits is also important from the practical policy viewpoint.

It is possible to show that the neglect of chartered bank rate-setting behaviour causes some analytical problems. The basic problem is that the estimates of deposit and loan demand functions are biased and that the monetary authorities will make wrong decisions with respect to the "appropriate" interest rate that can be expected to generate the

---

[2]Bank of Canada, Annual Report of the Governor to the Ministry of Finance (1975).

desired money supply growth targets if these biased functions are thought to be the true representation of the relationship between the demand for money and the rate of interest. A discussion as to how such biases can arise now follows.

The Market for Bank Deposits

Since the Bank of Canada has adopted a monetarist stance, the monetarist view of the demand and supply of money, and the relation of chartered bank rate-setting behaviour to this view, are of great interest. The basic assumption which underlies the monetarists' thinking is that there exists a stable demand function for money which has relatively few determinants, usually just income and the rate of interest. Much work has been done on the stability of this function, including some work in Canada.[3]

However, if the demand for money is positively related to the rate offered on chartered bank deposits, as would be expected, and chartered bank rate-setting behaviour is not taken into account, problems arise in any attempt at

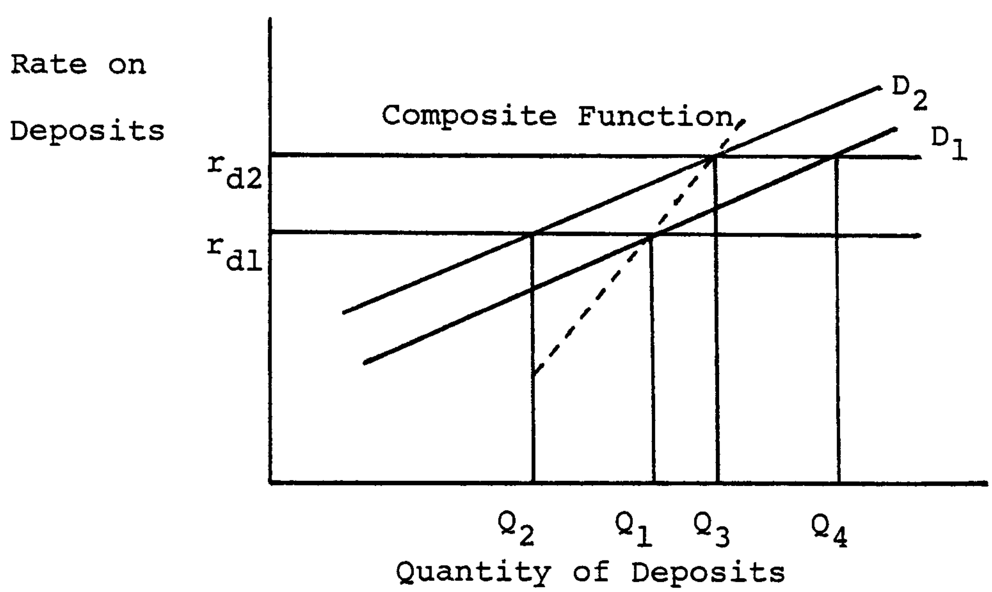
---

[3]See, for example, White (1976b), Foot (1977), and Cameron (1979).

estimation. So far, it appears that these problems have been ignored. As will be seen, the solution to these problems is in fact logically prior to determining the stability of the demand for money function.

It is generally assumed that banks are willing to accept any quantity of deposits demanded at the going interest rate. However, only in the case where the demand for deposits is not sensitive to the actions of near banks and other competitors will estimation of the demand for deposits equation lead to unbiased results without taking into account chartered bank rate-setting behaviour. The problems which can arise through ignoring the supply side of this market can be illustrated using the following diagram.

Figure 1
The Market for Bank Deposits



If, by way of example, trust companies increase the rate they offer on deposits then the demand curve for bank deposits will shift from D_1, say, to D_2. The quantity of bank deposits demanded will thus fall from Q_1 to Q_2. However, if banks immediately follow this move and increase the rate they offer on their deposits from r_{d1} to r_{d2} then the quantity of bank deposits will simultaneously shift from Q_2 to Q_3. In this situation it would be impossible to identify the true demand curve since only one point has been observed on each curve. Joining these points one obtains the composite function. Therefore, estimating the demand for deposits function without taking into account the rate-setting behaviour of chartered banks would not produce the true estimates of the coefficients in the demand function.

This may cause the monetary authorities to err in their chosen target rate of growth of the money supply as a consequence. For example, if the monetary authorities wanted to achieve a higher level of the money supply, say Q_3, they would try to induce a rate on deposits of r_{d2} if they relied on perceived composite function. In a given instance suppose that trust company rates remain unchanged. Then D_1 is the true demand curve and the level of deposits induced by the rate of r_{d2} would be Q_4, a level which is higher than was desired. Taking into account the effect of trust company deposit rates on bank deposits would not fully solve the problem because it would not take into account the effect of trust company deposit rates on bank deposit rates. This factor also affects the slope of the composite function. Additional information must, therefore, be available to monetary authorities so that unbiased estimates of the true demand function can be obtained and monetary policy can be pursued in a sensible manner.

The Market for Bank Loans

This same problem also arises when bank loan rate-setting behaviour is ignored. In econometric models of the chartered bank loan market it has often been assumed that banks are willing to make any quantity of loans demanded at the going rate.[4,5]

The supply side of the loan market is graphically represented by a horizontal line at the going rate. The demand side of the loan market has received a great deal of attention while the supply side has been relatively neglected. The problems which can arise through ignoring the supply side of the market are illustrated below.

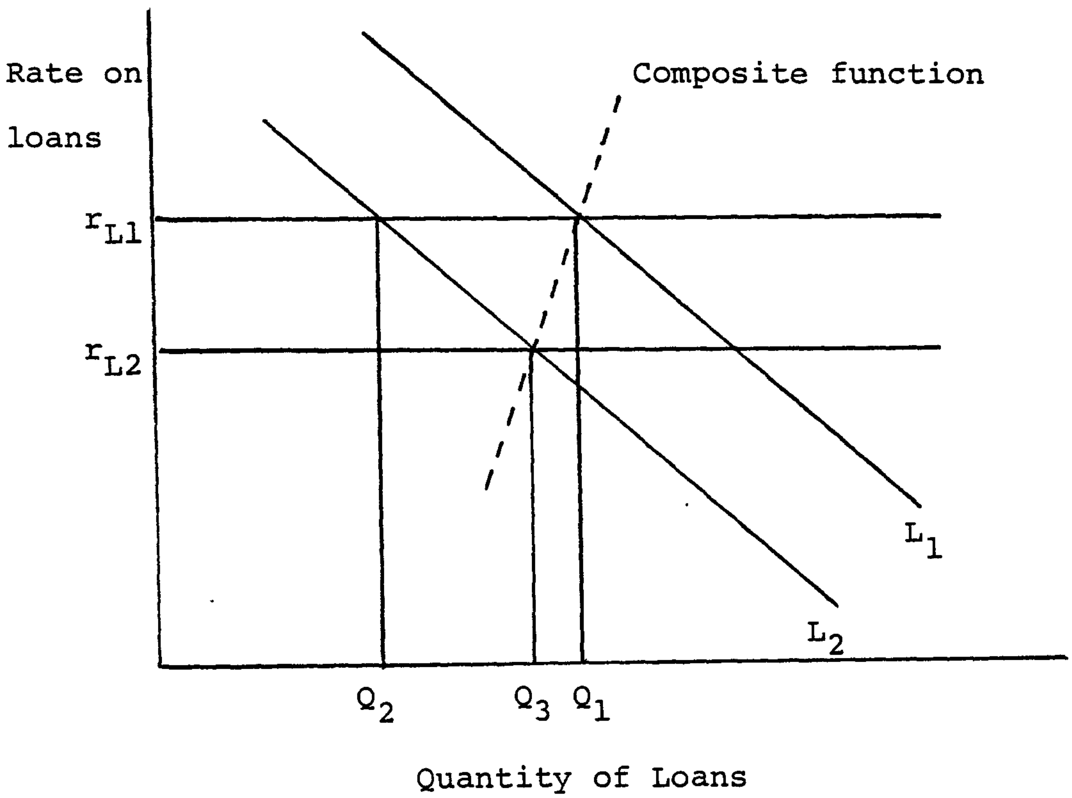
---

[4]See, for example, Shapiro (1964) and Miles (1968).

[5]This analysis assumes that there is no credit rationing and customers are, therefore, on their demand curve.

Figure 2

The Market for Bank Loans



If finance companies decrease the rate they charge on loans then the demand curve for bank loans will shift from L_1 to L_2 and the quantity of loans demanded will fall from Q_1 to Q_2. However, if banks immediately follow this move by reducing the rate they charge on loans from r_{L1} to r_{L2} then the quantity of loans demanded will simultaneously increase from Q_2 to Q_3. In this situation it would be impossible to identify the true demand curve since only one point would be observed on each curve. The effects of banks' and finance companies' actions cannot be separated and estimates of the partial responses of the demanders for bank loans to changes in the loan rates cannot be determined. Again, accurate measures of these partial effects are necessary if monetary policy is to be fully effective.

The objectives of this thesis are motivated in part by the above observation. These objectives are: (1) to develop a model of the rate-setting behaviour of chartered banks and (2) to use this model to evaluate the importance of the identification problems just outlined in the estimation of demand equations for deposits and loans. The analysis will be carried out as follows. Chapter Two provides background information on the Canadian banking system and surveys the literature with respect to this system and with respect to chartered bank interest rate-setting behaviour. The first section of Chapter Two contains a brief description of the major assets and liabilities of chartered banks. A fuller description of the balance sheet for the period 1968 to 1977 is given in the appendix to Chapter Two. This appendix serves to show the importance of deposits and loans in banks' balance sheets. The second section of Chapter Two contains a survey of the literature on Canadian chartered banks. In particular, it is shown how the rate-setting behaviour of chartered banks has been neglected.

In Chapter Three an optimizing model of chartered banks' rate-setting behaviour is outlined and the applicability of the model defended. The model takes into account the oligopolistic nature of the banking industry. It is a two-tier model, with the rates on deposits and loans being set at the industry level so as to maximize an industry objective. The problems presented by the oligopolistic nature of the industry (combined with the illegality of explicit collusion in setting these rates) with respect to achieving this objective are discussed and plausible hypotheses to accommodate these problems are suggested. The second tier of the model then concerns individual banks' asset and liability management, although this is not developed in detail in this thesis.[6] Next the model of rate-setting behaviour is developed more fully. The desired rates are those which would be set so as to maximize the banking industry's profits. But since the banking industry is oligopolistic in nature and explicit collusion is illegal, these desired rates are not attainable all of the time. Instead banks are assumed to partially adjust towards the desired rates, the speed of adjustment depending on changes

---

[6]Liability management refers to the behaviour of banks with respect to setting the rate on very interest-sensitive, short-term and large corporate deposits.

in the bank rate which act as signals for price change in the industry. A formal method of incorporating this partial adjustment behaviour is developed in this chapter.

In chapter Four the deposit and loan rate equations derived in Chapter Three are estimated. Various facets of the theory as outlined there are tested to help assess its overall validity.

In Chapter Five the estimated rate equations are then used to see if econometric identification is a major problem when estimating deposit and loan demand equations. Deposit and loan demand equations are estimated first not taking into account chartered bank rate-setting behaviour, as is usually done, and then secondly taking into account this behaviour, using the theoretical rate-setting equations developed. The results are then compared to see how important it is to consider chartered bank rate-setting behaviour when estimating deposit and loan demand equations.

In Chapter Six the major results of the previous chapters are summarized and their importance with respect to the carrying out of monetary policy determined. The major conclusions of the thesis are then reviewed followed by an outline of how the theory and empirical work could be extended and improved.

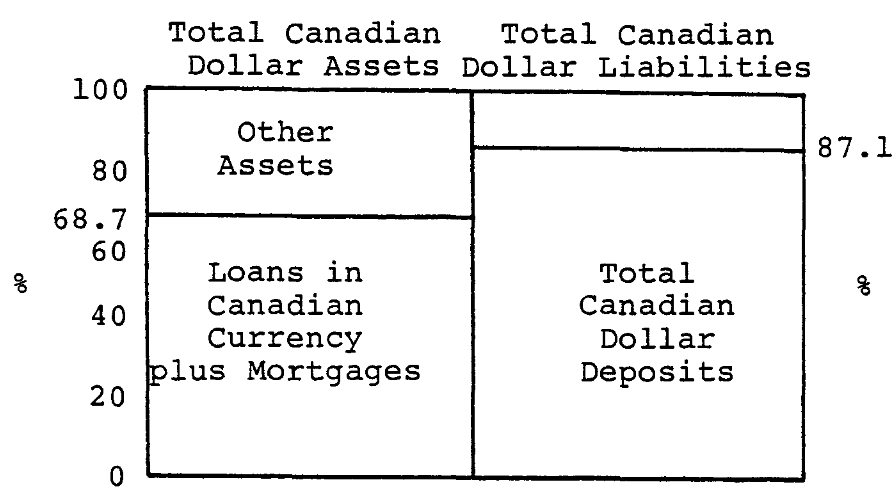
CHAPTER 2 -- CHARTERED BANKS IN CANADA: A DESCRIPTION OF THE BALANCE SHEET AND SURVEY OF THE LITERATURE

The Balance Sheet of Chartered Banks

The balance sheet of chartered banks can be divided into three major categories - deposits on the liability side and loans and other assets, primarily securities, on the assets side. The relationship of these three items to total Canadian dollar assets can be seen from the following chart.

Figure 3

Percentage distribution of Canadian assets and liabilities, December 1977



Source: Bank of Canada review, 1978.

A fuller description of chartered bank assets and liabilities can be found in the Appendix to this chapter. From Figure 3, however, one can see the relative importance of deposits, loans and other assets. As is discussed in the next section, both deposits and loans are generally assumed to be demand determined. This being the case, the only way banks can affect costs and revenues associated with the two largest items in the balance sheet is by changing the interest rates on them. The determination of these interest rates must, therefore, be an important part of the business of banking. However, this aspect of banking behaviour has been neglected in the literature. Most of the attention has been paid to asset management, or how banks allocate funds which have not been loaned out on different securities. Given the relative importance of the category 'Other Assets' in the bank's balance sheet, this emphasis seems to be somewhat misplaced.

Chartered banks have been the subject of a voluminous amount of work. I concentrate here on studies dealing with the Canadian banking system at a general level and only at the end of the survey do I consider other studies which deal specifically with chartered bank rate-setting behaviour.

Studies of the Canadian Banking System

In 1964, Shapiro[1] developed a quarterly econometric model of the Canadian monetary sector, the main purpose of which was to explain the determination of the money supply. Banks were assumed to be willing to accept any quantity of deposits demanded at the going rate and demand equations for both demand deposits and personal savings deposits were estimated. The demand deposits and personal savings deposits equations were both estimated by ordinary least squares (O.L.S.). How the rate on personal savings deposits is set was not analysed. Shapiro was also concerned with explaining the amounts of banks' major asset, loans. Banks were assumed to be willing to make any quantity of business loans demanded at the going rate, subject to the condition that total business loans demanded was less than total authorizations. Shapiro estimated a demand for business loans equation by O.L.S. and also two equations representing the supply side of the market, total authorizations and the prime rate. Neither of these equations was explicitly derived from an optimizing theory. Total authorizations were posited to be a function of

---

[1]Shapiro (1964)

the prime rate, the rate of return on a competing asset, long term bonds, the level of bank reserves and the difference between total authorizations and total business loans, lagged one period. The prime rate was posited to be a function of the difference between total authorizations and total business loans demanded, the rate of return on a competing asset and the lagged dependent variable.

Miles[2] was concerned with the theoretical underpinnings and empirical estimation of a model of the Canadian chartered banking industry. On the liability side, Miles assumed banks were willing to accept any quantity of deposits demanded at the going rate and estimated demand equations for demand deposits, personal savings deposits and non-personal term and notice deposits, all by O.L.S. With respect to the supply side of the deposit market, Miles did not estimate an equation for the rate on personal savings deposits because, he argued, it is an administered rate, although he did estimate an equation for the rate on non-personal term and notice deposits. This rate was postulated to be a function of the rate on a competitive financial

---

[2]Miles (1968).

instrument, either treasury bills or finance company paper, and the rate of return currently available on banks' asset portfolios, represented either by the prime rate or the ratio of earning liquid assets to total bank assets.

Being concerned solely with banks, Miles paid much more attention to their assets than did Shapiro. He explored the effects of banks' asset holdings of the peculiar nature of cash reserve requirements - the fact that, for any given averaging period, the amount of excess primary reserves held by the banking industry cannot be controlled by the banks themselves. Miles estimated an equation for earning liquid assets and included in this category Canada bonds, treasury bills, call and day loans and net foreign assets. As far as loans were concerned, exactly the same model was used as in Shapiro's thesis.

Kirkham[3] explored the portfolio behaviour of selected financial intermediaries, one group of which was chartered banks. His primary concern was with the determination of banks' holding of securities. He assumed that there was a hierarchy of bank assets,

---

[3]Kirkham (1970)

banks automatically making any loans demanded, subject to the condition that total loans demanded is less than or equal to total authorizations. An equation explaining the demand for total loans was estimated by O.L.S. and an equation explaining the prime rate on loans was estimated. The determinants of the prime rate were very similar to those used by Shapiro and again the equation was not derived from any kind of optimizing theory. The prime rate was posited to be a function of the rate of return on a competing asset, long term bonds, the bank rate, the ratio of the difference between total authorizations and total business loans to total assets lagged one period, the ratio of total loans to total assets lagged one period and the prime rate itself lagged one period. Given the remainder of total assets, it was hypothesized that banks have a desired proportion of that total which they wish to hold in the form of a particular asset, this proportion being determined by standard portfolio theory. The actual proportion held in any period then is determined in a partial adjustment framework. A demand equation was thus estimated for each security as a ratio of total liquid assets. Kirkham did estimate an equation explaining the rate on personal savings deposits. This rate was posited to be a function of competing rates (trust and loan company chequing deposit and term deposit rates), the prime rate, the ratio of total deposits to total assets and the lagged rate on personal savings deposits.

Of the several large-scale econometric models of the Canadian economy that do exist, only the Bank of Canada's model, RDX[4], has paid a significant amount of attention to the financial sector. This model is very large by any standards: the RDX2 version of the model[5] has 258 endogenous variables, 72 of which, or 28 percent of the total, are in the financial sector. Equations explaining the public's demand for nine categories of liquid assets as a proportion of total liquid assets were derived from a framework developed by Tobin and Brainard.[6] Constrained estimation techniques were used to preserve the identity that the sum of the ratios should equal unity. Included in these nine categories were four different types of bank deposits - personal savings and personal chequing, demand, swap and non-personal term and notice. As far as the supply sides

---

[4]Helliwell, et al. (1969).

[5]Helliwell, et al. (1971) and Maxwell, Helliwell and Aubry (1976).

[6]Brainard and Tobin (1968).

of the deposits markets are concerned, equations explaining the rate on non-personal term and notice deposits and the rate on swapped deposits were estimated. The rate on non-personal term and notice deposits was postulated to be a function of the average yeild on one to three year government bonds while the rate on swapped deposits was tied to the covered Euro-dollar rate. Separate equations explaining chartered bank personal loans and general loans were estimated by O.L.S. These are not pure demand equations since they do contain one variable which represents the supply side of the market. It is assumed that supply is a function of a measure of credit availability which is based on bank liquidity. This measure is basically the difference between the current ratio and the long term ratio of chartered bank earning liquid assets, less required secondary reserves, to total assets.

Dingle, Sparks and Walker[7] were concerned with the response of chartered banks to monetary policy when it is transmitted to them via the daily management of the supply of excess cash reserves by the central bank. The approach of these authors differs from the preceding

---

[7] Dingle, Sparks and Walker (1972).

ones in that it is more theoretical in nature. They considered bank behaviour with respect to three broad classes of assets - excess cash, earning liquid assets[8] and less liquid assets. An individual bank is assumed to manage its cash position during the averaging period so as to end on the final day with a buffer intended to allow for any adverse clearing. There is an optimal level of this buffer since if it is too low, the banks will be forced to borrow from the Bank of Canada at an adverse rate and if it is too high, there is an opportunity cost involved in not investing in earning liquid assets. Therefore they use a stochastic reserve loss model to explain banks' holdings of excess cash reserves. If banks run short of cash, they will liquidate treasury bills of day-to-day loans first and then other earning liquid assets. As banks liquidate longer term bonds, they reach a threshold where they have to liquidate loans. Up to this point, loans are assumed to be demand determined. At this point banks must begin rationing credit, although it is not discussed

---

[8]Dingle, Sparks and Walker include in their definition of earning liquid assets; day-to-day loans, treasury bills, call loans, Government of Canada bonds with less than three years to maturity and net foreign assets.

whether such rationing would occur by price or non-price means. Dingle, Sparks and Walker estimated equations to explain both business loans and personal loans. Business loans were postulated to be primarily demand determined, the major explanatory variables being past and expected expenditure flows, the current disposable revenue of borrowers and expectations with respect to future monetary policy. A supply constraint, represented by a distributed lag on current and past values of an earning liquid asset ratio, was also entered in the equation. The change in personal loans was postulated to be determined by an expenditure variable and a supply constraint variable. No rate equations were estimated.

This general model of chartered bank asset management developed by Dingle, Sparks and Walker has been tested more recently by White and Poloz.[9] Attention is focussed on individual banks' portfolio adjustment items, principally liquid assets and wholesale deposits and the effectiveness of monetary policy in effecting desired interest rate levels resulting from the purchase and sale of adjustment items. The main

---

[9] White and Poloz (1980).

concern here is the day-to-day cash management of chartered banks and thus the only interest rates of concern are those on very short-term wholesale deposits. Equations for these rates are not estimated.

In addition to these studies of the chartered banks, there are a few recent studies, primarily from the Bank of Canada, dealing with particular aspects of banking. These include Freedman,[10] who was concerned solely with the foreign currency business of Canadian banks. He assumed that banks are willing to accept any quantity of foreign currency deposits demanded at the going rate. Interest rates offered by banks are set on the basis of rates obtainable by investors on competing financial instruments and the rates banks can earn on assets in which they invest. Foreign currency loans are primarily a function of borrowers demands for funds.

White[11] has recently completed a very extensive study dealing with chartered bank asset management. Banks' assets, other than loans, are disaggregated to a very high degree and explanatory equations estimated

---

[10] Freedman (1974).

[11] White (1975a).

for them. Since it is concerned solely with asset management, though, White's study does not deal with rate-setting behaviour or the determination of the quantities of deposits and loans. In a more recent study White[12] looks at several different definitions of the money supply, each of which includes some bank liabilities. The major thrust of this work is in regard to the relative stability of an equation explaining the money supply defined in a narrow sense, that is, currency plus chequing accounts, versus an equation explaining the money supply defined in a broader sense, that is, including savings deposits also. Equations are, in general, estimated by O.L.S., although White does consider the impact of simultaneous equation bias in the equation explaining the narrow money supply. For both theoretical and empirical reasons he believes there is no reason to use anything but O.L.S. when doing empirical work. The theoretical reason is that simultaneous equation bias would only occur if monetary aggregates were the immediate target variable rather than short-term interest rates, thus making movements in the error term of the equation and in the contemporaneous explanatory interest rates statistically dependent. The empirical reason is

---

[12] White (1975b)

that more sophisticated estimation techniques make little difference to the results. However, it should be noted that the narrow definition of money does not include any interest-bearing bank deposits, and it has been noted here that this aspect of those deposits can lead to problems of simultaneity. When looking at wider definitions of the demand for money this aspect of the simultaneity problem should be considered also. A further aspect of the simultaneity problem is that between money demand and income. This has been the subject of a recent study by Poloz.[13]

Studies of the interest rate-setting behaviour of financial intermediaries

There is apparently only one Canadian study that attempts to develop a theoretical model of financial intermediary interest-rate-setting behaviour. In this study, Clinton and Masson[14] develop a model along the following lines. Assuming the financial intermediary faces a demand for deposits function of the following form:

---

[13]Poloz (1979).

[14]Clinton and Masson (1975).

$$D = D(r_d, r_c) + u, \tag{2-1}$$

where D is deposits,

r_d is the rate on deposits,

r_c is the rate on competitive deposits, and

u is a stochastic error term,

and assuming also that the financial intermediary receives a rate of return on its assets, r, determined by the market, then the intermediary may select the interest rate r_d which maximizes its profits, Π,

$$\Pi = (r - r_d)\ D \tag{2-2}$$

In this model there is only one asset, only one liability, no reserve requirements and, of course, the balance sheet identity must hold.

If an interior solution is assumed to exist , the necessary and sufficient conditions for profits to be maximized are:

$$\frac{\partial \Pi}{\partial r_d} = (r - r_d)\ \frac{\partial D}{\partial r_d} - D = 0 \tag{2-3}$$

and

$$\frac{\partial^2 \Pi}{\partial r_d^2} = (r - r_d)\ \frac{\partial^2 D}{\partial r_d^2} - 2\frac{\partial D}{\partial r_d} > 0 \tag{2-4}$$

Solving the first order condition for the optimal deposit rate r_d^*, one obtains

$$r_d^* = \frac{(r - D)}{(\partial D/\partial r_d)} \qquad (2\text{-}5)$$

However, this theory is not applied to banks because the banking system holds a large percentage of outstanding marketable Government of Canada debt. It may be unreasonable to assume, therefore, that r is exogenously determined by the market. Thus, when specifying an equation to explain the rate on chartered bank non-chequing savings deposits, it is simply assumed that this rate is a function of the prime rate, which represents the yield on the major earning asset of banks. No rate on assets competing with personal savings deposits is included because Clinton and Masson feel banks have no real competitors. Clinton and Masson also estimate an equation to explain the rate on non-personal term and notice deposits similar to the savings deposit rate. This rate is postulated to be related to variables that reflect the liquidity management aspects of the rate. The prime rate is included because this is the yield on banks' major earning asset. The day loan rate is included because this asset is used to make adjustments at the margin. The covered U.S. treasury bill rate captures the influence of foreign competition in the short-term market and finally, a liquidity variable is included to reflect intensity of banks' competition for non-personal term and notice deposits.

The quantities of deposits are assumed to be demand determined. Equations for demand, personal savings and non-personal term and notice deposits are derived from a Tobin-Brainard Framework and estimated by ordinary least squares. As far as the loan market is concerned, demand functions, which include one supply factor, are estimated for business and miscellaneous general loans and personal loans, also by ordinary least squares. An equation explaining the prime rate is also estimated, this rate assumed to be a function of the U.S. prime rate, the bank rate, and a bank liquidity variable.

Clinton and Masson's study is the only Canadian work in which an attempt is made to develop an optimizing model of liability rate-setting in Canadian financial intermediaries. Other studies which touch upon this rate-setting behaviour do not involve attempts to specify theoretical foundations for the estimated equations. Outside of Canada, there have been a few studies which involve optimizing models of rate-setting behaviour although, as with the Clinton and Masson study, these are concerned with financial intermediaries in general, as opposed to chartered banks specifically. One of the earlier of these studies was by Gramlich and Hulett[15] who formulated a theory of interest rate determination based on standard portfolio balance theory. We outline here the nature of their model.

Gramlich and Hulett developed estimating equations for financial intermediary supplies directly from portfolio balance principles. Deposit institutions, in determining their own portfolio behaviour, gain utility from their expected income and lose utility from uncertainty about this income. The institution is assumed to maximize expected utility, which is a function of expected returns and their variance.

The financial intermediary holds two earning assets, mortgages (M) and bonds (B). Its profits (Π) thus are equal to

$$\Pi = r_m M + r_b B - r_d D, \quad \text{where} \tag{2-6}$$

r_m is the mortgage rate

M is the quantity of mortgages

---

[15] Gramlich and Hulett (1972).

r_b is the bond rate

B is the quantity of bonds

r_d is the deposit rate and

D_1 is the quantity of deposits.

The intermediary is assumed to hold a constant proportion $(1 - \alpha)$ of deposits in liquid form, so the balance sheet constraint can be written as

$$M + B = \alpha D \tag{2-7}$$

Assume the institution has a subjective view of interest rate elasticities and cross elasticities embodied in a demand function for deposits. This will constrain its behaviour with respect to maximizing profits. It is assumed that this demand function takes the following form

$$D = b_{11}r_d + b_{12}r_2 + \ldots + b_{1n}r_n + b_{1m} + u_1, \tag{2-8}$$

where r_d is the own-rate on deposits, and r_2 to r_n are competing rates. The influence of net worth and all non-interest rate variables are embodied in the constant and residual.

The general objective function assumed to be maximized is

$$G = r'A - K\,A'\,S\,A + \lambda(1 - i'A) \tag{2-9}$$

where r' is a 1 x n row vector of the expected rates of return on the n assets, A is an n x 1 column vector of the n assets, each divided by unclaimed net worth, K is a constant measuring the household's aversion to risk,[16] S is an n x n variance covariance matrix of the expected rates of return, λ is a scalar and i' is a 1 x n row vector of 1's. Substituting the three equations (2-6) to (2-8) into (2-9) one obtains

$$G = (r_m \; r_b - D)\{M \; B \; r_d\} - K(M \; B \; r_d) \; S_g\{M \; B \; r_d\} - \lambda[M + B - \alpha(b_{11}r_d + b_{12}r_2 + \dots + b_{1n}r_n + b_{1m} + u_1)] \tag{2-10}$$

where { } denotes a column vector and

$$S_g = \begin{bmatrix} S_{MM} & S_{MB} & S_{MU} \\ S_{BM} & S_{BB} & S_{BU} \\ S_{UM} & S_{UB} & S_{UU} \end{bmatrix}$$

Differentiating equation (2-10) with respect to M, B and r_d and solving for r_d, one obtains

---

[16] Let the utility of the return on net worth (Y) be given by the function $U(Y) = 1 - e^{-aY}$, then $K = a/2$.

$$r_d = a_{11}r_m + a_{12}r_b - a_{13}(b_{12}r_2 + \dots + b_{1n}r_n)$$
$$+ a_{14} - a_{13}b_{1m} + v_1 - a_{13}u_1' \qquad (2\text{-}11)$$

Deposit rates depend positively on both asset rates, positively on the rates on all assets which compete with these deposits in the household demand function and negatively on all other factors which increase deposits. Rather than include all the competing rates r_2 to r_n in the estimating equation, Gramlich and Hulett use the coefficients b_{12} to b_{1n} estimated in the demand function to form a competing rate variable and reduce problems with multicollinearity.

Slovin and Sushka[17] investigated whether different objective functions would have an important effect on derived savings deposit interest rate equations. The different objective functions chosen were profit maximization, deposit maximization subject to a minimum return on net worth and utility maximization, where utility is a function of profits and the quantity of deposits. Whereas the deposit maximization model differs substantially from the profit maximization model in its

---

[17] Slovin and Sushka (1975).

empirical implications the utility maximization model displays comparative statics properties that are similar to those of the profit maximization model. On testing the different hypotheses, Slovin and Sushka were led to conclude that the model of deposit maximization was inappropriate. Since the properties of the profit maximization and utility maximization models were similar, it did not seem to matter which was chosen. They chose the profit maximization version to derive an equation for the savings deposit rate at commercial banks and this was postulated to be a function of the treasury bill rate, a weighted average competing rate, a weighted average bank asset rate, the Federal Reserve discount rate, changes in the Regulation Q ceiling rate and the difference between the quantities of deposits and loans.

Conclusions

It can be concluded that, in general, studies of the Canadian banking system have ignored the rate-setting behaviour of chartered banks. Equations used to explain chartered bank rates are of an *ad hoc* nature, rather than being based on an optimizing theoretical framework. Further, the theoretical models of rate-setting behaviour which have been developed have in general been applied to financial institutions other than banks. As noted at the beginning of the chapter, loans and deposits make up very large proportions of banks' Canadian dollar assets and liabilities respectively, so the rates on them will have a large effect on the profits of banks, as well as on monetary aggregates, which are of vital importance to the economy in general. It would seem, therefore, that it would be useful to develop an optimizing model of chartered bank rate-setting behaviour and to apply this to the particular case of Canadian chartered banks.

APPENDIX TO CHAPTER TWO -- THE BALANCE SHEET OF CHARTERED BANKS

This appendix contains a description of chartered bank assets and liabilities for the data period used in this study, 1968 to 1977. In particular it is designed to draw attention to the predominance of deposits and loans in banks' balance sheets.[1]

Canadian Dollar Liabilities

Total Canadian dollar liabilities increased fairly steadily over the whole period 1968-1977 (except for a slight levelling off in the last half of 1969 and the first half of 1970) from approximately $25b in the first quarter of 1968 to almost $100b in the last quarter of 1977.

Canadian Dollar Deposits

Total Canadian dollar deposits over the period under consideration made up eighty-six to ninety percent of total liabilities. Although total Canadian dollar deposits increased at a fairly steady rate, its various components as percentages of the total were by no means steady. Personal

---

[1] The data contained in this appendix are drawn from various issues of the Bank of Canada review.

savings deposits (notice deposits which are held by individuals as opposed to business or governments) make up the largest proportion of Canadian dollar deposits and this proportion has shown somewhat cyclical behaviour in the period under consideration. In the first quarter of 1968 almost fifty-four percent of total Canadian dollar deposits were personal savings deposits, this proportion rising to a peak of almost fifty-nine percent in the first quarter of 1970, falling to a low of just over fifty percent in the last quarter of 1972, increasing again to fifty-seven percent in the third quarter of 1974 and again falling to forty-two percent in the last quarter of 1977.

The next largest category of Canadian dollar deposits is public demand deposits. The majority of public demand deposits is made up of current accounts, although personal chequing deposits are also included in this category. These deposits are payable on demand, having chequing privileges, but they do not earn any interest.[2] In the first quarter of 1968, public demand deposits made up almost twenty-five percent of total Canadian dollar deposits,

---

[2]A low rate of interest may be paid on the minimum monthly balance of Provincial and Municipal accounts.

this proportion falling to seventeen percent in the last quarter of 1977. There is a marked seasonal variation in this proportion also.

The third largest category of Canadian dollar deposits is other notice deposits, which is made up primarily of non-personal term and notice deposits. Other notice deposits accounted for fifteen percent of total Canadian dollar deposits in the first quarter of 1968, this proportion increasing to approximately twenty-four percent in the last quarter of 1977. This was by no means a steady increase, but rather was marked by cyclical variation.

There are three other kinds of deposits and these make up relatively small proportions of total Canadian dollar deposits. These deposits, as a proportion of total deposits, have varied from a low of three and a half percent in the third quarter of 1970 to a high of nine percent in the first quarter of 1976. Provincial Government deposits made up almost two percent of total Canadian dollar deposits in the first quarter of 1968, this proportion falling to one and one-half of one percent in the last quarter of 1977, although this was by no means a steady decline. The category of other bank deposits is made up primarily of the deposits of foreign banks, less than twenty percent being deposits of other Canadian chartered banks. These deposits are used in the clearing of cheques. Over the period 1968 to 1977, other bank deposits made up between one and two percent of total Canadian dollar deposits, this proportion increasing to a peak of two percent in the first quarter of 1976. The final category of deposits is Government of Canada deposits. In the first and last quarters of the years under consideration these made up approximately four to five percent of total Canadian doposits, this proportion falling somewhat in the middle quarters.

Personal Savings Deposits

There are three kinds of personal savings deposits - chequing, non-chequing and fixed term. Chequing personal savings deposits are deposits which have some characteristics of both pure chequing and pure savings deposits. They pay a small amount of interest, although less than that paid on pure savings accounts, and they have chequing privileges, although service charges are higher than on pure chequing accounts. In the first quarter of 1968 chequing personal savings deposits accounted for sixty-two percent of total personal savings deposits, this proportion declining fairly steadily to fifteen percent in the last quarter of 1977. In the first quarter of 1968, non-chequing personal savings deposits accounted for twenty-six percent of total personal savings deposits, this proportion increasing steadily to a peak of forty-five percent in the third quarter of 1971 and then falling to thirty-six percent in the third quarter of 1974 and rising again to fourty-eight percent in the last quarter of 1978. Fixed-term personal savings deposits pay higher interest rates than pure savings deposits in return for minimum amounts of funds being deposited for fixed lengths of time. This type of deposit has increased from twelve percent of total personal savings deposits in the first quarter of 1968 to thirty-six percent in the last quarter of 1977.

Other Notice Deposits

As was noted earlier, the major component of other notice deposits is non-personal term and notice deposits. There are four kinds of non-personal term and notice deposits - chequing, non-chequing, notice bearer term note and fixed term. Fixed term deposits make up by far the largest proportion of the total, over seventy-six percent both in the first quarter of 1968 and the last quarter of 1977, although this proportion has been somewhat variable. Chequing deposits accounted for twelve percent of total on-personal term and notice deposits in the first quarter of 1968, this proportion declining steadily to two percent in the last quarter of 1977. In the first quarter of 1968, the non-chequing deposits made up six percent of total non-personal term and notice deposits and this proportion has remained fairly steady, except for the period from the third quarter of 1969 to the first quarter of 1972 when it increased, peaking at over sixteen percent in the third quarter of 1971. Notice bearer term notes[3] made up less than five percent of total non-personal term and notice deposits until the end of 1971, but this proportion increased rapidly to almost twenty percent in the first quarter of 1974, ending the period under consideration at almost seventeen percent.

Canadian Dollar Assets

By their very nature, a large proportion of banks' major liabilities, deposits, can be withdrawn on demand or at very short notice. Banks, therefore, must maintain at their immediate disposal, sufficient quantities of cash, or assets which can readily be converted into cash, to meet deposit withdrawals. In fact, banks are legally required to hold specific percentages of their Canadian dollar statutory deposits[4] in the form of primary and secondary reserves.

---

[3]Notice bearer term notes are usually issued only to investment or bond dealers who transfer them to their corporate clients for a profit.

[4]Canadian dollar statutory deposits are averages of the four consecutive Wednesdays ending with the second last

Assets Held to Satisfy Primary Reserve Requirement

The primary reserve requirement specifies the minimum percentage of statutory deposits which banks must hold, by law, in the form of Bank of Canada notes or deposits and the time period which is applicable.[5] Banks do in fact hold more Bank of Canada notes and deposits than they are legally required to, but this excess is very small.

Assets Held to Satisfy Secondary Reserve Requirements

The secondary reserve requirement specifies the minimum percentage of total Canadian dollar deposits which banks must hold, by law, in the form of Bank of Canada notes or deposits in excess of those held to satisfy the primary reserve requirement, day-to-day loans to investment dealers who have lines of credit with the Bank of Canada or treasury

---

Wednesday of the previous month. They consist of deposit liabilities payable on demand and after notice in Canadian currency.

[5]The required cash reserve ratio was eight percent of total statutory deposits until June 1967. For the next eight months, the required minimum monthly average on demand deposits was increased by one-half of one percent per month while that on notice deposits was decreased by one-half of one percent. Since February 1968, the required ratios have been twelve percent for demand deposits and four percent for notice deposits. Since January 1969, the chartered banks have been required to maintain the minimum cash reserve ratio on a half-monthly rather than on a monthly basis.

bills.[6] Banks' holdings of treasury bills are very much greater than their holdings of the other two assets. When reserve requirements are compared to the actual totals of these three assets a significant excess of these assets over legal requirements was held.

Loans

By far the largest category of bank assets is loans. Banks do in fact make two very different kinds of loans.

1. Very liquid loans - day-to-day loans and call and short loans. The role played by day-to-day loans has already been discussed. Call and short loans[7] made up a very small proportion, one to two percent, of total Canadian dollar assets for the entire period under

---

[6]This requirement was introduced in March 1968 replacing a voluntary agreement under which banks held seven percent of their Canadian dollar deposit liabilities in the form of secondary reserves. The required ratio was six percent in March 1968, seven percent from April 1968 to May 1969, eight percent from June 1969 to June 1970, nine percent from July 1970 to November 1971, eight and a half percent in December 1971, eight percent from January 1972 to November 1974, seven percent in December 1974, six percent in January and February 1975, five and a half percent from March 1975 to January 1977 and five percent from February 1977 on.

[7]Call and short loans are made by chartered banks to investment dealers for short periods of time. Only the class of loans called special call loans are in fact retrievable on call.

consideration while day-to-day loans made up a somewhat smaller proportion.

2. Illiquid loans - loans in Canadian dollars and mortgages. In the first quarter of 1968, loans in Canadian dollars and mortgages[8] accounted for sixty percent of total Canadian dollar assets, this proportion increasing to seventy percent by the last quarter of 1977. If one looks at total Canadian dollar assets less assets held to satisfy reserve requirements then the domination of loans becomes much more apparent. Total loans in Canadian dollars increased from just over $14b in the first quarter of 1968 to $62b in the last quarter of 1977. Total mortgages increased from almost $755m in the first quarter of 1968 to almost $7b in the last quarter of 1977.

Although the total of loans in Canadian dollars has increased steadily in the time period under consideration, its components, as proportions of the total, have by no means been steady. Loans to municipalities declined steadily from five and a half percent of total loans in Canadian

---

[8]The two kinds of mortgages are mortgages insured under the National Housing Act and other residential mortgages.

dollars in the first quarter of 1968 to just under three percent in the second quarter of 1977. Canada savings bond loans made up one and one-half to two percent of total loans in Canadian dollars for the period under consideration, this proportion exhibiting a very marked seasonal pattern. Loans to grain dealers made up just over four percent of total loans in Canadian dollars in the first quarter of 1968, this proportion increasing to over six percent at the end of 1969 and the beginning of 1970, then declining to just over one percent in the last quarter of 1977. Loans to sales finance companies accounted for three percent of total loans in Canadian dollars in the first quarter of 1968, this proportion declining slightly to less than three-quarters of one percent in the last quarter of 1977, whilst exhibiting a very regular seasonal pattern. Loans to provinces accounted for one percent of total loans in Canadian dollars in the first quarter of 1968, the proportion falling to only one-tenth of one percent in the first quarter of 1977.

By far the largest category of loans in Canadian dollars is general loans, in the first quarter of 1968 accounting for eighty-five percent of total loans in Canadian dollars. There was a lot of variation in this proportion, no distinct trend emerging until the first quarter of 1970 when the proportion increased rapidly to a peak of ninety-three percent in the third quarter of 1973, remaining relatively constant for the rest of the period under consideration. The category general loans is itself made up of four components. In the first quarter of 1968, loans to institutions accounted for three percent of total general loans, this proportion declining steadily to less than one percent in the last quarter of 1977. Loans to farmers accounted for eight percent of total general loans in the first quarter of 1968, this proportion falling steadily to less than six and a half percent in 1974, and increasing again to seven percent in the last quarter of 1977. Personal loans accounted for thirty-one percent of total general loans at the beginning of 1968, this proportion increasing to thirty-five percent by the last quarter of 1977. The largest category of total general loans is business loans which made up almost sixty percent of the total at the beginning of 1968, this proportion decreasing slightly to fifty-seven percent in the last quarter of 1977.

Unlike any of the other categories of loans, for both personal and business loans authorized limits, or maximum lines of credit, are established. Authorized limits have far exceeded amounts outstanding for the period under consideration.

CHAPTER 3 -- A TWO-TIER MODEL OF CHARTERED BANK RATE-SETTING BEHAVIOUR

Canada has a branch banking system consisting of a small number of very large banks. A list of these banks and their total assets is given in Table 3-1. Given the small numbers, individual banks cannot ignore their competitors' reactions, as is presumed in models such as that of Gramlich and Hulett, when they are setting rates. Under these circumstances it does not seem appropriate to assume each bank simultaneously determines the rate it offers on deposits, the rate it charges on loans and the quantities of various securities it holds so as to maximize its own objective function.

The fact that there are very few competitors in the banking industry is important but this is not the only thing which has to be taken into consideration, since non-bank and foreign bank competition is also important. It has been established, though, that high barriers to entry exist in the Canadian banking industry.[1] There are not only economic barriers to entry, for example, economies of scale,

---

[1] Orr (1974).

Table 3-1

Total Assets of Individual Canadian Chartered Banks, December 31, 1977

Bank	Total Assets	Percentage of Total Industry Assets
	$m	%
Royal Bank	35,670	23.7
Canadian Imperial Bank of Commerce	32,782	21.8
Bank of Montreal	25,908	17.2
Bank of Nova Scotia	22,113	14.7
Toronto Dominion	19,467	12.9
Banque Canadienne Nationale	6,837	4.5
Banque Provincial du Canada	4,366	2.9
Mercantile Bank	2,014	1.3
Bank of British Columbia	1,140	0.8
Canadian Commercial and Industrial Bank	124	0.1

Source: Canada Gazette, February, 1978.

but non-economic barriers also. The Bank Act itself can be considered a barrier since (at the time of writing) there are at least three provisions in it that could discourage entry. These are:

1. procedures which lead to a lag between application and entry.[2]
2. unhindered branching by existing banks.
3. restrictions on entry by foreign banks.[3]

Another possible barrier to entry is limit pricing. Orr[4] tested the limit pricing barrier to entry model and his conclusions suggested that banks did not keep prices lower than would be predicted in an attempt to discourage entrants. He did qualify this conclusion, though, by noting that "the fact that profits in banking are greater than predicted is consistent with the conclusion that there are significant barriers to entry not considered in our equations."[5]

We summarize our argument as follows. There are so few banks that each will have to be aware of the other

---

[2]Bank Act, 1967, Section 4-16.

[3]Ibid., Section 52-7.

[4]Orr (1974).

[5]Orr (1974), p. 96.

banks' reactions while, at least in the short run, the banking industry as a whole does not have to worry extensively about outside entrants. Theoretically, as far as rate-setting is concerned, the best solution for the banking industry would be for all the banks to collude to bring about the monopolistic solution. However, since it is explicitly forbidden that the banks agree with each other on the rates charged for loans or paid on deposits,[6] how could such a solution come about?

It is common in oligopolistic industries for one firm to take on the role of price leader. The model of the Canadian banking industry developed here involves the concept of price leadership. There are two problems which the price leader must solve: firstly, what are the rates which will maximize the industry's profits, and secondly, when should the rates be changed? The latter is a difficult problem but would be easily solved if there were an external signal which all the banks could react to. If this were the case, therefore, none of the chartered banks would in fact be a price leader. However, the effective price leader could still be within the industry. In the United States, the possibility that changes in the ceiling rate on deposits

---

[6] Bank Act, Section 138.

or changes in the discount rate have acted as signals for rate changes in the banking industry have been tested.[7] The evidence supported these hypotheses. It is possible that changes in the U.S. discount rate could act as signals in Canada also. A more reasonable alternative is that in Canada changes in the bank rate could act as such a signal, since changes in this rate and the deposits and loans rates seem closely related. Table 3-2 shows the bank rate, the non-chequing personal savings deposits rate and the prime loan rate, and the direction of change of each from the first quarter of 1969 to the fourth quarter of 1977. In any quarter, whether the deposit rate or the prime loan rate changes or not, and if it does, in what direction it moves, seems to be closely linked to movements in the bank rate.

Tables 3-3a and 3-3b summarize the information in Table 3-2 in such a way that the hypothesized relationship between these rates is more easily seen to hold true. The two most noticeable things about Tables 3-3a and 3-3b are:

1. the predominance of the diagonals, that is, most often the deposit rate and the prime rate change in the same direction as the bank rate.

---

[7] Jaffee (1971).

Table 3-2

Bank Rate, Non-chequing Personal Savings Deposit Rate and Prime Rate 1969-1977

Year and Quarter	Bank Rate	Non-chequing Deposit Rate	Prime Rate	Direction of Change of Bank Rate	Direction of Change of Non-chequing Deposit Rate	Direction of Change of Prime Rate
1969-1	6.67	5.25	7.17	+	+	+
1969-2	7.17	5.67	7.67	+	+	+
1969-3	8.00	6.50	8.50	+	+	+
1969-4	8.00	6.50	8.50	0	0	0
1970-1	8.00	6.50	8.50	0	0	0
1970-2	7.50	6.50	8.50	-	0	0
1970-3	6.83	6.00	8.00	-	-	-
1970-4	6.17	5.67	7.67	-	-	-
1971-1	5.50	5.00	6.83	-	-	-
1971-2	5.25	4.50	6.50	-	-	-
1971-3	5.35	4.50	6.50	0	0	0
1971-4	4.75	4.17	6.08	-	-	-
1972-1	4.75	4.00	6.00	0	-	-
1972-2	4.75	4.00	6.00	0	0	0
1972-3	4.75	4.00	6.00	0	0	0
1972-4	4.75	4.00	6.00	0	0	0
1973-1	4.75	4.00	6.00	0	0	0
1973-2	5.75	4.75	7.08	+	+	+
1973-3	6.75	6.25	8.33	+	+	+
1973-4	7.25	6.75	9.17	+	+	+
1974-1	7.25	7.25	9.50	0	+	+
1974-2	8.58	8.58	10.83	+	+	+
1974-3	9.25	9.08	11.50	+	+	+
1974-4	8.92	9.08	11.12	-	0	-
1975-1	8.25	7.50	9.67	-	-	-
1975-2	8.25	6.50	9.00	0	-	-
1975-3	8.50	6.75	9.25	+	+	+
1975-4	9.00	7.25	9.75	+	+	+
1976-1	9.17	7.50	9.92	+	+	+
1976-2	9.50	8.00	10.25	+	+	+
1976-3	9.50	8.00	10.25	0	0	0
1976-4	9.00	7.83	9.92	-	-	-
1977-1	8.17	6.42	8.92	-	-	-
1977-2	7.67	6.08	8.58	-	-	-
1977-3	7.50	5.75	8.25	-	-	-
1977-4	7.50	5.75	8.25	0	0	0

\+ increase　　0 constant　　- decrease

Source: Bank of Canada Review, various issues.

Table 3-3a

Relationship between quarter to quarter changes in the Bank Rate and changes in the deposit rate

Deposit Rate / Bank Rate	Increase	Constant	Decrease
Increase	12	0	0
Constant	1	9	2
Decrease	0	2	10

Source: Bank of Canada Review, various issues.

Table 3-3b

Relationship between quarter to quarter changes in the Bank Rate and changes in the prime rate

Prime Loan Rate / Bank Rate	Increase	Constant	Decrease
Increase	12	0	0
Constant	1	9	2
Decrease	0	1	11

Source: Bank of Canada Review, various issues.

2. there are no changes in either the deposit rate or the prime rate in the opposite direction to changes in the bank rate.

This seems to be reason enough[8] to test the hypothesis that changes in the bank rate act as a signal to all the individual banks for them to change their deposit and prime loan rates, simultaneously.

If rates are set at the industry level, as has just been hypothesized, and if the total quantities of loans and deposits are demand determined, what is left for individual banks to do? There are, of course, many ways in which banks can engage in non-rate competition, such as the number of branches available. A major concern, we suggest, is the provision of adequate liquidity. Since the magnitude and timing of flows of deposits and loans are uncertain, the specific needs of one bank will not be the same as those of another bank and the problem of providing adequate liquidity is

---

[8]It could be argued that the bank rate responds to financial pressures which are in part created by the chartered banks and that it is not a completely exogenous variable. However, if banks treat it as an exogenous price signal it would be expected that changes in the bank rate would always precede changes in the rates on deposits and loans. The information contained in this table is not sufficient to show that this is the case although such information is available from the press releases of the Bank of Canada and of the chartered banks.

therefore a problem for each bank individually. The model proposed is thus a two-tier model in the sense that in the first tier the rates on deposits and loans are set at the industry level. In the second tier, taking these rates as given, banks will then operate individually to ensure that they have adequate liquidity.

There are two sources of liquidity: asset management and liability management.[9] Banks can hold various highly liquid assets which can quickly be converted into cash with little risk of incurring a capital loss. However, such shorter term assets generally yield a lower return than longer term assets. So banks face a tradeoff between liquidity and return. Asset management can therefore be analyzed using standard portfolio theory. The second source of liquidity involves increases in banks' liabilities. Banks bid for highly liquid funds in the money market by offering high rates of return for short term deposits, e.g., bearer term deposit notes. These deposits are highly interest sensitive and banks must compete for them with other agents in the money market as eell as with each other. Liability

---

[9]Bank Management texts usually restrict liability management to mean banks' setting of interest rates on very short-term deposits. In some recent studies, though, for example Clinton and Masson's, liability management includes bank behaviour with respect to setting any set of rates on deposits. I use this term in its more traditional sense.

management is the policy banks pursue with respect to the interest rates they offer on these deposits so as to secure the quantities of the deposits desired. It has typically been analyzed by specifying and estimating an equation for the rate on non-personal term and notice deposits.

The second tier of this model is not developed in this thesis for two reasons. As noted earlier, White has recently explored chartered bank asset management extensively. With respect to liability management and the rates on short term deposits, recent experience includes price wars, ceiling rates being set by the Bank of Canada and the Bank of Canada allowing ceiling rates to be agreed to by the banks themselves.[10] Thus, that part of recent Canadian banking history that relates to the second tier of the model is much too complex for it to be adequately dealt with along with the other work done in this thesis. The major objective of this thesis is to derive chartered bank rate-setting equations from an optimizing framework.

The balance sheet of chartered banks

Before rate-setting equations for chartered banks can be derived the balance sheet of chartered banks must be

---

[10] See Courchene (1976a), for example, pp. 155-156 and 185-188.

specified in more detail. This will allow the specification of banks' revenues and costs and thus banks' profit functions. It will then be noted which deposit and loan rates are set in tier one of the model so as to maximize their joint profits, subject to the balance sheet constraint.

The major Canadian assets and liabilities of chartered banks, described in the previous chapter, and the appendix to that chapter, can be summarized in the following balance sheet equation:

$$D_t = R_{1t} + R_{2t} + S_t + L_t + B_t, \text{ where} \tag{3-1}$$

D_t is Canadian Dollar deposits, time period t

R_{1t} is Primary cash reserves required to be held by law

R_{2t} is Secondary reserves required to be held by law

S_t is All other major Canadian marketable assets

L_t is Total loans in Canadian dollars plus mortgages and

B_t is a Balancing item = all other assets - all other liabilities.

In addition, several categories of deposits can be distinguished. For example, there is a major distinction between demand and notice deposits in that the legal reserve requirements differ. Hence we have:

$$D_t = D_{1t} + D_{2t}, \text{ where} \tag{3-2}$$

D_{1t} is Demand deposits, and

D_{2t} is Notice deposits.

Demand and notice deposits can also be categorized depending on whether they are held by individuals or firms. Demand deposits can be broken down in the following manner:

$$D_{1t} = D_{11t} + D_{12t}, \quad \text{where} \tag{3-3}$$

D_{11t} is Personal chequing deposits, and

D_{12t} is Current accounts of firms.

Notice deposits can be similarly disaggregated:

$$D_{2t} = D_{21t} + D_{22t}, \quad \text{where} \tag{3-4}$$

D_{21t} is Personal savings deposits, and

D_{22t} is Non-personal term and notice deposits.

Personal savings deposits can be disaggregated into the following three categories:

$$D_{21t} = D^1_{21t} + D^2_{21t} + D^3_{21t}, \quad \text{where} \tag{3-5}$$

D^1_{21t} is Chequing personal savings deposits

D^2_{21t} is Non-chequing personal savings deposits and

D^3_{21t} is Fixed-term personal savings deposits.

Several important categories of loans also need to be distinguished.

$$L_t = BL_t + CL_t + M_t + OL_t \quad \text{where} \tag{3-6}$$

BL_t is Business Loans,

CL_t is Consumer Loans,

M_t is Mortgages, and

OL_t is Other Loans.[11]

The category S_t, all other major Canadian marketable assets in equation (3-1) is primarily made up of different kinds of securities held by banks, i.e., treasury bills held in excess of the secondary reserve requirements, Government of Canada securities and Canadian securities.

Revenue

The main source of bank revenue is the interest earned on loans. There is wide variation in the rates charged on loans both among the categories distinguished in the previous section and within those categories. The two major factors causing rates to differ among borrowers are differences in risk and in the duration of the loan. However, for business loans the whole structure of rates is based on the prime rate. It represents the base price for

---

[11]The other categories of loans in Canadian dollars are loans to provinces, municipalities, grain dealers, sales finance and consumer loan companies, institutions and farmers and Canada savings bond loans.

funds to which is added a premium depending on the perceived riskiness of individual loans. Thus, in our model, banks' revenue from business loans is represented by simply multiplying the prime rate by the total of business loans outstanding.[12] The additional revenue from loans paying a rate higher than the prime will not tend to vary with changes in the prime rate and will, in part, be offset by losses on loans defaulted. The modelling efforts will thus concentrate on explaining the prime rate.

The system of rates charged on consumer loans is somewhat different from that on business loans in that most consumers will pay the same rate on a particular loan and that this rate does not change very frequently. Consequently, although the rate on consumer loans must bear some relationship to the prime rate, one cannot characterize it simply by the prime rate plus a premium and the rate on consumer loans must be explained separately from the prime rate if it is to be explained at all. It was decided not

---

[12]This assumes the rate on all business loans outstanding changes with the prime rate. Based on data from the Bank of Canada roughly two-thirds of business loans are call loans and this is true for them. The remaining loans are term loans and an unknown percentage of these are charged a rate which is fixed for the period of the loan while the remainder are like call loans.

to include the rate on consumer loans in the first tier of the model because of the very infrequent nature of changes in this rate. Thus, banks' revenue from consumer loans is considered exogenous and is approximated by multiplying the rate on consumer loans by total consumer loans outstanding. Although some consumer loans are term loans this approximation is considered reasonable since the rate has not changed very often. Finally, as far as mortgages are concerned, all these loans were quite long term loans for the period examined. Each particular mortgage pays the rate which was in effect when it was taken out for a fixed period of time, usually five years. There is thus no simple way to represent mortgage income, although in any particular period it is primarily predetermined. Thus, this revenue can be considered exogenous and the mortgage rate will not be determined in tier one of the model.

Another important source of bank revenue is the interest earned on the various kinds of securities held. As noted earlier, in tier one of the model banks are not concerned with the relative returns of various securities, but only with the average returns of securities compared to loans. Since the rates between different securities vary, primarily to reflect the riskiness of the issues and the term to maturity of the securities and both of these factors tend to be relatively constant, income from securities can be represented by a weighted average rate multiplied by total securities held, this rate being exogenous in tier one of the model.[13]

The third important source of bank revenue is the charge levied on cheques written against demand deposits, personal chequing deposits in the case of individuals and current accounts in the case of businesses. Two kinds of notice deposits do have chequing privileges, chequing personal savings deposits in the case of individuals, and chequing non-personal term and notice deposits in the case of businesses. The charge levied is usually fixed either on a per cheque basis or a per month basis. This charge is changed extremely infrequently, to reflect rising costs of administration. Given this, and the fact that the number of cheques written is not under the control of banks, means this source of revenue can be considered exogenous.

---

[13]In their study, Clinton and Masson questioned the validity of this rate being exogenous. Apart from the possibility that at tier one of the decision-making process banks act as if this rate is exogenous, over the period under consideration banks' share of outstanding treasury bills has fallen markedly while their share of other bonds has remained at around 25%. This can be seen from the following Table:

Costs

In any period of time, a large part of the costs of a bank are in the nature of fixed costs, although a portion of them will vary with the level of bank services. Such costs arise because of the necessity to hold large amounts

Table 3-4

Chartered bank holdings of marketable government bonds outstanding

Year	Chartered Banks Treasury Bills	Chartered Banks Bonds	Total Treasury Bills	Total Bonds Out-standing-Column 3-Canada Savings Bonds	Column 1 / Column 3	Column 2 / Column 4
1967	1,742	2,888	2,455	13,237	0.7096	0.2182
1968	2,145	3,429	2,825	14,372	0.7593	0.2386
1969	2,116	2,977	2,895	14,324	0.7309	0.2078
1970	2,714	3,889	3,625	14,724	0.7487	0.2641
1971	2,716	4,608	3,830	14,531	0.7091	0.3171
1972	2,984	4,148	4,160	14,602	0.7173	0.2841
1973	3,475	3,816	4,690	14,321	0.7409	0.2665
1974	3,757	4,364	5,630	15,146	0.6673	0.2881
1975	3,493	4,278	6,200	15,885	0.5634	0.2693
1976	4,219	4,424	7,845	17,717	0.5378	0.2497
1977	4,949	4,587	10,315	21,607	0.4798	0.2123

Source: Bank of Canada Review, Table 21.

of real estate, the labour intensive nature of banking and the large amounts of administration necessary to conduct business. Other costs, however, are variable and banks can exercise some influence over them.

The main variable cost incurred by banks is the interest they pay on notice deposits. There are several different categories of notice deposits paying different interest rates, although the interest paid on deposits within any particular category is uniform. The notice deposits of individuals, are called personal savings deposits. This category is made up of three very different kinds of deposits. Chequing personal savings deposits are tailored to the individual who does not want separate chequing and savings accounts. Thus, chequing personal savings deposits have chequing privileges, but they also pay a small rate of interest. Bank's costs with respect to chequing personal savings deposits can be represented by multiplying the rate on chequing personal savings deposits by the total of these deposits. Since chequing personal savings deposits made up a very small proportion of total personal savings deposits for our period of study, and because the rate on these deposits was changed extremely infrequently,[14] it was

---

[14]In November 1970 from 3 1/2% to 3%, in November 1971 from 3% to 2 3/4% and in May 1973 from 2 3/4% to 3%.

decided not to make this rate endogenously determined in tier one of the model. The second category of personal savings deposits is non-chequing personal savings deposits. These are pure savings deposits that, in principle, require notice before a withdrawal can be made, (although this has not been enforced in practice) and yield a much higher interest rate than chequing personal savings deposits. Again, the banks' costs with respect to non-chequing personal savings deposits can be represented by multiplying the rate on these deposits by the total of them. The relationship between this rate and the bank rate was noted earlier and this rate will be endogenously determined in tier one of the model.

The final category of personal savings deposits is fixed-term personal savings deposits. As the name implies, these deposits are left with banks for a fixed period of time, in one of three categories between one and five years. The interest paid on these deposits depends on the going rate at the time of the original deposit. Thus, as with mortgages, there is no simple way of aggregating to get total cost although in any particular period a large part of this cost is predetermined. Fixed-term personal savings deposits are among the fastest growing of any bank deposits. The cost of these deposits is approximated by multiplying an average rate on fixed-term personal savings deposits and 'new' fixed-term personal savings deposits, with the cost of 'old' fixed-term personal savings deposits being considered exogenous. However, it was not felt that the rates on fixed-term personal savings deposits should be determined in tier one of the model. The determination of these rates is best looked at from the point of view of liability management and, thus, would be determined in tier two of the model.

Notice deposits owed to business wealth holders are called non-personal term and notice deposits. The term of these deposits is usually less than those of fixed-term personal savings deposits and can be as short as overnight. Thus, the cost of these deposits can be approximated by the product of the going rate and total non-personal term and notice deposits outstanding. The rates on these deposits are assumed to be determined in tier two of the model since these deposits are used for liability management purposes. Banks will thus compete with each other for these deposits.[15] Also, because there are other non-bank financial institutions in the market for short-term money, banks will face competition from outside of the banking industry also.

---

[15]Banks have competed so vigorously with each other in fact that, for example, in mid-May 1972 the interest rate on term deposits was bid above the prime rate. This led to the June 12, 1972 'Winnipeg Agreement' under which the banks set a maximum rate on deposits of $100,000 or more for terms of

Profits

Based on the discussion previously, the profits of banks can be represented by the following equation:

$$\Pi = r_{BLt}BL_t + r_{CLt}CL_t + r_{rt}R_{2t} + r_{st}S_t$$
$$- r_{NCSt}D^2{}_{21t} - r_{CDt}(D^3{}_{21t})^N$$
$$- r_{NPTNt}D_{22t} + NR_t, \quad \text{where} \qquad (3\text{-}7)$$

Π is profits,

r_{BLt} is the prime rate,

BL_t is business loans,

r_{CLt} is the rate on consumer loans,

CL_t is consumer loans,

r_{rt} is a representative rate on assets held to satisfy secondary reserve requirements,

---

up to 364 days. It would be possible to argue that for the period of the 'Winnipeg Agreement' these rates were set so as to maximize the banking industry's profits. The agreement was known to be only temporary, however, so this is not probable. A discussion of the events leading up to the 'Winnipeg Agreement' and the course of the ceiling rates up until its termination on January 15, 1975 can be found in Courchene (1976a).

R_{2t} is day-to-day loans and treasury bills held to satisfy secondary reserve requirements,

r_{st} is a representative rate on all other securities,

S_t is all other securities,

r_{NCSt} is the non-chequing personal savings deposits rate,

D^2_{21t} is non-chequing personal savings deposits,

r_{CDt} is an average of current rates on fixed-term savings deposits,

$(D^3_{21t})^N$ is 'new' fixed-term personal savings deposits,

r_{NPTNt} is the rate on non-personal term and notice deposits,

D_{22t} is non-personal term and notice deposits, and

NR_t is net revenue = all other revenue minus all other costs.

Theory of Rate-setting Behaviour

It is generally assumed that banks are willing to accept any quantities of deposits or make any quantities of loans at the going rates. This being so, if banks want to maximize profits, then their choice variables are the rates on deposits and loans. Although the banking industry is a classic example of an oligopoly, it was argued earlier in this chapter that it is reasonable to test the hypothesis that banks act collusively to set at least some rates so as to maximize their collective profits. In this 'first stage' of the rate-setting process in the banking industry model postulated here, the prime rate on loans and the rate on non-chequing personal savings deposits were chosen. Banks are assumed not to compete with each other over the levels of these rates, although the banking industry as a whole does face competition from other parts of the financial sector.

Demand for Loans and Deposits Equations

In stage one of the model, it is assumed that banks take the demand functions for loans and deposits as exogenous and set the prime rate and rate on non-chequing personal savings deposits so as to maximize the industry's profits. Before rate-setting equations can be derived, therefore, these demand equations for loans and deposits, as perceived by the industry, must be specified. Since r_{BLt} and r_{NCSt} are the choice variables, only those categories of loans or deposits which would be expected to be affected by these variables have to be specified. Thus, for example, equations for current accounts (D_{12t}) and non-personal term and notice deposits (D_{22t}) need not be specified since these are business accounts and, by definition, would not be affected by the rate on non-chequing <u>personal</u> savings deposits. The equations are specified in the most general form possible. Equations need to be specified, therefore, for business loans, personal chequing deposits, chequing personal savings deposits, non-chequing personal savings deposits, and 'new' fixed-term personal savings deposits. Each of the equations for these variables will take the same general form:

$$F_t = F(r_{Xt}, Z_i), \quad \text{where} \tag{3-8}$$

F_t is the deposit or loan category being considered, r_{Xt} is the rate of interest paid or changed on non-chequing personal savings deposits or business loans, whichever is relevant, and Z_i is the vector of other variables besides this rate which affects the demand for that category of deposits or loans.

Derivation of the Rate-setting Equations

Substituting equations of the general form of equation (3-8) for the relevant variables into the profit function (3-7) we obtain:

$$\Pi = r_{BLt}BL(r_{BLt}, Z_1) + r_{CLt}CL_t + r_{rt}R_{2t} + r_{st}S_t$$
$$- r_{NCSt}D^2{}_{21}(r_{NCSt}, Z_4) - r_{CDt}(D^3{}_{21}(r_{NCSt}, Z_5)^N)$$
$$- r_{NPTNt}D_{22t} + NR_t \tag{3-9}$$

Differentiating equation (3-9) with respect to r_{BLt} and $r_{NCSt,}$ setting these derivatives equal to zero and solving for r_{BLt} and r_{NCSt} we obtain equations representing banks' optimal behaviour vis-a-vis setting these two rates. Since this procedure is rather messy, the actual derivation is carried out in the appendix to this chapter and just equations (A17 and A18) are reproduced here as equations (3-10) and (3-11).[16]

$$r_{BLt} = - \frac{BL\ (r_{BLt}, Z_1)}{\partial BL/\partial r_{BLt}} + r_{st} \tag{3-10}$$

$$r_{NCSt} = \left(\frac{\partial D_{11}/\partial r_{NCSt} + \partial D^1{}_{21}/\partial r_{NCSt}}{\partial D^2{}_{21}/\partial r_{NCSt}} + \frac{\partial D^2{}_{21}/\partial r_{NCSt} + \partial (D^3{}_{21})^N/\partial r_{NCSt}}{\partial D^2{}_{21}/\partial r_{NCSt}}\right) r_{st}$$

---

[16]It should be noted that equations (3-10) and (3-11) are not reduced-forms since r_{BLt} appears on both sides of equation (3-10) and r_{NCSt} on both sides of equation (3-11). However, since the two equations are not simultaneous, each can be examined as if it was a reduced-form equation.

$$- \frac{D^2_{21}\ (r_{NCSt},\ Z_4)}{\partial D^2_{21}/\partial r_{NCSt}}$$

$$- \frac{\partial (D^3_{21})^N/\partial r_{NCSt}}{\partial D^2_{21}/\partial r_{NCSt}}\ r_{CDt} \qquad (3\text{-}11)$$

Looking at equations (3-10) and (3-11) one can see the explanatory variables which are expected to appear in the prime loan and non-chequing personal savings deposit rate equations and the expected signs of the coefficients on these variables. As far as the prime rate equation is concerned, the explanatory variables include r_{st} and those variables which determine loan demand. r_{st} is expected to enter the prime rate equation with a positive sign. The variables from the loan demand equation would be expected to enter the prime rate equation with coefficients of the same sign as in the demand equation since $BL(r_{BLt},\ Z_1)$ enters the equation preceded by a negative sign but divided by $\partial BL/\partial r_{BLt}$ which is expected to be negative.

For the non-chequing personal savings deposit rate equation, there is a larger set of explanatory variables and it is not possible to deduce the signs on all of the coefficients. The coefficient on r_{st} is not signable since $\partial D^2_{21}/\partial r_{NCSt}$, the own-rate response, is expected to be positive while $\partial D_{11}/\partial r_{NCSt}$, $\partial D^1_{21}/\partial r_{NCSt}$, and $\partial (D^3_{21})^N/\partial r_{NCSt}$

are all expected to be negative if these deposits are gross substitutes for non-chequing personal savings deposits. In this case the coefficient on r_{CDt} is expected to be positive. As in the loan rate equation, the explanatory variables from the deposit demand equation are also expected to appear in the deposit rate equation, although in this case with coefficients of the opposite sign.

If one specifies the exact functional form of the demand for loans and deposits equations then reduced-form equations for the two rates and precise restrictions on estimated rate equations can be derived. For the remainder of this thesis the specific case where all the demand equations are assumed to be linear in the explanatory variables is chosen. Again since the actual derivation of the rate equations is messy this is carried out in the appendix to this chapter. The demand equations (A19) to (A23) are reproduced here as equations (3-12) to (3-16).

$$BL_t = \alpha_{11}\, r_{BLt} + \alpha_{Z1}\, Z_1 \qquad \alpha_{11} < 0 \tag{3-12}$$

$$D_{11t} = \alpha_{21}\, r_{NCSt} + \alpha_{Z2}\, Z_2 \qquad \alpha_{21} < 0 \tag{3-13}$$

$$D^1_{21t} = \alpha_{41}\, r_{NCSt} + \alpha_{42}\, r_{CSt} + \alpha_{Z3}\, Z_3 \tag{3-14}$$

$$\alpha_{41} < 0,\ \alpha_{42} > 0.$$

$$D^2_{21t} = \alpha_{51}\, r_{NCSt} + \alpha_{Z4}\, Z_4 \qquad \alpha_{51} > 0 \tag{3-15}$$

$$(D^3_{21t})^N = \alpha_{61}\, r_{NCSt} + \alpha_{62}\, r_{CDt} + \alpha_{Z5}\, Z_5$$

$$\alpha_{61} < 0,\ \alpha_{52} > 0. \tag{3-16}$$

The reduced-form rate equations (A27) and (A28) are reproduced here as equations (3-17) and (3-18).

$$r_{BLt} = -\frac{\alpha_{Z1}}{2\alpha_{11}} Z_1 + \frac{1}{2} r_{st} \tag{3-17}$$

$$r_{NCSt} = \frac{(\alpha_{21} + \alpha_{41} + \alpha_{51} + \alpha_{61})}{2\alpha_{51}} r_{st} - \frac{\alpha_{Z4}}{2\alpha_{51}} Z_4 - \frac{\alpha_{61}}{2\alpha_{51}} r_{CDt} \tag{3-18}$$

When the demand equations for loans and deposits are linear functions of the explanatory variables, so are the equations explaining r_{BLt} and r_{NCSt}. The explanatory variables and the expected signs of the coefficients on these variables are all the same as in the general case. The gain from specifying an exact functional form for the demand equations is that precise restrictions on the rate equations have been derived. The explanatory variables and the expected signs of the coefficients on these variables are all the same as in the general case. There is a further gain in terms of identification of the rate and demand equations. For example, the equation for business loans is identified by r_{st} in the rate equation since r_{st} does not appear as an explanatory variable in the business loans equation and the coefficient on it is independent of Z_1, the set of explanatory variables in the business loans equation. These same considerations apply to the demand for non-chequing savings deposits equation.

<u>The Role of the Bank Rate as a Signal for Price Change</u>

The rate-setting equations derived in the previous section are unrealistic in the sense that banks are explicitly forbidden by law to collude so as to bring about such a monopolistic solution. However, the rates generated by the equations can be sensibly thought of as desired rates towards which banks will partially adjust in any period. That is, we assume:

$$r_{it} - r_{it-1} = \lambda_i \, (r^*_{it} - r_{it-1}) \qquad \text{where} \qquad (3\text{-}19)$$

i = BL, NCS

r_{it} is the actual rate in time period t

λ_i is a coefficient of adjustment, and

r^*_{it} is the desired rate in time period t.

As was postulated in the previous chapter, because of the oligopolistic nature of the banking industry, the bank rate could act as a price signal to the individual banks in place of collusion.[17] Thus, adjustment towards the desired rate is likely to depend on changes in the bank rate, i.e.,

$$\lambda_i = g_i\ (\Delta BR_t) \quad \text{where} \tag{3-20}$$

ΔBR_t is the change in the bank rate.

To test this theory, the relationship, as before, must be specified more precisely. Since it does not seem reasonable that changes in the loan and deposit rates depend totally on changes in the bank rate, the relationship should involve a constant term. Thus, a simple linear formulation seems plausible:

$$\lambda_i = a_i + b_i\ |\Delta BR_t| \qquad a_i,\ b_i > 0 \quad \text{where} \tag{3-21}$$

---

[17]In fact even if there did exist more explicit collusion, changes in the bank rate could be the least-cost method of effecting changes in the desired rates.

$|\Delta BR_t|$ is the absolute value of the change in the bank rate. Substituting this into equation (3-19) one obtains:

$$r_{it} - r_{it-1} = (a_i + b_i\ |\Delta BR_t|)\ (r^*_{it} - r_{it-1})$$

$$= a_i r^*_{it} - a_i r_{it-1} + b_i |\Delta BR_t|\ r^*_{it}$$

$$- b_i\ |\Delta BR_t|\ r_{it-1} \tag{3-22}$$

or

$$r_{it} = a_i r^*_{it} + (1-a_i)\ r_{it-1} + b_i\ |\Delta BR_t|\ r^*_{it}$$

$$- b_i\ |\Delta BR_t|\ r_{it-1} \tag{3-23}$$

It remains, therefore, to substitute the two equations explaining banks' desired rates on loans and deposits into these equations to obtain the actual rate equations to be estimated. Combining equations (3-17) and (3-23) and (3-18) and (3-23) one obtains:

$$r_{BLt} = - a_{BL} \frac{\alpha_{Z1}}{2\alpha_{11}} Z_1 + \frac{a_{BL}}{2} r_{st} + (1-a_{BL})\ r_{BLt-1}$$

$$- b_{BL} \frac{\alpha_{Z1}}{2\alpha_{11}} |\Delta BR_t|\ Z_1 + \frac{b_{BL}}{2} |\Delta BR_t|\ r_{st}$$

$$- b_{BL}\ |\Delta BR_t|\ r_{BLt-1} \tag{3-24}$$

$$r_{NCSt} = a_{NCS} \frac{(\alpha_{21} + \alpha_{41} + \alpha_{51} + \alpha_{61})}{2\alpha_{51}} r_{st} - a_{NCS} \frac{\alpha_{Z4}}{2\alpha_{51}} Z_4$$

$$- a_{NCS} \frac{\alpha_{51}}{2\alpha_{51}} r_{CDt} + (1-a_{NCS}) r_{NCSt-1}$$

$$+ b_{NCS} \frac{(\alpha_{21} + \alpha_{41} + \alpha_{51} + \alpha_{61})}{2\alpha_{51}} |\Delta BR_t| r_{st}$$

$$- b_{NCS} \frac{\alpha_{Z4}}{2\alpha_{51}} Z_4 - b_{NCS} \frac{\alpha_{51}}{2\alpha_{51}} r_{CDt}$$

$$- b_{NCS} |\Delta BR_t| r_{NCSt-1} \qquad (3\text{-}25)$$

The relationship between the speed of adjustment and the bank rate is not postulated to be exactly the same for the prime rate and the deposit rate. Banks have been observed to change these rates at different times. Usually, the prime rate is changed quite quickly following changes in the bank rate, whereas, changes in the deposit rate tend to lag somewhat. This could be due to interest on loans being paid on a minimum daily balance while interest on non-chequing personal savings deposits is paid on a minimum monthly balance. The costs of decision-making lags are thus less for deposits and the speed of adjustment would be expected to be less.

The Identification Problem

In all previous studies of demand functions for deposits and loans, the own-rate of interest appears as an explanatory variable. Since, as was noted in the introduction, banks will respond to shifts in their perceived demand functions on deposits and loans by adjusting their own interest rates, there is a problem of simultaneity.[18] This leads to problems in identifying the separate effects of changes in exogenous variables on the demand for deposits and loans of banks and their respective interest rates.

The solution to this problem requires two steps. First, it is necessary to formulate a theory of bank rate-setting behaviour, as has been done here. The effects of an exogenous shock on rates could then be determined from the reduced-form rate equation. There still remains, however, the problem of simultaneity, and it is not sufficient to estimate reduced-form rate equations and structural demand functions (for loans and deposits) separately by ordinary least squares. When estimating the structural demand

---

[18] Banks' perceived demand functions may in fact differ from the actual demand functions. Unless, however, the errors in the perceived demand functions are completely uncorrelated with the errors in the actual demand functions a problem of simultaneity will still exist.

functions, the actual values of the own-rates on deposits or loans which, because of simultaneity will be correlated with the error term in the relevant demand function, should be replaced by predicted values of those rates. In a simple two-stage least squares procedure this is exactly what is done with the rate variable being regressed on all of the exogenous variables in the model at the first stage. Since an optimizing model of rate-setting behaviour has been developed from which reduced-form rate equations are developed, these equations can be used at the first stage. Thus our choice of exogenous variables has basis in economic theory.

Conclusions

In this chapter, theoretical rate-setting equations ave been derived within a profit-maximization framework, taking into account the oligopolistic nature of the banking industry. The major difference between this study and that of Clinton and Masson is that our rate-setting equations are explicitly derived from a theoretical model for chartered banks. Gramlich and Hulett have provided a similar theoretical model which we have adapted so that the differences in the banking structure between Canada and the United States were taken in account. These rate equations can then be used in a two-stage procedure to estimate demand functions for loans and deposits correctly.

In the next chapter, empirical equations are estimated and the various aspects of the theory are tested. The estimated rate equations are then used to see whether, when estimating demand for loans and deposits equations, the problem of identification is serious.

APPENDIX TO CHAPTER THREE -- DETAILED DERIVATION OF THE RATE-SETTING EQUATIONS

The profit function of banks takes the following form:

$$\Pi = r_{BLt}\, BL_t + r_{CLt} CL_t + r_{rt}\, R_{2t} + r_{st}\, S_t - r_{NCSt}\, D^2{}_{21t}$$

$$- r_{CDt}\, (D^3{}_{21t})^N - r_{NPTNt}\, D_{22t} + NR_t, \quad \text{where} \qquad \text{(A1)}$$

Π	is profits
r_{BLt}	is the prime rate
BL_t	is business loans
r_{CLt}	is the rate on consumer loans
CL_t	is consumer loans
r_{rt}	is a representative rate on assets held to satisfy secondary reserve requirements
R_{rt}	is day-to-day loans and treasury bills held to satisfy secondary reserve requirements
r_{st}	is a representative rate on all other securities
S_t	is all other securities
r_{NCSt}	is the non-chequing personal savings deposits rate
$D^2{}_{21t}$	is non-chequing personal savings deposits
r_{CDt}	is an average of current rates on fixed-term personal savings deposits
$(D^3{}_{21t})^N$	is 'new' fixed-term personal savings deposits
r_{NPTNt}	is the rate on non-personal term and notice deposits

D_{22} is Non-personal term and notice deposits, and

NR_t is net revenue = all other revenue minus all other costs

Banks must always be in a position to satisfy legal reserve requirements. Reserve requirements, R_{1t} and R_{2t}, are both identically related to the quantity of deposits. The identities take the following form:

$$R_{1t} = x_1 D^S_{1t} + x_2 D^S_{2t}, \quad \text{where} \tag{A2}$$

R_{1t} are cash reserves required to be held by law

D^S_{1t} are statutory demand deposits

D^S_{2t} are statutory notice deposits and

x_1, x_2 are required cash reserve ratios on demand and notice deposits respectively.

$$R_{2t} = B_t \,(D^S_{1t} + D^S_{2t}), \quad \text{where} \tag{A3}$$

R_{2t} are secondary reserves required to be held by law

D^S_t are statutory deposits = $D^S_{1t} + D^S_{2t}$, and

B_t is the required secondary reserve ratio.

Since statutory deposits for time period t are measured from the middle of time period t - 2 to the middle of time period t - 1, an approximation is needed in terms of calendar months. Using the following approximations:

$$D^{S}_{t} = \frac{D_{t-1} + D_{t-2}}{2} \tag{A4}$$

R_{1t} and R_{2t} can thus be written in terms of calendar month deposits.

$$R_{1t} = x_1 \frac{D_{11t-1} + D_{12t-1} + D_{11t-2} + D_{12t-2}}{2}$$

$$+ x_2 \left(\frac{D^{1}_{21t-1} + D^{2}_{21t-1} + D^{3}_{21t-1} + D_{22t-1}}{2} + \right.$$

$$\left. \frac{D^{1}_{21t-2} + D^{2}_{21t-2} + D^{3}_{21t-2} + D_{22t-2}}{2}\right) \tag{A5}$$

$$R_{2t} = B_t \left(\frac{D_{11t-1} + D_{12t-1} + D^{1}_{21t-1} + D^{2}_{21t-1}}{2} + \right.$$

$$\frac{D^{3}_{21t-1} + D_{22t-1} + D_{11t-2} + D_{12t-2}}{2} +$$

$$\left. \frac{D^{1}_{21t-2} + D^{2}_{21t-2} + D^{3}_{21t-2} + D_{22t-2}}{2}\right) \tag{A6}$$

The balance sheet identity must always hold. Since banks have a two-tier decision-making process, at the rate-setting stage S_t can be treated as a residual. The balance-sheet constraint can thus be rewritten as:

$$S_t = D_{11t} + D_{12t} + D^1{}_{21t} + D^2{}_{21t} + D^3{}_{21t} + D_{22t} - R_{1t} - R_{2t}$$
$$-BL_t - CL_t - NR_t \tag{A7}$$

Substituting (A5) and (A6) into (A7) and simplifying:

$$S_t = D_{11t} + D_{12t} + D^1{}_{21t} + D^2{}_{21t} + D^3{}_{21t} + D_{22t}$$
$$- \left(\frac{x_1 + B_t}{2}\right) (D_{11t-1} + D_{12-1} + D_{11t-2} + D_{12t-2})$$
$$- \left(\frac{x_2 + B_t}{2}\right) (D^1{}_{21t-1} + D^2{}_{21t-1} + D^3{}_{21t-1} + D_{22t-1} +$$
$$D^1{}_{21t-2} + D^2{}_{21t-2} + D^3{}_{21t-2} + D_{22t-2})$$
$$- BL_t - CL_t - NR_t \tag{A8}$$

Banks treat the following public's demand functions as constraints:

$$BL_t = BL\ (r_{BLt}, Z_1) \tag{A9}$$

$$D_{11t} = D_{11}\ (r_{NCSt}, Z_2) \tag{A10}$$

$$D^1{}_{21t} = D^1{}_{21}\ (r_{NCSt}, r_{CSt}, Z_3) \tag{A11}$$

$$D^2{}_{21t} = D^2{}_{21}\ (r_{NCSt}, Z_4) \tag{A12}$$

$$(D^3{}_{21t})^N = (D^3{}_{21}\,(r_{NCSt},\ r_{CDt},\ Z_5))^N \tag{A13}$$

Substituting equations (A8) to (A13) into the profit function (A1) one obtains:

$$\begin{aligned}
\Pi = {} & r_{BLt}\,BL\,(r_{BLt},\ Z_1) + r_{CLt}\,CL_t + r_{rt}\,\frac{B_t}{2}\,(D_{11t-1} + D_{12t-1} \\
& + D^1{}_{21t-1} + D^2{}_{21t-1} + D^3{}_{21t-1} + D_{22t-1} + D_{11t-2} + D_{12t-2} \\
& + D^1{}_{21t-2} + D^2{}_{21t-2} + D^3{}_{21t-2} + D_{22t-2}) \\
& + r_{st}\,(D_{11}\,(r_{NCSt},\ Z_2) + D_{12t} + D^1{}_{21}\,(r_{NCSt},\ r_{CSt},\ Z_3) \\
& + D^2{}_{21}\,(r_{NCSt},\ Z_4) + (D^3{}_{21}\,(r_{NCSt},\ r_{CDt},\ Z_5))^N \\
& + (D^3{}_{21t})^o + D_{22t} - (\frac{x_1 + B_t}{2})\,(D_{11t-1} + D_{12t-1} + D_{11t-2} \\
& + D_{12t-2}) - (\frac{x_2 + B_t}{2})\,(D^1{}_{21t-1} + D^2{}_{21t-1} + D^3{}_{21t-1} \\
& + D_{22t-1} + D^1{}_{21t-2} + D^2{}_{21t-2} + D^3{}_{21t-2} + D_{22t-2}) \\
& - BL\,(r_{BLt},\ Z_1) - CL_t - NR_t) - r_{NCSt}\,D^2{}_{21}\,(r_{NCSt},\ Z_4) \\
& - r_{CDt}\,(D^3{}_{21}\,(r_{NCSt},\ r_{CDt},\ Z_5)^N - r_{NPTNt}\,D_{22t} + NR_t
\end{aligned} \tag{A14}$$

where

$(D^3_{21t})^o$ are 'old' fixed-term personal savings deposits.

Differentiating (A14) with respect to r_{BLt} and r_{NCSt} and equating to zero, one obtains:

$$\frac{\partial \Pi}{\partial r_{BLt}} = \frac{\partial BL}{\partial r_{BLt}} r_{BLt} + BL\ (r_{BLt},\ Z_1) - \frac{\partial BL}{\partial r_{BLt}} r_{st} = 0 \qquad \text{(A15)}$$

$$\begin{aligned}\frac{\partial \Pi}{\partial r_{NCSt}} = {} & \left(\frac{\partial D_{11}}{\partial r_{NCSt}} + \frac{\partial D^1{}_{21}}{\partial r_{NCSt}} + \frac{\partial D^2{}_{21}}{\partial r_{NCSt}} + \frac{\partial (D^3{}_{21})^N}{\partial r_{NCSt}}\right) r_{st} \\ & - \frac{\partial D^2{}_{21}}{\partial r_{NCSt}} r_{NCSt} - D^2{}_{21}\ (r_{NCSt},\ Z_4) \\ & - \frac{\partial (D^3{}_{21})^N}{\partial r_{NCSt}} r_{CDt} = 0 \qquad \text{(A16)}\end{aligned}$$

Solving equations (A15) and (A16) for r_{BLt} and r_{NCSt}, respectively, one obtains:

$$r_{BLt} = - \frac{BL\ (r_{BLt},\ Z_1)}{\partial BL/\partial r_{BLt}} + r_{st} \qquad \text{(A17)}$$

$$\begin{aligned} r_{NCSt} = {} & \left(\frac{\partial D_{11}/\partial r_{NCSt} + \partial D^1{}_{21}/\partial r_{NCSt} + \partial D^2{}_{21}/\partial r_{NCSt}}{\partial D^2{}_{21}/\partial r_{NCSt}}\right. \\ & \left. + \frac{\partial (D^3{}_{21})^N/\partial r_{NCSt}}{\partial D^2{}_{21}/\partial r_{NCSt}}\right) r_{st} - \frac{D^2{}_{21}\ (r_{NCSt},\ Z_4)}{\partial D^2{}_{21}/\partial r_{NCSt}} \\ & - \frac{\partial (D^3{}_{21})^N/\partial r_{NCSt}}{\partial D^2{}_{21}/\partial r_{NCSt}} r_{CDt} \qquad \text{(A18)}\end{aligned}$$

If it is assumed that the business loan demand equation is specified as follows:

$$BL_t = \alpha_{11}\, r_{BLt} + \alpha_{Z1}\, Z_1 \qquad \alpha_{11} < 0. \tag{A19}$$

and the deposit demand equations are similarly specified

$$D_{11t} = \alpha_{21}\, r_{NCSt} + \alpha_{Z2}\, Z_2 \qquad \alpha_{21} < 0. \tag{A20}$$

$$D^1{}_{21t} = \alpha_{41}\, r_{NCSt} + \alpha_{42}\, r_{CSt} + \alpha_{Z3}\, Z_3$$

$$\alpha_{41} < 0,\ \alpha_{42} > 0. \tag{A21}$$

$$D^2{}_{21t} = \alpha_{51}\, r_{NCSt} + \alpha_{Z4}\, Z_4 \qquad \alpha_{51} > 0. \tag{A22}$$

$$(D^3{}_{21t})^N = \alpha_{61}\, r_{NCSt} + \alpha_{62}\, r_{CDt} + \alpha_{Z5}\, Z_5$$

$$\alpha_{61} < 0,\ \alpha_{62} > 0. \tag{A23}$$

Substituting equations (A19) to (A23) into (A14) in place of the general functional forms specified there one obtains:

$$\Pi = r_{BLt}\,(\alpha_{11}\, r_{BLt} + \alpha_{Z1}\, Z_1) + r_{CLt}\, CL_t + r_{rt}\, \frac{B_t}{2}\, (D_{11t-1}$$

$$+ D_{12t-1} + D^1{}_{21t-1} + D^2{}_{21t-1} + D^3{}_{21t-1} + D_{22t-1}$$

$$+ D_{11t-2} + D_{12t-2} + D^1_{21t-2} + D^2_{21t-2} + D^3_{21t-2} + D_{22t-1})$$

$$+ r_{st} (\alpha_{21} r_{NCSt} + \alpha_{Z2} Z_2 + D_{12t} + \alpha_{41} r_{NCSt} + \alpha_{42} r_{CSt}$$

$$+ \alpha_{Z3} Z_3 + \alpha_{51} r_{NCSt} + \alpha_{Z4} Z_4 + \alpha_{61} r_{NCSt} + \alpha_{62} r_{CDt}$$

$$+ \alpha_{Z5} Z_5 + (D^3_{21t})^o + D_{22t} - (\frac{x_1 + B_t}{2}) (D_{11t-1} + D_{12t-1}$$

$$+ D_{11t-2} + D_{12t-2})) - (\frac{x_2 + B_t}{2}) (D^1_{21t-1} + D^2_{21t-1}$$

$$+ D^3_{21t-1} + D_{22t-1} + D^1_{21t-2} + D^2_{21t-2} + D^3_{21t-2}$$

$$+ D_{22t-2}) - \alpha_{11} r_{BLt} + \alpha_{12} Z_1 - CL_t - NR_t)$$

$$- r_{NCSt} (\alpha_{51} r_{NCSt} + \alpha_{Z4} Z_4) - r_{CDt} (\alpha_{61} r_{NCSt} + \alpha_{62} r_{CDt}$$

$$+ \alpha_{Z5} Z_5) - r_{NPTNt} D_{22t} + NR_t \qquad \text{(A24)}$$

Differentiating (A24) with respect to r_{BLt} and r_{NCSt} and equating the first-order conditions to zero, one obtains:

$$\frac{\partial \Pi}{\partial r_{BLt}} = 2 \alpha_{11} r_{BLt} + \alpha_{Z1} Z_1 - \alpha_{11} r_{st} = 0 \qquad \text{(A25)}$$

$$\frac{\partial \Pi}{\partial r_{NCSt}} = (\alpha_{21} + \alpha_{41} + \alpha_{51} + \alpha_{61})\ r_{st} - 2\ \alpha_{51}\ r_{NCSt}$$

$$- \alpha_{Z4}\ Z_4 - \alpha_{61}\ r_{CDt} = 0 \tag{A26}$$

Solving equations (A25) and (A26) for r_{BLt} and r_{NCSt}, respectively, one obtains:

$$r_{BLt} = - \frac{\alpha_{Z1}}{2\alpha_{11}}\ Z_1 + \frac{1}{2}\ r_{st} \tag{A27}$$

$$r_{NCSt} = \left(\frac{\alpha_{21} + \alpha_{41} + \alpha_{51} + \alpha_{61}}{2\alpha_{51}}\right) r_{st} - \frac{\alpha_{Z4}}{2\alpha_{51}}\ Z_4 - \frac{\alpha_{61}}{2\alpha_{51}}\ r_{CDt} \tag{A28}$$

CHAPTER 4 -- EMPIRICAL ESTIMATION OF THE RATE EQUATIONS

Introduction

The objective of this chapter is to present empirical estimates of equations for the rate on non-chequing savings deposits and the prime rate, based on the theoretical discussion of the previous chapter. This theory is based on two sets of assumptions: (1) that the desired levels of the two rates are set so as to maximize the profits of the banking industry, and (2) that adjustment towards these desired rates is a function of changes in the bank rate. Where possible, the validity of these separate assumptions will be tested.

Estimation of the Equation for the Rate on Non-chequing Savings Deposits

The equation to be estimated, as set out in the last chapter, is as follows:

$$r_{NCSt} = a_{NCS} \frac{\alpha_{21} + \alpha_{41} + \alpha_{51} + \alpha_{61}}{2\alpha_{51}} r_{st}$$

$$- a_{NCS} \frac{\alpha_{Z4}}{2\alpha_{51}} Z_4 - a_{NCS} \frac{\alpha_{61}}{2\alpha_{51}} r_{CDt} + (1-a_{NCS})\ r_{NCSt-1}$$

$$+ b_{NCS} \frac{(\alpha_{21} + \alpha_{41} + \alpha_{51} + \alpha_{61})}{2\alpha_{51}} |\Delta BR_t| \; r_{st}$$

$$- b_{NCS} \frac{\alpha_{Z4}}{2\alpha_{51}} |\Delta BR_t| \; Z_4 - b_{NCS} \frac{\alpha_{61}}{2\alpha_{51}} |\Delta BR_t| \; r_{CDt}$$

$$- b_{NCS} |\Delta BR_t| \; r_{NCSt-1} \qquad (4\text{-}1)$$

The sign of the coefficient on r_{st} cannot be predicted since α_{21}, α_{41}, and α_{61} are all expected to be negative, while α_{51}, is expected to be positive. Since a_{NCS} is expected to be positive, the coefficients on the variables which comprise Z_4 and on r_{CDt} are expected to have signs opposite to those expected in the demand for deposits equation. The coefficient on the lagged dependent variable is expected to be positive since a_{NCS} is expected to lie between 0 and 1. Since b_{NCS} is expected to be positive, all of the interactive terms involving $|\Delta BR_t|$ and other variables are expected to enter the equation with the same sign as found in the case of the original non-interactive variables, except for the coefficient on $|\Delta BR_t| \; r_{NCSt-1}$ which is expected to be negative.

The variables incluced in the vector Z_4 must now be specified. These are the variables, other than the own rate which are included in the demand function for non-chequing personal savings deposits. The desired quantity of such deposits will be determined by individuals trying to maximize the utility they get from these deposits, subject to an income or wealth constraint. The optimal quantity will depend partly on the returns from such deposits relative to possible returns elsewhere and partly on such factors as risk and convenience. If non-chequing personal savings deposits are held for transactions purposes, then the correct scale variable is some measure of current income or expenditure. On the other hand if the demand is for an asset then the correct scale variable is wealth. In fact, non-chequing personal savings deposits, given their nature, are probably held for both of these reasons although the asset motive is likely to dominate.[1] Finally, it would be expected that the equation explaining non-chequing personal savings deposits would contain a constant term. Based on these considerations the vector Z_4 can be specified in the following way:

$$Z_4 = (\text{constant}, W_t, r_{TCNCSt}, r_{CDt}, D^2_{21t-1}), \quad \text{where} \tag{4-2}$$

[1]Money could be left in non-chequing personal savings deposits for upcoming large transactions but this would not be very efficient since, for the period considered, interest was paid only on the minimum monthly balance.

W_t is wealth

r_{TCNCSt} is the rate on trust company non-chequing savings deposits

r_{CDt} is the rate on chartered bank certificates of deposit and

D^2_{21t-1} is lagged non-chequing personal savings deposits.

The demand for non-chequing personal savings deposits as an asset leads to the inclusion of wealth as a variable in the demand function. Wealth is expected to enter this equation with a positive coefficient since a portion of any increase in wealth would be allocated to savings deposits. Trust company non-chequing deposits and chartered bank certificates of deposits compete with chartered bank non-chequing personal savings deposits for a place in the portfolios of individuals. Therefore, the coefficients on both r_{TNCSt} and r_{CDt} would be expected to be negative. The coefficient on the lagged dependent variable is expected to be positive.

Data and Definitions of Variables Used in Estimation of Deposit Rate Equation

Before the equation for the non-chequing personal savings deposit rate can be estimated statistical series representing the theoretical concepts had to be chosen.

Monthly data for the period January 1969 to December 1977 were chosen in preference to quarterly data because of the possible rapid speed of adjustment of financial variables. r_{NCSt} was taken to be the average of the Wednesdays' rate on chartered bank non-chequing savings deposits, (B14019).[2] r_{st} was calculated as a weighted average of the rates on chartered bank assets which make up S_t, where S_t comprised all securities held freely[3] (those held to satisfy secondary reserve requirements were excluded here).

---

[2]The Cansim numbers for the data used will be noted, where appropriate, in parentheses following the name of the variable.

[3]The securities which make up S_t are; securities eligible to satisfy secondary reserve requirements (day-to-day loans and treasury bills) which are held in amounts in excess of those required, Government of Canada bonds, and Canadian, provincial, municipal and corporate securities. Excess secondary reserves is the daily average excess amount held for the period, (B817). The rate on excess secondary reserves is a weighted average of the rates on the assets which make up secondary reserves, weighted by the proportion of total secondary reserve assets that each asset makes up. Total secondary reserve assets comprise the daily average of excess cash for the period, which is determined by subtracting the required cash, (B810), from actual cash, (B818 plus B819), the daily average of day-to-day loans for the period, (B804), and the daily average of treasury bills for the period, (B805). The rate on day-to-day loans is the weekly average of the Wednesday closing rates, (B14002). The rate on treasury bills is the arithmetic average of the Wednesday's average yield on three month treasury bills, (B14007), and six month treasury bills, (B14008). Government of Canada bonds comprise both the end of period holdings of Government of Canada direct and guaranteed bonds three years and under, (B665), and those over three years, (B610). The rate on the three year and under bonds is

There are four variables assumed to make up Z_4. The series on wealth, W_t, is the same as that used by Clinton and Masson in their monthly financial model.[4] Wealth there is defined as the sum of deposits and other financial assets held by the public.[5] W_t was deflated by the consumer price index of all items, unadjusted for seasonality, (D61601). The rate on trust company

---

represented by the Government of Canada securities average of the Wednesday's bond yields, one to three years, (B14009). The rate on the over three year bonds is represented by the arithmetic average of the rates on Government of Canada bonds three to five years, (B14010), five to ten years, (B14011), and over ten years, (B14013). The end of period holdings of Canadian securities are broken down into provincial, (B617), municipal, (B618), and corporate, (B619). The rates on these securities are the McLead, Young and Weir bond yield average for ten industrial bonds, (B14014), ten municipal bonds, (B14015), and ten industrial bonds, (B14016).

[4]Clinton and Masson (1975).

[5]Included in this definition are the following varialles, all measured at month-end: total currency outside banks, (B2001), Canada savings bonds outstanding, (B2406), short Canadas held by the public, (B2446), and long Canadas held by the public. This is defined as the general public's total holdings of Government of Canada direct and guaranteed securities minus Government of Canada treasury bills and short Canadas held by the public and outstanding Canada savings bonds. Also included is commercial paper outstanding, both sales finance and consumer loan company paper, (B17417), and other commercial paper, (B15002). The following chartered bank liabilities are included: demand deposits less items in transit, (B459), total personal savings deposits, (B451), and total non-personal term and notice deposits, (B455). Trust and mortgage loan company savings deposits and time deposits greater than one year are also included. The series on wealth is available, on request, from the Bank of Canada.

non-chequable savings deposits, r_{TCNCSt}, and the rates on chartered bank certificates of deposit were made available by the Bank of Canada. The rate representing chartered bank certificates of deposits, r_{CDt}, was computed as the arithmetic average of the rates on the one to two year, the three to four year and the over five year certificates of deposit. The deposits variable is chartered bank non-chequing personal savings deposits, (B453). This variable was also deflated by the consumer price index.

The bank rate, BR_t, is the average of Wednesday rates (B14006). The actual day of the month on which the bank rate is changed is also given in the Bank of Canada Review. It was noticed that chartered banks react somewhat differently to changes in the bank rate when changing the prime rate as compared to changing the rate on non-chequing personal savings deposits. In particular there were more cases when banks changed the deposits rate the month after the change in the bank rate than was the case for the prime rate. On examining each change individually it was found that this occurs when the bank rate was changed late in the month. Since loans pay interest on a minimum daily balance it is in banks' interest to change the prime rate as quickly as possible. Interest on deposits, however, is paid on the basis of a minimum monthly balance and banks pay a set rate of interest effective the first of the month.[6] The options are, therefore, to backdate the change to the first of the month in which the bank rate is changed or make the change effective the first of the next month. It was noticed that when the change in the bank rate occurred early enough in the month the first of these options was taken whereas if the change in the bank rate occurred late in the month it was the second option which was chosen. In order to account for this phenomenon and test the hypothesis that the timing of changes in the bank rate was important, two data series on the bank rate were constructed and, at the empirical stage two sets of regressions were run for each of the prime rate and the rate on non-chequing personal savings deposits equations. In one set the bank rate enters the regression equations unadjusted while, in the other, the bank rate enters the regression equations adjusted so that if a change in the bank rate occurs after the 17th of any month that change was attributed to the next month. The 17th of the month was chosen as a cut-off by examining the dates the bank rate was changed and picking a date which seemed best

---

[6]Banks have recently made available a category of personal savings deposits which pays interest on a daily basis but this is outside our data period.

to represent the banks' behaviour. A range of dates around the 17th was experimented with in the empirical work and these made little difference to the results.

The Estimated Rate Equations for the Rate on Non-chequing Personal Savings Deposits, Bank Rate Adjusted

In Table 4-1[7] the O.L.S. estimates of the equations for the rate on non-chequing personal savings deposits are presented for the case with the bank rate adjusted as explained above. It should be noted that monthly dummy

---

[7] KEY:

r_{NCSt} - rate on chartered bank non-chequing savings deposits

r_{st} - representative rate on all other securities

D^2_{21t-1} - chartered bank non-chequing savings deposits, lagged one period

r_{CDt} - average rate on chartered bank fixed-term savings deposits

* - multiplication sign

ΔBR - change in bank rate

$|\ |$ - absolute value

$\bar{r}^2$ - coefficient of determination adjusted for degrees of freedom

Figures in parenthesis are 't' statistics.

Table 4-1

Estimated equations for the rate on non-chequing savings deposits, bank rate adjusted

Equation number	constant	r_{st}	D^2_{21t-1}	r_{CDt}	r_{NCSt-1}	$\|\Delta BR\|$ *constant	$\|\Delta BR\|$ $*r_{st}$	$\|\Delta BR\|$ $*D^2_{21t-1}$	$\|\Delta BR\|$ $*r_{CDt}$	$\|\Delta BR\|$ $*r_{NCSt-1}$	$\bar{r}^2$	Durbin h-statistic
4-1-1	-.69 (3.40)	.05 (1.06)	-3.96 (-3.28)	.25 (4.94)	.80 (23.74)	-2.78 (-3.58)	.50 (2.53)	-13.44 (-3.06)	.20 (.67)	-.23 (-1.86)	.984	1.78
4-1-2	-1.22 (-6.03)	.14 (2.97)	-6.86 (-5.85)	.31 (5.85)	.75 (23.31)						.978	2.31
4-1-3	-.78 (-4.06)	.07 (1.59)	-3.80 (-3.17)	.24 (5.08)	.79 (23.59)	-2.82 (-3.76)	.50 (2.55)	-15.56 (-3.63)	.23 (.80)	-.22 (-1.94)	.984	1.88
4-1-4	-1.33 (-6.99)	.19 (4.21)	-7.27 (-6.22)	.30 (5.72)	.71 (22.72)						.977	2.74

r_{NCSt}	constant	r_{st}	D^2_{21t-1}	r_{CDt}	r_{NCSt-1}	BR	$\bar{r}^2$	Durbin h-statistic
4-1-5	-1.28 (-5.53)	.16 (2.62)	-6.89 (-5.85)	.31 (5.83)	.75 (17.56)	-.03 (-.56)	.978	2.21
4-1-6	-1.39 (-6.35)	.21 (3.55)	-7.29 (-6.21)	.30 (5.71)	.73 (17.07)	-.03 (-.56)	.977	2.61

Key to table can be found in footnote 7.

variables are always included in these equations, unless otherwise specified, but the coefficients are not reported.

It was necessary to drop one of the variables which comprise Z_4 from the regression equation because of the high degree of collinearity between W_t and $NCSD_{t-1}$. W_t was dropped and the reasons for this will be discussed in detail later. Similarly, because of the high degree of collinearity between the rate on non-chequing personal savings deposits it was decided to drop one of these variables as well. After some experimentation r_{TCNCSt} was dropped. The equation estimated and reported in Table 4-1, equation (4-1-1) is thus as follows:

$$\begin{aligned} r_{NCSt} = & - a_{NCS} \frac{\alpha_{Z41}}{2\alpha_{51}} + a_{NCS} \frac{(\alpha_{21} + \alpha_{41} + \alpha_{51} + \alpha_{61})}{2\alpha_{51}} r_{st} \\ & - a_{NCS} \frac{(\alpha_{Z42} + \alpha_{61})}{2\alpha_{51}} r_{CDt} - a_{NCS} \frac{\alpha_{Z43}}{2\alpha_{51}} D^2{}_{21t-1} \\ & + (1-a_{NCS})\, r_{NCSt-1} - b_{NCS} \frac{\alpha_{Z41}}{2\alpha_{51}} D^2{}_{21t-1} \\ & - b_{NCS} \frac{(\alpha_{21} + \alpha_{41} + \alpha_{51} + \alpha_{61})}{2\alpha_{51}} |\Delta BR_t|\, r_{st} \\ & - b_{NCS} \frac{(\alpha_{Z42} + \alpha_{61})}{2\alpha_{51}} |\Delta BR_t|\, r_{CDt} \\ & - b_{NCS} \frac{\alpha_{Z43}}{2\alpha_{51}} |\Delta BR_t|\, D^2{}_{21t-1} - b_{NCS} |\Delta BR_t|\, r_{NCSt-1} \end{aligned} \tag{4-3}$$

The results appear satisfactory. As noted earlier, the coefficient on r_{st} cannot be signed a priori. All of the variables which can be signed enter with the correct sign. Seven of the ten variables in (4-1-1) are significant at the 95% level of confidence. In addition the coefficients on the lagged dependent variables, a_{NCS} and b_{NCS}, have the correct signs.[8] Ninety-eight percent of the variation in the rate on non-chequing personal savings deposits is explained by this equation. Given the Durbin h-statistic, the hypothesis of zero autocorrelation can be accepted at the 95% level of confidence.

The separate components of the theory, i.e., the profit maximizing behaviour and the adjustment hypothesis, can be tested in two alternate ways. By dropping the interactive terms an 'F' test can be used to test the significance of the complete set of coefficients. This is a weak

---

[8]Unique values of a_{NCS} and b_{NCS} cannot be determined from these O.L.S. estimates. Values of a_{NCS} and b_{NCS} can be determined, for example, from the coefficients on r_{NCSt-1} and $|\Delta BR|*r_{NCSt-1}$ in equation (4-1-1) and are 0.20 and 0.23 respectively. Taking this value of a_{NCS} from the coefficient on D^2_{21t-1} the value of $\alpha_{Z43}/\alpha_{Z51}$ is -39.6. Taking this value, from the coefficient on $|\Delta BR_t|*D^2_{21t-1}$, the value of b_{NCS} is 0.34. Other values would be obtained if other coefficients were used.

test of b_{NCS}, however, because it is not constrained to have a single value. Alternatively, a strong test of significance can be performed by estimating the equation non-linearly so as to get separate and unique estimates of a_{NCS}, b_{NCS} and the α's. The 'F' tests based on the linear estimation will be presented here and the results of the non-linear estimation will be presented later.

By dropping all of the interactive terms (equation 4-1-2) it can be seen how the rate equation which is generated by simply assuming banks maximize their joint profits performs. The assumption of partial adjustment is retained so that the problems as to how this might come about, given the complexities of the market structure are ignored. This equation is in fact quite satisfactory with all of the signable coefficients entering with the correct sign and significantly at the 95% level of confidence. The $\bar{R}^2$ has fallen slightly from equation (4-1-1), however. Moreover, the Durbin h-statistic indicates that it is now not possible to accept the hypothesis of zero autocorrelation at the 95% level of confidence and an 'F' test comparing the results of equations (4-1-1) and (4-1-2) to test the significance of the interactive variables as a group indicates the interactive variables are significant at the 95% level of significance.[9] This evidence supports the hypothesis that the banks' rate of adjustment depends on the absolute change in the bank rate.

Equation (4-1-1) was also run without monthly dummy variables so that a similar 'F' test could be performed on the significance of the monthly dummy variables as a group. The results are presented in equation (4-1-3). An 'F' test indicates that the monthly dummy variables are not significant at the 95% level of confidence.[10]

The equation was then run without both the interactive terms and the monthly dummies. The results are presented in equation (4-1-4). An 'F' test indicates that the combination of the interactive terms and monthly dummies is significant at the 95% level of confidence.[11]

---

[9] The critical 'F' statistic with (5,100) degrees of freedom at the 95% level of significance is 4.40. From equations (4-1-1) and (4-1-2), 'F' is estimated to be 8.29.

[10] The critical 'F' statistic with (11,100) degrees of freedom at the 5% level of significance is 2.45. From equations (4-1-1) and (4-1-3), 'F' equals 1.17.

[11] The critical 'F' statistic here with (16,000) degrees of freedom, at the 95% level of significance, is 2.02. From equations (4-1-1) and (4-1-4), 'F' equals 3.87.

Although the hypothesis of the role of the bank rate in affecting chartered bank deposit rate-setting behaviour was accepted, it is not the only hypothesis which can be tested. In some earlier studies, such as the study of Clinton and Masson,[12] the bank rate has been similarly used in deposit rate equations. The inclusion of a variable representing the level of the bank rate can be rationalized as either affecting the desired rate on deposits or the speed of adjustment to this desired rate. The level of the bank rate could affect the desired rate if it is thought to be an indicator of the future levels of the competing deposit rates in the demand function for deposits. With respect to affecting the speed of adjustment towards the desired rate this formulation could give irrational results in certain situations. For example, if banks had reached the desired level of the rate on non-chequing personal savings deposits and the bank rate changed, they would change their deposit rate. Thus a variable representing the level of the bank rate, as opposed to the absolute value of the change used earlier, was added to the variables appearing in equations (4-1-2) and (4-1-4) and the results are presented in equations (4-1-5) and (4-1-6). These results are not very supportive of this formulation of the

---

[12] Clinton and Masson (1975).

hypothesis. In both cases the bank rate variable enters with the wrong sign and is insignificant at the 95% level of confidence.

The preferred equation in the whole set is thus equation (4-1-3). Here, the interactive variables are retained on the basis of the 'F' test while the monthly dummies are dropped by reason of this same test. Further, equation (4-1-3) is found to be superior to equation (4-1-6) which embodies the alternate hypothesis as to the effects of the bank rate.

As noted earlier, an alternative method of testing the separate components of the theory is to estimate equation (4-1-3) non-linearly. Recall that the adjustment mechanism postulated in the previous chapter had the form:

$$\lambda_2 = a_{NCS} + b_{NCS} \, |\Delta BR_t| \tag{4-4}$$

Since this adjustment mechanism takes the form of a multiplicative relationship as noted earlier, when the equation is estimated linearly only weak tests of significance can be performed on a_{NCS} and b_{NCS} since both are over-identified. Only by estimating equation (4-1-3) non-linearly can unique estimates of a_{NCS} and b_{NCS} be obtained and a strong test of significance performed.

To facilitate such estimation, equation (4-1-3) can be rewritten as:

$$
\begin{aligned}
r_{NCSt} = &- (B1*B2)/2 + ((B1*B3)/2)\ r_{st} - ((B1*B4)/2)\ r_{CDt} \\
&- ((B1*B5)/2)\ D^2{}_{21t-1} + (1 - B1)\ r_{NCSt-1} \\
&- ((B6*B2)/2)\ |\Delta BR_t| + ((B6*B3)/2)\ |\Delta BR_t|\ r_{st} \\
&- ((B6*B4)/2)\ |\Delta BR_t|\ r_{CDt} - ((B6*B5)/2)\,|\Delta BR_t|\ D^2{}_{21t-1} \\
&- B6\ |\Delta BR_t|\ r_{NCSt-1} \qquad (4\text{-}5)
\end{aligned}
$$

where

$B1 = a_{NCS}$

$B2 = \alpha_{Z41}/\alpha_{51}$

$B3 = (\alpha_{21} + \alpha_{41} + \alpha_{51} + \alpha_{61})/\alpha_{51}$

$B4 = (\alpha_{Z42} + \alpha_{61})/\alpha_{51}$

$B5 = \alpha_{Z43}/\alpha_{51}$

$B6 = b_{NCS}$

When equation (4-1-3) was estimated linearly ten coefficients were estimated. When equation (4-5) is estimated non-linearly only six coefficients are estimated. Thus once the constant term, the coefficients a_{NCS}, b_{NCS} and the coefficients on r_{st}, r_{CDt} and $D^2{}_{21t-1}$ are estimated, the coefficients on $|\Delta BR_t|$, $|\Delta BR_t|\ r_{st}$, $|\Delta BR_t|\ r_{CDt}$ and $|\Delta BR_t|\ D^2_{21t-1}$, are fully determined, reflecting the presence of four restrictions. The results of estimating equation (4-5) non-linearly are presented in Table 4-2. Different starting values were tried when doing this estimation to ensure a global extreme had been found.

Table 4-2

Non-linear estimation of rate on non-chequing personal savings deposits equation[13]

r_{NCSt}	B1	B2	B3	B4	B5	B6	$\bar{r}^2$	Durbin h-statistic
4-2-1	0.158	10.85	1.24	-2.41	55.55	0.48	0.982	0.89
	(5.14)	(7.99)	(3.23)	(-6.88)	(5.71)	(5.09)		

The coefficients which are of primary interest in these results are B1 and B6, the parameters of the postulated adjustment mechanism, that is, a_{NCS} and b_{NCS}. The value of a_{NCS} is 0.16 whereas the value of b_{NCS} is 0.48. Both are highly significant statistically. The coefficients on B4 and B5 have the correct signs, the signs on B2 and B3

[13]Figures in parenthesis are ratios of the value of the coefficient to the asymptotic standard errors.

being indeterminate a priori. All of the coefficients are statistically significant.

As a check on the reasonableness of the linear estimates the implied values of the coefficients on the variables which entered equation (4-1-3) can be calculated and compared to the actual estimates. This is done in Table 4-3. As can be seen from this table, the regression results using the linear technique appear reasonable, although strong tests of significance cannot be performed on them.

The Estimated Equations for the Rate on Non-chequing Personal Savings Deposits, Bank Rate Unadjusted

As noted earlier, in order to test the hypothesis that the timing of bank rate changes within any month is important, two sets of equations must be estimated. The first set using data on the bank rate that has been adjusted were presented in the last section. In Table 4-4 the results which are obtained when data on the bank rate has not been adjusted are presented.

Since timing of changes in the bank rate affect banks' adjustment, what is of most interest here is the 'F' statistic testing the significance of the interactive variables as a group. This can be obtained from equations (4-4-1) and (4-4-2). The 'F' statistic obtained is 2.12.

Table 4-3

Comparison of linear and non-linear estimation results, Rate on Non-chequing Personal Savings Deposits Equation

coefficient on \ equation number	4-1-3	4-2-1
constant	-0.78	-0.86
r_{st}	0.07	0.10
r_{CDt}	0.24	0.19
D^2_{21t-1}	-3.80	-4.39
r_{NCSt-1}	0.79	0.84
$\lvert \Delta BR_t \rvert$	-2.82	-2.60
$\lvert \Delta BR_t \rvert \; r_{st}$	0.50	0.30
$\lvert \Delta BR_t \rvert \; r_{CDt}$	0.23	0.58
$\lvert \Delta BR_t \rvert \; D^2_{21t-1}$	-15.56	-13.33
$\lvert \Delta BR_t \rvert \; r_{NCSt-1}$	-0.22	-0.48

Table 4-4

<u>Estimated rate on non-chequing savings deposits equations, bank rate unadjusted</u>

r_{NCSt}	constant	r_{st}	D^2_{21t-1}	r_{CDt}	r_{NCSt-1}	$\lvert\Delta BR\rvert$ *constant	$\lvert\Delta BR\rvert$ *r_{st}	$\lvert\Delta BR\rvert$ *D^2_{21t-1}	$\lvert\Delta BR\rvert$ *r_{CDt}	$\lvert\Delta BR\rvert$ *r_{NCSt-1}	$\bar{r}^2$	Durbin h-statistic
4-4-1	-.91	.11	-5.15	.26	.76	-1.76	.27	-8.66	.19	-.14		
	(-4.43)	(2.20)	(-4.21)	(4.81)	(22.28)	(-1.87)	(1.42)	(-1.93)	(.56)	(-.96)	.982	1.94
4-4-2	-1.22	.14	-6.86	.31	.73							
	(-6.03)	(2.97)	(-5.85)	(5.85)	(23.31)						.978	2.30
4-4-3	-1.00	.13	-5.19	.25	.75	-1.89	.28	-9.74	.22	-.15		
	(5.12)	(2.75)	(-4.26)	(5.01)	(22.09)	(-2.09)	(1.50)	(-2.28)	(.69)	(-1.13)	.981	1.83
4-4-4	-1.33	.19	-7.27	.30	.71							
	(-6.99)	(4.21)	(-6.22)	(5.72)	(2.27)						.977	2.75

r_{NCSt}	constant	r_{st}	D^2_{21t-1}	r_{CDt}	r_{NCSt-1}	BR	$\bar{r}^2$	Durbin h-statistic
4-4-5	-1.32	.18	-6.96	.31	.75	-.04		
	(-5.52)	(2.70)	(-5.89)	(5.83)	(17.83)	(-.80)	.978	2.14
4-4-6	-1.42	.22	-7.35	.30	.73	-.04		
	(-6.27)	(3.51)	(-6.24)	(5.71)	(17.28)	(-.72)	.977	2.54

This compares to the critical 'F' statistic at the 95% level of confidence with (5,100) degrees of freedom of 4.40 and an 'F' statistic obtained earlier of 8.29. Thus, not only has the significance of the interactive variables fallen considerably when making a comparison with the bank rate adjusted case, but also it is no longer statistically significant at the 95% level of confidence. This evidence supports the hypothesis that the timing of changes in the bank rate affects banks' adjustment of their non-chequing personal savings deposits rates and that it is appropriate to adjust the bank rate series to take account of changes late in the month.

The importance of adjusting the data on the bank rate to reflect the fact that the timing of changes in the bank rate is important is further enhanced by the result that when the unadjusted bank rate was entered as a variable in the rate on non-chequing savings deposits equation, in neither formulation tested was it significant. As noted above from equations (4-4-1) and (4-4-2) it can be shown that the interactive variables are not significant as a group while from equations (4-4-5) and (4-4-6) it can be seen that the bank rate enters the equation with the wrong sign and insignificantly different from zero. The researcher would have thus been led to the conclusion that the bank rate has no effect on the rate on non-chequing personal savings deposits, a conclusion which seems to be at obvious variance with the workings of the banking system.

Estimation of the Prime Rate Equation

The second rate equation to be estimated is that of the prime rate. The actual equation derived in the last chapter is as follows:

$$r_{BLt} = - a_{BL} \frac{\alpha_{Z1}}{2\alpha_{11}} Z_1 + \frac{a_{BL}}{2} r_{st} + (1 - a_{BL})\ r_{BLt-1}$$

$$- b_{BL} \frac{\alpha_{Z1}}{2\alpha_{11}} |\Delta BR_t|\ Z_1 + \frac{b_{BL}}{2} |\Delta BR_t|\ r_{st}$$

$$- b_{BL}\ |\Delta BR_t|\ r_{BLt-1} \qquad (4\text{-}6)$$

Since a_{BL} is expected to be positive, the coefficient on r_{st} is expected to be positive. Further, since α_{11} is expected to be negative, the coefficients on the variables which comprise Z_1 in this equation are expected to have the same sign as they have in the demand for loans equation, while the coefficient on the lagged dependent variable is expected to be positive. Since b_{BL} is expected to be positive all of the interactive terms are expected to enter the equation with the same sign as they originally entered except the coefficient on $|\Delta BR_t|\ r_{BLt-1}$ which is expected to have a negative sign.

Again the major task to be accomplished before equation (4-6) can be estimated, is to specify the variables to be included in the demand function for business loans (other than the prime rate), that is, the variables included in Z_1. It is postulated that firms have a desired investment plan wich they want to carry out and which they must finance. Any lags involved are assumed to be associated with the investment decision itself and not the ability to obtain finance. Because loans are usually paid back over a period of time, however, at any point in time there will be loans outstanding which were taken out to finance past investment. Thus, previous values of business investment will affect the current stock of loans outstanding. Since loans must be paid back the influence of previous values of business investment should at some point decline and this can be represented by a distributed lag on business investment. Finally, a firm would try to obtain any loan at the lowest possible cost, so the relative cost of different alternatives would be considered. Finally it would be expected that the equation explaining business loans would contain a constant term. Based on these considerations it was decided to specify the vector Z_1 in the following way:

$$Z_1 = (\text{constant}, BI_t, BI_{t-1}, \ldots , BI_{t-K}, r_{FCPt}) \qquad (4\text{-}7)$$

where BI_{t-K} is business investment in period t-K and
r_{FCPt} is the rate on finance company paper.

As noted earlier the signs of the coefficients on the variables which make up Z_1 are expected to be the same as in the demand for loans equation. Thus the distributed lag on business investment would be expected to have positive weights which gradually and eventually decline towards zero. r_{FCPt} is a competing rate and the coefficient on this variable is expected to be positive if finance company paper is a gross substitute for business loans.

Data and Definitions of Variables Used in Estimation of Prime Rate Equation

We now turn to a discussion of the statistical series representing the theoretical concepts. r_{BLt} is the rate on chartered bank prime business loans, (B14020). r_{st} is the same variable used earlier in the deposit rate equation. Business investment is represented by total business gross fixed capital formation, unadjusted for seasonality, (D40021), deflated to constant dollars. Data on this variable are only available quarterly, so monthly data had to be generated by linear interpolation. In this interpolation inventories were excluded as they are highly variable on a short term basis and any interpolation would be suspect. Moreover, from the point of view of business loans random variation in inventories should not affect demand. As far as the distributed lag on business fixed investment is concerned, this was estimated using the Almon method which means the degree of polynomial and length of lag must be chosen (usually on the basis of maximizing r^2). Thus, a choice had to be made between choosing that combination which maximized overall r^2 in one of the prime rate equation or the business loans equation and imposing that combination on the other equation, or, choosing the combination which maximized r^2 in each equation singly. Since, when the dependent variables differ, it is not valid to compare r^2 across equations, the second alternative was taken. Thus polynomials of varying degrees (from one to three) and lengths of lag (from one to twenty) were tested and the final choice was made on the size of r^2 in the rate equation alone. The degree of polynomial chosen was two and the length of lag thirteen.

r_{FCPt} is the average of the Wednesday rates on thirty day finance company paper, (B14039). Both the rates on ninety day finance company paper and the McLeod, Young and Weir bond yield (average for ten industrial bonds) were also tried but neither variable performed as well as the thirty day finance company paper rate.

<u>The Estimated Prime Rate Equations, Bank Rate Adjusted</u>

With the 'Z1' variables now specified these can be inserted into equation (4-6). The equation then becomes:

$$
\begin{aligned}
r_{BLt} = &- a_{BL} \frac{\alpha_{Z11}}{2\alpha_{11}} - \frac{a_{BL}}{2} r_{st} - a_{BL} \frac{\alpha_{Z12}}{2\alpha_{11}} r_{FCPt} \\
&- a_{BL} \frac{\alpha_{Z13}}{2\alpha_{11}} AL1 - a_{BL} \frac{\alpha_{Z14}}{2\alpha_{11}} AL2 + (1 - a_{BL}) r_{BLt-1} \\
&- b_{BL} \frac{\alpha_{Z11}}{2\alpha_{11}} |\Delta BR_t| - \frac{b_{BL}}{2} |\Delta BR_t| r_{st} \\
&- b_{BL} \frac{\alpha_{Z12}}{2\alpha_{11}} |\Delta BR_t| r_{FCPt} - b_{BL} \frac{\alpha_{Z13}}{2\alpha_{11}} |\Delta BR_t| AL1 \\
&- b_{BL} \frac{\alpha_{Z14}}{2\alpha_{11}} |\Delta BR_t| AL2 \\
&- b_{BL} |\Delta BR_t| r_{BLt-1} \qquad (4\text{-}8)
\end{aligned}
$$

where AL1 and AL2 are the two Almon variables representing specific combinations of present and lagged values of business investment. More generally the Almon variables are obtained from the expression $\sum_{i=0}^{\ell} \sum_{j=0}^{m} j^{\ell} x_{t-j}$ where m is the length of lag and $\ell < m$ the degree of polynomial.

In Tables 4-5[14] and 4-6 the results of the estimated prime rate equations, based on the adjusted bank rate, are presented. Table 4-5 summarizes the resulting equation omitting the monthly dummy variable coefficients and details of the Almon lag variables. Table 4-6 presents the details of the Almon lag for the preferred equation while Figure 4 portrays this lag structure diagrammatically.

In equation (4-5-1) the theoretical equation is estimated exactly as it is set out in (4-8). The results appear reasonable. Excluding the distributed lag on business investment, all of the variables enter this equation with the correct sign except $|\Delta BR_t|$, which should enter with the same sign as the constant term. Four of the coefficients are significant at the 95% level of confidence. The overall $\bar{r}^2$ of the equation is high, 99.1% of the variation in the prime rate being explained. Both a_{BL} and b_{BL} do have the correct

---

[14] KEY:

r_{BLt}	- prime rate
r_{st}	- representative rate on all other securities
r_{FCPt}	- rate on finance company paper
AL1, AL2	- Almon variables representing specific combinations of present and lagged values of business investment in machinery and equipment
*	- multiplication sign
ΔBR_t	- change in bank rate
$\| \|$	- absolute value

Table 4-5

<u>Estimated prime rate equations, bank rate adjusted</u>

r_L	cons	r_{st}	r_{FCPt}	AL1	AL2	r_{L-1}	$\lvert\Delta BR\rvert$ *cons	$\lvert\Delta BR\rvert$ $*r_{st}$	$\lvert\Delta BR\rvert$ $*r_{FCPt}$	$\lvert\Delta BR\rvert$ *AL1	$\lvert\Delta BR\rvert$ *AL2	$\lvert\Delta BR\rvert$ $*r_{L-1}$	$\bar{r}^2$	Durbin h-Statistic
4-5-1	-.02	.08	.10	-241.60	241.81	.82	.46	.10	.15	-97.49	88.57	-.19		
	(-.11)	(1.76)	(3.96)	(-3.83)	(3.87)	(27.65)	(.67)	(.62)	(1.93)	(-.78)	(.70)	(-1.93)	.991	-2.19
4-5-2	.12	.06	.17	-264.46	264.43	.77								
	(.61)	(1.37)	(6.28)	(-3.93)	(3.97)	(27.06)							.986	-.92
4-5-3	.08	.08	.11	-72.34	72.36	.82	.44	.15	.19	-102.24	95.76	-.29		
	(.44)	(1.66)	(4.05)	(-2.00)	(2.03)	(26.42)	(.62)	(.95)	(2.36)	(-.80)	(.75)	(-2.96)	.989	-.66
4-5-4	.21	.09	.18	-79.57	78.72	.74								
	(1.08)	(2.03)	(6.59)	(-2.14)	(2.15)	(24.93)							.984	1.20

r_L	cons	r_{st}	r_{FCPt}	Z1	Z2	r_{L-1}	BR	$\bar{r}^2$	Durbin h-statistic
4-5-5	.23	.03	.17	-265.55	266.50	.74	.04		
	(.98)	(.48)	(6.32)	(-3.94)	(3.99)	(18.38)	(.82)	.986	-.63
4-5-6	.27	.07	.18	-81.33	80.95	.72	.02		
	(1.14)	(1.23)	(6.57)	(-2.17)	(2.18)	(17.01)	(.46)	.984	1.39

Key to table can be found in footnote 14.

Table 4-6

Interpretation of Lag Weights on Business Investment in Equation (4-5-3)

Table 4-6a Interpretation of lag weights on business investment

length of lag	
0	4.60
1	3.18
2	1.95
3	0.89
4	0.003
5	-0.70
6	-1.23
7	-1.59
8	-1.77
9	-1.77
10	-1.59
11	-1.24
12	-0.71
13	0

Table 4-6b Interpretation of lag weights on business investment times $|\Delta BR_t|$

length of lag	
0	5.15
1	3.35
2	1.79
3	0.46
4	-0.64
5	-1.51
6	-2.14
7	-2.53
8	-2.69
9	-2.62
10	-2.32
11	-1.78
12	-1.01
13	0

signs.[15] From the Durbin h-statistic the hypothesis of zero autocorrelation cannot be accepted at the 95% level of confidence.

As was done in the case of the rate equation for non-chequing personal savings deposits equation, the regression was also run without the interactive terms. The results are presented in Table 4-5, equation (4-5-2). The equation is also quite satisfactory without the interactive variables. However, using the 'F' test to determine the significance of the interactive variables as a group it is found that they are very significant at the 95% level of confidence.[16]

Presented as equation (4-5-3) in Table 4-5 are the results obtained when equation (4-5-1) is run without monthly dummy variables. Using the 'F' test it is found that the

---

[15] Since this equation is overidentified there are multiple estimates of a_{BL} and b_{BL}. a_{BL} equals double the coefficient on r_{st} or 0.16, and one minus the coefficient on r_{BLt-1}, or 0.18. b_{BL} equals double the coefficient on $|\Delta BR_t| * r_{st}$ or 0.20 or the negative of the coefficient on $|\Delta BR_t| * r_{BLt-1}$ or 0.19.

16

[16] The critical 'F' statistic with (6,100) degrees of freedom at the 95% level of significance is 3.71, while from equation (4-5-1) and (4-5-2), 'F' equals 7.7.

the monthly dummy variables are not significant at the 95% level of confidence.[17] Excluding the distributed lag, all of the variables have the correct sign, six of them being significant at the 95% level of confidence. The estimated values of a_{BL} and b_{BL} again have the correct signs.[18] $\bar{r}^2$ is still high and the Durbin h-statistic is still low. Again the hypothesis of zero autocorrelation is accepted at the 95% level of confidence.

In equation (4-5-4), equation (4-5-1) is re-run without both the set of interactive variables and the set of monthly dummies. The critical 'F' statistic with (17,100) degrees of freedom is 2.02 while the 'F' statistic obtained from comparing equations (4-5-1) and (4-5-4) is 5.24. The presence of both the interactive and monthly dummy variables is thus significant at the 95% level of confidence.

---

[17]'F' = 2.22 compared to critical 'F' with (11,100) degrees of freedom of 2.42.

[18]The value of a_{BL} determined from the coefficient on r_{st} is 0.16 and determined from the coefficient on r_{BLt} is 0.18. The coefficient on b_{BL} determined from the coefficient on $|\Delta BR_t|*r_{st}$ is 0.30 and determined from the coefficient on $|\Delta BR_t|*r_{BLt-1}$ is 0.29.

In equations (4-5-5) and (4-5-6) the results of re-running equation (4-5-2) and (4-5-4) respectively with the level of the bank rate as an additional explanatory variable are presented. In both cases the coefficient on the level of the bank rate has the correct sign but is insignificant at the 95% level of confidence. Except for the coefficient on r_{st}, the values of the other coefficients have not changed markedly. $\bar{r}^2$ is still high in both cases and the Durbin h-statistic remains low enough to accept the hypothesis of zero autocorrelation at the 95% level of confidence.

The preferred equation in this set thus appears to be equation (4-5-3) which includes the interactive variables, but not the monthly dummy variables. This choice was made on the basis of the 'F' tests and because equation (4-5-3) is preferrable to equation (4-5-6) on both theoretical and empirical grounds. The Almon lag variables in this equation are interpreted in Table 4-6 and shown diagrammatically in Figure 4. It would be expected that the lag weights for both business investment and business investment times $|\Delta BR_t|$ would be positive and eventually decline towards zero. In both cases the lag weights are initially positive. This can be seen most clearly from Figures 4a and 4b. Shortening the length of lag to four periods would eliminate the wrong sign on the coefficients on business investment lagged more than

Figure 4

Diagrammatic representation of lag weights on business investment in equation (4-5-3)

Figure 4a

Lag on business investment

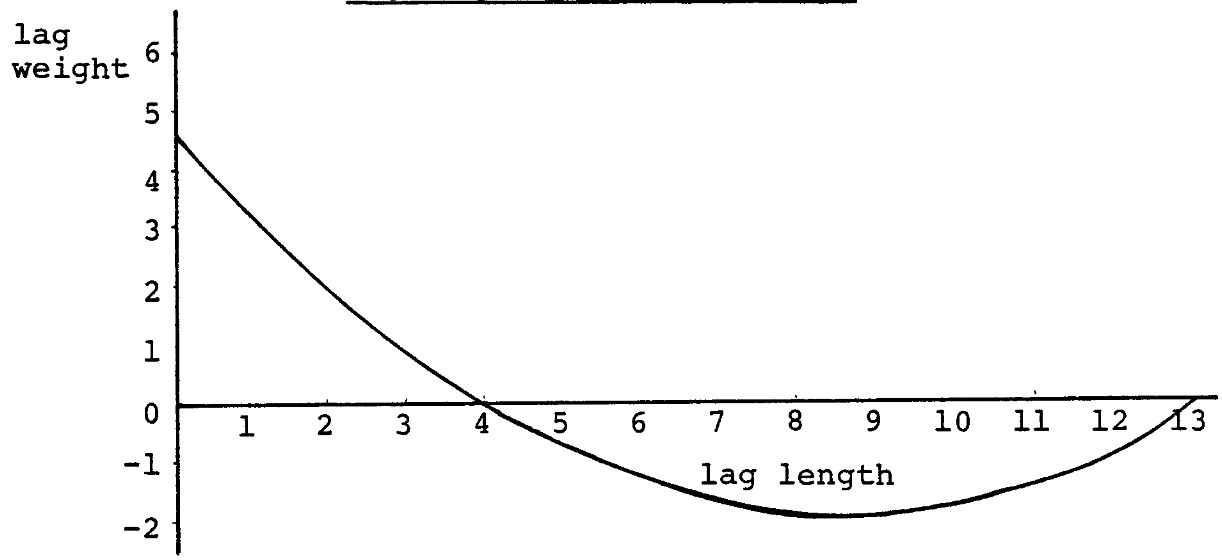
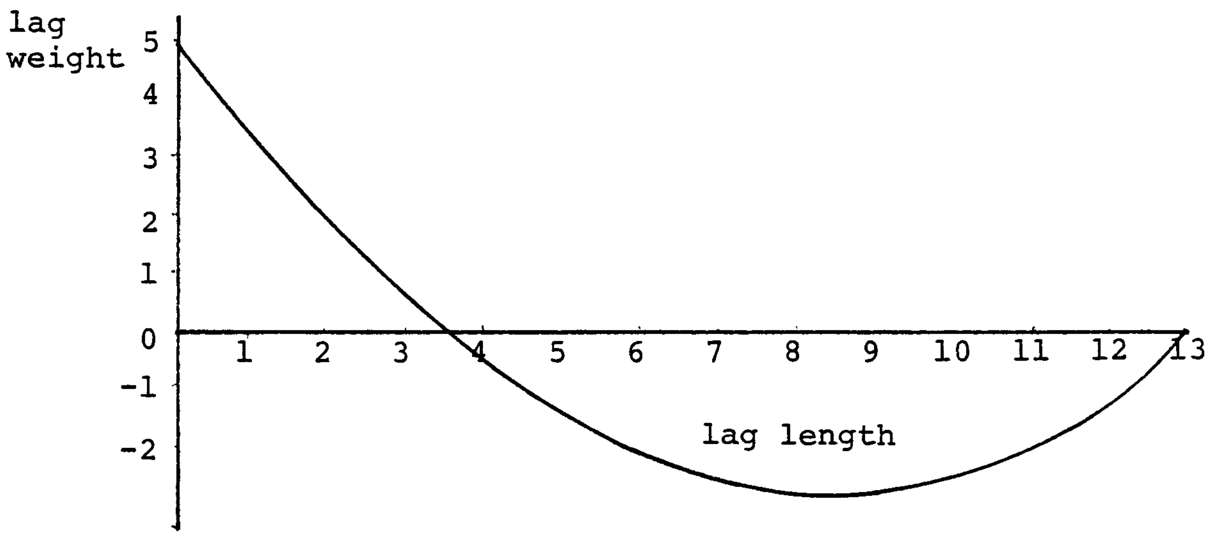


Figure 4b

Lag on business investment times $|\Delta BR_t|$



four periods, for this equation, but it would involve two other problems. First, r^2 would not be maximized and secondly the length of lag in the business loans equation would then be very different.

As noted with the rate on non-chequing savings deposits equation, it is also desirable to estimate the prime rate equation by non-linear least squares. The reasons are the same as were given for estimating the rate on non-chequing savings deposits equation by non-linear least squares. The major problem is that a_{BL} and b_{BL} are over-identified. In equation (4-5-3) two values for $a_{BL,}$ 0. and 0.18, and two values for $b_{BL,}$ 0. and 0. , were obtained. It would thus be desirable to obtain single point estimates of these coefficients so that strong tests of significance would be performed. Thus equation (4-8) can be rewritten in the following way:

$$
\begin{aligned}
r_{BLt} = & - ((B1*B2)/2) + (B1/2)\ r_{st} - ((B1*B3)/2)\ r_{FCPt} \\
& - ((B1*B4)/2)\ AL1 - ((B1*B5)/2)\ AL2 + (1 - B1)\ r_{BLt-1} \\
& - ((B6*B2)/2)\ |\Delta BR_t| + (B6/2)\ |\Delta BR_t|\ r_{st} \\
& - ((B6*B3)/2)\ |\Delta BR_t|\ r_{FCPt} - ((B6*B4)/2)\ |\Delta BR_t|\ AL1 \\
& - ((B6*B5)/2)\ |\Delta BR_t|\ AL2 - B6\ |\Delta BR_t|\ r_{BLt-1} \qquad (4\text{-}9)
\end{aligned}
$$

where $B1 = a_{BL}$ $\qquad$ $B4 = \alpha_{Z13}/\alpha_{11}$

$B2 = \alpha_{Z11}/\alpha_{11}$ $\qquad$ $B5 = \alpha_{Z14}/\alpha_{11}$

$B3 = \alpha_{Z12}/\alpha_{11}$ $\qquad$ $B6 = b_{BL}$

The results of estimating equation (4-9) non-linearly are presented in Table 4-7.

Table 4-7

Non-linear Estimation of Prime Rate Equation[19]

r_{BLt}	B1	B2	B3	B4	B5	B6	$\bar{r}^2$	DW
4-7-1	0.14	-0.96	-1.26	688.76	-662.38	0.41	0.989	2.16
	(4.94)	(-1.16)	(-11.44)	(2.17)	(2.11)	(5.50)		

The variables of major interest are B1($= a_{BL}$) and B6($= b_{BL}$) the parameters in the postulated adjustment mechanism. As noted earlier no unique estimate of a_{BL}, could be found when linear estimation techniques were used and two such values, 0.16 and 0.18 were noted. Using non-linear techniques the single estimate determined is 0.14.

[19]Figures in parenthesis are ratios of the value of the coefficient to the asymptotic standard errors.

The coefficient is highly significant at the 95% level of confidence. Similarly the unique estimate of b_{BL} found here is 0.41. It, too, is highly significant at the 95% level of confidence.

As far as the coefficients on the constant term r_{FCPt} (B3), AL1 (B4) and AL2 (B5) are concerned, these would be expected to have the opposite signs to their counterparts in equation (4-5-3). As can be seen from Table 4-7 this is in fact the case, each variable also being significantly different from zero at the 95% level of confidence.

As was done with the results for the rate on non-chequing personal savings deposits, as a check on the reasonableness of the linear estimates, the implied values of the coefficients on the variables which entered equation (4-5-3) can be determined and compared to the non-linear estimates. This is done in Table 4-8.

As can be seen from this table, the regression results using linear techniques appear reasonable, although strong tests of significance cannot be performed on them.

<u>The Estimated Prime Rate Equations, Bank Rate Unadjusted</u>

Finally, as with the rate equation for non-chequing personal savings deposits, in order to test the hypothesis

Table 4-8

Comparison of linear and non-linear estimation results, prime rate

coefficient on \ equation number	4-5-3	4-7-1
constant	0.08	0.07
r_{st}	0.08	0.07
r_{FCPt}	0.11	0.09
AL1	-72.34	-48.21
AL2	72.36	46.36
r_{BLt-1}	0.82	0.86
$\|\Delta BR_t\|$	0.44	0.20
$\|\Delta BR_t\|\ r_{st}$	0.15	0.21
$\|\Delta BR_t\|\ r_{FCPt}$	0.19	0.26
$\|\Delta BR_t\|$ AL1	-102.24	-141.20
$\|\Delta BR_t\|$ AL2	95.76	135.78
$\|\Delta BR_t\|\ r_{BLt-1}$	-0.29	-0.41

that the timing of bank rate changes within any month is important, a second set of equations has been estimated for the prime rate. In Table 4-9 the results obtained when data on the bank rate has not been adjusted are presented.

What is of most interest here is the effect on the adjustment hypothesis and this can be determined by comparing the 'F' statistic obtained by comparing equations (4-9-1) and (4-9-2) with the 'F' statistic which was obtained comparing equations (4-5-1) and (4-5-2). The 'F' statistic obtained previously was 7.7 whereas when unadjusted bank rate data is used it increases to 10.7. Thus, unlike the previous case, the results do not change dramatically when the unadjusted bank rate is employed. Further, the suggestion is that banks adjust the loan rate more rapidly in response to changes in the bank rate. It was noted earlier that this seemed to be the case.

Conclusions

In this chapter, the theoretical rate-setting equations developed in Chapter 3 were estimated empirically. Both maintained hypotheses, that the deposit rate and the prime rate are set so as to maximize the banking industry's profits and that the banks' adjustment of them is dependent on the bank rate, are consistent with the empirical results. It was also found that the timing of bank rate changes

Table 4-9

Estimated prime rate equations, bank rate unadjusted

r_{BLt}	constant	r_{st}	r_{FCPt}	AL1	AL2	r_{BLt-1}	$\lvert\Delta BR\rvert$ *cons	$\lvert\Delta BR\rvert$ $*r_{st}$	$\lvert\Delta BR\rvert$ $*r_{FCPt}$	$\lvert\Delta BR\rvert$ *AL1	$\lvert\Delta BR\rvert$ *AL2	$\lvert\Delta BR\rvert$ $*r_{BLt-1}$	$\bar{r}^2$	Durbin h-statistic
4-9-1	.04	.06	.11	-226.97	229.17	.82	-.04	.34	.10	-111.90	80.91	-.18		
	(.24)	(1.43)	(4.63)	(-3.91)	(3.98)	(30.87)	(-.06)	(2.40)	(1.29)	(-.98)	(.71)	(-1.89)	.992	-1.76
4-9-2	.12	.06	.17	-264.46	264.43	.77								
	(.61)	(1.37)	(6.28)	(-3.93)	(3.97)	(27.06)							.986	-.92
4-9-3	.15	.04	.12	-56.96	59.00	.82	.06	.37	.15	-126.40	103.85	-.32		
	(.90)	(.98)	(5.00)	(-1.72)	(1.81)	(29.28)	(.10)	(2.55)	(1.86)	(-1.06)	(1.87)	(-3.46)	.990	-.76
4-9-4	.21	.09	.18	-79.57	78.72	.74								
	(1.08)	(2.03)	(6.59)	(-2.14)	(2.15)	(24.93)							.984	1.20

r_{BLt}	constant	r_{st}	r_{FCPt}	AL1	AL2	r_{BLt-1}	BR	$\bar{r}^2$	Durbin-h statistic
4-9-5	.32	.005	.17	-265.39	267.09	.73	.06		
	(1.29)	(.08)	(6.43)	(-3.96)	(4.02)	(17.95)	(1.29)	.987	-.40
4-9-6	.36	.05	.18	-83.28	83.65	.71	.05		
	(1.47)	(.74)	(6.66)	(-2.23)	(2.26)	(16.49)	(1.00)	.984	1.68

within a month is of importance, particularly in the case of the rate on non-chequing personal savings deposits. The original hypothesis that the bank rate affects this rate would have been rejected if the timing of changes in the bank rate had not been taken into account.

CHAPTER 5 -- TESTING THE SIGNIFICANCE OF THE IDENTIFICATION PROBLEM

As noted in the first chapter, unless the rate-setting behaviour of chartered banks is taken into account when estimating demand functions for deposits or loans, the estimated coefficients may not reflect the true values of the effects of the independent variables. The solution to the problem requires two steps. First, it is necessary to formulate a theory of rate-setting behaviour to allow estimation of a rate-setting equation; and secondly, it is necessary to use the estimated rate equations in the estimation of the demand equations. The effects of an exogenous shock on rates could then be determined from the reduced-form rate equation. To determine the empirical significance of the simultaneity problem, both a demand for non-chequing personal savings deposits equation and a demand for business loans equation were estimated. Initially, we present estimates in which no account was taken of banks' rate-setting behaviour. Subsequently, we present two-stage estimates which do account for the endogenous rate-setting behaviour. The magnitude by which the results differ gives some indication of how important empirically the identification problem is.

The Demand for Non-chequing Personal Savings Deposits

The demand for non-chequing personal savings deposits equation was assumed to take the following form:

$$D^2_{21t} = \alpha_{51} \, r_{NCSt} + \alpha_{Z4} \, Z_4 \qquad \alpha_{51} > 0 \tag{5-1}$$

where $Z_4 = (\text{constant}, W_t, r_{TNCSt}, r_{CDt}, D^2_{21t-1})$

The variables are defined in exactly the same way as they were in the deposit rate equations, all non-rate variables being in real terms. An increase in wealth would be expected to be allocated across several kinds of assets, including non-chequing personal savings deposits. This variable would be expected to enter the deposits equation with a positive sign. Two of the closest competitors for these funds would be trust company non-chequing savings deposits and bank certificates of deposit. The rates on these two variables would thus be expected to enter the demand for non-chequing personal savings deposits equation with negative signs. Finally lagged non-chequing personal savings deposits would be expected to enter the equation with a positive sign. This is the prediction of simple partial adjustment models.

Empirical estimates of this equation are presented in Table 5-1. Because of the high degree of collinearity

Table 5-1
Empirical estimates of Non-chequing Personal Savings Deposits Equations

$NCSD_t$	constant	r_{NCSt}	r_{CDt}	D^2_{21t-1}	$\bar{r}^2$	Durbin h-statistic	rho
5-1-1	.0013 (1.25)	.0011 (5.83)	-.0013 (-4.90)	1.01 (185.50)	.998	4.00	
5-1-2	.0016 (1.09)	.0011 (4.20)	-.0014 (-3.58)	1.01 (127.22)	.995	0.26	.388
5-1-3	.0020 (1.94)	.0013 (6.74)	-.0017 (-5.80)	1.01 (183.25)	.998	4.17	
5-1-4	.0026 (1.66)	.0014 (4.55)	-.0018 (-4.03)	1.01 (117.73)	.998	0.16	.409

between wealth and lagged non-chequing personal savings deposits it was decided not to include both of these variables. After experimenting with dropping each variable from the equation it was decided to include only lagged non-chequing personal savings deposits.[1] Similarly, because of the high degree of collinearity between the rate on chartered bank certificates of deposit and the rate on trust company non-chequing deposits, it was decided to drop one of these variables. After some experimentation it was decided to drop the trust company rate.

In equation (5-1-1) estimation was carried out without taking into account banks' rate-setting behaviour (by O.L.S.) or the simultaneous nature of the determination of rates and deposits. All of the variables enter the

---

[1]When both wealth and lagged non-chequing personal savings deposits were included in the equation, wealth entered with a coefficient of 1.41 and a 't' statistic of 0.34. The coefficients and 't' statistics on r_{NCSt} and r_{CDt} were largely unchanged from equation (5-1-1) while the coefficient on D^2_{21t-1} was unchanged, although its 't' statistic was reduced to 52.2. The coefficient of determination adjusted for degrees of freedom was the same as equation (5-1-1). When lagged non-chequing personal savings deposits was left out of the equation the coefficient on wealth was 208.97 with a 't' statistic of 32.2. $\bar{r}^2$ fell to 0.932 while the Durbin-Watson statistic was 0.06, indicating the possibility of missing variables. White (1976b) encountered a similar problem.

equation with the correct signs and are significant at the 95% level of confidence. The fact that the lagged dependent variable enters the equation with a coefficient greater than unity is due to the collinearity between it and wealth.[2] $\bar{r}^2$ is extremely high. The Durbin h-statistic indicates that the hypothesis of zero autocorrelation must be rejected at the 95% level of confidence. This must, therefore, be corrected for, since the presence of a lagged dependent variable in the equation means the estimates of the coefficients will be both biased and inconsistent if autocorrelation is present.

---

[2] If desired non-chequing personal savings deposits, D^{2*}_{21t}, are a function of the rate on non-chequing personal savings deposits, the rate on chartered bank certificates of deposit and wealth and if this function is linear, i.e.,

$$D^{2*}_{21t} = B_1 + B_2\, r_{NCSt} + B_3\, r_{CDt} + B_4\, W_t$$

and if W_t and D^*_{21t-1} are highly collinear, D^*_{21t-1} could be used as a proxy for W_t, i.e.,

$$D^{2*}_{21t} = B_1 + B_2\, r_{NCSt} + B_3\, r_{CDt} + B_4\, D^*_{21t-1}$$

Substituting this equation into a sumple partial adjustment framework one obtains

$$D^2_{21t} - D^2_{21t-1} = \lambda(D^{2*}_{21t} - D_{21t-1})$$
$$= \lambda(B_1 + B_2\, r_{NCSt} + B_3\, r_{CDt} + B_4\, D^*_{21t-1})$$

or

$$D^2_{21t} = \lambda B_1 + \lambda B_2\, r_{NCSt} + \lambda B_3\, r_{CDt} + (1-\lambda + B_4)\, D^*_{21t-1}$$

Thus if B_4 is larger than λ the coefficient on D^2_{21t-1} will be greater than unity.

In equation (5-1-2), the demand for non-chequing personal savings deposits equation is estimated by ordinary least squares but adjusted for autocorrelation using the Hildreth-Lu procedure.[3] The values of the coefficients change very little while the estimated rho is 0.39.

In equation (5-1-3), the demand for non-chequing personal savings deposits equation is estimated taking into account bank's rate-setting behaviour and the simultaneous nature of the determination of the demand for deposits and deposit rate equations. The fitted values obtained from equation (4-1-3), were used as an instrumental variable in equation (5-1-1), to replace the actual values of the rate on non-chequing personal savings deposits. As can be seen from the results this has a marked effect on the empirical estimates, especially on the coefficients of the rate variables. The coefficient on r_{CDt} has increased by almost 25% from -0.0013 to -0.0017 and is even more significant at the 95% level of confidence. A slightly smaller change occurs with the coefficient on r_{NCSt}. The coefficient on r_{NCSt} increased by almost 20% from 0.0011 to 0.0013. However, the Durbin h-statistic indicates that the hypothesis of

---

[3]The value of $\bar{r}^2$ in this equation relates to the transformed dependent variable.

zero autocorrelation cannot be accepted at the 95% level of confidence. This must, therefore, be corrected.

Such a correction has been made in equation (5-1-4). Because of the simultaneous determination of the rate on deposits and the demand for deposits instrumental variables must still be used, combined with a technique to correct for autocorrelation. This technique has been developed by Fair.[4] Because of the presence of a lagged dependent variable, consistent estimates of the coefficients require that the set of instrumental variables include all the following: the exogenous variables from the O.L.S. estimation, these variables lagged once, the included endogenous variable from the O.L.S. estimation lagged once, and lagged value of the dependent variable. The rate on non-chequing personal savings deposits is regressed on this set of instrumental variables, providing a set of fitted values for that rate. The demand for non-chequing personal savings deposits is then regressed on the fitted values of the rate on deposits and the included exogenous variables. A value for ρ is calculated from the residuals of this regression and all of the data are transformed by ρ. A two-stage lesst squares estimation is performed again on the transformed equation and this process is

---

[4]Fair (1970).

repeated until ρ converges to a constant value. The results of this procedure are presented in equation (5-1-4). The coefficients here on the rate variables are markedly different from equation (5-1-1). The coefficient on the rate on non-chequing personal savings deposits is 0.0014, an increase of over 25% from its value in equation (5-1-1). Similarly the coefficient on the rate on bank certificates of deposit has increased by almost 40% from -0.0013 to -0.0018. The value of rho in this equation is 0.409. In summary then, the bias in the O.L.S. regression could be of the order of 25% in the case of the own elasticity and perhaps more in the case of the cross elasticity.

<u>The Demand for Business Loans</u>

The demand for business loans equation was assumed to take the following form:

$$BL_t = \alpha_{11}\, r_{BLt} + \alpha_{Z1}\, Z_1 \qquad \alpha_{11} < 0 \tag{5-2}$$

where Z_1 = (constant, r_{FCPt}, BI_t, ... , BI_{t-K})

All of the variables are defined as they were in the prime rate equations except for business loans which did not appear as a variable in the prime rate equation. This variable is represented by the end of period total business loans outstanding, (B1401). All non-rate variables are in real terms. It would be expected that the lag weights on business investment would be positive and, at some stage, decline towards zero as the length of the lag increases. Since finance company paper is a substitute source of financing for bank loans, the coefficient on this rate would be expected to be positive.

Empirical estimates of equation (5-2) are presented in Table 5-2. In equation (5-2-1) the equation was estimated without taking into account bank's rate-setting behaviour or the simultaneous nature of the determination of the demand for loans and the rate on loans. Ordinary least squares was used. Excluding the lags, all of the variables entered the equation with the correct sign and were significant at the 95% level of confidence. As far as the distributed lag on business investment is concerned, a second degree polynomial with the length of the lag being thirteen was chosen on the basis of maximizing $\bar{r}^2$. In Table 5-3 the distributed lag on business investment is interpreted. It can be seen that all the lag weights are positive and that they eventually decline towards zero. In Figure 5 this lag structure is represented diagrammatically. The $\bar{r}^2$ for the equation is extremely high while the low Durbin-Watson statistic indicates the presence of autocorrelation.

In equation (5-2-2), the demand for business loans equation is estimated by ordinary least squares but adjusted

Table 5-2
Empirical estimates of Business Loans Equations

BL_t	constant	r_{BLt}	r_{FCPt}	A1	A2	$\bar{r}^2$	DW	rho
5-2-1	-.03 (-9.58)	-.006 (-8.49)	.003 (6.42)	10.79 (8.31)	-7.13 (-5.51)	.989	.33	
5-2-2	-.03 (-3.40)	-.002 (-3.08)	.001 (3.33)	7.25 (4.47)	-3.79 (-2.37)	.789	2.14	.929
5-2-3	-.03 (-9.33)	-.006 (-8.47)	.004 (6.49)	10.86 (8.35)	-7.20 (-5.55)	.989	.34	
5-2-4	-.03 (-2.68)	-.003 (-2.53)	.001 (3.14)	7.35 (4.33)	-3.85 (-2.33)	.998	2.17	.921

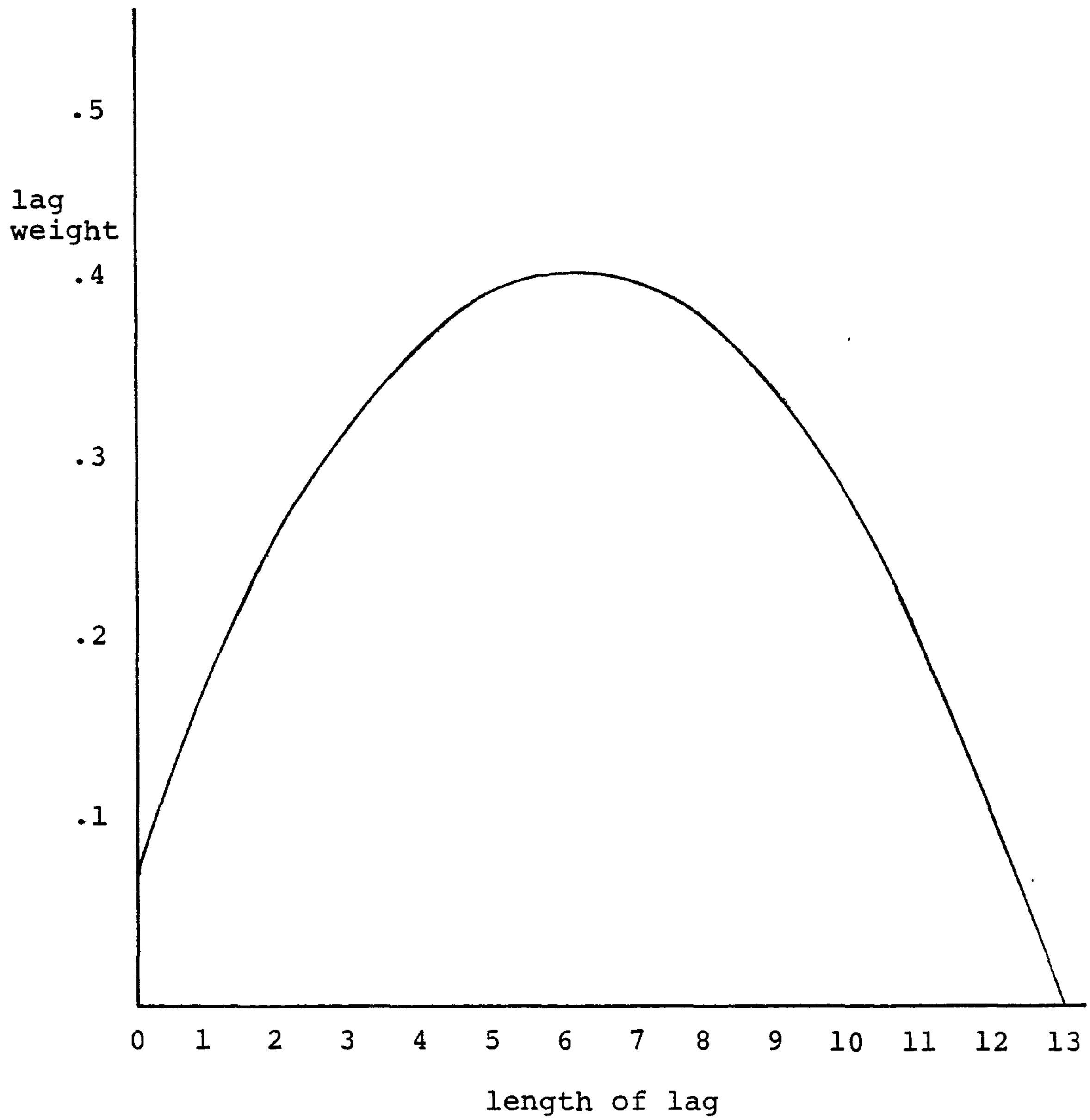
Table 5-3

Interpretation of lag weights on business investment in equation (5-2-1)

Length of Lag	Lag Weight
0	0.07
1	0.17
2	0.25
3	0.31
4	0.36
5	0.39
6	0.40
7	0.40
8	0.38
9	0.33
10	0.28
11	0.20
12	0.11
13	0

Figure 5

Diagrammatic representation of lag weights on business investment in equation (5-2-1)



for autocorrelation using the Hildreth-Lu procedure.[5] As can be seen there are some very large changes in the values of the coefficients. The coefficients on the prime rate and the rate on finance company paper both decrease in magnitude to a third of their original size. The Durbin-Watson statistic is now 2.14 and the estimated rho is 0.93.

In equation (5-2-3), the demand for business loans equation is estimated, taking into account bank's rate-setting behaviour and the simultaneous nature of the determination of the demand for loans and the rate on loans. The fitted values obtained from equation (4-5-3) were used as an instrumental variable in equation (5-2-1) to replace the actual values of the rate on business loans. As can be seen from the results this makes no difference to the coefficient on the prime rate, although the coefficient on the rate on finance company paper increases in magnitude by 25%. However, from the Durbin-Watson statistic it can be seen that autocorrelation is present and it must be corrected.

The procedure used in the demand for deposits equation to combine the correction for autocorrelation with

---

[5] Again the value of $\bar{r}^2$ in this equation relates to the transformed dependent variable. This is the reason for its marked fall in value.

instrumental variables estimation was again used here. There was a modification of the instrumental variables used at the first stage of the estimation procedure to take account of the fact that there is no lagged dependent variable in the demand for loans equation. The results obtained from using this technique can be seen in Table 5-2, equation (5-2-4). As can be seen there has been a marked change in all of the coefficients compared to equation (5-2-1). The value of the coefficient on the prime rate has fallen by 50%, and its 't' statistic has fallen by an even greater magnitude. The value of the coefficient on the rate on finance company paper has fallen by two-thirds and its 't' statistic is less than half its original value. The coefficient of first-order autocorrelation, rho, is 0.92.

Conclusions

In this chapter an evaluation was made of the empirical significance of the identification problem which can arise due to not considering banks' rate-setting behaviour when estimating demand functions for deposits and loans. It was found that in both the cases of non-chequing personal savings deposits and business loans, taking into account banks' rate-setting behaviour had a sizeable effect on the estimated coefficients in the demand function for deposits and loans. In the case of deposits, considering chartered bank rate-setting behaviour led to an almost 20% increase in the coefficient on r_{NCSt} and an almost 25% increase in the coefficient on r_{CDt}. With a correction for autocorrelation in addition these changes became over 25% and almost 40% respectively. In the case of loans, taking into account chartered bank rate-setting behaviour led to an increase in the coefficient on the rate on finance company paper of 25%. With a correction for autocorrelation also the value of the coefficient on the prime loan rate fell to half its original value while the coefficient on the rate on finance company paper fell to one-third of its original value. Compared to just considering autocorrelation, taking into account chartered bank rate-setting behaviour led to an increase of 50% in the coefficient on the prime loan rate. Thus, in the case of both the demand equations for non-chequing personal savings deposits, and business loans, the identification problem is important empirically and the techniques used to estimate these equations should be appropriately chosen.

CHAPTER 6 -- CONCLUSIONS

In this thesis deposit and loan rate-setting equations for chartered banks have been derived on the premise that those rates are set so as to maximize the banking industry's profits. Banks are among the most profitable firms in the Canadian economy and deposits make up the major part of their liabilities, while loans are the largest single item on the asset side of their balance sheet. Since the quantities of both deposits and loans are usually assumed to be demand determined, setting the rates on them is the major way banks can affect their profitability. This aspect of chartered bank behaviour has, however, been relatively neglected in the literature. The emphasis there has usually been on the direct management of asset stocks. Generally no rate equations are estimated, and when they are they have no theoretical basis to them. Optimizing models of financial intermediary rate-setting behaviour that do exist have not been applied to chartered banks. From the point of view of having a more complete knowledge of one of the most important institutions in the economy, the banking industry, this rate-setting behaviour was analysed in detail.

Chartered bank rate-setting behaviour is also very important for the correct implementation of monetary policy. As noted earlier, the monetary authorities will try to affect the availability or terms of credit. Since there have not been any concerted attempts at credit rationing in recent years, and since most loan rates are set on a 'prime plus' basis, this aspect of monetary policy must be directed towards affecting the prime rate on loans. To be able to do this successfully the monetary authorities must have an accurate idea as to what the determinants of this rate are and, in particular, how it is affected by their policy instruments. The two policy instruments of major concern are open market operations, in which the quantities of and rates on securities are manipulated, and the bank rate. If the monetary authorities believe that, say, Clinton and Masson's specification of the prime rate equation is essentially correct, then the conclusion that must be drawn is that open market operations will have no direct effect on the prime rate while changes in the bank rate will have a direct effect. The advantages of the specification developed in this thesis are twofold. First, the rate on securities appears as one of the determinants of banks' desired prime rate, and thus the way in which changes in the monetary base would be expected to affect the prime rate is developed. Secondly, the way in which the bank rate affects the prime rate, by acting as a signal to chartered banks to change their loan rates, appears reasonable.

Another avenue of monetary policy is for the Bank of Canada to effect changes in the money supply either directly or via the interest rate on deposits. These two policy instruments are not independent, and the dependence stems from the fact that the quantity of deposits, which makes up the largest portion of the money supply, is sensitive to the rate of interest offered by banks on these deposits. Suppose that the monetary authorities want to fix the money supply at a certain level. It has two alternatives. First, via its control of high powered money, it can set the level of money supply directly at that level. Alternatively it could try to effect a rate on non-chequing personal savings deposits equal to the rate which would generate a quantity of deposits compatible with the desired level of the money supply. How could the monetary authorities in fact effect such a rate? Again, it would first need to know what the determinants of the rate were and the relationship between the rate and the policy instruments under its control, open market operations and the bank rate. As with the specification of the prime rate, there are two advantages of the specification used in this thesis compared to that of, say, Clinton and Masson. The first is that the links between open market operations and the deposit rate are developed, and secondly that the way the Bank Rate enters the equation is reasonable. Further the explanatory power of the equation is also greater.

The major point with respect to monetary policy is, therefore, that the ways in which monetary policy is transmitted, particularly to market interest rates, must be developed in much more detail than it has been in the past if the monetary authorities are going to make correct decisions. The relationships between the policy instruments under the control of the monetary authorities and the target variables must be developed in detail. In this thesis it has been shown that the monetary authorities can affect both the prime rate on loans and the rate on non-chequing personal savings deposits via open market operations since the rate on securities is a determinant of the chartered banks' desired levels of each of these rates. Also it has been shown that the Bank Rate may be a much more effective instrument of monetary policy than generally recognized since it directly affects both the loan and deposit rates.

Because of the oligopolistic nature of the Canadian banking industry and because explicit collusion is illegal, the assumption that the rates on loans and deposits are set so as to maximize the industry's profits must be justified.

In this thesis an optimizing model of chartered bank rate-setting behaviour was integrated into the institutional framework of the Canadian banking industry. To do this a two-stage model of the Canadian banking industry was developed. At the first stage of this model certain rates, and in particular the prime rate on loans and the rate on non-chequing personal savings deposits, are set so as to maximize the collective profits of the industry. To circumvent the illegality of explicit collusion a price leadership model is developed. In this model, however, it is not one of the individual banks which is the price leader but rather changes in the bank rate act as a signal for all of the individual banks to change their rates. The speed of adjustment at which the banks would change their rates was postulated to be a function of changes in the bank rate. This formulation was tested and the hypothesis accepted in the case of both the prime rate and the deposit rate.

The second stage of this two-stage model is concerned with both asset and liability management and is not developed in this thesis. Since deposit and loan flows are stochastic, banks must maintain enough reserve capacity so they can meet any new loan demands or which can be used to invest any new deposits that are not loaned out. Previous studies which have concentrated on asset management are, thus, not inconsistent with the model developed here.

It is to be noted, however, that since deposit and loan flows may vary widely between individual banks, asset and liability management is best looked at from the point of view of individual banks. Any study which aggregates over banks will necessarily lose a lot of information.

As was noted earlier in this chapter, the monetary authority's policy with respect to directly determining the level of the money supply is not independent of its interest rate policy since the quantity of deposits is responsive to the interest rate offered on them. It is extremely important, however, from the point of view of monetary policy to have reliable estimates of the parameters in these demand functions. Not taking into account these problems could, for example, lead to the mistaken belief that the demand function for deposits has a certain slope, when it in fact has a different slope. This can lead to some problems in the application of monetary policy. For example, if the monetary authorities aim to set a certain interest rate based on the assumption that the interest elasticity of demand is a certain value, then an X percent error in this value will result in missing the target rate of growth of the money supply by X percent.

When demand functions for deposits and loans were considered two problems were seen to arise. The first is that, due to the nature of deposit markets, some rates would tend to change simultaneously. Thus an increase in the rate on trust company non-chequing personal savings deposits would create an incentive for banks to increase the rate they offer on deposits rather than lose deposits to trust companies. Since both of these rates change simultaneously and since both would be independent variables in the demand function for bank non-chequing personal savings deposits, it would be impossible to identify the partial effect of either variable on the quantity of deposits. The second problem is simply the simultaneous nature of the determination of the rates on the quantities of loans and deposits. The two factors just noted make the estimation of demand functions for deposits and loans problematic.

It was shown that to be able to identify the partial effects of all the independent variables in the demand functions for loans and deposits, it is first necessary to estimate rate-setting equations for loans and deposits. This will mean that the partial effect of, say, a change in the rate on trust company non-chequing personal savings deposits on the bank deposit rate can be determined. Because of the simultaneity between rates and quantities it is not sufficient to proceed to estimate demand function by ordinary least squares. Rather, two-stage least squares must be used, with the reduced-form of the rate-setting equations being used at the first stage.

When this estimation procedure was followed it was found that there were large changes in the values of the estimated coefficients in the demand functions for loans and deposits, compared to the simple ordinary least squares estimates of these parameters. For example, the magnitude of the difference in the deposits equation was in the order of twenty-five percent. If such an error existed in the equations explaining all of the components of the money supply, the monetary authorities might miss their target rate of growth of the money supply by twenty-five percent. Taking account of bank rate-setting behaviour is thus very important from the point of view of the correct application of monetary policy.

Suggestions for Further Work

There are two groups of suggestions for further work. The first of these is that alternative models could be used to derive the rate equations. There are two parts to the derivation of the rate equations - the determination of desired rates and the adjustment mechanism. A more complete study needs to be done on all of the components of the theory.

The second group of suggestions for further work lies in the specification of the demand functions for deposits and loans. Many different formulations have been used in the literature and it should be determined whether these specifications affect the conclusions reached here. In particular other non-linear forms of the demand functions could be estimated.

Finally, the demand and rate equations could be estimated simultaneously with cross equation restrictions.

BIBLIOGRAPHY

Almon, S. "The Distributed Lag Between Capital Appropriations and Expenditures." Econometrica, XXX (January, 1965), 178-196.

Bank of Canada Review: Monthly, Ottawa, Bank of Canada, 1969-77.

Bank of Canada. Annual Report of the Governor to the Minister of Finance and Statements of Accounts. Ottawa, Bank of Canada, 1975.

Brainard, W.C. and Tobin, J. "Pitfalls in Financial Model Building." American Economic Review, (May, 1968), 92-122.

Cameron, N. "The Stability of Canadian Demand for Money Functions." Canadian Journal of Economics, (May, 1979), 258-281.

Canadian Bankers Association. Factbook-Chartered Banks of Canada, Factbook 1975. Toronto, 1975.

Supplement to the Canada Gazette. "Chartered Banks of Canada Statement of Assets and Liabilities." Ottawa: Queen's Printer.

Clark, C. "The Demand for Money Results and the Choice of a Permanent Income Estimate: Some Canadian Evidence, 1926-65." Journal of Money, Credit and Banking, (1973).

Clinton, K. "The Demand for Money in Canada, 1955-70: Some Single-Equation Estimates and Stability Tests." Canadian Journal of Economics, (February, 1973), 53-61.

Clinton, K. and Masson, P. A Monthly Model of the Canadian Financial Sector. Ottawa, Bank of Canada, August, 1975. (Bank of Canada Technical Report, No. 4).

Courchene, T.J. Money, Inflation, and the Bank of Canada. An Analysis of Canadian Monetary Policy from 1970 to Early 1975. Montreal: C.D. Howe Research Institute, 1976.

Courchene, T.J. Monetarism and Controls: The Inflation Fighters. Montreal: C.D. Howe Research Institute, 1976.

Courchene, T.J. and Kelly, A.K. "Money Supply and Money Demand: An Econometric Analysis for Canada." Journal of Money, Credit and Banking. (May, 1971), 219-244.

Crosse, H.D. and Hempel, G.H. Management Policies for Commercial Banks. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1973.

Dingle, J.F., Sparks, G.R. and Walker, M.A. "Monetary Policy and the Adjustment of Chartered Bank Assets." Canadian Journal of Economics, (November, 1972), 494-514.

Fair, R.C. "The Estimation of Simultaneous Equation Models with Lagged Endogenous Variables and First Order Serially Correlated Errors." Econometrica, XXXVIII (May, 1970), 507-516.

Foot, D.K. "The Demand for Money in Canada: Some Additional Evidence." Canadian Journal of Economics, (August, 1977), 475-485.

Freedman, C. The Foreign Currency Business of Canadian Banks: An Econometric Study. Ottawa, The Bank of Canada, 1974. (Bank of Canada Staff Research Studies, No. 10).

Freedman, C., Longworth, D. and Masson, P. The Role of U.S. Interest Rates in Canadian Interest Rate Equations: An Exploratory Analysis. Ottawa, The Bank of Canada. (Bank of Canada Technical Report, No. 9).

Galbraith, J.A. Canadian Banking. Toronto: 1970.

Gorbet, F.W. and Helliwell, J.F. The Equations of RDX2 Revised and Estimated to the Fourth Quarter of 1970. Ottawa, The Bank of Canada, 1973.

Gramlich, E.M. and Hulett, D.T. "The Demand and Supply of Savings Deposits." In Savings Deposits, Mortgages and Housing. Edited by E.M. Gramlich and D.M. Jaffee. Toronto: D.C. Heath Canada Ltd., 1972.

Helliwell, J.F., Officer, L.H., Shapiro, H.T. and Stewart, I.A. The Structure of RDX1. Ottawa, Bank of Canada, 1969. (Bank of Canada Staff Research Studies, No. 5).

Helliwell, J.F., Officer, L.H., Shapiro, H.T. and Stewart, I.A. The Structure of RDX2: Parts 1 and 2. Ottawa, Bank of Canada, 1971. (Bank of Canada Staff Research Studies, No. 7).

Jaffee, D.M. Credit Rationing and the Commercial Loan Market. An Econometric Study of the Structure of the Commercial Loan Market. New York: John Wiley and Sons, Inc., 1971.

Kirkham, P.G. "The Portfolio Behaviour of Selected Canadian Financial Institutions: An Econometric Analysis." Unpublished Ph.D. Dissertation, Princeton University, 1970.

Lafrance, R. "Bank Pricing and Portfolio Allocation: An Econometric Study of Canadian Banks 1961-73." University of Montreal, 1979a (Working Paper No. 7906).

Lafrance, R. "A Disequilibrium Model of Bank Pricing and Portfolio Allocation: Canadian Banks 1961-73." University of Montreal, 1979b (Working Paper No. 7909).

Laumas, G.S. and Formuzis, P.A. "The Demand for Money in Canada." Canadian Journal of Economics, I (August, 1968), 640-644.

Maxwell, T., Helliwell, J. and Aubry, J. The Equations of RDX2 Revised and Re-estimated to the Second Quarter of 1972. Ottawa, Bank of Canada, 1976. (Bank of Canada Staff Research Studies, No. 13).

Miles, P.L. "Assets and Liabilities of Chartered Banks: An Econometric Analysis." Unpublished Ph.D. Dissertation, McGill University, 1968.

Orr, D. "The Economic Determinants of Entry into Canadian Banking: 1963-67." Canadian Journal of Economics, VII (February, 1974), 82-101.

Pattison, J.C. "An Econometric Analysis of Asset Selection by Individual Canadian Banks, 1967-78." Unpublished Ph.D. Dissertation, University of London, 1972.

Poloz, S.S. "Simultaneity and the Demand for Money in Canada." University of Western Ontario, 1979. (Research Report No. 7920).

Shapiro, A.A. "The Demand for Liquid Assets by Canadian Manufacturing Corporations." Canadian Journal of Economics, (February, 1972), 140-144.

Shapiro, H.T. "The Canadian Monetary Sector: An Econometric Analysis." Unpublished Ph.D. Dissertation, Princeton University, 1964.

Shapiro, H.T. "Distributed Lags, Interest Rate Expectations and the Impact of Monetary Policy: An Econometric Analysis of The Canadian Experience." American Economic Review, Papers and Proceedings, (1968), 444-461.

Slater, D.W. "The 1967 Revision of the Canadian Banking Acts; Part One: An Economist's View." Canadian Journal of Economics, I (February, 1968), 79-91.

Slovin, M.B. "Deposit Rate Setting at Financial Intermediaries: Theoretical Models and Econometric Analysis with Additional Focus on Savings and Loan Associations." Unpublished Ph.D. Dissertation, Princeton University, 1972.

Slovin, M.B. and Sushka, M.E. Interest Rates on Savings Deposits: Theory, Estimation and Policy. Lexington: D.C. Heath of Canada Ltd., 1975.

Smith, L.B. and Winder, J.W.L. "Price and Interests Rate Expectations and the Demand for Money in Canada." Journal of Finance, XXVI (June, 1971) 671-682.

Smith, L.B. and Winder, J.W.L. Statutes of Canada 1966-67. Ottawa: Queen's Printer, 1967.

White, W.R. Management by the Canadian Banks of their Domestic Portfolios, 1956-71: An Econometric Study. Ottawa, Bank of Canada, 1975a (Bank of Canada Staff Research Studies, No. 11).

White, W.R. The Demand for Money in Canada and the Control of Monetary Aggregates: Evidence from Monthly Data. Ottawa, Bank of Canada, 1975b (Bank of Canada Research Studies, No. 12).

White, W.R. and Poloz, S.S. "Monetary Policy and Chartered Bank Demand Functions for Excess Cash Reserves." Canadian Journal of Economics, (May, 1980) 189-205.

Woodworth, G.W. The Management of Cyclical Liquidity of Commercial Banks. Boston: The Bankers Publishing Company, 1967.